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NEW ZEALAND NEUROPTERA

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NEW ZEALAND NEUROPTERA

A POPULAR INTRODUCTION TO THE
LIFE-HISTORIES AND HABITS OF
MAY-FLIES, DRAGON-FLIES, CADDIS-
FLIES AND ALLIED INSECTS INHABIT-
ING NEW ZEALAND + + +
INCLUDING NOTES ON THEIR RELATION
TO ANGLING

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WITH ELEVEN COLOURED PLATES

BY
G. V. HUDSON, F.E.S.

AUTHOR OF "AN ELEMENTARY MANUAL OF NEW ZEALAND
ENTOMOLOGY" AND "NEW ZEALAND MOTHS
AND BUTTERFLIES"

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PREFACE

THE object of this little work is to provide the general reader with a popular account of the habits and life-histories of some of the more important and conspicuous neuropterous insects inhabiting our rivers, streams, and lakes.

For the general notes on the Neuroptera, and for the preliminary remarks on the various families, I am much indebted to Dr. Sharp, from whose volume on "Insects" these portions of the present work have been largely compiled.

The technical and descriptive matter, relating to adult insects, has been obtained from various scattered papers, chiefly by Mr. R. McLachlan. These descriptions have been recently summarised, re-arranged, and re-published by Captain Hutton in volume xxxi. of the Transactions of the New Zealand Institute, and I have very much pleasure in acknowledging the great aid I have received from both of these naturalists.

In addition, I have to express my thanks to many others, who have kindly supplied me with notes on localities, and with other valuable information and material.

G. V. HUDSON.

KARORI. WELLINGTON. NEW ZEALAND, 1903.

INTRODUCTION

THE order Neuroptera, although of small extent, comprises several well-known and beautiful groups of insects, amongst which may be specially mentioned the Termites, Dragon-flies, May-flies, Ant-lions, Lacewing-flies, and Caddis-flies. The habits, structure, and transformations of all these insects are exceedingly varied, so that if somewhat limited, so far as the number of actual species is concerned, the present order cannot be said to be lacking in interest.

The name Neuroptera is derived from the two Greek words, *νευρον*, a nerve, and *πτερον*, a wing, and has reference to the beautiful network with which the wings of most of these insects are ornamented. These nervures, or veins, form a very numerous series of cells, or areolets, and far exceed in number the cells in the wings of any other insects.

The Neuroptera may be briefly defined as follows:—

“Imago with biting mouth; with two pairs of wings, the anterior as well as the posterior membranous, usually with extensive neurulation, consisting of elongate nervures, and either of short cross-nervures forming numerous cells or of a complex mesh-work. (One division, Mallophaga, consists entirely of wingless forms; in the Termitidæ some of the individuals of each generation become winged, but others do not: except in these cases adult wingless forms are few.) The metamorphosis differs in the several divisions” (Sharp).

The order consists of the following eleven families:—

Family 1. Mallophaga (Bird-lice).

„ 2. Embiidæ.

„ 3. Termitidæ (White Ants, Termites).

„ 4. Psocidæ (Book-lice, Death Watches).

„ 5. Perlidæ (Stone-flies).

„ 6. Odonata (Dragon-flies).

„ 7. Ephemeridæ (May-flies).

„ 8. Sialidæ (Alder-flies and Snake-flies).

„ 9. Panorpidæ (Scorpion-flies).

„ 10. Hemerobiidæ (Ant-lions, Lacewing-flies, &c.)

„ 11. Phryganeidæ (Caddis-flies).

These families embrace insects of such diverse structure and habits, that they have been variously grouped by different entomologists, and several of the groups have been constituted distinct orders. The Bird-lice, for instance, are often spoken of as forming the small order Mallophaga, and the Caddis-flies as constituting the order Trichoptera.

The affinities between many of these families and certain groups of insects, belonging to other orders, are very remarkable, and appear to indicate that the Neuroptera are essentially of an archaic and ancestral type; and this idea is borne out by the numerous species of gigantic fossil neuropterous insects which have been recently discovered and described.

As illustrating the actual affinities of certain families of the Neuroptera, to families belonging to other orders of insects, the following examples may be cited: The Termitidæ, or White Ants, are somewhat allied to the Blattidæ, or Cockroaches; the Perlidæ, or Stone-flies, to the Phasmidæ, or Walking-stick Insects; whilst the Trichoptera, or Caddis-flies, are unquestionably very closely allied to the Lepidoptera, being in fact now generally regarded as the nearest living representatives of the ancestors of that extensive and important order of insects.

In the present work only the larger and more generally interesting families of the Neuroptera are dealt with, and even in the families which are described, very much more work remains to be done by future naturalists.

The geographical distribution of the various species in New Zealand is most imperfectly known at present, being based on the somewhat disconnected observations of a few isolated naturalists. The conclusions arrived at under this heading must therefore be regarded as provisional, and, as knowledge increases, subject to revision.

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NEW ZEALAND NEUROPTERA.

Family I.—MALLOPHAGA—BIRD LICE.

Not dealt with in this volume.

Family II.—EMBIIDÆ.

No species belonging to this family have been found in New Zealand at present.

Family III.—TERMITIDÆ *—TERMITES.

“*Each species is social, and consists of winged and wingless individuals. The four wings are, in repose, laid flat on the back so that the upper one only is seen except just at the bases; they are membranous and very elongate, so that they extend far beyond the apex of the abdomen; the hind pair is remarkably similar in size, form, and consistence to the front pair; near the base of each wing there is a suture, or line of weakness, along which the wings can be broken off, the stumps remaining in that case as short, horny flaps reposing on the back. Ligula channelled but not divided into two parts. The wingless individuals are very numerous, and have the head and thirteen body segments distinct; the body is terminated by a pair of short cerci. The metamorphosis is slight and gradual, and in some individuals is dispensed with*” (Sharp).

The *Termitidæ* is probably one of the most remarkable families of insects in existence. Its members are social in their habits, and live together in large communities

* These insects are often popularly known as “white ants,” but the term is an objectionable one as they have no real affinity with the true ants although the members of both groups live in societies. The best popular name for these insects is Termites, pronounced as two syllables.

which, in some of the tropical species, consist of enormous assemblages of individuals. Their nests also attain very large dimensions, and many of them are twenty feet in height, being thus comparable in size to human dwellings.

So far as the New Zealand species are concerned, these peculiar features of the Termites are only exhibited in a very simple manner; hence any extended account of the tropical species would be quite out of place in the present work. Those desiring to learn more of the singular instincts, habits, and structure of these remarkable insects are therefore referred to the Cambridge Natural History, vol. v., p. 356, where Dr. Sharp has given us a most interesting and concise account of all the principal facts at present known regarding the various species of Termites.

Genus CALOTERMES, Hagen (1853).

"Head rather small, triangular or rounded; eyes large, ocelli small; antennæ as long as the head, 16- to 20-jointed. Prothorax as wide, or nearly as wide, as the head, transverse, truncate or arcuate in front, with the sides and apical edge forming a semicircle. Tarsi with plantula. Wings with the subcostal nervure narrow, widening out towards the tip, and connected with the costal by five or six nervules crossing the costal area.

"*Soldiers* short and stout, with a large cylindrical head, flattened in front and rugged or truncated before the jaws.

"*Distribution*.—Warm climates in both hemispheres" (Hutton).*

CALOTERMES BROUNI.

Calotermes brouni, Froggart, Pro. Linn. Soc. of N.S.W., 2nd series, vol. xxi., p. 531, pl. 36, figs. 1, 1a (1897). *C. improbus*, Brauer, Reise der "Novara," Neuroptera, p. 45, not of Hagen.

"General colour dark reddish-brown, with the wings fuscous and the nervures chocolate-brown. Length to tip of wings, 11 mm.; to end of the body, 6 mm. *Soldier* with the head ochreous, more ferruginous towards the jaws; antennæ bright-yellow, with the apices of the joints pale. The rest dull-white. Length, 6 mm. *Worker* with the head pale-yellow, the rest dull-white. Length, 4 mm.

"*Locality*.—Auckland (*Broun*)" (Hutton).*

CALOTERMES INSULARIS.

Termes insularis, Walker, Cat. Neuroptera Brit. Mus., part iii., p. 521 (1853); White, Zool. "Erebus" and

* Transactions of New Zealand Institute, xxxi., pp. 208-249. This reference holds good in the case of all quotations from Captain Hutton given in this work.

"Terror," Insects, pl. 7, fig. 11 (1874). *Calotermes insularis*, Hagen, Cat. Termitina in Brit. Mus., p. 6 (1858); Froggart, Pro. Linn. Soc. of N.S.W., 2nd series, vol. xxi., p. 524, pl. xxxv., fig 4 (1897).

"General colour bright ferruginous; wings hyaline, nervures light brownish-yellow. Length to tip of wing, 23 mm.; to end of the body, 5 mm.; expanse of wings, 38-43 mm. The wings are much longer than in the last species.

"Localities.—New Zealand (British Museum) and Victoria.

"The type specimens were collected in New Zealand by Dr. Sinclair, but it does not appear to have been taken again by Captain Broun. Mr. Froggart has determined one specimen from the Melbourne Museum with it on account of the very long wings. Walker, in his description of the types, says that the wings are nearly twice the length of the body; and he gives the dimensions as length of the body $3\frac{1}{2}$ lines (8 mm.), expanse of the wings 19 lines (41 mm.)."

Genus STOLOTERMES, Hagen (1858).

"Head large, circular; eyes oval, small, with coarse facets; ocelli present; antennæ 12- to 14-jointed. Prothorax heart-shaped. Tarsi without plantula; the first joint as long as those following. Neuration of the wings as in *Calotermes*.

"Distribution.—Tasmania and New Zealand" (Hutton).

STOLOTERMES RUFICEPS.

Stolotermes ruficeps, Brauer, Reise der "Novara," Neuroptera, p. 46 (1868); Froggart, Pro. Linn. Soc. of N.S.W., 2nd series, vol. xxi., p. 538, pl. 36, figs. 2, 2a.

(Plate I., fig. 1, fig. 2 soldier, fig. 3 larva, all magnified.)

This species has occurred at Auckland and at Wellington.

The expansion of the wings is about 1 inch, and the length of the body about $\frac{1}{4}$ inch. The general colour of the body is dark reddish-brown. The wings are clouded with blackish-brown with beautiful green reflections.

The full-grown larva is about $\frac{5}{16}$ inch in length. The general colour is dull yellowish-white, with the mandibles and eyes dark brown. The head is rather large and round; the wing-pads are large, the intestinal canal is indicated by a brownish shading in the middle of the body. The soldier is barely $\frac{3}{8}$ inch in length. The head is large, oval, bright yellow, becoming bright brown towards the mouth; the jaws very large bright brown with the tips black. The rest of the body resembles that of the larva, except that there are no wing-pads.

This species inhabits partially decayed logs, excavating extensive burrows within. In habits it seems to closely resemble the European *Calotermes flavicollis*. The males and females appear in the winged state from January until May. They are seldom seen flying about, but

occasionally occur in large numbers in the nests within the logs. After a couple of these winged insects have paired, each of them sheds its wings, and the female subsequently becomes very much distended with eggs. At this time she is generally situated near the central portion of the nest, and there are often several soldiers in her immediate vicinity. As a rule, however, there are only a few soldiers in any single nest, these individuals being sometimes altogether absent. The soldier of *S. ruficeps* is undoubtedly an adult form; but the worker seems to be nothing more than a larva, which will subsequently develop into a winged male or female. The New Zealand termites have not yet been closely studied, and, no doubt, there are many other interesting facts to be ascertained respecting them.

Family IV.—PSOCIDÆ—BOOK LICE.

Not dealt with in this volume.

Family V.—PERLIDÆ—STONE-FLIES.

"Insects of moderate or large size, furnished with four membranous wings; these are usually complexly reticulate; the hind pair are much the larger, and have a large anal area of more simple venation, which becomes plicate when folded. The coxæ are small, the legs widely separated. The larvæ are aquatic in habits, the metamorphosis is slight" (Sharp).

This family is represented in New Zealand by three described species of fairly large size. There are, however, several smaller species, with which I am acquainted, that are at present undescribed; and it is probable that when our insects are better known a considerable number of native species will ultimately be found.

Genus STENOPERLA, McLachlan (1866).

"The first two joints of the maxillary palpi are short, equal, broad; the others smooth; the third and fourth are each twice the length of the second; the fifth is shorter than the fourth. Antennæ short and slender. Wings when at rest surrounding the body; the anterior much narrower than the posterior, elongated; the transverse nervules are numerous and evenly distributed; the posterior wings three times as broad as the anterior, plicated, the transverse nervules distributed pretty evenly over the whole surface.

"Distribution.—New Zealand" (Hutton).

STENOPERLA PRASINA.

Chloroperla prasina, Newman, Zoologist, vol. 3, p. 852 (1845). *Hermes prasinus*, Walker, Cat. Neuroptera Brit. Mus., p. 206 (1852). *Stenoperla prasina*, McLachlan, Trans. Ent. Soc., ser. 3, vol. 5, p. 354 (1866).

(Plate I., fig. 4, fig. 5 larva, enlarged.)

This pretty insect is fairly common throughout the whole of New Zealand.

The expansion of the wings varies from $1\frac{3}{4}$ to $2\frac{1}{4}$ inches. The insect's general colour is grass-green, with the metathorax and abdomen brown. The head is hardly broader than the prothorax, the latter being rounded behind. The rest of the body is very narrow. The fore-wings are narrow and bright green, especially in the living insect. The hind-wings are very broad and pale green. The legs are also green.

The larva of this insect is found in rapid-running rivers and streams, but apparently is not usually very abundant. It is extremely active in the water, and generally contrives to secrete itself under a stone immediately after being exposed to view. Thus it is always very difficult to capture, which circumstance perhaps gives rise to an idea, that the larva is less abundant than is actually the case. The food of this larva consists of various other aquatic insects, chiefly the larvæ of *Ephemeridæ*, those belonging to the genus *Atalophlebia* being probably the favourite prey of this insect. It also devours the larva of *Ameletus perscitus*. The larva of *S. prasina* actively pursues its victims amongst the stones in the bed of the stream, and seizes them by means of its powerful jaws. It is extremely voracious, and might perhaps prove destructive to very young trout. On the other hand, there is no doubt that these larvæ must in turn form an important element in the food supply of the trout themselves, as the insects are to be found in the streams throughout the entire year, being, in fact, as common in midwinter as at any other season.

The length of the full-grown larva, including the terminal appendages, is about $1\frac{3}{4}$ inches. In general appearance it bears a considerable resemblance to the perfect insect, except, of course, in the matter of wings. The head and thorax are dull brownish-green; the former has three conspicuous black spots on the top, representing the ocelli of the perfect insect. The meso- and meta-thorax are each furnished with a pair of wing-pads. The anterior pair are very vivid green in colour, the posterior pair being paler. The abdomen is purplish-brown with the segmental divisions sharply marked in white. The first five segments of the abdomen are each furnished with a pair of gills, one gill on each side. These appendages are cylindrical, and

gradually taper from base to apex. They are white in colour, and appear to be partially articulated. The legs of the larva are very strong.

This larva grows extremely slowly, and it is quite possible that it occupies more than a year in reaching maturity. It is capable of travelling considerable distances on land, especially towards the end of its larval life. At this period it is, in fact, quite impossible to confine the insects in a shallow vessel, as they will immediately climb out of the water in order to get away.

When about to change into the imago, this larva leaves the water and clings firmly to a stone or the stem of some plant, generally near the edge of the stream. The skin then dries and cracks open at the back, and the perfect insect makes its escape, drying and expanding its wings in the usual manner. The empty skins of the larvæ are often seen after the insect has emerged, and are then very conspicuous. Sometimes they are met with a considerable distance away from the water, showing that the larva must have travelled a long way from its native element before emerging. These skins are, in fact, occasionally found clinging to the stems of trees four or five feet above the ground, the trees themselves being situated perhaps ten or fifteen yards away from the bank of the river or stream.

The perfect fly is most abundant in November and December, but few specimens being found as late as January. It flies somewhat feebly at evening dusk, when it is readily seen and captured. It is often extremely common in the neighbourhood of rivers, especially during the early part of December. The beautiful green colour of the fore-wings is very protective to the insect when resting amongst foliage during the day; hence specimens are seldom detected at this time. Unfortunately the green colour fades very much in the dead insect, a series of dried specimens giving but a poor idea of the appearance of this interesting species when alive.

STENOPERLA (?) CYRENE.

Chloroperla cyrene, Newman, Zoologist, vol. 3, p. 853 (1845). *Perla* (?) *cyrene*, Walker, Cat. Neuroptera Brit. Mus., p. 168 (1852); McLachlan, Trans. N.Z. Inst., vol. vi., App., p. xcii.

(Plate VI., fig. 7.)

This species has occurred in the neighbourhood of

Wellington and also at Orepuki, near Invercargill. Although rather a rare insect, it will probably be found to be generally distributed throughout New Zealand.

The expansion of the wings is about $1\frac{1}{4}$ inches. "Black. Head scarcely depressed; antennæ with 40 joints, strong, submoniliform, scarcely shorter than the body, the joints sub-ovate. Prothorax sub-transverse, acutely angled, nearly quadrate, not much broader than the head. Caudal setæ very short, incurved, 14-jointed. Tibiæ banded with yellow. Wings blackish, semi-opaque, densely reticulated.

"This species is not a *Chloroperla* nor a true *Perla*, nor is it a *Stenoperla*. Probably it belongs to a new genus, but well-preserved specimens are wanting for description. It is easily distinguished by its yellow tibiæ" (Hutton).

The transformations of this insect closely resemble those of the preceding species. The perfect insect appears from November till March, and is occasionally found in the neighbourhood of water.

Genus LEPTOPERLA, Newman (1839).

"Exterior portion of the fore-wing with six strong parallel nervures, of which the fourth is forked at the extremity and the fifth unites with the fourth before its furcation; these longitudinal nervures are intersected by several delicate transverse nervules. Antennæ and caudal setæ elongated. Legs elongated.

"*Distribution*.—Tasmania and New Zealand" (Hutton).

LEPTOPERLA OPPOSITA.

Perla opposita, Walker, Cat. Neuroptera Brit. Mus., p. 171 (1852). *Leptoperla opposita*, McLachlan, Trans. N.Z. Inst., vol. vi., App., p. xcii. (1874).

This little insect is probably common, and generally distributed throughout the country.

The expansion of the wings is about 1 inch. The general colour is black and shining, with the abdomen and legs more or less dull brown. "Prothorax minutely punctured, rugulose on the disk, not broader in front, with a rim on each side and along the fore border, sides straight, angles rather sharp; scutellum with a yellow spot in front. Wings very slightly grey, darker about the transverse nervules; nervures black" (Hutton). The fore-wings are tinged with grey, with a spot of darker grey on each of the transverse veins near the middle and apex. The hind-wings are darker grey, with strong bluish reflections in the living insect.

The larva of this species inhabits certain rapid-running streams, but is not universally met with. It is full grown very early in the spring, being very abundant in favoured localities. It clings closely and firmly to the stones in the bed of the stream, and its colouring in such situations is extremely protective. It can crawl about in the

strongest currents with considerable agility by means of its long legs, which are very powerful.

The length of the larva, when full grown, is about $\frac{1}{2}$ inch. The general colour is dull greenish-brown, spotted and striped with dull grey. The head is small and narrow, with the eyes black and prominent. The prothorax is broader than the head and nearly oval in shape; the meso- and meta-thorax are very large and the wing-pads very prominent, and considerably extended. The abdomen is slender, with ten visible segments. The two terminal appendages are nearly as long as the body; they are very divergent and strongly curved outwards. Between the origins of these appendages is situated a retractile tuft of rather short and very stout bristles, which appears to be the only respiratory organ possessed by the larva. The legs are stout and rather long. The antennæ are about three-quarters the length of the body. The basal joint is very stout, the second joint cylindrical, and the remaining joints very numerous, gradually tapering towards the apex.

This larva is specially adapted for living in streams with very rapid and powerful currents, and its appearance during the late winter and early spring, when all water-courses are more or less swollen, renders its special structure in this respect highly necessary to its well-being. When full grown it leaves the water, usually crawling on to an exposed stone, where the fly makes its escape in the usual manner.

The perfect insect appears early in September, and may be found until the middle or end of December. It is generally discovered resting amongst boulders at the edges of the streams, very seldom flying or venturing any distance from its native element.

The present species also occurs in Tasmania, but Mr. McLachlan is of opinion that our insect is not the true *L. opposita*, therefore not identical with the Tasmanian insect.

Family VI.—ODONATA—DRAGON-FLIES.

“Elongate insects with very mobile head and large eyes, with small and inconspicuous antennæ ending in a bristle; with four elongate wings sub-equal in size and similar in texture, of papyraceous consistency and having many veinlets, so that there exists a large number of small cells. All the legs placed more anteriorly than the wings. The earlier stages of the life are aquatic; there is great change in the appearance of the individual at the final ecdysis, but there is no pupal instar” (Sharp).

The following are some of the principal terms employed by systematists in describing the neurulation of dragon-flies.

“On the anterior margin, about midway between the pterostigma and the

base, there is a short, thick, transverse nervule called the 'nodus,' which stops the sub-costal nervule. The nervules between the nodus and the base of the wing are called 'ante-nodals' or 'ante-cubitals,' while those between the nodus and the pterostigma are called 'post-nodals' or 'post-cubitals.' All the nervules which cross the wing obliquely are called 'sectors.' That which starts from the nodus is the 'nodal sector,' the one next behind it is the 'sub-nodal sector.' Below the sub-costal nervule comes the 'median nervule,' and then the 'sub-median.' The first cross-nervule uniting the median with the sub-median is the 'areculus,' which sends off two sectors. The upper one of these branches, and that branch next to the median nervule is called the 'principal sector,' while the posterior branch forms the 'median sector.' The 'triangle' is an easily recognised area which lies just below the sub-median nervule and a little outside the areculus" (Hutton).

The dragon-flies are well known to every one, and constitute one of the most distinct and easily recognised families of insects, their elegant structure, beautiful colours, and wonderful powers of flight render them of exceptional interest, even to the most casual observer of natural objects. In addition to the special characters above summarised, dragon-flies exhibit many remarkable peculiarities, when compared with other insects. The structure of the thorax is, for instance, quite unique. The prothorax is small, and often partially concealed in the concavity at the back of the head. The meso- and meta-thorax are very intimately combined, and their relations are such, that the former is placed much above the latter. This peculiarity is carried to its greatest extent in some of the *Agrioninae* where, not only are the wings placed at a considerable distance behind the three pairs of legs, but also the fore-wings are placed almost directly above the hind pair. In the *Anisopterides* these peculiarities are much less marked; but even in them the three pairs of legs are placed quite in front of the wings. The legs are slender, and are chiefly remarkable for the beautiful series of hair-like spines, with which they are armed. Their position in relation to other parts of the body is peculiar to the dragon-flies; the legs seem unfit for walking, the insects never using them for that purpose; but it is probable that they are of great importance in capturing the prey.

Perhaps the most striking anatomical peculiarity of the dragon-flies is to be found in the structure of the male organs of reproduction. The ejaculatory duct opens on the ventral plate of the penultimate segment, but the organs of intromission are, however, placed on the under side of the second segment. The precise mode in which the fertilising fluid is transferred from the ninth to the

second segment is not well understood, but the insect may be often seen bending its body inwards and upwards, thus bringing the ninth ventral plate into contact with the second. There is, therefore, little doubt that the transference of the seminal fluid is effected during these movements.

The food of dragon-flies consists of living insects, which they capture on the wing by their own superior powers of flight. The exact mode of capture is not known with absolute certainty, owing to the extreme rapidity of the dragon-fly's movements. It is certain, however, that they capture flying insects, and it seems most probable that this is done by means of the legs. These are inserted so as to be close to the mouth; they are directed forwards, and are held bent at right angles so as to form a sort of net, and are armed with a beautiful system of fine spines; it is probable that if the dragon-fly pursue an insect on the wing and strike it with the trap formed by its six legs, then these immediately come together under the mouth, so that the victim, directly it is captured by the leg trap of its pursuer, finds itself in the jaws of its destroyer. The excessive mobility of the head permits the victim to be instantly secured by the mouth, and the captured fly is turned about by this and the front pair of legs, and is nipped rapidly, so that the wings and drier parts fall off, the more juicy parts of the prey are speedily squeezed into a little ball which is then swallowed or further compressed by the mouth for the extraction of the juices.*

The wonderfully rapid and perfect flight of the dragon-fly has led Amand† to suggest that its mechanism would form a suitable model for a flying machine to be propelled by electricity. From observations which have been made on European dragon-flies it is considered probable that the life of the perfect insect may endure for several weeks if not months. Single individuals of many of the larger species appear to have a domain as it were of their own. Westwood mentions, for instance, that he has seen what he believed to be the same specimen of a rare dragon-fly hawking daily, for several weeks together, over a small pond.

The larvæ of dragon-flies, or nymphs as they are often termed, are always strictly aquatic in their habits, and

* Sharp, *loc. cit.* 415.

† Rev. Sci. Nat. Montpellier (3), ii., p. 470.

although carnivorous like the perfect insect, they are very sluggish in their movements. They lurk amongst water-weeds or mud in stagnant pools, and capture their prey by means of a peculiar structure termed the mask. This organ is apparently formed by a backward growth of the bases of the labium and lingua, a hinge being formed between the two, at the most posterior point of their growth. The prolonged portions of these parts are free; usually the mask is folded under the head, but it can be unfolded and thrust forward with great rapidity. The front parts of the labium form a prehensile apparatus armed with sharp teeth, so that the structures make altogether a very effectual trap, that can be extended in order to secure the prey (see Plate III., figs. 3 and 6).

The respiratory organs of dragon-fly larvæ are very remarkable. In the nymphs of the *Anisopterides* a large number of minute gills is situated in the rectum, and these gills obtain air from water admitted into the rectum for the purpose. The extremity of the body is armed with projections of variable form that can be separated to allow ingress and egress of the fluid, or brought together so as to close the orifice. The water, so taken in, can, by some species, be ejected with force, and is used occasionally as a means of locomotion. These rectal gills can absorb free air, as well as air dissolved in water; if the water in which the creatures are placed does not contain sufficient air the nymphs thrust the extremity of the body above the surface and thus obtain a supply.

In the larvæ of the *Zygopterides* rectal branchiæ do not exist and respiration seems to be partly effected by means of three mobile processes at the extremity of the body, and partly by ordinary spiracles.

Ten species of dragon-flies are at present known in New Zealand, but of these only four can be called at all common.

The number of insects killed by dragon-flies, in places where they are abundant, must be enormous; the nymphs, too, are very destructive in the waters they inhabit, so that dragon-flies have no doubt been no mean factor in maintaining that important and delicate balance of life which it is so difficult to appreciate. The nymphs are no doubt cannibals; and this may perhaps be an advantage to the species, as the eggs are sometimes deposited in large numbers in a limited body of water where all must perish if the nymphs did not, after exhausting other food,

attack one another. De Selys found that from a pond filled with carp, roach, perch, and eels, several of the dragon-fly denizens disappeared directly the bream was introduced. On the other hand, there can be little doubt that the nymphs are sometimes injurious to fish; it has been recorded that in a piscicultural establishment in Hungary 50,000 young fishes were put into a pond in spring; in the following autumn only fifty-four fish could be found, but there were present an enormous quantity of dragon-fly nymphs.*

It has been observed that certain European species of dragon-flies form swarms and migrate; it will therefore be of interest to ascertain if the migratory instinct exists in any of our New Zealand species. In past years I have noticed swarms, but not distinct migrations. Of late all our dragon-flies appear much scarcer than in former times, though this apparent decline in numbers may be due to temporary causes only.

The fossil remains of a huge dragon-fly have been discovered in the carboniferous strata at Commentry. From the restoration which has been made of this giant it would appear to have measured over two feet across the expanded wings.

Sub-Family I.—ANISOPTERIDES.

Dragon-flies having the hinder wings slightly larger than the anterior pair.

Tribe LIBELLULINA.

“Eyes large and contiguous, without any tubercle behind. The first ante-nodal nervule of the fore-wings is not always continuous across the lower costal space; the hind-wings are rounded at the anal angle in both sexes; the triangles of the fore- and hind-wing differ in shape; sectors of the arculus united at the base.

Genus SYMPETRUM, Newman (1855).

“Frontal tubercle slightly truncate; posterior lobe of the prothorax elevated. Pterostigma generally short or moderate; sectors of the arculus petiolate; one cross-nervule in the lower basal or median space. Fore-wings with 7 or 8 (rarely 9 or 10) ante-nodal and 6 or 7 post-nodal nervules, the last ante-nodal very rarely and the first two or three post-nodals never continuous across the lower costal space; triangle rather broad, free, on a level

* Sharp, *loc. cit.* 425.

with that of the hind-wing, three or four rows of post-triangular cells; nodal sector undulated beyond the middle. Hind-wings with 5 ante-nodal and 6 to 8 post-nodal nervules, the first three post-nodals not continuous across the lower costal space; triangle free.

"Distribution.—Cosmopolitan" (Hutton).

SYMPETRUM BIPUNCTATUM.

Libellula (Diplax) bipunctata, Brauer, Reise der
"Novara," Neuroptera, p. 26 (1868).

(Plate II., fig. 1).

"Head with the lips reddish, the front rather golden, with a narrow black line to the base of the antennæ; vertex yellow, the occipital triangle reddish. Thorax reddish, the sides yellowish, with black spots. Basal segment of the abdomen with a black spot on each side, the second or third with a black spot in the middle. Wings hyaline, the posterior pair yellowish at the base; costa yellow at the base; pterostigma margined with black.

"Male with the legs black, the coxæ reddish, femora and tibiæ yellow on the outside. Pterostigma reddish; 9 or 10 ante-nodals.

"Female with the legs yellowish, the femora black on the outside and the tibiæ on the inside; tarsi black. Pterostigma yellow; 8 or 9 ante-nodals.

"Length of the body, $1\frac{1}{4}$ inches; expanse of wings $2\frac{1}{4}$ inches.

"Locality.—New Caledonia.

"Variety *novæ-zealandiæ*, McLachlan, Ent. Mo. Mag., 1894, p. 271.

Differs from the type chiefly in the greater extension of yellow at the base of the wings and its deeper tint. In the anterior wings of the female this colour extends to the second ante-nodal, to the arculus, and to near the end of the lower basal cell; and in the posterior wings it forms a triangular basal space reaching the triangle and continued in an oblique manner to the anal margin, some distance below the end of the membranule" (Hutton).

This very pretty dragon-fly may easily be distinguished from any of our other red species by its larger size and stouter build. The yellow colouring at the base of the wings is also a good distinctive character. It is very uncertain in its appearance, but has been recorded from the following localities in the North Island, *i.e.*, Auckland, Rotorua, Lake Papaitonga (near Ohau, Manawatu) and Paikakariki. In February, 1887, I observed it in swarms at the last-named locality, and although on numerous subsequent visits I have specially looked for it, I have never again seen it.

Tribe GOMPHINA.

"Eyes large, separated; apices of the triangles of the wings directed outwards; the quadrangle without nervules; wings unequal, the hinder pair broader.

Genus UROPETALA, Selys (1857).

"The lower lip notched in the centre; occiput without any horns; eyes elongated; bristle of the antennæ articulated. Sides of the thorax without any salient points. Pterostigma long; all the triangles of the wings divided, the basilar space not divided. Discoidal triangle of the forewings with the superior side as long as or longer than the interior side, and divided into three cellules. Superior anal appendages of the male flattened, narrowed at the base; inferior appendages rather shorter, not sloped.

"*Distribution*.—New Zealand" (Hutton).

UROPETALA CAROVEL.

Petalura carovei, White, Zool. "Erebus" and "Terror," Insects, pl. 6, fig. 1. *Uropetala carovei*, Selys, Mon. Gomphines, p. 370, pl. 19, fig. 2 (1857).

(Plate II., fig. 3; fig. 2 nymph.)

This very handsome insect is the largest dragon-fly we have in New Zealand. It is generally distributed throughout the country, but is commonest in the North Island.

The expansion of the wings of the male is $4\frac{1}{2}$ inches, of the female $4\frac{3}{4}$ inches. The general colour is shining blackish-brown, with bright yellow markings. The markings, however, fade into dingy-white in old specimens which have been long on the wing, and in dried specimens the colours also lose much of their brilliancy.

The male insect has two small leaf-like appendages at the extremity of the abdomen, which are spread out during flight, so that the sexes of this dragon-fly are always easily distinguishable.

The nymph of this insect inhabits mud in stagnant streams, but is very seldom observed.

Its length when full grown is about $2\frac{1}{4}$ inches. The head is furnished with a very large and powerful "mask," armed with two very sharp, strong forceps for seizing its prey. The antennæ have six unequal joints; the eyes are rather large, oval, and shining black. The prothorax is very small; the rest of the thorax is of moderate size. The wing-pads are very conspicuous and dark brownish-black in colour. The legs are long, stout, and strongly fringed with yellowish hair. The general colour of the larva is dull brown, with a few obscure greyish-white patches on the head, thorax, and legs.

This larva is no doubt carnivorous, but no details are at present known respecting its habits. When mature it leaves the mud and clings to the stem of a tree, or some other firm object, after which the winged insect escapes as usual through a rent in the back. The empty nymph-case of this insect may sometimes be found attached to trees growing in swampy places near the banks of streams, but they are not of frequent occurrence.

The perfect insect appears in December and January. It flies with great rapidity, and is often observed far away from any water. It also frequents very elevated situations, and I have seen it in the Nelson province on the Tableland of Mount Arthur, no less than 3,600 feet above the level of the sea. This is an extremely bold insect, and, although powerful on the wing, is very easily caught. In fact, it is so fearless that I have sometimes captured a specimen, when perched, by means of the thumb and forefinger only. According to my observations, male specimens of this species are commoner than the females, in the proportion of about three to one.

Tribe CORDULIINA.

“Resembles *Libellulina*, but the eyes have a slight horny tubercle behind, the triangles of the wings are generally wider, the sectors of the arculus are often completely separated, the last ante-nodal nervule is always continuous, there is only a small number of post-nodal nervules, the nodal sector is never undulated beyond the middle, and the males usually have the anal angle of the wings angulated.

Genus SOMATOCHLORA, Selys (1878).

“Tubercles behind the eyes slight. Pterostigma rather short. Fore-wings with 7 or 8 ante-nodal and 6 to 8 post-nodal nervules; hind-wings with 5 (or rarely 6) ante-nodals and 8 to 10 post-nodals. Sectors of the arculus united at their bases, but not petiolate. Basal and hypotrigonal areas undivided; lower basal (or median) area with one cross-nervule in both wings. Internal triangle of the fore-wings with three cells; triangle of the hind-wings followed by two cells. Superior anal appendages of the male long, sub-cylindrical, rather thicker in the middle; the inferior pair short, sub-triangular. Those of the female long, sub-cylindrical, slightly curved upwards, and pointed at the apex.

“*Distribution*.—North America and other places” (Hutton).

SOMATOCHLORA SMITHII.

Cordulia smithii, White, Zool. “Erebus” and “Terror,” Insects, pl. vi., fig. 2 (no description); *C. novæ-zealandiæ*, Brauer, Reise der “Novara,” Neuroptera, p. 78, tab. ii., fig. 3-3b (1868).

(Plate III., fig. 1 ♀, 2 nymph, 6 head of ditto magnified, showing mask extended).

This dragon-fly is common and generally distributed throughout New Zealand, and has also occurred at the Chatham Islands. It appears, however, to be decreasing in numbers in those localities, which are in the vicinity of settlement.

The expansion of the wings is about $2\frac{3}{4}$ inches, and the length of the body about 2 inches. In the living insect the head is bronzy green in front with the sides yellow; the eyes are dark reddish-brown, in the female with metallic green reflections; in the male they are the most brilliant metallic green. The thorax is metallic bronzy green, brighter in the male. The legs are black; the anterior femora wholly pale brown. In the female the wings are often shaded with pale orange-brown just before the pterostigma. The abdomen is black with bronzy-green reflections, the sides are marked with bright orange-brown, almost interrupted with black at each articulation. In the male the abdomen is narrower at base and apex than in middle. The superior anal appendages of the male are black, long, acute at the apex, and bent upwards in the middle, converging and sub-dilated, angled exteriorly. The inferior appendages are simple, half the length, triangular and yellow. The anal appendages of the female are cylindrical, incurved, and acute.

The nymph inhabits the mud at the bottom of stagnant streams and ponds, feeding on the smaller insects which frequent those situations.

Its length when full grown is about 1 inch. The head is broad and somewhat triangular in shape when the mask is closed. The eyes are prominent and black in colour. The antennæ are seven-jointed, the two basal joints being considerably stouter than the remainder. The prothorax is small and has a blunt protuberance at each of its anterior angles, the rest of the thorax is of moderate size. The posterior wing-pads are larger than the anterior. The abdomen is rather large. There is a crest of horny spines on the back and the edges of several of the posterior segments are produced into horny flanges at the sides. The legs are long and slender and are very sparingly clothed with minute bristles. The general colour is dull brown, with a row of black dots on each side of the abdomen.

This larva is extremely hard to find, and I spent at least two hours carefully examining the mud from a stagnant pool in the Hutt River before I succeeded in discovering a single specimen. When enveloped in the mud, as the insect always is in a state of nature, it is quite impossible to detect except by means of its movements, which are very deliberate. When full grown this nymph leaves the water and ascends the stem of a neighbouring plant, after which the winged insect escapes in the usual way.

The perfect dragon-fly is an extremely swift and powerful flier. In fact its movements are so rapid that it appears to vanish in one spot and reappear some yards distant. It often occurs many miles away from water, and I have observed it flying around mountain crags over 5,000 feet above the sea-level. Although so much smaller in size it is far more difficult to capture than *Uropetala carovei*, as it is so very timid, and when at rest it can only be approached with the utmost caution. During the last eighteen years its steady decline in numbers in the vicinity of Wellington has been very noticeable, and it is now quite a rare insect here. I conjecture that its dis-

appearance is due to the trout eating the nymphs, though it would seem difficult for the fish to discover an insect so retired in its habits. The female dragon-fly deposits her eggs in the water, beating her body violently on the surface whilst doing so. It is therefore possible that, when thus engaged, she is often captured and devoured by the trout.

This dragon-fly varies considerably in colour as well as in the number of the "ante-nodal nervures" in the fore-wing.

SOMATOCHLORA GRAYI.

Epithea grayi, de Selys, Synopsis Cordulines, p. 49 (1871).

"*Male*.—Head with the lips yellowish, the face pale brown, the upper part of the front metallic green. Thorax brown, with metallic-green reflections. Wings slightly tinged, the extreme base ochraceous, especially in the hind-wings, where the colours expand along the membranule; neuration black, including the costa; pterostigma small, reddish; triangle traversed by a nervule in the fore-wing, free in the hind-wing; three post-trigonal cellules followed by two rows; the anal margin excavated, but almost filled in by the membranule, which is brownish-grey, paler at the base; 8 ante-nodals in the fore-wing. Legs black, the anterior femora and an external band on the intermediate yellowish. Abdomen inflated at the base, a little constricted at the third segment, then broadening and flattening to the eighth, afterwards attenuated; oreillettes prominent. It is blackish above, excepting the first and second segments, which are yellowish, and the third to the tenth have on each side a broad yellow spot occupying their basal half. Superior anal appendages blackish, almost double the length of the tenth segment, villose, cylindrical and straight in their first three-quarters, the apex expanding and forming a sort of club curved suddenly outwards almost at a right angle to the inner edge, the outer edge simply inclined, the extremity blunt, almost truncate. Seen in profile the upper side has a small point, directed in front. Inferior appendages shorter, yellowish, sub-triangular, slightly curved upwards, with a blunt point. Length of the abdomen, 39 mm.; of the hind-wing, 33 mm.

"*Female* unknown.

"*Locality*.—New Zealand" (Hutton).

I am unacquainted with this species.

SOMATOCHLORA BRAUERI.

Epithea braueri, de Selys, Synopsis Cordulines, p. 50 (1871).

"*Male*.—Head brown, rhinarium yellow, upper side of the front greenish, base of the eyes yellowish-brown. Thorax brown, the upper portions and sides bronzy green. Wings tinged, slightly ochraceous at the extreme base; the posterior with the anal margin excavated, membranule large, blackish, paler at the base; pterostigma small, reddish-brown; triangles divided in all the wings; 8 ante-nodal nervules in the fore-wings and 6 in the hind; 7 or 8 post-nodals. Legs brown, the tarsi blackish. Abdomen slender, brown, with bronzy reflections, with a sinuated dorsal blackish bronzy band, not well defined, prolonged over all the segments, the articulations blackish;

oreillettes scarcely evident. Superior anal appendages sub-cylindrical, dark brown, double the length of the tenth segment, without any tooth, slightly bent inwardly and curved outwardly in the second half, where there is a slight dilatation outwardly, the apex blunt. Inferior appendage one-quarter shorter, regularly attenuated, the extremity slender, truncated, slightly elevated. Length of the abdomen, 40 mm.; of the hind-wings, 36 mm.

"*Female* differs from the male in having a broad spot of yellowish-white below the pterostigma; 7 or 8 ante-nodals in the fore-wing and 5 or 6 in the hind, 6 or 7 post-nodals in the fore-wing and 8 or 9 in the hind (the right and left wings often different). Legs black, the proximal halves of the femora brown below. Anal appendages as in *S. smithii*. Length, 50 mm.; of abdomen, 36 mm.; of fore-wing, 37 mm.; of hind-wing, 36 mm.

"*Locality*.—Canterbury" (Hutton).

I am unacquainted with this species.

Tribe ÆSCHNINA.

"Eyes large and contiguous. Apices of the triangles of all the wings directed outwards; the quadrangle with transverse nervules."

Genus ÆSCHNA, Fabricius.

"Eyes sinuated behind. The inferior appendage generally entire, sometimes quadrid. Anal margin of the hind-wings of the male generally projecting, with the posterior margin sinuated.

"*Distribution*.—Widely spread in both hemispheres" (Hutton).

ÆSCHNA BREVISTYLA.

Æschna brevistyla, Rambur, Hist. Névroptères, p. 205 (1842).

(Plate IV., fig. 5.)

This handsome dragon-fly has occurred at Auckland, Kawhia, Rotorua, and Levin in the North Island, and in the Canterbury District in the South Island. It is, however, a very rare species in New Zealand.

The expansion of the wings is 3½ inches, and the length of the body 2½ inches.

The general colour of the body is dark reddish-brown with bright yellow and blue markings. There is a broad yellow stripe on each side of the thorax, and two fine oblique stripes on the back of the mesothorax; there is a number of small blue marks at the base of the wings. The abdomen is much inflated at the base and then constricted; the inflated portion has one central and two lateral yellow marks, and a very broad bright blue band, followed by a black band just before the constriction. The rest of the abdomen is reddish-brown with numerous yellow stripes and spots. The wings are slightly tinged with reddish, the veins are brown and the pterostigma is black. The superior anal appendages are narrow in the male, those of the female are very short.

The perfect insect appears about February. This dragon-fly also occurs in Eastern Australia.

Sub-family **ZYGOPTERIDES**.—Dragon-flies having the wings of the two pairs equal in size, or the hinder a little the smaller.

Tribe AGRIONINA.

“Eyes small and distant; wings equal, attenuated at their bases.

Genus LESTES, Leach (1817).

“Wings horizontal in repose. Nodal sector arising three to five cells behind the nodus; the sub-nodal not angulated or hardly undulated; the ultra-nodal sector interposed and the short sector angular under the nodus; two supplementary sectors interposed between the sub-nodal and the median sectors. Pterostigma three or four times as long as broad, surmounting 2 to 4 cellules. Two ante-nodals in all the wings. Quadrilateral with the internal side a third or a fourth of the interior. Anal appendages of the female cylindrical, subulate, shorter than the last segment.

“*Distribution*.—Cosmopolitan.

Second Section.

“External inferior angle of the quadrilateral much pointed. Colour blackish-bronze, mixed with blue or clear red. Inferior appendages of the male short.

“*Distribution*.—Asia, Australasia, Oceania” (Hutton).

LESTES COLENSONIS.

Agrion colenonis, White, Zool. “Erebus” and “Terror,” Insects, pl. 6, fig. 3. *Lestes colenonis*, Selys, Synopsis Agrionines, p. 44 (1862).

(Plate III., fig. 4 ♂, 5 ♀.)

This pretty dragon-fly is very common, and generally distributed throughout the country.

The expansion of the wings is $2\frac{1}{2}$ inches, and the length of the body $1\frac{3}{4}$ inches.

The general colour of the male is dark purplish-black, with brilliant blue markings. The front of the labium, the pronotum, two broad stripes on the mesonotum, the articulations of the wings and the articulations of the abdomen are brilliant blue. The legs are black above and yellowish-brown beneath. The superior appendages of the male are like pincers toothed inside and having a tubercle at the base inside, which is the commencement of a dilatation, terminated towards the middle by a very sharp tooth; the end inclined downwards and curved slightly outwards. The inferior appendages are not half the length of the superior; they are brown, thick, approximated, and slightly attenuated.

In the female the head and pronotum are dull slaty black, the central portions of the mesonotum brilliant green-edged, first with a narrow band of white and then broadly with black. The abdomen is bright green at the

base, becoming dull purple towards the tip; the end of each segment is marked with a shaded ring of black, and the beginning of the succeeding segment with a sharp, fine ring of white. The anal appendages are separated, sub-cylindrical, yellowish, shorter than the last segment, the valves slightly toothed at the tips.

The transformations of this dragon-fly probably closely resemble those of the next species, but the nymphs are very rarely met with, and have not yet, I think, been closely observed. The perfect insect first appears in December and becomes steadily commoner until about the middle of February, when its numbers then begin to decline. The males first appear and seem to be gradually supplanted by the females; stragglers of both sexes are, however, occasionally observed as late as the beginning of May, and, in fact, this dragon-fly is often one of the last insects to leave us in the autumn.

Genus XANTHAGRION, de Selys (1876).

“Head, thorax, and abdomen medium. The post-ocular rays clear, united by an occipital line. Lower sector of the triangle arising from the basal nervule of the post-costal; pterostigma lozenge-shaped, short on all the wings; post-nodal nervules 11 to 15. No spine on the vulva of the female.

“*Distribution*.—Australia and New Zealand.

“The New Zealand species differ from those of Australia in having the basal post-costal nervule placed between the first and second ante-nodals instead of below the first” (Hutton).

XANTHAGRION ZEALANDICUM.

Telebasis zealandica, McLachlan, Ann. Mag. Nat. His., ser. 4, vol. 12, p. 35 (1873); Trans. N.Z. Inst., vol. vi., App., p. xciii. *Xanthagrion zealandicum*, de Selys, Synopsis Agrionines, p. 232 (1876).

(Plate IV., fig. 1 ♀ variety, 2 ♀, 3 ♂, 4 nymph magnified; Plate III., fig. 3 head of nymph with mask extended (much magnified).

This beautiful little dragon-fly is extremely common throughout the country.

The expansion of the wings of the male is $1\frac{3}{4}$ inches, and the length of the body $1\frac{1}{2}$ inches. The abdomen is brilliant red with black rings at the sutures. The head and thorax are black above, with long brownish hairs; there is a large red spot behind each eye, the two connected by a transverse red line. The prothorax is black, its borders and three discal spots are red; the posterior lobe is rounded and but little projecting. The thorax has two bright-red lines; the sides are reddish, with two black lines. The legs are bright-red, with black spines. The superior anal appendages are short, sub-triangular, with an obscure tubercle inside. The inferior

appendages are hooked, as long as the 10th segment. The pterostigma surmounts one cellule.

In the female the expansion of the wings is $1\frac{3}{4}$ inches, and the length of the body $1\frac{1}{4}$ inches. The red colouring is replaced by yellow on the head and thorax; the abdomen is bronzy black above and pale yellowish beneath.

There are 13-14 post-nodal nervules and three cells between the quadrilateral and the nodus.

There is a variety of the female about the same size as the male, and much resembling an individual of that sex, except that the abdomen is of a duller red with broader black rings, and the general colour of the legs and thorax is darker (see Plate IV., fig. 1). This form is unquestionably a true female, although some doubts have been expressed regarding this, by those who have not had an opportunity of seeing the living insects. I have, however, often captured specimens of this variety connected with specimens of the typical male, and have also observed them depositing eggs. The variety is very much rarer than the ordinary form of the female, although I have usually succeeded in obtaining one or two specimens, wherever the dragon-flies were to be found in large numbers. The larva of this insect inhabits most stagnant pools and slow-running streams. It lives concealed amongst various water-weeds, and captures and devours small insects, which it readily seizes by means of its well-developed mask.

The length of the full-grown nymph including the terminal appendages is about $\frac{3}{4}$ inch. The head is rather broad, somewhat heart-shaped, with the eyes prominent and shining black. The antennæ are six-jointed and very slender; the first joint is short and rather stout, the second slightly longer and thinner, the third joint very slender and the longest of the series, the remaining three joints are also slender and gradually decrease in length. The thorax is not so broad as the head, its central portion is somewhat elevated. The wing-pads are elongate and conspicuous. The terminal appendages are slightly more than half the length of the abdomen, very broad, and traversed with numerous tracheæ; viewed from above they appear very narrow as their edges only are then visible. The legs are long, rather slender, with the tarsi three-jointed. The general colour of the mature larva is dull greenish-brown, but younger larvæ are light green.

The perfect insect appears about the middle of November, and continues increasing in numbers during the whole of December, but becomes much rarer towards the end of the summer. It is very common in all situations which are well watered, but only flies in the hottest sunshine, and few specimens are to be seen on dull days, even in places where the insect is most abundant during bright sunny weather.

I have on several occasions observed this dragon-fly engaged in pairing and subsequently depositing its eggs,

and its habits, when thus occupied, are very interesting and remarkable.

In the first place the male insect seized the female round her neck by means of his anal forceps, the two dragon-flies flying about for some time connected in this way and forming together a straight line. Later on the pair settled on a firm object, the male still holding the female in the same manner as before. Finally the male drew the female slightly towards him, by arching his abdomen, and the female at the same time bent her body downwards and forwards, its extremity coming in contact with the special organ situated on the second segment of the male's abdomen. A connection is undoubtedly thus established, and I have not the slightest doubt that the true copulative organs of the male are actually situated on the second segment of the abdomen, as is now generally stated by naturalists. The insects remained connected in this way for five or ten minutes, and I observed several pairs thus engaged.

When pairing was accomplished the process of egg-laying at once began. During this operation the male still retained hold of the female by means of his anal claspers, the two insects resuming the "straight line" position. After selecting the stem of some water-plant, or similar object extending downwards beneath the water, the female slowly moved backwards along the stem towards the water, pulling the male after her. First the extremity of her body came in contact with the water; afterwards both insects continued to move backwards, until the whole of the female was submerged except her thorax and the tips of her wings. At this time the female frequently struck the extremity of her body against the stems and leaves of the submerged portions of the plant. This action was no doubt actual oviposition, though I was unable to positively prove it. The female still continued to move backwards until she was at last wholly submerged and the male's abdomen half in the water. At this stage the male loosened his hold and the female went still deeper into the water alone, and did not return to the surface for at least thirty minutes. After remaining out of the water for a few minutes, the female climbed down below the surface by herself, and in about fifteen minutes I lost sight of her amongst the watercress in the bed of the stream. I saw, however, several other pairs in which the female was egg-laying and partially submerged, but was not able to watch these for a very

lengthened period, as they were disturbed during the process.

Whilst submerged the female is covered with a coating of air, which of course looks silvery-white below the water. This air is, no doubt, retained by the integument, assisted by the numerous bristles and hairs which are situated thereon.

XANTHAGRION ANTIPODUM.

Xanthagrion antipodum, de Selys, Synopsis Agrionines, p. 239 (1876).

“Differs from *X. zealandicum* in having no spots behind the eyes, but a yellow occipital line only, and no yellow spots on the prothorax; the first abdominal segment has no yellow spot; the femora have a black ray on the outside. There are only 11 post-nodal nervules. The pterostigma is rather shorter than the opposite cell. Length of the abdomen, 24 mm.; of the hind-wing, 17 mm.

“*Locality*.—New Zealand.

“Described from a single female specimen” (Hutton).

I am unacquainted with this species. It appears to be very closely allied to *Xanthagrion zealandicum*.

XANTHAGRION SOBRINUM.

Telebasis sobrina, McLachlan, Ann. Nat. Hist., ser. 4, vol. 12, p. 36 (1873). *Xanthagrion sobrinum*, de Selys, Synopsis Agrionines, p. 234 (1876).

“Very like *X. zealandicum*, but larger; the basal spot on the first segment of the abdomen is divided; the superior anal appendages are much exserted, scarcely half the length of the inferior, sub-triangular, the lower edge concave. Four cellules between the quadrilateral and the nodus in all the wings; *pterostigma* surmounting fully two cellules; anterior wings with 15 post-nodal nervules. Length, 39 mm.; of abdomen, 31 mm.; of hind-wing, 22 mm.; expanse, 56 mm.

“*Locality*.—New Zealand and Chatham Islands.

“In Chatham Island specimens the basal black spot on the first abdominal segment is not divided, and there are 15 to 18 post-nodal nervules” (Hutton).

Family VII.—EPHEMERIDÆ—MAY-FLIES.

“*Delicate insects with atrophied mouth and small, short antennæ; with four membranous wings having much minute cross-veining; the hinder pair very much smaller than the other pair, sometimes entirely absent: the body terminated by three or two very elongate slender tails. The earlier stages are passed through in the water, and the individual then differs greatly in appearance from*

the winged insect; the passage between the two forms is sudden; the creature in its first winged state is a sub-imago, which by shedding a delicate skin reveals the final form of the individual" (Sharp).

The following are some of the principal terms employed by systematists in describing the neururation of these insects:—

"The anterior margin of the wing is called the 'costal' nervure, and immediately below it is the 'sub-costal'; and below that is the 'radius': none of these are branched. Next comes a nervure which branches very near the base of the wing into an upper, called the 'sector,' and a lower, called the 'prebrachial'; further on the sector sends out a second lower branch, the 'cubitus,' which thus lies between the sector and the prebrachial. Starting again from the base, three longitudinal nervures branch off together, the upper of which is called the 'pobrachial,' the middle the 'anal,' and the lower the 'axillary' nervure" (Hutton).

The *Ephemeridæ* is one of the most interesting families of the Neuroptera whether we regard it from the standpoint of the entomologist, the angler, or the general observer of nature. In a purely popular sense the May-flies are probably best known as the types of brief and ineffective life, the name *Ephemera* being derived from the Greek *Εφημερος*—diurnal—and having allusion to the extremely short space of time which they occupy as perfect insects. If, however, the duration of the preparatory stages of the May-fly is taken into account the total life of the individual is really quite as long as that of most other insects.

The earlier stages of the May-flies are of great interest and importance; but the perfect insects shrivel so much in the process of drying that the study of the structure of preserved specimens is not altogether satisfactory. The discrimination between many of the species of May-flies, when in their final condition, is attended with much difficulty to any one but a specialist in the group, whilst in most cases the same insects, in their earlier stages, could be readily distinguished even by an amateur naturalist.

It is probable that May-fly larvæ are more modified for an aquatic life than any other insects. They possess a complex series of tracheal gills, which differ very much in structure amongst the various species (see Plate XI., figs. 14–18). The internal anatomy of the larvæ also shows some points of extreme interest. The long tails of the insect serve as auxiliary organs of respiration, and there is a special modification of the great dorsal vessel, by means of which the blood is forced into these appendages for respiratory purposes. Owing to the almost

complete transparency of many of these larvæ the entire circulation of the blood may be easily seen if the insect be placed in a shallow vessel of water and viewed under a magnifier of moderate power.

The food of these larvæ is apparently very varied. The Rev. E. A. Eaton, who is probably one of the greatest British authorities on the *Ephemeridæ*, says that though sometimes the stronger larvæ devour the weaker, yet the diet is even in these cases partly vegetable. The alimentary canal frequently contains much mud; very small organisms, such as diatoms and confervæ, are thought to form a large part of the bill of fare of Ephemerid larvæ. Although the mouth is atrophied in the imago, it is highly developed in the larva. As soon as the May-fly larva attains maturity the winged insect escapes through an opening in the back, slowly flies ashore, and afterwards rests for a variable period, according to the species, amongst the vegetation on the bank of the stream. In this condition the insect is termed the sub-imago, as a further transformation afterwards takes place, *i.e.*, the shedding of another and extremely delicate skin from the entire body and appendages of the insect. After this second change the wings are more transparent, the legs and tails considerably longer than before, and the insect is then in its final, or imago, condition. The sub-imago is an extra phase of life peculiar to the May-flies, and, so far as is known, does not occur in any other family of insects. In most insects, however, an extremely delicate inner membrane can be detected inside the ordinary skin of the nymph, or pupa, this membrane being no doubt analogous to that which invests the sub-imago of the May-fly. There is, however, this remarkable difference—in the May-fly the inner skin is retained for a considerable period after the insect has left the nymph, that is during the sub-imago state; in other insects the two skins are shed simultaneously, one within the other, and in these no such stage occurs.

In localities where May-flies are abundant, numerous specimens of the sub-imago may be seen flying away from the water in almost a straight line, with a slow and steady flight, generally about fourteen feet above the ground. This flight occurs during the early twilight, and is so characteristic that when once recognised it cannot be mistaken. It is very distinct from the peculiar up-and-down flight of the imago about to be described.

The perfect May-fly takes no food ; its alimentary canal gradually becomes distended with air, afterwards acting as a kind of balloon, whilst the insects are performing their well-known aerial dances. During these flights the May-flies rise and fall in the air, almost in perpendicular lines, and it is at this time that the pairing of the sexes takes place. Of these remarkable dances it has been well said * that to the May-flies themselves, the movements may, by the number of the separate eyes, by their curved surfaces, and by the innumerable facets composing them, be multiplied and correlated in a manner of which our own sense of sight allows us to form no conception. We can see on a summer's evening how beautifully and gracefully a crowd of May-flies dance, and we may well believe that to the marvellous ocular organs of the flies themselves, these movements form a veritable ballet. It has already been explained that during these dances the stomach of the May-fly becomes distended with air, and it is further believed that the contents of the sexual glands are driven along their simple and direct canals † by the expansion of the balloon-like stomach. During these dances the momentary conjugation of the sexes occurs, and immediately thereafter the female, according to Eaton, resorts to the waters for the appropriate deposition of her eggs. As regards this, Eaton says: "Some short-lived species discharge the contents of their ovaries completely *en masse*, and the pair of egg clusters laid upon the water rapidly disintegrate, so as to let the eggs sink broadcast upon the river-bed. The less perishable species extrude their eggs gradually, part at a time, and deposit them in one or other of the following manners: Either the mother alights upon the water at intervals to wash off the eggs that have issued from the mouths of the oviducts during her flight, or else she creeps down into the water to lay her eggs upon the under side of stones, disposing them in rounded patches, in a single layer evenly spread, and in mutual contiguity." The eggs are very numerous, and it is thought may sometimes remain in the water as long as six or seven months before they hatch. The number of individuals produced by some kinds of May-

* Sharp, "Insects," 440 *et seq.*

† The sexual organs of the *Ephemeroidea* are remarkable for their simplicity, and for the fact that the ducts by which they communicate with the exterior continue as a pair to the extremity of the body and do not, as in other insects, unite into a common duct. This extraordinary structure exists in both sexes.

flies is remarkable. Swarms consisting of millions of individuals are occasionally witnessed. In the perfect state these insects are a favourite food of fishes, and most of the "duns" and "spinners" of the angler are rude representations of *Ephemeridæ*. Ronald says* that the term "dun" refers to the sub-imago condition, "spinner" to the perfect insect.

These sensitive creatures are unable to resist the attractions of artificial light; and since the introduction of the electric light, accounts often appear of myriads being lured by it to destruction. Their dances may frequently be observed to take place in peculiar states of light and shade, in twilight or where the sinking sun has its light rendered broken by bushes or trees; possibly the broken lights are enhanced in effect by the ocular structures of the insects.

That insects so fragile, so highly organised, with a host of powerful enemies, but themselves destitute of the means of attack or defence, should contrive to exist at all is remarkable; and it appears still more unlikely that such delicate insects as *Ephemeridæ* should leave implanted in the rocks their traces in such a manner that they can be recognised; nevertheless such is the case, and the May-fly palæontological record is both rich and remarkable. From the great variety and large size of many of the fossil May-flies, Scudder considers that the fragile, short-lived May-flies of the present day must be regarded as the lingering fragments of an expiring group.

Genus ICHTHYBOTUS, Eaton (1899).

"A genus of the sectional type of *Ephemera*, resembling *Pentagenia* in style of wing-neuration, and in having the median caudal seta abortive in the male imago, but either not much shorter than or subequal in length to the outer setæ in the female. Legs as in *Ephemera*, excepting the claws of the fore-tarsus of the male, the outer claw being hooked and the inner obtuse. Distinguished from the other genera of this sectional type by the male genital forceps, resembling in pattern those of a *Siphurus* (cf. *S. lacustris*), the forceps-basis sub-quadrate with the posterior angles obliquely truncate for the insertion of the limbs, the first joint in which is shorter than the basis. The name in Greek means *fed on by fish*."†

ICHTHYBOTUS HUDSONI.

Ephemera hudsoni, McLachlan, Ent. Mo. Mag., 1894,

* "Fly-Fisher's Entomology," 4th ed., 1849, p. 49.

† Trans. Ent. Society of London, 1899, p. 285.

p. 270; *Ichthybotus hudsoni*, Eaton, Trans. Ent. Soc. Lond., 1899, p. 285.

(Plate V., fig. 4 ♂, 5 ♀, 6 ♂ sub-imago, 7 ♀ ditto, 8 nymph, magnified.)

Hitherto this fine May-fly has been taken only in the neighbourhood of Wellington, but it is not at all likely that the insect is restricted to this locality alone. It is probably generally distributed throughout the North Island, and most likely it occurs in parts of the South Island also.

The expansion of the wings of the male is $1\frac{5}{8}$ inches, of the female $1\frac{7}{8}$ inches. In the male the general colour of the body is dark reddish-brown. The costal margin of the fore-wings is edged with dull red between the first two longitudinal veins. The remainder of the wings is transparent. There are two tails which are nearly twice the length of the body. The anterior legs are as long as the body, the other two pairs being stouter and very much shorter. The female is stouter than the male; the general colour of the body is bright orange-brown, the wings are bright yellow, fading somewhat after death. The costal margin is bordered with dull red as in the male. The anterior pair of legs are less than half the length of the body, and rather stout. There are three tails, the two outer ones are not quite so long as the body, and the middle tail is slightly shorter than the others.

The larva of this insect inhabits the soft, sandy mud near the margins of rivers and streams. It lives in a cylindrical burrow dug out of the mud, and in order to keep a supply of fresh water in its dwelling it is constantly waving its abdomen up and down. The gills are almost incessantly moving. They vibrate with a peculiar wavy motion, which appears to start near the thorax and pass downwards along the insect. The food of the larva apparently consists of mud, the vegetable particles existing therein probably affording it the necessary nourishment.

The length of the larva when full grown is about $1\frac{1}{2}$ inches. The head is dull reddish-brown. The mandibles are rather long and but slightly curved at the tips. The anterior legs are very strong, and apparently used for digging. The other legs are stout and short. The antennæ are rather long and very thin. The thorax and wing-pads are dark brown; the abdomen is dingy white. Gills are present on each side of the first six segments of the abdomen. Each gill is double, and is fringed with numerous long blackish hairs (see Plate XI., fig. 14). There are three moderately long anal appendages, each of which is broadly fringed with hair. The whole larva is also covered with short hair.

This larva is difficult to find, as it is nearly always so enveloped in mud as to be quite unrecognisable. Hence specimens can only be obtained by carefully examining

the mud, and washing any suspicious-looking moving object in a small net. When a larva is thus found and afterwards liberated in the open water, it swims rapidly for a few seconds, and then immediately begins to again bury itself in the sand or mud. This is done by means of the powerful head, jaws, and anterior legs. One specimen I watched whilst thus engaged completely concealed itself in less than five minutes. As these larvæ spend nearly all their time underground, they can be devoured by fish only during emergence or as perfect insects. It is therefore probable that the permanent preservation of this May-fly larva in our rivers and streams is fully assured.

Unlike most other May-fly larvæ, this insect is extremely hardy, and can endure severe vicissitudes. On one occasion a specimen was accidentally left for a month in a tightly corked bottle with a little sand and water, but when it was liberated it appeared none the worse for its long imprisonment.

Although difficult to find, this larva evidently occurs in great profusion in certain localities. For instance, in the Wainui-o-mata River, about Christmas-time, the nymph skins may be seen in hundreds, and the perfect insect is very common there also.

I once observed a larva of this insect just about to emerge. It appeared very sluggish, and a large quantity of air was visible under the skin. The insect allowed itself to float slowly down the stream just below the surface, its gills working as rapidly as usual. Suddenly the skin of the thorax broke open at the back, and in two or three seconds a beautiful female sub-imago was standing on the water alongside the empty floating pupa skin. The rapidity of the transformation was marvellous, the May-fly only appearing to shake its wings once before they attained their full size.

The sub-imago of the male of *I. hudsoni* differs from the perfect insect in the following respects: The body is dull brown, the anterior legs are very much shorter and stouter, and the tails are not quite so long as the body. There are two conspicuous dusky transverse bands on the fore- and hind-wings. The female sub-imago has the body pale yellowish-red, with the tip of the abdomen blackish. The three tails are equal in length, but very short. The fore-wings have two conspicuous broken blackish, transverse bands; the hind-wings have a narrow blackish band near the base, followed by two broad blotches near the edge of the wing.

The sub-imago rests amongst foliage on the banks of the stream for about thirty-six hours before changing.

If disturbed, however, it flies with considerable rapidity, and at this time the female especially is very conspicuous; its bright yellow wings, with black bands, giving it, when flying, a most striking appearance. As a rule the sub-imago is seldom seen in a state of nature, and can only be obtained with any degree of certainty by rearing individuals from the larva. The perfect insect appears from the beginning of December until the end of January. In some localities it is very common at evening dusk, and its large size and characteristic vertical flight render it a conspicuous object when projected against the bright background of the evening sky. At such times the long tails of the males can clearly be seen hanging downwards from the insect, thus presenting a most graceful appearance. The females are not nearly so common. They fly much closer to the ground than the males, and on this account alone they are much more difficult to obtain. This May-fly is not often found in the daytime, although, on rare occasions, I have dislodged male specimens from amongst foliage on the margins of streams.

In the *Entomologist's Monthly Magazine* for December, 1894, page 271, Mr. McLachlan thus alluded to the peculiarities exhibited by this insect: "A very remarkable species in coloration, and still more remarkable for the condition of the median caudal seta as exhibited in the male and female sub-imago in my collection; such a condition, if constant, being probably sufficient for generic separation, showing relationship with *Heptagenia* on the one hand, and *Pentagenia* on the other." Subsequently (in 1899) the genus *Ichthybotus* was founded for its reception by Mr. Eaton.

Genus ATALOPHLEBIA, Eaton (1881).

Imago.—Pronotum of the female with a longitudinal median ridge. Hind tibiæ generally longer than the femora and longer than the tarsus; tarsal claws all narrow and hooked. Middle caudal seta generally developed. Hind-wings more or less obtusely ovate, with costal and sub-costal nervures much arched, the radius nearly straight; transverse nervules abundant in the fore-wing; those in the marginal area, before the bulla, well defined. Forceps basis of male either entire or at most merely emarginate in the middle of its apical edge.

Sub-imago.—Quiescent during many hours, standing upon all its feet, with the wings erect, and with the lateral caudal setæ spreading.

Distribution.—Australasia, Japan, Ceylon, South Africa, South America.

ATALOPHLEBIA VERSICOLOR.

(*Atalophlebia versicolor*, Eaton, Trans. Ent. Soc. Lond., 1899, p. 286.)

This species is common in the Wellington district, but has not been recorded from any other locality at present.

The expansion of the wings of the male is about 1 inch, of the female about $1\frac{1}{8}$ inches.

Sub-imago (dried, and perhaps partly reddened *post mortem* in the killing-bottle).—Fore-wings, in the marginal and sub-marginal areas, tinted with dull reddish-purple, but elsewhere marbled with blackish-grey; the cross-veinlets in the lighter spaces bordered more or less narrowly with this same colouring.

Imago ♂ (dried).—Notum and legs raw umber or light pitch-brown, opaque at the extreme tips of the fore-femur and fore-tibia; the fore-tarsus matches the tibia in tint. Abdomen and forceps dark pitch or bistre-brown; the markings faded. Setæ medium warm, sepia brown, with the distinct joinings blackish; some of the alternate joinings indistinct or not coloured. Basal joint in the forceps limbs compressed, narrowed somewhat suddenly after the acute end of the inferior dilatation. Penis lobes contiguous to each other, concave beneath towards the line of contact, up-curved, narrowed, and sloped off towards their truncate tips. Wings vitreous with black neuration; fore-wing, in the marginal and sub-marginal areas, tinted with transparent raw umber or brown amber; cross-veinlets of the same areas, 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).

Superficially this May-fly appears to be mainly distinguished from *A. dentata* by the marbled wings of the sub-imago and by the less vivid red colour of costal region of the fore-wings of the imago. In its general habits and transformations it closely resembles that species.

ATALOPHLEBIA DENTATA.

Leptophlebia dentata, Eaton, Trans. Ent. Soc. Lond., 1871, p. 80, pl. 4, fig. 18. *Atalophlebia dentata*, Eaton, Trans. Linn. Soc., 2nd series, Zool., vol. iii., p. 88 (1884). Trans. Ent. Soc. Lond., 1899, p. 287.

(Plate VI., fig. 4 ♀, 5 nymph magnified, 6 ♂ sub-imago.)

This pretty May-fly is very common in the neighbourhood of Wellington, and although it has not yet been recorded from any other locality it is probably a generally distributed species.

The expansion of the wings in both sexes is about $1\frac{1}{4}$ inches. The general colour of the body and legs is bright reddish-brown. The costal margin of the fore-wings is bordered with bright red, stronger in the female. There are three tails, each of which is nearly twice the length of the body, the tails and anterior legs of the male being, as usual, considerably longer than those of the female.

The larvæ of this insect are extremely abundant under stones in the streams, a dozen specimens or more, often

being discovered under a single boulder. They are seldom seen swimming in the open, or walking on the upper surfaces of the stones, and it is probable that, but for their secretive habits, their numerous enemies would speedily exterminate them. These larvæ are equally common throughout the entire year, and are always to be found in all stages of growth; mature individuals are, however, most abundant during the summer months. The larvæ of this species, and, in fact, those of the genus *Atalophlebia* generally, constitute one of the most important of the various food supplies afforded to trout by our native Neuroptera. Although individually small, these larvæ are so numerous that they are probably far more valuable as fish food than the larvæ of many of the larger but rarer species, and the fact that they are plentiful at all seasons is a great additional advantage. The importance of these insects in their relation to the cultivation of trout in our streams will, I think, be fully appreciated after an examination of the tables, showing the various species of insects devoured by trout, given in the Appendix.

The full-grown larva of *A. dentata* measures about $\frac{3}{4}$ inch in length, exclusive of any appendages. The head is large, somewhat quadrangular, with the eyes black and very prominent; the prothorax is very broad and almost rectangular. The remaining segments of the thorax taper somewhat, and the wing-pads are rather small. There are seven double pairs of gills on the abdomen, which are kept almost continuously in motion by the larva. Each gill is oval in shape and very pointed at the apex (see Plate XI., fig. 18). The femora of all the legs are oval and very stout. The tails are very slender, considerably longer than the body, the middle tail being the longest. The general colour of the insect is dull brown with black markings.

When about to emerge, this larva crawls out of the water on to a dry stone, and the winged insect escapes in the usual manner.

The sub-imago is very much paler and duller in colour than the imago. The wings are uniformly shaded with dull brown, with the neuration blackish. The insect remains in this state for about two days, during which time it is usually completely quiescent.

The perfect May-fly is found in thousands over the streams during the entire summer, but is most abundant during October and November. It flies in groups of a dozen or more with the characteristic up-and-down flight. These groups can readily be seen projected against the bright evening sky, but are generally out of reach of the net. Occasionally, however, a group will descend a little

lower than usual, when quite a number of specimens may often be secured together.

ATALOPHLEBIA CRUENTATA, n. sp.

(Plate I., fig. 6 nymph magnified.)

The imago of this species very closely resembles that of *A. dentata*, but is generally rather smaller, the colouring is paler and the costal shading of the fore-wings is orange-yellow in place of red.

The nymph of this insect is found commonly in all the streams in the vicinity of Wellington, but is not nearly so abundant as those of either of the two preceding species. It lives amongst the sandy *débris* in the bed of the stream, and is therefore often rather difficult to obtain. On lifting up a large stone this larva either immediately secretes itself amongst the smaller stones underneath, or else clings so closely to the surface of the large stone that it is very difficult to detect, and thus frequently escapes capture. By adopting these tactics it must very often elude fish and other enemies, and on this account alone, apart from its comparative rarity, I do not think that it forms at all an important article of food so far as the trout are concerned.

The length of the nymph when full grown is about $\frac{1}{2}$ inch. Its general colour is bright orange-red. The head and prothorax are rather small and narrow. The wing-pads are of moderate size and black in colour. The legs are rather long and slender, and the anterior pair have two black bands. The abdomen has a dark line down the middle; it is furnished with six pairs of small double gills, which are constantly vibrated by the larva for respiratory purposes.

This larva usually frequents rather slow-running portions of the stream, generally near the bank. It is very hardy in an aquarium. In fact, a constant supply of swift-running water does not seem so essential to its welfare as it does in the case of nymphs belonging to the other members of the genus.

The sub-imago of this species very closely resembles that of *A. dentata*, but the brown colouring of the wings is slightly darker. As a matter of fact, neither the imago nor the sub-imago of these two May-flies can be separated with certainty, unless a very careful and special examination is made of them, but the obvious differences, which are exhibited by their respective nymphs, ensure their immediate and certain recognition during that stage of their existence.

ATALOPHLEBIA NODULARIS.

Leptophlebia nodularis, Eaton, Trans. Ent. Soc. London, 1871, p. 81, pl. 4, fig. 20. *Atalophlebia nodularis*, Eaton, Trans. Linn. Soc., Zool., vol. iii., p. 89, pl. x., fig. 16e.

"*Imago*.—Reddish-black, with translucent spaces on segments 2 to 5 of the abdomen, one on each side of a dark median longitudinal line. Caudal setæ annulated. Wings vitreous, with the marginal and sub-marginal areas reddish-brown. Legs reddish, the fore- and hind-femora with a black band in the middle. Length, 9 mm.; of the wing, 10–12 mm.; of the setæ, 16 mm.

"*Sub-imago*.—Wings light grey, with dark neuration, with an ill-defined irregular dark cloud enclosing a light space.

"*Localities*.—Christchurch, Dunedin, and Wellington" (Hutton).

I have been unable to identify this species with certainty.

ATALOPHLEBIA SCITA.

Baëtis scita, Walker, Cat. Neuroptera in Brit. Mus., p. 570 (1853). *Leptophlebia scita*, Eaton, Trans. Ent. Soc. London, 1871, p. 81, pl. 4, fig. 21. *Atalophlebia scita*, Eaton, Trans. Linn. Soc., Zool., vol. iii., p. 90, pl. x., fig. 16f.

"*Imago*.—Dark brown, the segments of the abdomen broadly tipped with black, the third to the sixth with a pair of translucent yellowish spots. Setæ annulated. Wings vitreous; the fore-wings with a brown spot at the base of the costa, and with less distinct ones in the marginal area at the bulla, and in the pterostigmatic space. In the marginal area there are, in the male, 7–8 cross-nervules before the bulla and 11–13 beyond it; in the female there are 9 before and 18 beyond the bulla. Length of body, ♂ 6 mm., ♀ 9 mm.; of the wings, ♂ 7–8 mm., ♀ 11 mm.

"*Sub-imago*.—Wings dark grey, with black neuration, the nervules of the fore-wings edged with darker; their scarcity behind the sub-costal in the middle of the front of the disk gives rise to the appearance of a pale spot, whilst the mutual approximation of three or four about the bulla, and again in the midst of the pterostigmatic space, produces frequently two dark spots.

"*Locality*.—Christchurch" (Hutton).

I am unacquainted with this species, which appears to very closely resemble *Deleatidium lillii* in superficial appearance.

Genus DELEATIDIUM, Eaton (1899).

"Distinguished as a genus from *Leptophlebia* by the ♂ imago having genitalia conformable in pattern to those of an *Atalophlebia* and by the nymph having tracheal branchiæ in the form of single, ovate, acute, penni-veined, foliaceous lamellæ. The cross-veinlets of the fore-wing, in the typical species, are in two of the specimens widely spaced in places; but in the other specimens of the same and of the other sex the blanks are less noticeable or are filled up. The name in Greek signifies a little bait" (Eaton).

DELEATIDIUM LILLII.

Deleatidium lillii, Eaton, Trans. Ent. Soc. Lond., 1899, p. 289, pl. x., fig. 4.

This little May-fly has occurred at Wellington and at Dunedin. It is probably a common and generally distributed species.

"*Sub-imago* (in fluid).—Wings uniformly light grey with opaque neurulation. Setæ grey; their joinings towards their tips evenly defined.

"*Imago* (dried).—♂ body pitch-brown, the thorax polished above. Femora and fore-tibiæ raw umber-brown; fore-tarsus and hinder tibiæ lighter in tint; hinder tarsi somewhat of a sepia-grey throughout. Wings vitreous with pitch-black neurulation, except in the fore-wing, the finer cross-veinlets 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 the humeral cross-vein, 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 fore-wing, before the bulla, are usually about 6 faint cross-veinlets, and beyond that 2-4 faint and 8-11 stronger veinlets, all simple. Setæ light sepia-grey with blackish joinings, of which some in the basal quarter are alternately distinct and faint. In the abdomen, segments 3-6 are sometimes transparent and whitish to a variable extent at the base.

"♀ very like the ♂, but the colouring at the fore-wing roots, interior to the humeral cross-vein, is rather darker in tint. The marginal area of the fore-wing contains about 3-5 faint cross-veinlets before the bulla and 2 faint and 13 stronger beyond that, all simple. Ventral lobe of the ninth abdominal segment slightly (not deeply) emarginate, with acute points" (Eaton).

The transformations of this species closely resemble those of *Atalophlebia dentata*.

The length of the nymph when full grown is about $\frac{3}{8}$ inch. The head is large, somewhat square with rounded angles; the eyes are very prominent; the antennæ are two and half times the length of the head. The prothorax is very small; the meso- and meta-thorax and the wing-pads are large and well developed dark brownish-black, the wing-pads being almost black. The abdomen is rather narrow and tapering, dull brown; there are two pale spots on segments 2, 3, and 4. The gills are acutely oval, single with a central trachea emitting numerous branches. The anal setæ are about the same length as the entire insect. Younger larvæ are semi-transparent with numerous fine black markings.

The perfect insect appears from October till January, and is often found in enormous numbers flying over streams and rivers at evening dusk.

Genus COLOBURISCUS, Eaton (1887).

Imago.—Legs all functional; hind-tibia longer than the femur or the tarsus; tarsi 5-jointed, the fifth joint rather indistinct; first joint of the hind-tarsus shorter than the second; unguis in all the tarsi dissimilar. Posterior wings well developed, oblong-oval, with the dilatation of the mar-

ginal area acute in front and with relatively scanty neuration in the narrow axillar region. Median caudal seta rudimentary.

Distribution.—Australia and North America.

COLOBURISCUS HUMERALIS.

Palingenia humeralis, Walker, Cat. Neuroptera in Brit. Mus., p. 552 (1853); and *Baëtis remota*, Walker, l.c., p. 564 (1853). *Coloburus humeralis*, Eaton, Trans. Ent. Soc. London, 1871, p. 132, pl. 3, fig. 1, and pl. 6, fig. 6; and Trans. Linn. Soc., Zool., vol. iii., p. 202, pl. 18, fig. 32a. *Coloburiscus humeralis*, Hutton, Trans. N. Z., Inst., xxxi., 217. Eaton, Trans. Ent. Soc., London, 1899, p. 290.

(Plate VI., fig. 8 ♂, 9 ♀, 11 sub-imago ♀, 10 nymph magnified).

In the North Island this May-fly occurs at Wanganui and is very common in the neighbourhood of Wellington. It has also been taken in Canterbury and Otago in the South Island.

The expansion of the wings of the male is $1\frac{1}{4}$ inches, of the female $1\frac{1}{2}$ inches. The body of both sexes is blackish-brown; the anterior legs are black, much longer in the male than in the female; the middle and hind legs are dull yellow with the tarsi blackish. There is a small dull yellow patch near the base of the fore-wings, and a brown patch on the costa near the apex. The central tail is very short, and the two outer tails are about one and a half times as long as the body.

The larva of this insect inhabits rapids in swift-running streams during the entire year, mature individuals being most frequently met with in early spring.

The length of the nymph, when full grown, is a little more than $\frac{1}{2}$ inch. The head is of moderate size; the antennæ are very slender and about two and a half times as long as the head. The thorax is very large, oval, and convex, the wing-pads closely envelop the hinder portions of the thorax, and are rather inconspicuous. There are six pairs of gills on each side of the abdomen. Each gill is attached by a narrow footstalk; it becomes broad in the middle and terminates in a widely divergent fork. The entire gill is armed with numerous short stout spines (see Plate XI., fig. 17). The two outer tails, which are rather stout, are about two-thirds as long as the body, and the central one is very short. The colour of the larva is rich brownish-black and very shining. It is paler on the under surface and at the bases of the limbs. Younger larvæ are entirely reddish-brown, becoming gradually darker in colour as they grow older.

The food of the larva probably consists of decaying vegetable matter.

These larvæ inhabit only the most rapid portions of the stream. They cling very firmly to the stones and

twigs amongst the rapids, where they are often found in large groups. When thus congregated they have a very close resemblance to a bunch of small black twigs, or some other kind of submerged vegetable refuse. Their ability to hold on in the swiftest currents is most remarkable, but they are very feeble swimmers, and are seldom seen in sufficiently calm water to admit of this method of progression. They are very often found in great numbers underneath large boulders in the rapids of the river, where they must be comparatively safe from the attacks of their numerous enemies. This nymph is, in fact, solely adapted for living in extremely agitated water. Its gills are not vibrated like those of most other May-fly larvæ, but are held erect and immovable over the creature's back. In this position they are most efficiently aerated by means of a rapid current of running water passing immediately over the nymph. Owing to these peculiarities this May-fly is extremely difficult to rear in captivity, and larvæ can only be kept alive for a few hours, even if confined in very shallow vessels of water. In deep vessels they almost immediately perish. This insect can, in fact, only be reared by selecting a large number of the mature nymphs, when it will sometimes chance that one or two of them may be within a few hours of their transformation, and these perhaps will have sufficient vitality left to emerge. Unless the larvæ are actually mature they invariably all perish, usually within less than thirty-six hours after they have been removed from their native stream.

Before emergence this larva crawls out of the water on to a dry stone, and the May-fly escapes through a large hole in the back of the thorax. During the latter end of the spring and most of the summer, great numbers of these empty nymph skins are to be found on all the stones just above the level of the water.

The sub-imago has the body dull grey in colour. The legs and tails are considerably shorter than in the imago. The veins of the wings are clouded with grey, and there is no brown mark on the costa near the apex.

This period of the insect's life lasts about two and a half days, and during the whole of the time it rests quietly amongst the foliage on the bank of the stream.

The perfect insect appears about the end of October; it is extremely abundant throughout the whole of November, and specimens may be taken as late as the middle or end of January. It flies in groups over streams during

the late afternoon, generally between five and seven o'clock. Each individual rises and falls in its flight, after the usual manner of May-flies, and in favourable localities the insects are often seen in very great numbers. It is consequently an important species to the angler, as its nymph must furnish an abundant food supply for trout throughout the entire year, the perfect flies also contributing a liberal supply of food during the three months they are more or less abundant.

Genus AMELETUS, Eaton (1899).

"Hind-tibia sub-equal in length to (hardly if at all longer than) the tarsus; basal joint in this tarsus measured along the sole, equal to the next joint, and also dorsally sub-equal thereto, the breadth of the colouring of the tibio-tarsal boundary making it difficult to ascertain their exact proportions dorsally. In every tarsus the outer or posterior claw is narrow and hooked, the inner broad and obtuse, costal shoulder of the hind-wing obtuse." *

AMELETUS ORNATUS.

Chirotonetes (?) ornatus, Eaton, Trans. Linn. Soc., 2nd series, Zoology, vol. iii., pp. 208 and 321, pl. 19, fig. 33c (1888); Hutton, Trans. N. Z. Inst., xxxi., p. 217. *Ameletus ornatus*, Eaton, Trans. Ent. Soc. Lond., 1899, p. 291.

(Plate VI., fig. 1 ♂ subimago, 2 ♀ ditto, 3 nymph magnified.)

This insect has been found at various localities in the vicinity of Wellington. It is very common in the Wainui-o-mata Valley.

The expansion of the wings of the male is 1 inch, of the female $1\frac{1}{2}$ inches. In general appearance the imago of this May-fly very closely resembles that of *Coloburiscus humeralis*, but the brown patch on the costa near the apex is not nearly so pronounced in the present insect, and it is mainly formed by a darkening of the veins only, the membrane of the wing being but slightly shaded with brown. The femur of the anterior legs in the male is also considerably longer than it is in the corresponding sex of *C. humeralis*.

The larva of this insect inhabits only swift clear streams, and frequents the most rapid portions of these, where the current dashes over a stony bottom. It is extremely active, and swims with great rapidity, hence being very difficult to capture. Its colouring is also protective when it is resting on the stones, which is its

* Trans. Ent. Soc. Lond., 1899, 290.

habit; and although the nymph is often very common in favourable localities it is very hard to see.

The food of the larva probably consists of minute particles of vegetable matter, which it finds among the stones. The best method of obtaining specimens of this larva is to carefully sweep with a small net against the current over the shallow rapids, which the insects frequent. In this way two or three specimens may often be secured at once in a stream, where perhaps the presence of the insect was never suspected. Whilst sweeping, half of the net should be kept above the surface of the water, as I have noticed that if a larva is approached in deep water it invariably rises upwards and darts away with great rapidity above the net. This habit would, no doubt, often enable it to escape when pursued by a fish, as a sudden movement above the fish would be very difficult for the pursuer to quickly follow.

The greatest number of mature larvæ are found in the streams during December and January. In February there are still a few full-grown specimens, but in June I observed that the nymphs of this May-fly were all very small, measuring about $\frac{1}{4}$ inch in length. They are, however, equally active at that season, although of course the water is very much colder than in summer.

The length of the full-grown larva, including the tails, is $\frac{3}{4}$ inch. Its general colour is obscure grey, mottled with darker, mature specimens being almost slaty black, but young larvæ are nearly transparent. The head is small, the thorax rather broad, with the wing-pads large and conspicuous. There are seven pairs of small oval gills, situated on the sides of the abdomen, the insertion of each gill being marked by a black dot. The tails are about two-thirds the length of the abdomen. They are fringed with strong hair throughout, and their colour is pale greyish-ochreous, except the middle half of each tail, which is black. The legs are rather short, and are striped with black.

The emergence takes place in the usual manner, the nymph selecting for this purpose a dry stone close to the edge of the stream. During December and January very large numbers of the empty nymph skins may be observed on the stones, showing that the insect actually exists in large numbers, although not often observed.

The sub-imago has the body rather stout, the two outer tails about the same length as the abdomen, the central tail very short, and the wings are prettily marbled with black in the male and dull green in the female. It will thus be seen that the close resemblance of this insect to *C. humeralis* exists during the final condition only, the insect's characters in its preparatory stages, including the sub-imago, being very different to the corresponding stages of that species.

The duration of the sub-imago state of *Ameletus ornatus* is about two days. When at large the perfect insect so closely resembles *C. humeralis* that it is of course difficult to estimate their relative abundance, or to describe their individual habits. The present species is not, however, so common as *C. humeralis*, although, judging from the number of its larval skins which we see on the stones, it must still be an abundant insect in many localities.

AMELETUS PERSCITUS.

Ameletus perscitus, Eaton, Trans. Ent. Soc. Lond., 1899, 291.

(Plate V., fig. 1 ♂, 2 nymph magnified, 3 ♀ sub-imago.)

This very pretty May-fly is fairly common in the neighbourhood of Wellington. It has not at present been recorded from any other locality.

The expansion of the wings is about $1\frac{1}{2}$ inches, and the length of the body $\frac{5}{8}$ inch. The body is pale ochreous, with a series of pale brown markings and black dots on the back. The wings are bright clear yellow and very shining. The central tail is very short. In the male the two other tails are half as long again as the body, but in the female they are considerably shorter.

The larva of this insect is found under stones in rapid streams throughout the entire year. It is generally full grown about the end of December, but some specimens do not reach maturity until the beginning of March. This larva is a very rapid swimmer, and cannot readily be captured without the aid of a small net. Unlike most May-fly nymphs it is carnivorous, and feeds on the larvæ of various smaller species (*Atalophebia* and *Deleatidium*), which it captures by means of its powerful jaws.

The length of the mature larva is rather less than 1 inch. The head is nearly round and very large. The eyes and ocelli are black and very conspicuous. The organs of the mouth are well developed; the mandibles and maxillæ are long, slender, and sickle-shaped. The thorax is rather long and narrow, and the wing-pads do not project beyond the parallel sides of the thorax. The abdomen is furnished with seven pairs of very large leaf-like gills (see Plate XI., fig. 16), which are frequently simultaneously vibrated by the larva. There are three stout tails at the end of the body, each of which is strongly fringed with long hair. The legs are rather short and slender, pale yellowish-brown striped with black. The general colour of the larva is dull greenish-ochreous, with dark brown or blackish markings. Younger specimens are usually much paler and yellower in colour.

This larva may be at once recognised by its very large head and conspicuous eyes, no other May-fly nymph with

which I am acquainted approaching it in this respect. The general colour of the larva is very protective, which renders its detection a matter of considerable difficulty when it is resting on stones in the water. These nymphs are very common in some streams, and as they are always to be found, they must provide the trout with a certain amount of food, especially during the winter. On the other hand, being carnivorous and very rapacious, they destroy large numbers of the larvæ of the smaller Ephemeridæ, which are equally, if not more, serviceable as food to the trout, than themselves, so that it is doubtful whether the angler has much cause to thank this insect.

When full grown this nymph crawls out of the stream and clings tightly to the surface of a dry stone, the winged insect afterwards emerging through a large rent in the back of the thorax. In one specimen I observed the process of exclusion lasted about eight minutes, but the wings expanded to their full size almost as soon as they were withdrawn from their cases. The May-fly appears to give them one shake, and then places them in the usual vertical position over its back.

The sub-imago is a most beautiful insect. Its wings are semi-opaque and of the most brilliant yellow, with a few faint blackish markings. The legs and tails are considerably shorter than in the imago. The eyes are bright green in colour.

The insect remains in this condition for about three days, during which interval of time it quietly rests amongst the vegetation on the bank of the stream. The colouring of the sub-imago is no doubt protective, the beautiful yellow tint of the wings closely resembling the hue of certain faded leaves. This resemblance is especially noticeable when the sub-imago is resting just after emergence on the surface of the water. At this critical moment the May-fly is in great danger of attack both from fish beneath the water and from birds above it, these creatures being only too ready to seize and devour the helpless insect. It is therefore probable that a special protective resemblance, such as the present species enjoys, would be most efficient in preserving it from destruction at this time; and such a resemblance would readily be produced by natural selection continually preserving those variations, which conformed in the closest possible manner to the leaf-like pattern.

The perfect insect appears in January, February, and March. It is about for a much longer interval than most

of the other May-flies, and its beautiful sub-imago is also more frequently seen by casual observers. The imago is seldom seen, and I have not yet observed it flying at night.

This May-fly is not nearly so common as *Ichthybotus hudsoni*, although its nymphs are much more frequently observed, probably owing to their inhabiting the clear portions of the streams, instead of secreting themselves in burrows in the banks.

Genus ONISCIGASTER, McLachlan (1873).

Imago.—Legs all functional; hind tibiæ much shorter than the tarsus; claws dissimilar in each tarsus. Hind-wings well developed, obtusely sub-ovate, the dilatation of the marginal area obtuse in front; axillar region well developed, largely occupied by numerous long anastomosing nervules from the inner margin. Median caudal seta shorter than the outer pair. Abdomen very robust.

Distribution.—New Zealand.

This is a very interesting genus, and is probably rapidly approaching extinction.

ONISCIGASTER WAKEFIELDI.

Oniscigaster wakefieldi, McLachlan, Ent. Mo. Mag., vol. 10, p. 108 (1873); Journ. Linn. Soc., vol. 12, p. 139, pl. 5, figs. 1–5; Eaton, Trans. Linn. Soc., 2nd series, Zool., vol. iii., p. 224, pl. 21, fig. 36 (details imago) and pl. li. (nymph); Sharp, in Cambridge Natural History, vol. v., Insects, p. 442, fig. 284; Hutton, Trans. N. Z. Inst., xxxi., 218; Eaton, Trans. Ent. Soc. Lond., 1899, 292.

This remarkable species has occurred in the Canterbury and Nelson districts, but appears now to be an extremely rare insect.

The expansion of the wings of the male is about $1\frac{1}{2}$ inches, of the female $1\frac{3}{4}$ inches. "The general colour of the imago is dark brown, rather lighter in the male. The wings are vitreous, faintly tinged with light brown; nervules dark edged. The legs are light brown, banded with darker. Length, 16–21 mm.; wing, ♂ 16 mm., ♀ 19–21 mm.; setæ, 17 and 5 mm. Expanse of the wings, ♂ 35 mm., ♀ 40 mm.

"The sub-imago has the body greyish. The wings are sub-opaque, smoky grey; nervules of the anterior portion of the fore-wing broadly edged with dark brown. Length of the setæ, 13 and 7 mm." (Hutton).

"In this species the female has three dorsal segments, viz., the seventh to ninth, sinuate somewhat deeply on each side at the posterior margin, and dilated laterally into thin expansions, that are rounded off to the base in front and acute behind, so as to form broad serratures like coxæ of *Oniscus murarius*. Above these the back, in dried specimens, is somewhat fornicate, with a median longitudinal depression. The first and second of the lateral

serratures are broader, and are rather more produced at the point than the third" (Eaton).

Respecting the extreme rarity of this insect at the present time, Captain Hutton remarks as follows:—

"In 1874 this insect was common in the neighbourhood of Christchurch. I have lived there during the last nineteen years without seeing a single specimen. Whether they have been killed off by the trout or by the sparrows I cannot say."

I am unacquainted with this interesting insect.

ONISCIGASTER INTERMEDIUS.

Oniscigaster intermedius, Eaton, Trans. Ent. Soc. Lond., 1899, 292, pl. x., 6a detail.

In the North Island this species occurs in a certain restricted spot near Wellington, and I once captured a single specimen on the Tableland of Mount Arthur in the South Island, at an elevation of 3,600 feet above the sea-level.

Concerning the specific character of this May-fly Eaton says:—

"A single female imago differs from *O. wakefieldi* in having only two dorsal segments, viz., the eighth and ninth, dilated laterally, and this only moderately; back sub-fornicate above the dilatation. Lateral borders of eighth segment almost straight, except where they gently curve inwards near the base, and very nearly parallel, diverging only to a very small extent posteriorly; back transverse at the posterior margin; the postero-lateral angles obtuse. Ninth segment as broad or perhaps a little broader than the eighth; its lateral margins saliently curved, and bordered each by a linear flange terminating posteriorly in a minute point; the posterior margin of the dorsum transverse between these points. Wings marked as in *O. wakefieldi*."

The transformations of this insect closely resemble those of the next species.

ONISCIGASTER DISTANS.

Oniscigaster distans, Eaton, Trans. Ent. Soc. Lond., 1899, 293, pl. x., 6b and 6c.

(Plate I., fig. 9 ♀, 10 ditto, sub-imago, 11 nymph enlarged.)

This handsome species has been found at Wainui-o-mata, near Wellington.

The expansion of the wings of the male is $1\frac{3}{4}$ inches, of the female $1\frac{3}{4}$ inches. The general colour in both sexes is blackish-brown and very

shining. The cross-veins on the costa near the base of the wing are very thick, especially in the female. The costa of the fore-wing is shaded with brown near the apex. The length of the body is about $\frac{3}{4}$ inch. In this species none of the abdominal segments are produced into lateral flanges.

The nymph inhabits the rapid rocky stream which flows into the Upper Wainui-o-mata River on its eastern side above the reservoir, locally known as George's Creek.* It is not very active, and, owing to its large size, is easily seen and captured by means of the hand only. Hence its speedy extinction by trout appears inevitable; and it is noteworthy that in the lower portions of the Wainui-o-mata, where trout have been abundant for many years, none of these insects occur.

The length of the full-grown larva, including the terminal appendages, is nearly $1\frac{1}{4}$ inches. The head is rather small, with the eyes black and very prominent. The thorax is rather narrow with the wing-pads small. The abdomen is broad; the edges of each segment are produced into distinct flanges, which project backwards like teeth. There are six pairs of gills, which do not ordinarily extend beyond the sides of the abdomen, but in the living insect are usually held somewhat above the back. (See Plate XI., fig. 15, single gill much magnified.) They are almost continuously in motion. A very pronounced row of projections exists on the dorsal surface of the abdomen, which forms a very characteristic, serrated, horny crest. The tails are stout and strongly fringed; the ends of the two outer tails are often curved; the central tail is straight and slightly shorter than the other two. The legs are rather short and moderately slender. The general colour of the larva is dull slaty brown marked with black, and sometimes slightly tinged with dull reddish. Younger larvæ are very much paler, with the black markings darker; occasionally they have in addition several irregular white patches on the body.

The food of this insect appears to consist of vegetable matter, probably contained in the earthy matter composing the bed of the stream. It is found in the streams throughout the entire year. Very small specimens are most abundant in autumn and winter, the nymph becoming full grown about November. At this season the larva leaves the water and ascends a dry boulder, generally near the middle of the stream. The May-fly then escapes through a rent in the back of the nymph.

The sub-imago of this species is extremely handsome when alive, a dried specimen giving but a feeble idea of its real appearance. The general colour of the wings is deep purplish-black, beautifully mottled with darker black. All the appendages are, as usual, shorter and stouter than in the imago. The insect remains in the sub-imago state for three or four days. During a con-

* I have also found this insect in the Mangatariri River, at the foot of Mount Holdsworth.

siderable portion of this time it rests on the boulders with its wings erect, and specimens may then easily be picked up by hand. Whilst thus resting it is no doubt often devoured by birds, and the insect's early extermination, through this cause alone, would appear probable.

As yet I have not observed the perfect May-fly in a state of nature, having reared all the specimens at present obtained from the sub-imago.

Family VIII.—SIALIDÆ—ALDER-FLIES.

“ Four wings of moderate size, meeting in repose over the back at an angle; the hinder of the two pairs slightly the smaller; the anal area small or nearly absent, not plicate. Nervures moderately numerous, transverse veinlets moderately numerous, forming irregularly disposed cells. The metamorphosis is great; there is a quiescent pupa. The larva has the mandibles formed for biting, armed with strong teeth ” (Sharp).

Genus CHAULIODES, Latreille (1805).

“ Prothorax as large as the head. Three ocelli close together. Antennæ pectinated or serrated. Neuration moderate, the nervules slender. Joints of the tarsi cylindrical. Caudal appendages of the male conical and simple.

“ *Distribution*.—Asia, Africa, America, Australia ” (Hutton).

CHAULIODES DIVERSUS.

Hermes diversus, Walker, Cat. Neuroptera in Brit. Mus., p. 205 (1852). *H. dubitatus*, Walker, *l.c.*, p. 204. *Chauliodes diversus*, McLachlan, Ann. Mag. Nat. Hist., ser. 4, vol. 4, pp. 37 and 39.

(Plate VII., fig. 1 ♂, 2 ♀, 3 larva, 4 pupa).

This large and conspicuous insect has been found abundantly in the North Island, and at Nelson in the South Island. It is probably generally distributed throughout New Zealand.

The expansion of the wings of the male is about 2 inches, of the female fully 3½ inches. The head is considerably broader than the thorax, with very prominent eyes, and three conspicuous ocelli on the crown. The thorax and abdomen are slender in the male, but rather stout in the female. The general colour of the body of both sexes is dull reddish-brown, irregularly clothed with numerous minute whitish hairs. The antennæ of the male are rather longer than the body; in the female they are considerably shorter. The wings in both sexes are elliptical, very pale brown with numerous dusky dots on the veins, especially near the costa.

The larvæ of this insect are very familiar to anglers and are generally called "Black Creepers." They are strictly aquatic in their habits, and dwell under the stones in the beds of rivers and streams, where they are often very abundant. These larvæ are found in the streams throughout the entire year, but are most numerous during the late spring. Their food consists chiefly of the larvæ of Ephemeridæ (May-flies), but they prey on aquatic insects generally, which they capture and devour whilst lurking beneath the stones in the bed of the stream.

The growth of these larvæ is probably very slow, and I should imagine that at least a twelvemonth would be occupied by the insect in reaching its full size; but, as larvæ of all ages are found in the streams during the entire year, it is a difficult matter to ascertain precisely the length of time taken by a single individual in attaining maturity. I have, however, observed that small specimens are commonest in the autumn, winter, and early spring, and have also noticed that very small specimens are of comparatively rare occurrence. It may thus be fairly assumed that larvæ, resulting from eggs deposited by the female insect about December, do not mature, at the earliest, until the following October or November. This is corroborated by the fact that we do not find any larvæ preparing to undergo their transformation during the winter; but larvæ about to change are very abundant in December and January.

The full-grown larva of *C. diversus* measures from $1\frac{1}{4}$ to $1\frac{1}{2}$ inches in length. The head is broad, nearly round, highly polished, black and extremely hard. It is furnished with the usual mouth organs, which are well developed, the maxillæ and mandibles being especially powerful; the latter are furnished with several teeth. The antennæ are three-jointed and very minute. The prothorax is oblong-oval, black, extremely hard, and highly polished on its upper surface. The meso- and meta-thorax each have a pair of horny dorsal plates. The legs are rather short, moderately stout, and furnished with two-jointed tarsi. The visible segments of the abdomen are nine in number, each of which, except the last, is furnished with a pair of cylindrical pointed processes, fully as long as the segment is wide. These processes spring from the sides of the insect, and are the gills; but as they have a certain superficial resemblance to legs, the larva is sometimes regarded by the uninitiated as a kind of water centipede. The last segment of the abdomen is destitute of gills, but possesses two appendages projecting backwards, each of which terminates in a pair of very strong, horny hooks. These hooks are very serviceable to the larva for locomotive purposes, especially when it is engaged in climbing about the rocky bed of a rapid torrent.

When full grown this larva leaves the water and secretes itself under a large stone, immediately on the edge of the stream. Here it excavates an oval cell in the

soft, wet mud, or sand, beneath the stone, and carefully smoothes it within. During the course of a few days the larva becomes somewhat shrivelled, and after a week or so sheds its skin and appears as a pupa. This habit of leaving the water, just at the time when the shrinkage in the volume of the rivers occurs, is no doubt very beneficial to the insect as, unlike many other neuropterous pupæ, it is able to imbibe air and thus escape destruction by drought.

The pupa of *C. diversus*, in its natural curved position, measures about 1 inch in length. Its limbs closely resemble those of the perfect insect, except the wings which are, of course, rudimentary. The larval gills are replaced by a series of wart-like projections, situated on each side of the first eight segments of the abdomen.

This pupa is not endowed with the power of locomotion until shortly before it undergoes its final transformation. About this time the legs are gradually stretched out, and in a few days are sufficiently powerful to enable the insect to leave its prison in the earth and walk about. Shortly afterwards the skin is cast off, and the perfect fly ascends the stem of some plant, and dries and expands its wings.

The imago appears from the middle of November until the middle of January. It is seldom seen in the daytime, but is usually observed at evening dusk, flying in rather a slow and laborious manner. It is sometimes fairly abundant, especially in the neighbourhood of rivers. When on the wing this large insect is not conspicuous, unless seen against the bright glow of the evening sky; and it is still less noticeable in the daytime whilst resting on tree-trunks or amongst foliage.

Family IX.—**PANORPIDÆ—SCORPION-FLIES.**

No species belonging to this family have been found in New Zealand at present.

Family X.—**HEMEROBIIDÆ—ANT-LIONS, LACEWING-FLIES, &c.**

“*Head vertical; maxillæ free with five-jointed palpi; labial palpi three-jointed. Wings sub-equal in size, with much reticulation, without anal area. Tarsi five-jointed. Metamorphosis great; the larvæ with mandibles and*

maxillæ co-adapted to form spear-like organs that are suctorial in function. Pupa similar in general form to the imago, enclosed in a cocoon" (Sharp).

"The Hemerobiidæ are an extremely varied assemblage of Neuroptera; the perfect insects of the various sub-families are very different in appearance; but the family as a whole is naturally defined by the very peculiar structure of the mouth organs of the larvæ. These insects have, in fact, a suctorial mouth in their early life, and one of the ordinary biting type in adult life.

"This is a very unusual condition, being the reverse of what we find in the Lepidoptera and some other of the large orders, where the mouth is mandibulate in the young, and suctorial in the adult. The suctorial condition is in the Hemerobiidæ chiefly due to modification of the mandibles; but this is never the case in the insects that have a suctorial mouth in the imaginal instar. Nearly all the Hemerobiidæ are terrestrial insects in all their stages; a small number of them are, to a certain extent, amphibious in the larval life, whilst one or two genera possess truly aquatic larvæ. The metamorphosis is, so far as the changes of external form are concerned, quite complete. There are no wingless forms in the adult stage." *

The classification of the *Hemerobiidæ*, given by Hagen and generally adopted, recognises seven sub-families, of which only two are at present known to occur in New Zealand.

Sub-family I.—MYRMELEONIDES, or ANT-LIONS..

Antennæ short, clubbed, the apical space of the wing with regular oblong cellules.

Genus MYRMELEON, Linne (1748).

Antennæ short, clavate or sub-clavate. Abdomen long and slender.

Distribution.—Widely spread in warm latitudes.

MYRMELEON ACUTUS.

Myrmeleon acutus, Walker, Cat. Neuroptera Brit. Mus., p. 377 (1853). *M. novæ-zealandiæ*, Colenso, Trans. N. Z. Inst., vol. 17, p. 156 (1885).

(Plate I., fig 7.)

* Sharp, *loc. cit.* 453.

This beautiful insect appears to be common in most sandy localities in the North Island.

In the South Island it has been found at Nelson, and occasionally as far south as Christchurch.

The expansion of the wings of the male is $2\frac{1}{2}$ inches, of the female 3 inches. "Black, slender, slightly tinged with grey; head yellow towards the mouth, with a yellow spot on each side of the face and a yellow streak by the base of each antenna; palpi tawny; antennæ wanting. Abdomen much shorter than the wings; legs black, femora beneath towards the base, and hind-tibiæ yellow. Wings slightly grey, long, very narrow, slightly pointed; pterostigma pale yellow; veins black with yellow bands; sub-costal areolet simple, their veins forked at intervals from one-third of the length of the wing to the pterostigma, where there is a dark-brown spot; rows of dark-brown spots along the radius and its sector, and along the cubitus and its fork; small brown spots on the forks of the marginal veins and on the gradate veinlets towards the tip of the wing and along the hind border; a larger brown spot at the tip of the fork of the cubitus and another by the last of the quadrate areolet between the first sector of the radius and the cubitus; hind-wings a little shorter and narrower than the fore-wings, with a few brown dots towards the tip and along the hind border. Length of the body, 30 mm.; expanse of the wings, 71 mm." (Walker).

The perfect insect appears in January and February, and frequents many sandy situations. It is not often observed at large, but is frequently found in houses, having been attracted thither by the lights at night.

Sub-family II.—HEMEROBIIDES, or LACEWING-FLIES.

"Wings in repose forming an angular roof over the body; the antennæ moniliform or pectinate, not clavate" (Sharp).

Genus STENOSMYLUS, McLachlan (1867).

"Prothorax elongated, sub-cylindrical. Wings long and narrow, rounded or acute at the apex, sub-falcate with the apical margin excised in the New Zealand species. Sub-costal nervules numerous, those in the disk very numerous. Tarsal plantulæ bifid or deeply excised.

"*Distribution*.—Australia and New Zealand" (Hutton).

At present this extremely interesting genus is only represented in New Zealand by four species. Two of these were discovered comparatively recently, and it may therefore reasonably be anticipated that others still remain to be found. This is especially probable amongst the densely wooded ranges and valleys of the west coast of the South Island, which have been, as yet, but little explored by entomologists.

STENOSMYLUS INCISUS.

Osmylus (?) *incisus*, McLachlan, Journ. of Entomology, vol 2, p. 112, pl. 6, fig. 1 (1863). *Stenosmylus incisus*, McLachlan, Ent. Mo. Mag., vol. 6, p. 195.

(Plate VIII., fig. 2, 3 larva magnified, 4 pupa magnified.)

This very beautiful insect appears to be fairly common in the forests of the North Island. In the South Island it has occurred in the Nelson and Otago districts.

The expansion of the wings is $2\frac{1}{2}$ inches. The fore-wings are very narrow near the base, with the apex much rounded and the termen rather deeply excised. In colour the body is brownish-black; the wings are tinged with very pale brown, and are clouded with darker brown. There are three irregular blotches on the dorsum, and a somewhat lunate mark near the apex, besides a very large number of more or less distinct smaller markings. The hind-wings are more or less elliptical in shape; their markings closely resemble those of the fore-wings, but are less distinct. These markings vary very much in strength in different individuals. One rather uncommon variety has nearly all the smaller markings absent, and the larger ones are merged almost insensibly into the ground colour of the wing, which is considerably darker than usual. On the other hand, many specimens have the wings almost transparent, and in these the darker markings are proportionally fainter.

The larva of this insect lives under stones close to the edges of streams, in densely wooded valleys. Although it does not frequent situations which are submerged for long periods, it is only to be found in very wet places.

The length of this larva when full grown is nearly $\frac{3}{4}$ inch. Its general colour is black and very shining. The head is round and very horny; the mandibles and maxillæ are closely pressed together, extremely long, and form in conjunction two lance-like organs, which project forwards and upwards. They are considerably more than one-third of the length of the body of the insect. The labial palpi are very long, and consist of six joints. The first is rather long and slender, the second stouter, short, and round, the third very long and slender, and the remaining three much shorter, of equal length and very slender. The legs are short and not very stout. The prothorax is rather narrow, and is longer than the other two segments of the thorax. Each division is furnished with two large metallic dorsal plates. The abdomen gradually tapers towards its extremity, which is furnished with a strong proleg. There are several shining metallic tubercles on each segment of the abdomen. Each tubercle emits three or four long, stout bristles.

This larva is unquestionably carnivorous, but I have not yet ascertained the precise nature of its food. Numerous small insects and crustaceans are found in the situations frequented by the larva, and it is probable that it preys upon these small creatures. When full grown the larva of this insect constructs a thin, white, silken cocoon, which is usually attached to a small stone

underneath a large boulder, and within which it changes into a pupa. In general structure the pupa closely resembles the perfect insect; but its limbs are incapable of any definite movements until shortly before its final transformation.

The perfect insect appears about November, and continues on the wing until about the middle of March. It frequents densely wooded forest ravines, and is generally dislodged by beating the profuse growth of ferns, which fringe the edges of the streams in such situations. As it flies with considerable rapidity, it is often difficult to capture, a lengthy pursuit being, as a rule, quite impracticable on account of the extremely rough nature of the ground.

When resting amongst foliage or in the bed of the stream this insect is very hard to detect, the general shape and colour of the creature's wings causing it to resemble, in the closest possible manner, a dead, or partially skeletonised, leaf. Seeing that hundreds of such leaves are always found where the insects occur, the value of such a protective resemblance is obvious.

STENOSMYLUS CITRINUS.

Stenosmylus citrinus, McLachlan, Ann. Mag. Nat. Hist., ser. 4, vol. 12, p. 38 (1873); Trans. N. Z. Inst., vol. 6, App., p. xcvi.

(Plate VIII., fig. 6 type, 5 variety.)

This extremely beautiful insect has occurred at Waitara, near New Plymouth and in the neighbourhood of Wellington. In the latter locality it is fairly common, though somewhat scarcer than the preceding species.

The expansion of the wings is from 2 to $2\frac{1}{4}$ inches, and the length of the body about $\frac{5}{8}$ inch.

"The whole insect is of a delicate citron colour, excepting the abdomen, which is infusate; but the colour of this part is probably changed in dry examples. On the face the colour becomes obscured, and below the base of the antennæ it is blackish. On the pronotum anteriorly there is a trace of a black median longitudinal line, and the sides are broadly black, with black hairs; the meso- and meta-nota have the sides broadly infusate, bordered by a black line. The anterior and intermediate tibiae have a black spot at each end and in the middle; the posterior femora are somewhat infusate, darker at each end, and with a trace of a black spot in the middle; all the legs are clothed with citron-coloured hairs. The anterior wings have many small black dots, those below the radius, and two discal ones, larger than the others; at the end of the first branch of the sector and the upper

cubital vein, before the apex, is a conspicuous irregular whitish spot margined with black, and along the excised apical margin and on the inner margin are smaller whitish spots, margined with blackish internally, or with a blackish dot on each side; the sector has sixteen principal branches; the inner series of gradate nervules is rudimentary. The posterior wings are paler than the anterior, without whitish spots; and the black dots are only faintly indicated on the costal margin." *

This species varies very much in colour. The wings are much brighter in some specimens than in others. The dull forms somewhat approach very pale specimens of *S. incisus*, but are quite distinct therefrom. Some of the bright forms are very beautiful, and almost golden when the insect is alive. One very striking and rare variety has the black spots on the wings very large, and the ground colour less golden and more yellow than usual (see fig. 5). The transformations of this insect appear to closely resemble those of *S. incisus*. The larva is, however, softer, larger, stouter, and of a pale brownish colour in place of black. Its jaws are also shorter, but in other respects it appears identical with the same stage in *S. incisus*. It constructs a cocoon exactly like that insect, but the enclosed pupa is pale yellowish-brown.

The perfect insect appears at the end of November, and may be met with until about the middle of March. It frequents the banks of streams in deep, forest-clad valleys, where it may often be taken in company with *S. incisus*.

STENOSMYLUS STELLÆ.

Stenosmylus stellæ, McLachlan, Ent. Mon. Mag. Second Series, vol. x. 259.

(Plate VIII., fig. 8 type, 7 variety *obliteratus*.)

This pretty little species appears to be extremely local, though it is sometimes very abundant in certain favoured spots which it frequents.

I first met with the insect in January, 1889, when I captured a single specimen of the variety *obliteratus*, at the source of the River Pearse, near Mount Arthur, Nelson, at an elevation of about 3,600 feet above the sea-level. From that time I believe no other specimens were found until November, 1898, when I re-discovered the insect at Wainui-o-mata. Here it occurred in the greatest profusion resting on the fuchsia bushes,

* McLachlan, Ann. Mag. Nat. Hist., July, 1873.

fringing three of the eastern tributaries of the main river above the Wellington Reservoir; subsequent experience has proved these streams to be unfailing localities for this insect. Although I have not heard of its occurrence elsewhere, I think there is little doubt that this species will be found in other places when the country has been more thoroughly explored by entomologists. It is evidently a very local insect, and one that should be specially looked for by collectors, when working in little-known districts.

The expansion of the wings ranges from $1\frac{1}{2}$ to $1\frac{1}{4}$ inches; the length of the body is about $\frac{3}{4}$ inch. The insect is thus described by Mr. McLachlan:—*

"Of the form and structure of *S. incisus*, McL., and *S. citrinus*, McL., but nearly one-half smaller.

"*Head and thorax* (including antennæ and palpi) dull reddish-brown varying to fuscous, the face and basal portion of the antennæ often paler. Pronotum usually darker on the sides, about one-half longer than broad, narrower than the head, the lateral margins nearly parallel, a deep transverse sulcus shortly before the posterior end; it is rather sparingly clothed with somewhat bristly yellowish hairs. *Legs* yellowish, somewhat dingy, with pale hairs; occasionally (especially in the ♀?) the base and apex of the femora and of the tibiæ, and the tips of the tarsal joints, are brownish or fuscous. *Abdomen* blackish in the dry insect: in one sex (probably the ♀) at the ventral apex there is a pair of closely applied geniculated and articulated valves clothed with pale hairs; the rest of the abdomen with only a few scattered hairs on the sutures.

"*Wings*—in the anterior the ground colour may be termed pale brownish-yellow (varying much in intensity), in which are large whitish spaces, viz., three large subquadrate spots on the inner margin; a large, badly limited, and very irregular discal space beyond the middle of the wing, usually connected with the third spot on the inner margin; and a nearly circular spot below, and slightly beyond, the pterostigma; the spots on the inner margin are separated by dark smoky-brown spaces, and the other pale markings are margined with dark smoky-brown; the inner margin narrowly dark smoky-brown, with whitish interruptions in the excised apical portion; the costal edge is also alternately whitish and dark brown; the pterostigma very dark brown, with a paler spot near its inner end (these markings give the wings a prettily variegated appearance): neuration mostly pale, but whitish in the pale spaces, and with the gradate nervules, and some other portions, blackish; costal nervules mostly simple; sector with about nine branches. Posterior wings pale brownish-yellow, without darker markings (except the pterostigma), but with three large whitish spaces, one at the anal angle, one discal beyond the middle, and one below the pterostigma.

"I have examined four examples. Named (by request) after Mr. Hudson's little daughter Stella.

"*Var. CONNEXUS var. nov.*

"Differs from the type form in the whitish markings of the anterior wings being absent, but their position is indicated by the dark markings which remain. The posterior wings are wholly pale brownish-yellow, excepting the dark-brown pterostigma.

* Ent. Mon. Mag. Sec. Series, vol. x. 259.

“*Hab.* As in the type form. I have examined two examples.

“*Var. OBLITERATUS var. nov.*

“In this form both whitish and dark markings have practically disappeared from the wings (the dark pterostigma always excepted), which are nearly uniformly brownish-yellow (or *vice versa*), the posterior paler. But on the anterior there is usually a faint trace of the pale markings (if examined in a good light), and the excised apical margin is narrowly darker with paler interspaces.

“*Hab.* As in the type form. I have examined four examples. In uniformity of coloration this form might be likened to a very diminutive *S. citrinus*.”

There is no doubt that these varieties all belong to the same species, Mr. McLachlan also being of that opinion. The forms above described represent extreme and intermediate conditions, and in a long series can be completely connected.

“In the falcate wings, and the character of the markings in the type form, there is some resemblance to the North Indian *Osmylus Langii*, McLach., and allied species of *Osmylus* from the same region.”

The early stages of this insect evidently closely resemble those of *S. incisus*. I have bred two specimens from small silken cocoons found under wet stones, near the edge of one of the streams above mentioned, and these cocoons were very similar to those constructed by the larva of *S. incisus*.

The perfect insect appears about the middle of November, and is most abundant during the first week in December. After that time it rapidly decreases in numbers.

STENOSMYLUS LATIUSCULUS.

Stenosmylus latiusculus, McLachlan, Ent. Mo. Mag., ser. 2, vol. 5, p. 241 (1894).

(Plate VIII., fig. 1.)

So far as is at present known, this is the rarest species of *Stenosmylus* found in New Zealand, and is represented in collections by only three specimens. Two of these are in Mr. McLachlan's collection. One was taken at a lighted window in the Otira Gorge and the other one at Greymouth (?), both these localities being on the west coast of the South Island. The third specimen is in my collection and was captured on the banks of the Oronga-

ronga River, about ten miles to the eastward of Wellington Harbour.

The expansion of the wings is slightly over $1\frac{1}{2}$ inches, and the length of the body about $\frac{5}{16}$ inch.

"Head above and pronotum yellowish; ocelli large but not prominent, approximate; antennæ pale-brown, the two basal joints and the base of the third joint yellow. Meso- and meta-nota yellowish, clouded with fuscous. Anterior legs pale yellow, the tips of the tibiæ and tarsal joints brownish, plantula brownish; posterior legs mostly fuscous. Abdomen (♀) fuscous above, dull yellowish beneath; apex obtuse, provided beneath with an ovipositor (?), which appears to consist of two closely applied 2-jointed pieces, the second joint directed backward from the first; the posterior margin of the seventh ventral segment produced in its middle into a quadrate valve, from within which a cylindrical process, broad at its base, is directed between the basal joints of the above-described apparatus. Wings long-oval, sub-acute at the apex, with a very slight sub-apical excision, ground colour pale grey; anterior wings with the neuration blackish and whitish irregularly alternate, giving a faint irregular tessellated appearance; pterostigmatic region long but ill-defined, whitish-testaceous; posterior wings almost without markings. Length of body, 13 mm.; of anterior wing, 26 mm.; its greatest breadth, 9 mm.; expanse of wings, 54 mm.

"Locality.—Otira Gorge.

"Variety.—The head above and the pronotum more dusky, and the black margins of the latter rather broader. Posterior legs wholly yellowish. The anterior wings rather more strongly marked. Smaller. Expanse of wings, ♀ 45 mm.

"Locality.—Greymouth (?)." *

This species may be easily recognised by its size, which is intermediate between *S. incisus* (or *citrinus*) and *S. stellæ*, also by its very slightly excised wings, and their peculiarly dull tessellated appearance. The perfect insect appears in January. It will probably be found to frequent the edges of clear mountain torrents, in valleys densely wooded with black birch (*Fagus cliffortioides*); each of the three specimens at present taken appears to have been found in a locality of this description.

Genus DREPANEPTERYX, Leach (1835).

"Antennæ rather shorter than the body, moniliform, the basal joint very robust; maxillary palpi long and slender, labial palpi very short; ocelli wanting. Thorax broad. Wings broad; anterior pair much dilated and rounded at the base, very numerous dichotomous nervures united by two longitudinal series on the costal area, and three somewhat irregularly placed oblique series on the disk, exclusive of the pair common to all the family; the apical margin excised, and with a recurved apex; the base of the inner margin with a mucronated process. Posterior wings shorter, with fewer nervures, somewhat lanceolate-acute, the hinder margin waved. Abdomen compressed. Legs long and slender.

"Distribution.—Europe, Asia, &c." (Hutton).

We have two species in New Zealand.

* Hutton, Trans. N. Z. Inst., xxxi. 231.

DREPANEPTERYX INSTABILIS.

Drepanepteryx instabilis, McLachlan, Journ. of Entomology, vol. 2, p. 115, pl. 6, fig. 4 (1863).

This pretty little insect has occurred at Palmerston North and Wellington in the North Island, and at Nelson and Otago in the South Island. It is not a very common species, though apparently generally distributed.

The expansion of the wings is from $\frac{1}{2}$ to $\frac{3}{4}$ inch. "Reddish-fuscous; antennæ pale greyish-ochreous, annulated with brown; prothorax black at the sides; legs very pale greyish-ochreous. Anterior wings deeply excised below the apex, greyish subhyaline, clouded and irrorated with greyish-brown, forming transverse streaks on the costal margin; six sectors radii, ten gradate veinlets in the inner series, fourteen in the outer, the latter deeply margined with blackish; longitudinal veins dotted with greyish-brown. Posterior wings whitish-hyaline, interruptedly margined with grey; some of the veins blackish.

"A variety has both series of gradate veinlets in the anterior wings margined with blackish; between them, on the costa, is a large subhyaline space without markings, and a somewhat conspicuous black spot near the base" (Hutton).

This species is very variable in size, as well as in the colouring of the wings. In some specimens they are nearly transparent throughout, whilst in others they are almost entirely brown, with a large transparent patch in the middle of each.

The larva of this insect probably feeds on *aphides*, but has not yet been observed. The imago appears from October till March. Single specimens are frequently disturbed from amongst foliage, but I have never met with the species in large numbers. It is very sluggish, and when captured usually drops to the bottom of the net, or rests quietly on the side. The wings are carried over the back, forming, when closed together, an extremely acute angle.

DREPANEPTERYX HUMILIS.

Drepanepteryx humilis, McLachlan, Journ. of Entomology, vol. 2, p. 116, pl. 6, fig. 5 (1863).

"Ochreous, slightly pilose; antennæ pale ochreous; eyes lurid. Pro- and meso-thorax somewhat fuscous at the sides. Legs pale ochreous, tarsi fuscous. Anterior wings slightly excised at the apical margin, subhyaline, clouded with greyish-ochreous, and with a few scattered black dots, most numerous along the costal margin; apical and inner margins narrowly fuscous, spotted with white; longitudinal veins with fuscous points; nine veinlets in the inner gradate series, some of which are fuscous, thirteen in the outer. Posterior wings hyaline, pterostigma ochreous. Length of the body, 6 mm.; expanse of the wings, 15 mm.

"*Locality*.—Auckland and Otago. Found also in Queensland.

"In the New Zealand examples the posterior wings have a fuscous dash at the anal angle, but they do not sufficiently differ from the Australian to warrant their separation specifically" (Hutton).

I am unacquainted with this insect.

Genus MICROMUS, Rambur (1866).

The base of the costal area of the fore-wing narrowed and without a recurrent nervure. Sub-costal area with one basal cell.

Distribution.—Tasmania and New Zealand.

MICROMUS TASMANIÆ.

Hemerobius tasmaniae, Walker, Trans. Ent. Soc. of London, ser. 2, vol. 5, p. 186.

This extremely delicate and beautiful little insect has occurred at Wellington, but at present no other precise locality is recorded for it in New Zealand.

The expansion of the wings is from $\frac{1}{2}$ to $\frac{1\frac{1}{8}}$ inch.

"Dull red; head tawny, with a band, a stripe, and a point on each side, hindward dull red. Thorax with some tawny marks. Legs whitish. Wings narrow, almost vitreous; the veins whitish; fore-wings pubescent; veins rather few, with brown points."

This species may be recognised by its very small size and brilliantly clear wings, without excisions, which are frequently ornamented with numerous sharply defined black dots.

The larva of this insect probably feeds on *aphides*, but is unknown at present.

The perfect insect may be met with throughout the year, but is never common. It is sometimes disturbed from amongst foliage; but it is more frequently observed on the lower surfaces of objects resting partially on the ground. I have often met with it in the depth of winter.

This species was originally described from specimens taken in Tasmania.

Family XI.—PHRYGANEIDÆ—CADDIS-FLIES.

(*Trichoptera* of many Authors.)

"Wings more or less clothed with hair, nervures dividing at very acute angles, very few transverse nervules; hind pair larger than the front, with an anal area, which is frequently large and, in repose, plicately folded. Antennæ

thread-like, porrect, of many indistinct joints. Mandibles absent or obsolete. Coxæ elongate and free, but contiguous. Metamorphosis great; larvæ caterpillar-like, usually inhabiting cases of their own construction. Pupa resembling the perfect insect in general form, becoming active previous to the last ecdysis. Wingless forms of the imago excessively rare" (Sharp).

The following remarks will explain the principal terms employed by systematists in classifying and describing these insects:—

"The maxillary palpi vary much, but are always 5-jointed in the female. The legs are long and slender, and the tibiæ are often furnished with spines in addition to the movable spurs which are found at the apex and sometimes near the middle of each tibia. These spurs usually differ in colour and in appearance from the spines, and are important characters in classification. The formula 2.4.4. means that the fore-tibia has a pair of apical spurs, while the middle and hind-tibiæ have median pairs in addition to the apical pairs.

"The neurulation of the anterior wings is also very important in classification, and the following remarks—taken from Mr. McLachlan—may help the student. The anterior margin is called the 'costa.' Parallel to the costa is a nervure called the 'sub-costa.' At the base of the wing the sub-costa emits the 'radius,' which runs parallel to it. Near its base the radius emits the 'sector,' which divides into two branches, each of which again divides. The space between the two principal branches of the sector is closed by a transverse nervule, and is called the 'discoidal cell.' Turning now again to the base of the wing we find another longitudinal nervure below the radius. This is the 'superior cubitus,' which almost immediately divides into two branches, which again divide. At the first furcation of the upper branch there is generally a semi-transparent whitish spot without any hairs, called the 'thyridium.' The 'inferior cubitus' is always fine and does not branch. At the point of its termination on the inner margin of the wing there is another transparent whitish spot, called the 'arculus.' The apical forks of the sector and superior cubitus divide the extremity of the wing into a number of apical cells, which are numbered from before backwards" (Hutton).

In their final condition the caddis-flies are not insects of very special interest, being generally dull coloured, of moth-like appearance, and rarely of large size. The distinctions between the various species and genera are, moreover, only to be appreciated by means of a very minute examination of the flies, which can seldom be successfully undertaken except by a specialist in the group. Hence the family has been much neglected by general entomologists, and it is only through the labours of Mr. McLachlan, and a few others, that a precise systematic knowledge of these insects has been obtained.

The Phryganeidæ form the division or series Trichoptera; the two terms are therefore synonymous; those entomologists, who consider these insects to form a distinct order, use the latter appellation for it.

In striking contrast to the imagines, the earlier stages

of the Phryganeidæ are of very great and general interest. The larvæ are aquatic and are well known to all anglers under the name of Caddis-worms. They construct for themselves cases of a great variety of materials, some species selecting sand, others stones, and others again twigs or various vegetable fragments floating in the water. These cases are, in some of the groups (Sericostomatides, Leptocerides and Hydroptilides) tubular and movable; whilst in others (Hydropsychides and Rhyacophilides) they are permanently fixed to the stones in the bed of the stream. When removed from their cases, caddis-worms bear a considerable resemblance to the caterpillars of moths: in order to move about they must put their head, and the three pairs of legs at the front of the body, out of their tube or case, and they then look very like case-bearing caterpillars. The part of the body that usually remains under cover is different in texture and colour, and frequently bears outstanding processes, or filaments, containing tracheæ for the purpose of extracting air from the water. Some peculiar spaces of a different texture may be seen on certain larvæ, and these may possibly be also connected with respiration. On each side of the extremity of the body there is a rather large hook, by which the creature attaches its dwelling to its body, and there are also frequently present on the anterior abdominal segment three large bosses, which are supposed to assist towards the same end. The hold it thus obtains is so firm that it cannot be dragged out by pulling from the front; fishermen have, however, discovered a way of extracting it by a strategic operation: the cases are, as a rule, partially open behind, and by putting a blunt object in and annoying the larva, it is induced to relax the hold of its hooks and advance forwards in the case, or even leave it altogether. The firm hold of the larva is maintained in spite of the fact that the body does not fill the case. It is necessary that water should pass freely into and out of the case, and that there should be some space for the respiratory filaments to move in. The mouth of the case is open, and the posterior extremity is arranged by the larva in such a manner as to allow a passage for the water; various ingenious devices are adopted by different species of larvæ, with the object of protecting the hind end of the body, and at the same time of permitting water to pass through the case.

The mode of changing the skin, or the frequency with which this occurs in the larval state of the caddis-flies,

has not yet been recorded. The duration of life in this stage is usually considerable, extending over several months. In New Zealand all the species seem to pass the winter as larvæ, completing their metamorphosis during the following spring or summer; and as one generation each year appears to be the rule, it is evident that the larval condition, in such cases, lasts from seven to ten months. During this stage the insects are chiefly vegetable feeders, some being said to feed on minute algæ; animal diet is not, however, entirely avoided, and it is said by Pictet that not only do some of the Phryganeidæ eat other insects, but that they also sometimes devour their companions.

At the end of the larval period of existence, the creature closes its case by a light web spun at each end, taking care not to prevent the ingress and egress of the water; it sometimes adds a stone or piece of stick, and having thus protected itself changes to a pupa. During the first part of this metamorphosis the creature is completely helpless, for there is so great a difference between the external structures of the larva and the pupa, as to make the latter a new being, so far as these organs are concerned. The changes take place in the interior of the larval skin, and as they are completed, this latter is shed piecemeal. The resulting pupa greatly resembles the perfect insect, differing consequently very much from the larva. The head of the pupa is armed in front with two curious projections that are, in fact, enormously developed mandibles; they serve as cutting implements to enable the pupa to effect its escape from its prison; they are cast off with the pupa skin, the perfect insect being thus destitute of these organs. The abdomen of the pupa differs from that of the perfect insect in possessing external respiratory filaments; the pupæ of some species have also the middle legs provided with swimming hairs, which do not exist in the imago. The skin of the pupa is at first very soft, but it soon hardens, and when about fifteen or twenty days have elapsed, the pupa opens its case by means of the mandibular processes, and swims through the water for some hours with its back downwards, finally ascending to the air by the help of some solid object; the pupa skin then swells and splits, and the thorax of the imago protrudes; this is soon followed by the disengagement of the head and other parts; and the imago, having thus escaped, the pupa skin remains, floating on the surface of the water, a complete

model of the external structure of the pupa, and contains a considerable number of tracheæ.

The eggs of caddis-flies are deposited in a singular manner; they are extruded in a mass surrounded by jelly; there may be as many as one hundred eggs in such a mass. This is sometimes carried about by the female after its extrusion from the interior of the body, but is finally confided to a suitable place in the stream or pool.

The Phryganeidæ are frequently regarded as the nearest existing allies to the great order Lepidoptera; moths and butterflies are thus supposed to have originally descended from some ancient form of insect, closely resembling our existing caddis-flies. Although not at present borne out by the discovery of fossil remains, there are no doubt many facts in connection with the structure and habits of these insects which strongly support the above idea, and the subject has been discussed at some length in several modern works on the Lepidoptera.

The Phryganeidæ are at present represented in New Zealand by the following five sub-families only:—

1. Sericostomatides.	3. Hydropsychides.
2. Leptocerides.	4. Rhyacophilides.
5. Hydropsilides.	

Sub-Family 1.—SERICOSTOMATIDES.

“Maxillary palpi of the male 2- or 3-jointed, ordinarily very pubescent or pilose, and always formed in quite a different manner from those of the female; varying greatly according to the genus. Larva with non-fasciculate respiratory filaments; the case free” (Hutton).

In this group the larvæ mostly inhabit streams. They construct movable cases out of sand and stones in preference to vegetable matter. The respiratory filaments are filiform.

Genus *CECONESUS*, McLachlan (1862).

“*Male*.—Head quadrate; antennæ about the length of the wings, basal joint short and rather thick, not so long as the head. Maxillary palpi oval-elongate, much swollen, curved up in front of the head, their apices when viewed from above appearing as two rounded tubercles between the antennæ, moderately hairy. Labial palpi with the basal joints short, the second and third of equal length, long. Anterior tibiæ with two short spurs; intermediate and posterior, each with four long unequal spurs. Anterior wings rather short and broad, very slightly hairy, the costa much arched, apical

margin almost straight; the costa from the base to the pterostigma is narrowly folded inwards; discoidal cell long and narrow; the superior cubitus does not fork before the anastomosis, and from this cause there are only eight apical cells; the anastomosis is complete and very oblique from the third apical cell; the lower part is not connected with the inner margin by a transverse nervule, and the last apical cell is continued from the apex to near the base of the wing, the apical portion being very broad; near the base of the third apical cell in all four wings is a small round hyaline spot. Posterior wings broad, folded, the discoidal cell short and triangular.

"*Female*.—The maxillary palpi are 5-jointed, the basal joint very short, the second slightly longer, the third to the fifth still longer and nearly equal. The venation of the anterior wings is regular, and in the posterior wings there are two additional apical forks.

"*Distribution*.—New Zealand" (Hutton).

ECONESUS MAORI.

Econesus maori, McLachlan, Trans. Ent. Soc., London, 1862, p. 3; Jour. Linn. Soc., vol. 10, pl. 2, fig. 1; Entom. Mo. Mag., 1894, 239.

This species is recorded from Auckland, and I have captured a few specimens in the vicinity of Wellington. It has also occurred at Ophir in the South Island, but does not seem to be generally common.

The expansion of the wings is $1\frac{1}{2}$ inches.

"*Male*.—Antennæ pale-ochreous; eyes blackish, slightly reticulated with brassy; head, thorax, and abdomen reddish-brown; legs reddish-ochreous; anterior wings rusty-brown, thickly irrorated with whitish spots, which are larger towards the base; on the inner margin are three elongated whitish spots, alternating with others of the dark ground-colour. Posterior wings subhyaline, tinged with brownish. Length of the body, 8 mm.; expanse of wings, 21 mm.

"*Female*.—Larger, the expanse of the wings being 30 mm.

"This insect, at first sight, has a somewhat deceptive resemblance to *Hydropsyche fimbriata*" (Hutton).

The perfect insect appears from October till April, and frequents the foliage on the margins of rivers and streams. It is sometimes attracted by light.

Genus PSEUDÆCONESUS, McLachlan (1894).

"*Male*.—Antennæ, palpi, and legs practically the same as in *Econesus*. Anterior wings without any costal fold, and no defined groove; the radius is confluent with the first apical sector (in both sexes and in both pairs as in *Econesus*); upper edge of the discoidal cell excised (straight in *Econesus*); apical forks Nos. 1, 2, and 3 present, the others irregular; the sixth apical cell very much dilated at its base in a nearly circular manner. Posterior wings with the apical forks Nos. 1, 2, 3, and 5 present, the venation apparently regular.

"*Female*.—The joints of the labial palpi shorter and broader, the terminal joint almost spoon-shaped. In both pairs of wings the apical forks Nos. 1, 2, 3, and 5 are present, and the venation appears to be normal and regular.

"*Distribution*.—New Zealand" (Hutton).

PSEUDÆCONESUS MIMUS.

Pseudæconesus mimus, McLachlan, Ent. Mo. Mag., 1894, p. 239.

(Plate X., fig. 10.)

This species is fairly common on the banks of many of the tributary streams of the Wainui-o-mata River, near Wellington.

The expansion of the wings is $1\frac{1}{2}$ inches.

“*Female*.—Much like the same sex in *E. maori*, but slightly smaller; the pale irrorations are larger and less regular; near the base of the third apical cell is a rather large, rounded, pale spot, on each side of which is a somewhat conspicuous brown spot. On the antepenultimate ventral segment is a very strong triangular tooth. The end of the abdomen in dried specimens is very similar to that of *E. maori*” (Hutton).

The perfect insect appears in November, and frequents streams running through dense forests.

PSEUDÆCONESUS STRAMINEUS.

Pseudæconesus stramineus, McLachlan, Ent. Mo. Mag., 1894, p. 240.

This species was described from specimens found on the Tableland of Mount Arthur, near Nelson, at elevations ranging between 2,800 and 4,500 feet above the sea-level.

The expansion of the wings is about $1\frac{1}{4}$ inches.

“*Male*.—Stramineous or pale testaceous. Anterior wings pale greyish, stramineous, closely irrorated with small whitish spots, apical margin narrowly interruptedly fuscous, inner margin with four or five long fuscous lines alternating with long pale spaces. Posterior wings whitish-stramineous, the apical portion yellowish, fringes concolorous. Penultimate and antepenultimate ventral segments of the abdomen each with an acute tooth; superior appendages lateral, quadrate, furnished with long hairs. Intermediate appendages (or penis-cover?), viewed from above, consolidated into a broad elongate plate, canaliculate above, deeply notched at the apex, furnished with very long hairs. Inferior appendages 2-branched, the branches distant, stout and cylindrical, curved so as to leave a semicircular space between them. Length of body, 7 mm.; expanse of wings, 28 mm.

“*Localities*.—Wellington and Nelson.

“*Female*.—Like the male, but the body darker, and the anterior wings yellower. A sharp, broad, triangular tooth on the antepenultimate ventral segment. Margin of the last dorsal segment nearly straight and slightly excised in its middle. Tubular piece forming two small, broad, triangular, obtuse lobes, if viewed laterally, but open above and beneath. Length of body, 10 mm.; expanse of wings, 33 mm.” (Hutton).

The perfect insect appears in January. It frequents the margins of mountain torrents.

As the transformations of the three foregoing species are at present unknown to me, I am unable to discriminate between them with certainty.

? AGILIS, n. sp.

(Plate II., fig. 4, 5 larva removed from case enlarged.)

So far as I am aware at present, this handsome species has only occurred in the valley of the first eastern tributary of the Wainui-o-mata River, above the Wellington Reservoir, locally known as George's Creek.

The expansion of the wings is about $1\frac{1}{2}$ inches. The antennæ are rather stout, and about the same length as the fore-wings. Spurs 2 . 4 . 4. The fore-wings have the costa slightly arched at the base, and much arched before the apex; the termen is sharply excavated near the middle. The general colour of the fore-wings is pale brown, paler in the middle with a large almost white patch towards the tornus, partially bordered by a number of dark chocolate brown markings. The hind-wings are yellowish-brown, darker towards the apex. The body is dark brown.

The larva constructs a stout, cylindrical, and slightly curved case about $\frac{3}{4}$ inch long, composed entirely of large pebbles firmly fastened together with silk. These cases are rather scarce, and are only found in the central and most rapid portions of the river, where the beautiful bright water dashes over the large boulders, resting on a clean and shingly bottom.

The length of the larva when full grown is about $\frac{5}{8}$ inch. The first three segments are pale brown, the third being scarcely horny. The rest of the body is dull white, very large, soft, and fat. The sides of all but the last two segments are furnished with a row of extremely short, fine hairs. There is a bunch of very fine respiratory filaments on each segment above and below this line, making four rows in all; but no filaments are present on the last two segments. The anal segment is abruptly truncated, the upper portion is furnished with numerous spines, and the lower with two small, but very strong, clasping hooks.

Apart from the contained larva the case of this insect can always be distinguished from that of *Pseudonema amabilis* by its larger size, and by the very much larger stones of which it is composed. When mature, this larva firmly fastens its case by its posterior end to a boulder, closes each of the apertures with a large pebble, but leaves sufficient space to admit of a free circulation of the water through its dwelling. As usual with these insects, the pupa swims about for some hours before emergence; and when the caddis-fly finally makes its escape the pupa skin may be found close by, and generally floating on the surface of the water.

The perfect insect appears early in December. It delights to rest on overhanging twigs, situated close to the most rapid-running waters. Whilst thus resting it is extremely difficult to see, the antennæ being placed

close together and thrust straight in front of the insect, whilst the wings are closely folded around the body. When in this position the creature much resembles a small stick, but if it be too closely approached it dashes with amazing rapidity into the water, floats down the stream for a considerable distance, and eventually seizes hold of some similar twig at the water's edge, where it reposes as before. These peculiar habits are no doubt protective, and certainly render both the detection and capture of the insect a most difficult matter. Its movements are, in fact, of such a sudden and bewildering nature, that the collector is often taken by surprise and loses his quest. The periodical submersions which this caddis-fly undergoes do not appear in any way to harm it, as the water runs off its hairy wings and back immediately it reappears above the surface.

Genus OLINGA, McLachlan (1894).

"Instead of *Olinx* (1870), which is preoccupied.

"Antennæ slightly shorter than the wings, stout, the basal joint very long and thick, fringed beneath with long and strong hairs; vertex small, with very long hairs at the sides, turned upwards; maxillary palpi apparently 2-jointed, curved over the face, short and subcylindrical; labial palpi long. Prothorax hidden, meso- and meta-thorax scarcely hairy, shining; the former long, narrowed posteriorly, with a broad concave space in the middle above; the metathorax is much narrower, also with a concave median space, in the centre of the posterior portion of which is a triangular metascutellum. Legs moderately long and slender, pubescent, the tibiæ with stronger and spine-like hairs, spurs 2.2.4, furnished with spine-like adpressed hairs similar to those on the tibia, the two pairs on the posterior tibiæ very long and near together; tarsi long. Anterior wings narrow at the base, the apex widely dilated, the apical margin oblique; venuration indistinct, sub-costa straight, the radius parallel, the two branches of the sector ending in long forks, which are connected by a transverse nervule, the whole membrane thickly coated with scales above. Posterior wings shorter, obtusely rounded at the apex, broad, the dorsal margin with a long fringe near the base, the membrane with procumbent hairs. Abdomen short and slender; a forked lobe proceeds from the middle of the last segment above; the penultimate segment is furnished beneath with a broad and obtuse lobe, extending beyond the apex in the male.

"*Distribution*.—New Zealand" (Hutton).

OLINGA FEREDAYI.

Olinx feredayi, McLachlan, Journ. Linn. Soc., vol. 10, p. 198, pl. 2, fig. 2 (1870).

(Plate IX., fig. 1 ♂, 2 ♀, 3 larva withdrawn from its case, 4 larva in its case; figs. 3 and 4 are magnified.)

This insect has occurred abundantly at Wellington.

in the North Island, and at Nelson and Christchurch in the South Island. It is probably common and generally distributed throughout New Zealand.

The expansion of the wings is 1 inch. The fore-wings in the male are dull yellowish-brown; there is a chitinous fold running from the base along the dorsum, and curving upwards parallel to the termen; the hind-wings are dusky. The female has the fore-wings golden-yellow without any chitinous fold.

The larva of this insect is extremely abundant in most running streams. It constructs a perfectly smooth, light brown, semi-transparent, and slightly curved cylindrical case, made entirely of a glutinous material secreted by the insect. These cases are to be found in the streams during the entire year, but many of those taken about December are very small, apparently indicating that the larva chiefly grows during the late summer, autumn, and winter, usually becoming mature in the spring. Some full-sized cases are, however, always to be found, and prolonged investigations prove that the successive broods of this insect must overlap one another to a very great extent. A glance at the table on p. 98 will show how largely these larvæ contribute towards the food supply of our trout, and as both the case and the contained larva are devoured, no difficulty is experienced in identifying with absolute certainty the numerous specimens, which are found during an examination of the contents of the stomachs of those fish.

The length of the larva, when full grown, is about $\frac{3}{4}$ inch, that of its case being about $\frac{1}{2}$ inch. The head and first segment of the thorax are very horny, and bright reddish-brown in colour. The anterior legs are short and very stout, the two other pairs are rather long and much slenderer. The remaining segments of the body are very large, soft, and bright green in colour. The two terminal segments are slightly paler. The last segment has two very large protuberances fringed with bristles and furnished with a pair of very small claspers.

This larva is very active, climbing amongst the stones in rapid streams with great agility. When full grown it fastens the posterior extremity of its case firmly to a stone, and closes the free end with a tight-fitting lid. These fixed cases are usually found in groups, comprising twenty or thirty individuals, attached close together on the under side of a single boulder. This habit of congregating in groups for purposes of pupation is very remarkable, and probably serves some useful purpose, though at present it is difficult to say in what way it is beneficial to the insect.

During the early summer most streams become very much smaller in volume, and owing to this circumstance many of these groups of fixed cases are left high and dry, and their inmates must consequently meet with an untimely death. In fact, the mortality experienced by the insect from this cause alone must be very considerable.

The pupa leaves the case by forcing open the lid, which closes its free end. After this is accomplished, it swims about for many hours before the final emergence of the caddis-fly takes place.

The length of the pupa is about $\frac{3}{4}$ inch. The head and thorax are pale green, the abdomen bright green. The eyes are prominent, dark reddish-brown; the mandibles are short, slender, horny, and much curved at the tips. The legs and wings are very delicate in structure, elongate, and semi-transparent. The abdomen has a pair of brown chitinous spots on the back of segments 2, 3, 4, and 5, and a double pair of such spots on segment 6. The dorsal appendages are slightly chitinous and brown; the ventral ones semi-transparent. There is an extremely fine black line extending down the side of the abdomen.

The perfect insect appears from the beginning of November until the end of February. It flies freely at evening dusk, when specimens may often be obtained in considerable numbers. It sometimes happens that females thus captured are found to be carrying their eggs, which are attached to the end of the body, and form a bright green globular mass.

Genus PYCNOCENTRIA, McLachlan (1866).

"Head transversely sub-quadrate, with an elongated tubercle on each side. Antennæ slender, about the length of the wings; basal joint thick, hairy, longer than the head. Maxillary palpi in the male 2-jointed, the basal joint very small and concealed, the second long and thick, curved up and furnished with long and strong hairs; those of the female 5-jointed, the basal joint short, the second long and stout, third equal to the second but thinner, the fourth and fifth shorter, equal. Anterior wings with dense pubescence, dilated before the apex; in the male there is a longitudinal fold furnished with coarse hairs extending nearly the whole length, and obliterating the discoidal cell; in the female this fold is absent. Posterior wings shorter and about as broad, obtuse at the apex; in the male with a longitudinal fold. Legs moderately long and slightly hairy; spurs 2. 2. 4, those of the anterior and intermediate tibiæ moderately long and unequal, both pairs of the posterior tibiæ nearly equal and close together.

"*Distribution*.—New Zealand" (Hutton).

PYCNOCENTRIA FUNEREA.

Pycnocentria funerea, McLachlan, Trans. Ent. Soc. London, 1866, p. 252.

This little caddis-fly has occurred at Auckland,

Wellington, and Nelson, and is probably generally distributed throughout New Zealand.

The expansion of the wings is about $\frac{9}{16}$ inch.

"Antennæ blackish-fuscous; head and thorax dark chestnut, clothed with blackish hairs. Wings dark fuscous, the folds in the male conspicuously darker; a small whitish spot at the anal angles of the anterior pair. Anterior legs greyish-ochreous, the intermediate and posterior femora and tibiæ fuscous, the tarsi ochreous. Abdomen blackish-fuscous, the divisions of the segments paler; in the male the upper margin of the last segment is produced in the middle into a long flattened lobe dilated at the base, then attenuated and obtuse at the apex, from under it project the curved points of the intermediate appendages; inferior appendages consisting of two branches, the upper obtuse and shorter than the lower; ventral surface of the antepenultimate segment of the female with a short obtuse lobe. Length of the body, 4 mm.; expanse of the wings, 13 mm." (Hutton).

The perfect insect appears from October till March, and is easily recognised by its very dark colouring. It usually frequents the margins of streams in rather open country, and is often fairly common in such situations.

PYCNOCENTRIA EVECTA.

Pycnocentria evecta, McLachlan, Journ. Linn. Soc., vol. 10, p. 199, pl. 2, fig. 3 (1870).

(Plate IX., fig. 5, fig. 6 larva in its case enlarged.)

This little species seems to be fairly common and generally distributed. It has been taken at Wellington, Christchurch, Lake Pukaki, and Ophir.

The expansion of the wings is about $\frac{5}{8}$ inch.

"Head with blackish and golden hairs. Prothorax with golden hairs; meso- and meta-thorax nearly hairless, blackish-fuscous. Wings greyish, the anterior with short golden hairs. Legs yellow, the tibiæ and tarsi with blackish hairs. Abdomen reddish-brown, the appendages yellow. In the male the antepenultimate ventral segment bears a broad flattened obtuse lobe, and from the last dorsal segment protrudes a small elongately triangular sub-obtuse yellow lobe. Length of the body, 4 mm.; expanse of the wings, 16-17 mm." (Hutton).

The larva is very abundant in many rivers and streams, but appears to prefer those flowing through open country, with a rather sluggish current and muddy bottom. It constructs a small, cylindrical and slightly curved case of secreted material, entirely covered with extremely minute stones and particles of sand. This case is usually greyish-green in colour, the greenish tinge being no doubt due to the presence of a certain amount of living vegetable matter amongst the sand grains attached to it. These cases occur in the streams throughout the year. In the

late autumn and winter they are very small; cases taken in June being less than $\frac{1}{8}$ inch in length, although they are quite as numerous then as at any other time. During the spring the larvæ gradually increase in size, and enlarge their cases accordingly, about the end of November; when most of the streams have very much diminished in volume and in rapidity of current, these insects speedily develop. They probably feed on vegetable matter, and the green slime-weed, which always grows profusely in slow-running streams, forms, no doubt, their chief article of diet. This caddis-worm constitutes an extremely important item in the food supply of trout, very large numbers of the cases and their contained larva being found in the stomachs of these fish. (See tables on pages 93 to 98.)

The length of the larva of this insect, when extended, is about $\frac{3}{16}$ inch. The head is large, very broad, but short, blackish-green, with a few irregular paler green marks. The prothorax is elongate, pale olive-green, with four round black dorsal spots. The rest of the body is very pale olive-green, marbled with darker olive-green, especially on the back. The surface is much wrinkled. Anterior legs short, moderately stout, with a very sharp single claw; middle and posterior legs much longer and slenderer, apparently employed exclusively in walking. Anal eminences very obtuse, each furnished with about nine very stout bristles, and a minute but very stout claw. Usual dorsal hump very small; lateral humps also small. There are traces of a few irregular, branching, white filaments.

As soon as this larva is mature it firmly fastens its case to a large rock or stone in the stream, and, when possible, always selects for this purpose a crevice in the stone. A large number of larvæ will frequently attach their cases very close together in such a situation, and it is most difficult either to detect or remove the cases when they are thus protected by the overhanging edges of the crevice. Both ends of the case are, of course, closed with the usual network, so that the enclosed pupa is securely protected from all enemies.

The perfect insect appears from November till February. It must be very common, although it is not often seen, owing no doubt to its small size, inconspicuous appearance, and nocturnal habits. I observed it very abundant on the banks of Lake Pukaki at evening dusk, and further investigation will probably reveal its presence in most places situated in the vicinity of water.

PYCNOCENTRIA AUREOLA.

Pycnocentria aureola, McLachlan, Journ. Linn. Soc., vol. 10, p. 200, pl. 2, fig. 4 (1870).

This species is very closely allied to the last, from which it can only be distinguished by a special examination of the male insect. At present it is only recorded from Wellington, Christchurch and Ophir, but is probably generally distributed throughout New Zealand.

The expansion of the wings is about $\frac{1\frac{1}{2}}{10}$ inch.

"Like *P. erecta*, but the male has no abdominal lobes. Length of the body, 4-5 mm.; expanse of the wings, 12-19 mm." (Hutton).

In its transformations this species no doubt closely resembles *P. erecta*.

The perfect insect appears from November till March. It frequents the same situations as *P. erecta*.

Genus HELICOPSYCHE, Hagen (1866).

"Spurs 2.2.4, long, but the exterior spur on the anterior tibia is minute, and that on the other pairs is slightly shorter than the internal; the sub-apical pair on the posterior tibiæ near the apical.

"This genus was founded originally to include the remarkable heliciform larvæ-cases made of grains of sand, which have only lately been hatched out in North America and Europe" (Hutton).

HELICOPSYCHE ZEALANDICA, n. sp.

(Plate XI., fig. 4 imago, 5 larva removed from case, 6 larva in case, all magnified.)

This very inconspicuous little insect must be quite common in the neighbourhood of Wellington. and is, in fact, probably generally abundant throughout New Zealand. It is, however, seldom seen, and but for the extremely interesting nature of the case constructed by its larva, the mature caddis-fly would probably have long remained unnoticed by entomologists.

The expansion of the wings is about $\frac{1}{2}$ inch. The general colour is dusky black, with a paler spot a little beyond the middle of the fore-wings. All the wings are fringed with long hairs. This insect has a strong superficial resemblance to *Pycnocentria fumera*, but apart from structural differences may readily be distinguished from that species by its smaller size and more transparent wings.

The larva of *Helicopsyche* is very abundant in most running streams in the Wellington District. It constructs a spiral case so closely resembling a small snail-shell, that similar cases found in Europe have deceived concholo-

gists, and led them to describe the cases as actual shells. The case constructed by the New Zealand insect is about $\frac{3}{16}$ inch in diameter. The whorls are rather flattened, and the inner portion of the spiral is smooth, and composed of extremely minute sand grains; further out the sand grains become coarser, and near the orifice of the case they are much larger, and give that portion of the structure a somewhat irregular appearance.

The enclosed larva is very elongate, curved and specially adapted for inhabiting a spiral tube. Its length when full grown is about $\frac{3}{16}$ inch. The head is rather large, oval, light reddish-brown. The prothorax is also reddish-brown, horny, and highly polished. The meso- and meta-thorax are dull green tinged with reddish-brown, and clothed with a few isolated bristles, the sides of the latter segment being furnished with hair-bearing tubercles. The abdomen is bright green and very shining. The first abdominal segment is furnished with an extremely large dorsal hump. The anterior legs are very short, the intermediate and posterior pair of moderate length. There are no visible respiratory filaments. The segments of the abdomen are very cylindrical. The terminal segment has two rather feeble claws.

These larvæ are found in the streams throughout the entire year. In mid-winter they are very abundant, but so minute are the cases that it requires a very close scrutiny to discover them. They are often secreted in the depressions on some of the larger stones in the bed of the stream, and in these situations we may sometimes find clusters of fifty or a hundred cases. As the season advances the cases become larger, and in warm weather the larvæ are very active, pulling their cases after them in all directions. On the approach of any moving object they may be observed detaching themselves from the stones with great celerity, and drifting down-stream like so many small pebbles. These tactics would no doubt preserve them from many enemies, but nevertheless large numbers of the larvæ are devoured by trout, as we find their heliciform cases very numerous in the stomachs of fish taken in streams, where the insects are abundant. The mature larva fixes its case very firmly to a large stone in the bed of the stream, generally selecting for this purpose a depression in the rock or stone. When finally anchored, the larva, after having closed the orifices of the case, changes into a pupa inside.

The pupa has the head small, pale brown, with the eyes prominent and yellowish-brown. The thorax is dull green. The wings are elongate, bright green, and curved upwards towards their extremities. The abdomen is elongate, pale green, with nine visible segments, curved upwards towards the tip; there is a slender black line on each side. The antennæ and legs are also curved in the same way as the wings and abdomen, so that the whole insect fits perfectly into its heliciform case.

The pupa leaves the case and swims about in the water for some hours before emergence. The perfect insect appears in December and January.

Sub-Family 2.—LEPTOCERIDES.

“Maxillary palpi 5-jointed in the male as well as in the female, strongly hairy, ordinarily ascending, and with the last joint usually long but simple, although often flexible. Wings very pubescent, and for the most part narrow. Antennæ, as a rule, very long and slender. The larva has the respiratory filaments short, and ordinarily few in number, placed in tufts on the sides of the abdomen; the case tubular and free.

Genus PSEUDONEMA, McLachlan (1862).

Tetracentron, Brauer (1865).

“Antennæ much longer than the wings, joints cylindrical, the basal joint long and thick. Maxillary palpi hairy; the basal joint short; second and third long, equal; fourth scarcely as long as the third, and less robust; fifth joint as long as the third and fourth together, flexible. Labial palpi with the terminal joint long and thin. Head sub-triangular, the eyes prominent. Abdomen robust. Spurs of the tibiæ 2.2.4. Anterior wings rather thickly clothed with short hairs, long, narrow, slightly dilated at the apex, which is elongated; discoidal cell broad; first apical cell much longer than the others, the second short, scarcely reaching half-way to the anastomosis, the fifth narrow and very acute, barely reaching the anastomosis. Posterior wings folded.

“*Distribution*.—New Zealand” (Hutton).

PSEUDONEMA OBSOLETA.

Pseudonema obsoleta, McLachlan, Trans. Ent. Soc. London, ser. 3, vol. 1, p. 305 (1862). *Tetracentron sarothropus*, Brauer, Verh. zool.-bot. Ges., in Wien, 1865, p. 418; Reise der “Novara,” Neuroptera, p. 12, tab. i., fig. 5. *Pseudonema obsoleta*, Hutton, Trans. N. Z. Inst., xxxi., 240.

(Plate X., fig. 1 ♀ imago, 2 larva withdrawn from case magnified. Larvæ in cases composed of—fig. 3 wood fragments and liverworts, 4 fragments of tree-fern fronds, 5 fragment of wood, 6 long slender twig, 7 pupa magnified.)

This extremely interesting insect has occurred at Auckland and Wellington in the North Island, and at Nelson, Christchurch, Ophir, and Invercargill in the South Island.

The expansion of the wings varies from 1½ inches to 1¾ inches. The fore-wings are dull grey, speckled and banded with black, and white spots;

the hind-wings are pale brown, paler near the base. The two anterior pairs of legs have the tarsi and tips of the tibia black. The posterior pair are pale yellowish-brown throughout. The antennæ are twice the length of the anterior wings. The maxillary palpi are very hairy, and about $\frac{1}{2}$ the length of the antennæ.

The transformations of this peculiar insect are very interesting. The larva, which is found in clear, dashing, forest streams, usually inhabits a piece of twig, through the centre of which it has tunnelled out a cylindrical hole. In this simple habitation it is enabled to live secure from all enemies, as the stick is always long enough to allow the insect to retreat a considerable distance from the opening at either end. In fact, I have found small larvæ inhabiting twigs nearly five inches long. If menaced in any way the larva always remains thus concealed in the middle of the twig, consequently its habitation cannot be distinguished from any other fragment of twig, of which there are usually hundreds floating about in the streams, where the insects abound. When the larva is not apprehensive of any danger it projects its head and thorax from the opening, and proceeds to walk about dragging the stick after it. The presence of a number of these animated twigs, of various shapes and sizes, in a basin of water has a most remarkable appearance. The enclosed insects are not readily seen, and it is thus often difficult to account for the singularly rapid movements with which the sticks are endowed. Although this larva usually inhabits a plain stick, hollowed out in the middle, more complicated dwellings are not infrequently constructed by the insect. Fragments of the stems of fern fronds (see Plate X., fig. 4), the green liverworts, which grow so plentifully on the stony banks of many of these forest streams (fig. 3), as well as many other kinds of vegetable remains, are built up by the larva into the most fantastic cases imaginable. In addition, the insect frequently employs ordinary fragments of wood from forest trees, which it hollows out in a similar manner to the sticks (fig. 5). This last-named habit proves, I think, that the larva does not select twigs already hollowed out, as I at first supposed, but bores them out itself to suit its own requirements.

The food of these larvæ consists chiefly of fallen leaves and sodden wood, both of which are present in great quantities in all forest streams. I have actually seen captive specimens feeding on the leaves of *Melicytus ramiflorus*, and on the berries of *Aristotelia racemosa*.

This insect is, in fact, very hardy, and can easily be kept in a shallow vessel of water, if it is supplied with a few leaves and twigs from its native stream. The larva may be found in the streams throughout the entire year, but it is most abundant about midsummer.

When extracted from its singular habitation the larva of *P. obsoleta* is not found to differ widely from many other caddis-worms (fig. 2). The head and first two thoracic segments are rather small, horny, and dark brown in colour; the two anterior pairs of legs are short, pale yellow barred with dark brown; the posterior legs are very long and are chiefly instrumental in moving the larva and its case. They project forwards from the case, and act somewhat as a pair of grappling-hooks. The last thoracic segment is of large size, and has four horny dorsal plates. The first segment of the abdomen is furnished with a very large dorsal hump. All the segments of the abdomen are very large, soft, and yellowish-white in colour. There are seven pairs of respiratory filaments on each side of the larva. The anal hooks are small, and each is situated on a moderately large protuberance. There is a number of stout bristles on the last two segments of the insect.

As soon as this larva has attained its full size, it fastens one end of its habitation securely to a log or other firm object, and closes both of the orifices with a loosely spun silken lid, means being thus provided for the free circulation of fresh water through the case for the use of the enclosed insect whilst it is in the pupa state.

The pupa is a most beautiful object. Its length is about $\frac{5}{8}$ inch. The jaws are small and prominent, the eyes very conspicuous; the head and thorax are brown, the abdomen ochreous-yellow. Legs and palpi brown. Respiratory filaments are situated on all the segments of the abdomen, except the last three. The extremely long antennæ are carried in two spirals beyond the end of the body.

The pupa is enclosed in a thin, tough cocoon inside the hollow stick or wooden case, which is firmly attached to a sunken log in the stream.

The insect remains in this condition for three or four weeks. About twenty-four hours before its final transformation the pupa leaves its old habitation and swims about in the water with considerable rapidity. After this the emergence of the imago takes place, but the insect's exact procedure during this operation is not quite clear. Probably the pupa does not leave its native element before emergence, as the empty pupa skin is always found floating on the surface of the water. The perfect insect appears from November till March. It is often common in the vicinity of forest streams, and may be captured at evening dusk. It flies with a peculiar zigzag flight, but in this respect it is not nearly so remarkable as the next species. It is also attracted by light. I have

taken *P. obsoleta* on the Tableland of Mount Arthur, at an elevation of no less than 3,600 feet above the sea-level. It is, I think, generally distributed throughout New Zealand, and probably occurs wherever there are dense forests and swift-running streams.

PSEUDONEMA AMABILIS.

Tetracentron amabile, McLachlan, Journ. Linn. Soc., vol. 10, p. 20, pl. 2, fig. 5 (1870). *Pseudonema amabilis*, Hutton, Trans. N. Z. Inst. xxxi., 241.

(Plate X., fig. 8, 9 larva in its case magnified.)

This delicate little insect is probably common, and generally distributed throughout New Zealand. It has occurred at Wellington, Christchurch, Lake Pukaki, Ophir, and Invercargill.

The expansion of the wings is about $1\frac{1}{2}$ inches. The fore-wings are very elongate and narrow, with the termen oblique; their colour is pale greyish-brown, dotted with darker brown; there is a rather conspicuous, oblique, white spot before the apex, and a very much smaller spot on the termen. The hind-wings are much broader, and uniform pale greyish-brown. The body is brown with grey hairs. The superior appendages of the male are triangular, fimbriated; the inferior appendages thick, directed upwards.

The larva of this insect inhabits clear, running streams. It constructs a strong cylindrical, slightly tapering case made entirely of small stones, thus differing in a remarkable manner from the case of the preceding insect, which is exclusively composed of vegetable detritus. The length of this case, when the larva is mature, is about an inch. In structure the larva itself appears to closely resemble that of *P. obsoleta*, but is of course much smaller. It is very active in its habits, and may often be seen travelling with great rapidity across sandy patches in the river-bed. It frequents the edges of rivers and streams, where the current is less rapid. Here there is usually a fair deposit of sandy or fine shingly material, which it certainly prefers to a river-bed entirely composed of rocks or large boulders. In these situations the larvæ are often very common, especially during the first fortnight in November, when they are full grown and the cases fairly conspicuous, owing to their comparatively large size.

When mature this insect closes both the orifices of its case by fastening a small stone to each end. Hence the case rests loosely on the river-bed, and is not attached to a firm object. The enclosed pupa closely resembles

that of *P. obsoleta*, but is of course considerably smaller. Its extremely long and delicate antennæ are very remarkable. The emergence of the imago occurs in the usual manner, and the pupa skin, with its exquisitely delicate antennal coverings, may be seen floating on the water after the escape of the caddis-fly.

The perfect insect appears about the middle of November, and is very abundant until the end of December. It flies in swarms at evening dusk, and may at once be recognised by its extremely rapid zigzag flight. When seen projected on the bright sky of sunset, its long fine antennæ are clearly visible, being held out straight in front of the insect, whilst it is on the wing. I noticed great numbers of these insects flying in this way around the margins of Lake Pukaki, and I expect that it will be found to frequent many other treeless situations of similar character. The larva of *P. amabilis* apparently takes the place of that of *P. obsoleta* in streams, where there is no forest detritus, and I consider that the differences in habit between these two insects, as regards the material and construction of their respective cases, is of unusual interest. The discovery of such a striking divergence of habit between two species so closely allied greatly surprised me. In fact, I fully expected to find the larva of *P. amabilis* inhabiting fragmentary grass stems, and on this assumption I made many unsuccessful examinations of submerged grass fragments in the streams. It is well, therefore, to bear in mind that conjectural analogies occasionally mislead, when applied to the supposed larval habits of little-known species of insects.

Genus NOTANATOLICA, McLachlan (1866).

“Antennæ very fine, nearly thrice the length of the wing, longer in the male than in the female, maxillary palpi very hairy, the first and fourth joints moderately long, nearly equal; the second, third, and fifth equal, each about thrice the length of the fourth. Anterior wings long and narrow, slightly hairy, costal and dorsal margins nearly parallel, discoidal cell closed; upper branch of the superior cubitus forked in the male, twice forked in the female.* Posterior wings broad, subtriangular, shorter than the anterior. Legs long; spurs 2. 2. 2, each tibia being provided with two small and equal apical spurs. Abdomen robust, depressed in the female. Anal appendages well developed in the male, the inferior pair biarticulate; in the female the apex of the abdomen is obtuse, with two rounded superior valves.

“*Distribution*.—Australasia and the Malay Archipelago” (Hutton).

* For the neurulation of *Notanatolica*, see Trans. Ent. Soc. London, ser. 3, vol. 5, pl. 19, fig. 3.

NOTANATOLICA COGNATA.

Leptocerus cognatus, McLachlan, Trans. Ent. Soc. London, ser. 3, vol. 1, p. 6 (1862). *Notanatolica cognata*, McLachlan, l.c., vol. 5, p. 258 (1866); Journ. Linn. Soc., vol. 10, pl. 2, fig. 6.

"Antennæ dark brown, with white tips to the joints; basal joint testaceous; palpi black, clothed with long grey hairs. Head and thorax testaceous. Abdomen brown. Legs pale greyish-ochreous. Anterior wings grey, sparingly clothed with heavy pubescence. Posterior wings hyaline, with coppery iridescence. Length of the body, 10 mm.; expanse of the wings, 30 mm.

"*Locality*.—Auckland" (Hutton).

I am unacquainted with this insect.

NOTANATOLICA CEPHALOTUS.

Leptocerus cephalotus, Walker, Cat. Neuroptera Brit. Mus., p. 73 (1852). *Notanatolica cephalotus*, McLachlan, Journ. Linn. Soc., vol. x., p. 213.

"Ferruginous, testaceous beneath. Head broader than the thorax; palpi slightly hairy; antennæ testaceous, more than four times the length of the body, with a black ring on each joint. Thorax with three brownish stripes. Legs testaceous. Wings sub-hyaline, the veins testaceous. Length of the body, 8 mm.; expanse of wings, 30 mm. (Walker).

"*Locality*.—Auckland.

"Mr. Walker remarks that the wings of the specimen are much rubbed, and Mr. McLachlan calls it a doubtful species" (Hutton).

I am unacquainted with this species.

Genus LEPTOCERUS, Leach (1815).

"Antennæ very long and slender. Maxillary palpi very long and strongly hairy. Labial palpi very small. Legs long and slender, the anterior pair much shorter than the others. Spurs 2. 2. 2, those on the anterior tibiae very short, the others long. Neuration of the anterior wings differing in the sexes. In the male the upper branch of the superior cubitus is once forked at the apex, while in the female it is twice forked. Apical cells Nos. 1 and 4 not reaching the anastomosis. Posterior wings usually much broader than the anterior; apical forks Nos. 1 and 5 present.

"*Distribution*.—Northern Hemisphere, in cold and temperate regions" (Hutton).

LEPTOCERUS (?) ALIENUS.

Leptocerus (?) alienus, McLachlan, Journ. Linn. Soc., vol. 10, p. 202 (1870).

"Brown, with long dark-grey hairs; antennæ white, with black rings. Anterior wings elongate, narrow, slightly dilated at the apex, rounded, dark grey, the longitudinal nervures with brown dots. Posterior wings sooty; in the female the superior cubitus is twice forked at the end. Length of the body, 8 mm.; expanse of the wings, 23 mm.

" *Locality*.—Christchurch.

" It is uncertain to what genus this insect should be referred. So far as the general characters and the venation of the anterior wings are concerned, it presents no apparent generic difference from the European species of *Leptocerus*, but the venation of the posterior wings is somewhat aberrant" (McLachlan).

I am unacquainted with this insect.

Genus SETODES, Rambur (1842).

" Antennæ and maxillary palpi varying. Legs long and slender, the anterior pair much shorter than the others; spurs of the tibiæ 0 . 2 . 2. Venation of the wings similar in both sexes. Anterior wings very long and narrow, lanceolate, not dilated, almost always acute, clothed with dense pubescence and with long fringes. Posterior wings still narrower than the anterior, always acute, often subfalcate at the tips. Abdomen slender.

" *Distribution*.—Europe" (Hutton).

SETODES UNICOLOR.

Setodes unicolor, McLachlan, Journ. Linn. Soc., vol. 10, p. 203, pl. 2, fig. 7 (1870).

This insect has occurred at Lake Horowhenua, at Wellington, at Christchurch, and at Lake Wakatipu. It does not, however, appear to be a common species.

The expansion of the wings is about $\frac{1}{2}$ inch. The general colour is greyish-brown; antennæ greyish-ochreous. Anterior wings greyish-yellow, with some brown dots. Posterior wings pale grey, sub-hyaline, iridescent. Legs greyish-ochreous. Abdomen greyish-ochreous, the last segment in the male with a pale fringe of hairs; superior appendages small, broad; the inferior pair approximated, elongato-triangular. Length of the body, 5 mm.; expanse of wings, 20–23 mm.

The perfect insect appears from November till February, and is often attracted by light.

Genus PHILANISCUS, Walker (1852).

" Maxillary palpi with the fifth joint long and filiform. Antennæ nearly filiform, rather stout, almost as long as the wings. Fore-tibiæ with two very short spurs at the apex; middle tibiæ with a pair of long spurs at the apex; hind-tibiæ with two pairs of long spurs, one at three-fourths of the length, the other at the apex.

" *Distribution*.—New Zealand and New South Wales.

" The larvæ are marine, and live among seaweed, in rock-pools, between tide marks. (See Journ. Linn. Soc., vol. 16, p. 417 (1882); and Ent. Mo. Mag., vol. 18, p. 278; vol. 19, p. 46; vol. 24, p. 154; also N. Z. Journ. of Science, vol. 1, p. 307.)

" The position of this genus is doubtful" (Hutton).

PHILANISCUS PLEBEJUS.

Philaniscus plebejus, Walker, Cat. Neuroptera Brit. Mus., p. 116 (1852). *Anomalostoma alloneura*, Brauer, Reise der "Novara," Neuroptera, p. 16, pl. 1, fig. 6 (1865).

(Plate IX., fig. 10, 7 larva removed from case, 9 larva in its case, 8 pupa; all magnified.)

Although this little caddis-fly is neither interesting nor attractive in its final condition, the strictly marine habits of its larva render it unique amongst caddis-flies, and most remarkable amongst insects generally. To Captain Hutton, of Christchurch, belongs the credit of first discovering the transformations of this species, and subsequent observations have in every way verified his original statements, regarding the exclusively marine habits of the larva.

This insect is probably generally distributed along the sea-coast throughout the whole of New Zealand, but at present actual specimens have only been taken at Auckland, Wellington, and Lyttelton.

The expansion of the wings is slightly more than $\frac{1}{2}$ inch. The general colour of the body is "dull-red with the sides of the thorax greyish. The antennæ are thick, pale tawny, ringed with grey, the apices dark grey; the clypeus is clothed with golden hairs; the head has four narrow lines of red hairs. The legs are dull red. The anterior wings are grey, subhyaline, tessellated with pale chestnut, with a thin, yellow, woolly coating. The posterior wings are hyaline, the veins reddish, the dorsal margin near the base clothed with black hairs. The inferior appendages in the male are large, curved upwards, with the apices bent downwards; in the female they are acute" (Brauer).

The larva inhabits rock-pools on the sea-beach, and is commonest near low-water mark, where it is completely outside the influence of any fresh water. It constructs a cylindrical case of coralline seaweed, a few minute stones, &c., being occasionally incorporated with the weed in the walls of the case. The length of a case belonging to a full-grown larva is generally about $\frac{1}{2}$ inch. In addition to the small fragments of seaweed, which form the body of the case and are mostly arranged transversely on its surface, long branching fragments are also frequently attached. These accessories undoubtedly very much increase the protective value of the case, and render its discovery, amongst large clumps of seaweed, a task of

the utmost difficulty. In fact, the smaller cases are quite impossible to detect, and this circumstance no doubt often prevents the enclosed larva from being destroyed by the numerous and rapacious enemies, to which a minute marine form must be constantly exposed. As I have found cases of all sizes in considerable numbers both in October and also in January, it may, I think, be fairly assumed that the larvæ lives in the sea during the winter months, and in fact throughout the entire year.

The length of a full-grown larva is about $\frac{5}{16}$ inch. The head is rounded, oval in form, blackish with a pale spot on the top; the prothorax is also black, the meso- and meta-thorax are green with two black, horny, dorsal plates. Both head and thorax are furnished with strong black bristles. The anterior legs are rather short and stout, the two other pairs somewhat long, rather slender. They are furnished with numerous short bristles. There is a pair of respiratory organs on each of the first eight segments of the abdomen. Each gill consists of a bundle of five filaments on a single footstalk. These gills are largest near the thorax, and become smaller towards the posterior extremity of the larva. The abdomen itself is pale green and very soft. There is a small hump on the back of the first segment, and a protuberance on each side; there are two humps on the back of the second segment. The last segment has two short curved claws, each seated on a moderately large protuberance. The last two segments are also furnished with a few strong black bristles.

When full grown the larva firmly fixes its case to the coralline seaweed, and closes up both ends with a loose network of silk, after which the enclosed insect is transformed into a pupa. This pupa has very strong mandibles, which are no doubt serviceable to the creature when escaping from the case. As is usual with caddises, the pupa swims about for some hours before the final transformation takes place.

The perfect insect appears about January. It frequents rocks on the sea-beach, and is sometimes extremely abundant. I have met with it in great numbers on the open coast, near the entrance to Wellington Harbour, where I also obtained many of the larvæ. Although I made a very careful search amongst the seaweed in rock-pools inside the harbour, I was unable to find a single specimen. I understand from Captain Hutton that the same, or a very similar marine caddis-fly, has been found in Sydney Harbour; and seeing that the insect is evidently most at home in the open sea, there appears to be no reason why this adventurous little species should not be widely distributed throughout the whole of the South Pacific Ocean.

Sub-Family 3.—HYDROPSYCHIDES.

“Maxillary palpi 5-jointed in both sexes, long, more or less deflexed, the last joint whip-shaped, and composed of numerous minute jointlets, slightly pubescent. Wings pubescent. Antennæ variable. Larvæ without any prominent hump on the first abdominal segment, external respiratory filaments present or absent, when present usually fasciculate” (Hutton).

“An extensive group in which the larvæ are believed to be chiefly of carnivorous habits. They vary, according to the species, as to the nature of the respiratory filaments, and live in fixed abodes; these are less tubular than is the rule in the portable cases, and are formed from pieces of sand and stone, spun together and fixed to large stones under water. Sometimes several larvæ live together in loosely compacted structures of this kind, and only form true cases when about to undergo their metamorphosis” (Sharp).

Genus HYDROPSYCHE, Pictet (1834).

“Antennæ very slender, the basal joint short and bulbous, the others after the second elongate, each slightly thickened within. Maxillary palpi with the second joint long, the third and fourth shorter, almost triangular, the fifth as long as the others united. Anterior wings narrow and elongate, obliquely truncated at the apex; anal lobe scarcely indicated; discoidal cell closed. Posterior wings much shorter, broader, folded, obtuse, usually with a long closed median cell.

“*Distribution*.—Cosmopolitan.”

HYDROPSYCHE FIMBRIATA.

Hydropsyche fimbriata, McLachlan, Trans. Ent. Soc. London, 1862, p. 9.

This species has been found at Wellington, and at Auckland.

The expansion of the wings of the male is about $\frac{1.5}{16}$ inch, of the female from $1\frac{1}{2}$ to $1\frac{3}{4}$ inches. “Antennæ pale-ochreous, annulated with dark brown; eyes varied with brown and black. Head and thorax reddish-brown. Abdomen blackish above. Legs ochreous. Anterior wings tawny-ochreous, much darker towards the apex, with numerous small pale spots; several of these are larger towards the base; on the inner margin elongate pale spots alternate with the dark ground-colour; fringe of the apical margin conspicuously yellowish-white. Posterior wings clothed with clay-coloured hairs. Inferior anal appendages in the male with very long terminal joints, which are pointed and curved upwards, approximating at the tips. Penis pale, with a callosity before the apex beneath; apex dark-red, tumid. Length of the body, 8 mm.; expanse of the wings, 22 mm.” (Hutton).

This insect has a deceptive resemblance to *Econesus maori*, but, apart from special structural characters, may be distinguished by its slightly excised wings.

The transformations of this insect probably closely resemble those of the next species, and I have often met with larvæ and pupæ identical in appearance but larger, which would, if they had been successfully reared, most likely have resulted in specimens of *H. fimbriata*.

The perfect insect appears in November, December, and January. It flies at evening dusk in the neighbourhood of water. It is extremely active and difficult to catch, captured specimens frequently without the slightest warning dashing out of the box. This activity of habit alone, will suffice to distinguish this species from *Æ. maori* or its allies, which are, in every respect, much more sluggish insects.

HYDROPSYCHE COLONICA.

Hydropsyche colonica, McLachlan, Journ. Linn. Soc., vol. 11, p. 131, pl. 4, fig. 16 (1873).

(Plate XI., fig. 7 ♂, 8 larva enlarged.)

This caddis-fly is very common on the banks of streams in the neighbourhood of Wellington. It has also occurred at Christchurch and at Ophir.

The expansion of the wings of the male is about $\frac{2}{3}$ inch, of the female $1\frac{1}{8}$ inch. General colour "blackish, head and prothorax covered with hoary hairs; antennæ brown, with pale rings. Legs yellow. Abdomen blackish, with a broad whitish line along each side. Anterior wings long and narrow, greyish-yellow, thickly reticulated with dark grey and with several short blackish streaks on the inner margin. Posterior wings smoky, the veins darker. In the male the last abdominal segment bears in its middle a nearly vertical short lobe, which is notched. Appendages testaceous or yellowish, the last joint of the inferior pair short, sub-obtuse, stout. Penis cylindrical, directed upwards, the apex thickened, bifid, bearing beneath two broad claw-shaped acute hooks. Length of the body, ♂ 7 mm., ♀ 8 mm.; expanse of wings, ♂ 22 mm., ♀ 28 mm." (Hutton).

The larva of this insect inhabits the streams throughout the entire year, but is commonest in the early spring, when full-grown individuals are often most abundant. It frequents the most rapid portions of the stream, where the water is clear and bright. It generally lives in a loosely constructed gallery composed of leaves, twigs, and fairly large pebbles, attached by means of fragile silk to the under-surface of a large boulder. This larva is able to cling with great tenacity by means of its strong anal prolegs—a faculty which is no doubt very serviceable to the insect, whilst making its way about in the rushing torrents, which it often frequents, and where

it is sometimes found crawling about without any protection.

The length of the larva when full grown is about $\frac{3}{4}$ inch. The head is round, much flattened above, dark brown and horny with the surface very rough. The prothorax is small, cylindrical, and horny throughout. The meso- and meta-thorax are slightly larger, and furnished with dark-brown horny plates on the dorsal surface. The segments of the abdomen are stout, rather soft, and dull greenish-brown in colour. There are two rather elongate appendages at the posterior extremity of the larva, each furnished with a very strong hook, and a conspicuous tuft of long brown bristles. The under-side of the mesothorax is furnished with two branching white filaments. The metathorax and the first seven segments of the abdomen are each furnished, on the under surface, with four branching white filaments. The last segment but one has two filaments, and the terminal segment two brushes of brown bristles, in addition to the above described terminal appendages. The anterior pair of legs are very short and stout; the two other pairs also short and rather slender.

This larva is a favourite article of food with the trout (see tables pages 93–98), and as it occurs in large numbers during the winter, and is full grown in very early spring, it must be an important item in the dietary of that fish.

When full grown this larva constructs a cocoon of rather large stones, loosely joined together with silk, but firmly attached to a boulder in the bed of the stream. The pupa is simply enclosed in this cocoon, and is not encased in any inner horny case. The perfect insect appears in December and January, and is often extremely abundant after dark, when large numbers may be observed either flying over the stream or running with great agility over the stones and herbage near the banks.

Genus POLYCENTROPUS, Curtis (1835).

“Antennæ strong, the joints short, the first bulbous. Maxillary palpi with the first and second joints very short, stout, almost transverse; the third and fourth cylindrical; the fifth as long as the others united, stout at the base. Anterior wings elongate-oval, densely pubescent, with short fringes. Posterior wings shorter, much broader, with obtuse apices; apical fringes short, those on the anal border longer; anal lobe well developed; discoidal cell open, and the two first costulæ generally connected near their middle by a small nervule.

“*Distribution*.—Europe, America, Ceylon” (Hutton).

POLYCENTROPUS PUERILIS.

Polycentropus puerilis, McLachlan, Journ. Linn. Soc., vol. 10, p. 204, pl. 2, fig. 8 (1870).

(Plate XI., fig. 9, 10 larva enlarged.)

This pretty and easily recognised caddis-fly has been

taken at Auckland and Wellington, in the North Island, and at Christchurch and Lake Pukaki, in the South Island. It is probably generally distributed throughout New Zealand.

The expansion of the wings is about $\frac{1\frac{3}{16}}$ inch.

"Fuscous, clothed with blackish and golden hairs intermingled. Antennæ yellow, with narrow brown rings. Anterior wings rather broad, the apices broadly elliptical; brown, thinly sprinkled with brownish-yellow dots. Posterior wings smoky-grey; apical forks 2 and 5 present, the first two costulae not connected by a nervule. Legs dirty testaceous. Abdomen brown. In the male there is a narrow, elongate, testaceous lobe from the apical margin of the last dorsal segment, curved downwards; intermediate appendages needle-shaped; the superior broad and spoon-shaped; the inferior elongated. Length of the body, 5 mm.; expanse of the wings, 15 mm." (Hutton).

This insect may be recognised by its dark brown forewings, with conspicuous cream-coloured patches on the dorsum.

The larva is found in the streams throughout the year, but is very scarce in the winter and early spring. It is full grown about January.

When mature it measures about $\frac{3}{4}$ inch in length. The head is large, oval, pale yellow speckled with black; the three thoracic segments are dull green; the anterior legs are short, slender, and not specially prehensile in structure; the other two pairs of legs are also slender, and of moderate length. The abdomen is pinkish-brown, elongate, composed of nine uniform and simple segments, gradually tapering towards the posterior extremity. There is a number of very slender hairs or filaments on the sides of the body. The anal claspers are elongate and very strong. They are composed of three joints; the first is stout and cylindrical, the second is much shorter and slenderer, and the third consists of a very strong and horny hook.

This larva inhabits very slow-running streams, and is usually found where the "green slime" weed is abundant, amongst which it forms extensive tubular galleries composed entirely of the weed interwoven with its own silk. These galleries often meander over the surfaces of rocks and boulders. They are very difficult to detect, except when distended by the larva as it wriggles to and fro inside the tube. It is, however, generally difficult to find the larva, as it always has to be disengaged from its slimy habitation, and very often escapes during the process. This caddis-worm is not full-grown until the middle or end of January; consequently it inhabits the streams when they are almost at their lowest level, and thus full of the "green slime," amongst which the insect is specially adapted to live.

This larva is carnivorous, feeding chiefly on smaller insects, which it captures whilst lurking in its secret

galleries. When full grown it constructs a large and extremely tough silken cocoon, covered on the outside with very numerous minute stones. It is generally situated on the side of a large boulder, just at the point where the stone is embedded in the sandy detritus of the river-bed. These cocoons are extremely difficult to remove without destroying the contained pupæ, and it is quite impossible to extract the insect without injury, owing to the tough, but very elastic, nature of the cocoon, which when pulled in one direction stretches and contracts in the other, thus compressing and injuring the enclosed insect. The cocoons are often very abundant in February, but I have only succeeded in getting one specimen as far as the swimming pupa stage, from which I was able to identify the insect as *P. puerilis*. Both larva and pupa very speedily die in confinement, the insect being apparently especially susceptible to the ill-effects of the imperfectly aerated water of the ordinary aquarium. The perfect insect appears from November till April. It is nocturnal in its habits and is often attracted by light. The specimens taken in November appear to emerge from pupæ, which have passed the entire winter in their cocoons in the streams; this appears to be a frequent habit with *P. puerilis*, as I have several times found the pupæ in streams during the winter.

Sub-Family 4.—RHYACOPHILIDES.

In this group the larval habitations are fixed. The pupa is enclosed in an inner cocoon, lying inside the original habitation of the larva.

Genus HYDROBIOSIS, McLachlan (1870).

“Antennæ slender, the basal joint shorter than the head, and stout. Maxillary palpi long and pubescent, the two basal joints short and stouter than the others, fifth not so long as the third and fourth together. Anterior wings elongate, the costal and dorsal margins nearly parallel; the apex longly elliptical, clothed with woolly pubescence and longer hairs on the veins; fringes short; neuration not very distinct. Posterior wings shorter and broader, folded, rounded at the apex; fringes long on the dorsal margin; pubescence slight; no closed discoidal cell; a transverse vein unites the upper branch of the sector with the radius; a second unites the lower branch of the sector with the superior cubitus, and a third is placed below this, much nearer the base of the wing. Spurs 2.4.4; those on the anterior tibiæ small, on the others long and straight.

“*Distribution*.—New Zealand” (Hutton).

HYDROBIOSIS FRATER.

Hydrobiosis frater, McLachlan, Journ. Linn. Soc., vol. 10, p. 207, pl. 2, figs. 9a, 9b (1870).

This species has occurred at Nelson and at Christchurch.

The expansion of the wings is about $\frac{3}{4}$ inch.

"Brown; antennæ brown with narrow yellowish rings; vertex blackish, with dark-grey hairs; ocelli large, yellowish. Anterior wings with long woolly black and grey hairs; pterostigma elongate, brown; a space on the middle of the dorsal margin pale grey, tufts of longer black hairs along the dorsal margin of the male only. Posterior wings sub-hyaline, the fringes blackish. Legs dull-red; anterior and intermediate tibiæ with a narrow median pale ring. Abdomen brown, yellowish beneath; the male with three ventral teeth. Length of the body, ♂ 5 mm., ♀ 7 mm.; expanse of the wings, ♂ 18 mm., ♀ 23 mm." (Hutton).

In February, 1892, I found this insect in great abundance on the banks of the Buller River, where it flows out of Lake Rotoiti.

HYDROBIOSIS UMBRIPENNIS.

Hydrobiosis umbripennis, McLachlan, Journ. Linn. Soc., vol. 10, p. 208, pl. 2, figs. 9c, 9d (1870).

(Plate XI., fig. 11, 12 larva, enlarged; 13 pupa enclosed in its inner cocoon, enlarged.)

At present specimens of this insect are only recorded from Wellington, Nelson, and Christchurch; but future investigation will probably prove that it is generally distributed throughout the country.

The expansion of the wings is from $\frac{3}{4}$ to 1 inch.

"Brown; antennæ yellow, with indistinct brown rings; ocelli large and conspicuous, yellow. Anterior wings brown, with blackish and whitish hairs; pterostigma darker, elongate; neuration pale yellowish-testaceous, apical fringe with yellowish dots and tufts of black hairs along the cubitus near the base. Legs pale testaceous; the anterior tibiæ and tarsi rather brownish externally, with paler rings. Abdomen brown above, yellowish beneath; the male with but one ventral tooth, which is long, on the apical margin of the penultimate segment. Length of the body, ♂ 8 mm., ♀ 11 mm.; expanse of the wings, ♂ 32 mm., ♀ 27 mm." (Hutton).

The larva of this insect inhabits clear, rapid streams, and swims with great activity amongst the stones. It is carnivorous, chiefly feeding on small May-fly larvæ. The larvæ of *H. umbripennis* are found in the streams during the entire year, but are commonest in the spring and early summer, only very small specimens occurring in the autumn and early winter.

The length of the larva when full grown is a little less than $\frac{3}{4}$ inch. The head and prothorax are very horny, narrow, and pale brown in colour. The rest of the insect is dull green, and very soft. The segments of the abdomen gradually decrease in size towards the posterior extremity. The terminal appendages are slender, and are each furnished with a pair of strong hooks. The anterior legs are very stout, the tibia and tarsus being modified into two prehensile claws, which are employed by the larva in capturing its prey. I have been unable to detect any traces of external gills in this larva.

Unlike most of the caddis-fly larvæ, this insect does not live in any kind of case, but swims about the streams entirely unprotected, during the whole of its larval life. When full grown, however, it constructs a compact, oval cocoon of rather small stones, which is firmly affixed to the surface of a boulder in the bed of the stream. These cocoons are very hard so long as they remain intact, but when once they are injured in any way they immediately collapse. Inside the stone cocoon the larva invests itself in an oval, semi-transparent envelope, somewhat resembling in appearance thin horn or gelatine. Through this inner cocoon the enclosed insect may be readily seen, and may at once be identified by means of its long, narrow head, which is curved downwards and laid upon the breast of the insect. The creature remains in this transition state for many days, during which time it frequently turns itself round inside the gelatine cocoon. Finally, however, it is transformed into a light green pupa of extreme delicacy. In fact, this pupa is so fragile and soft that it is seldom possible to extract it from the inner cocoon without inflicting the most serious injuries. As the enclosed insect develops, the gelatine cocoon becomes more and more opaque: thus the final stages of the pupa are not clearly discernible. The mature pupa emerges through an opening in one end of the inner cocoon, but practically leaves no visible sign of its means of exit from the outer stone cocoon. When free the pupa always swims about in the water for several hours before it gives rise to the winged fly.

The perfect insect is fairly common in the vicinity of streams, and may sometimes be taken at light.

During the late spring and early summer I have observed that large numbers of the stone cocoons, constructed by the larvæ of this species and its allies, are invariably left high and dry on the boulders situated at the edges of rivers. This circumstance is due to the shrinkage in the volume of water, which nearly always takes place at that season, leading of course to the destruction of very large numbers of the living pupæ,

which are then within the dried-up cocoons. It is, however, somewhat remarkable that this extensive and constantly recurring destruction has not led to the exclusive preservation of larvæ endowed with an instinct to fix their cocoons in deep water some distance from the edge of the stream, but such a beneficial instinct does not yet appear to have been universally produced. These remarks will apply with equal force to *Olinga feredayi*, the extensive annual mortality of which insect from the same cause has already been noticed.

Genus PSILOCHOREMA, McLachlan (1866).

“Antennæ very slender, slightly longer than the wings. Head transverse, produced in front between the antennæ, rugose, the hinder portion forming a raised collar. Ocelli very distinct. Maxillary palpi slender, slightly hairy, the two basal joints short and broad, the third longer and slender, the fourth shorter than the third, the fifth longer than the third. Mesothorax ovate, with a raised tuft of hairs in the middle in the male. Legs moderately long, alike in both sexes; spurs 2.4.4. Anterior wings narrow, the margins nearly parallel, hairy clothing short and dense; the apex somewhat dilated; on the cubital veins in the male are tufts of raised hairs; discoidal cell closed, with a smaller cell below it; apical cells long and narrow: apical forks present in all five veins. Posterior wings rather shorter and broader; pubescence scanty; apical forks present in all five veins. Abdomen moderately robust.

“*Distribution*.—New Zealand.

“In this genus the wings are nearly flat when in repose” (Hutton).

PSILOCHOREMA MIMICUM.

Psilochorema mimicum, McLachlan, Trans. Ent. Soc. London, ser. 3, vol. 5, p. 274 (1866).

This species has occurred at Auckland, Wellington, and Christchurch. It is fairly common in most situations in the vicinity of water, and is a very pretty little insect when alive.

The expansion of the wings is about $\frac{3}{4}$ inch.

“Antennæ fuscous, annulated with yellow, the apical portion wholly fuscous. Head and mesothorax dark chestnut. Anterior wings smoky, with pale golden and whitish markings; a whitish indented fascia a little below the apex; several raised tufts of blackish hairs along the dorsal margin towards the base. Posterior wings greyish-hyaline. Legs greyish-ochreous, the tips of the tarsal joints annulated with pale yellowish. Abdomen blackish-fuscous, the appendages testaceous. In the male the superior appendages are very small, slender at the base and clavate, hairy; inferior appendages very large and broad, concave and furnished with numerous minute blackish teeth internally, the outer margin broadly emarginate. Between the inferior appendages, on the superior portion, arises a long flattened and obtuse piece, probably the upper penis-cover. Length of the body, $6\frac{1}{2}$ mm.; expanse of wings, 16 mm.” (Hutton).

The transformations of this species appear to closely resemble those of *H. umbripennis*.

The perfect insect appears about midsummer, and is often attracted by light, but single individuals are occasionally seen at all times in the year.

PSILOCHOREMA CONFUSUM.

Psilochorema confusum, McLachlan, Journ. Linn. Soc., vol. 10, p. 210, pl. 2, fig. 10 (1870).

The expansion of the wings is about $\frac{3}{4}$ inch.

"Brown; antennæ yellow, indistinctly ringed with brown; basal joint with golden hairs. Anterior wings pale brown, with pale yellow woolly clothing mixed with black; an indistinct whitish wavy band before the apex and some pale markings on the disk. Neuration very irregular in the male. Posterior wings grey, sub-hyaline, iridescent, fringes grey. Legs pale yellow; anterior and intermediate tibiæ and tarsi rather brownish externally. Abdomen brown, the apical margin of each ventral segment broadly dingy yellowish. Inferior appendages in the male elongated and slender, bent in the middle almost at right angles. In the female the penultimate ventral segment bears a tuft of hairs in the middle. Length of the body, 4 mm.; expanse of the wings, 15 mm." (Hutton).

Localities.—Auckland and Wellington.

In its metamorphosis this species closely resembles *H. umbripennis*; the larva is, however, much smaller, with the head proportionately narrow. The inner cocoon is more transparent and much smaller; the outer cocoon is also smaller. I have observed that the larva remains in its cocoon for many days before manifesting any change.

The perfect insect appears from November till March, and is much attracted by light. It is commonest about midsummer.

Sub-family 5.—HYDROPTILIDES.

"Very minute, strongly pubescent and hairy, the wings with numerous erect hairs. Palpi very hairy, simple in structure, alike in both sexes. Antennæ short and stout. The larvæ are without any external respiratory filaments, and make cases usually movable (fixed in a Brazilian species), formed of silk, to the exterior of which are sometimes attached minute grains of sand. The cases have a slit at each end, and the larvæ present their heads at either indiscriminately" (Hutton).

The members of this family comprise the most minute of the caddis-flies, and the perfect insects bear an extreme resemblance to small moths of the group *Tineina*.

Genus OXYETHIRA, Eaton (1873).

"Antennæ stout, the joints somewhat cup-shaped, slightly longer than broad, the basal joint much longer than the others. Maxillary palpi slender, the third to fifth joints long. Ocelli present. Spurs 0.3.4. Anterior wings extremely long and slender, the apices narrowly acuminate, clothing very dense, costal fringes long; neurulation simple, the sector ends in a long simple fork, as also does the upper branch of the superior cubitus; few, if any, transverse nervules. Posterior wings exceedingly long and narrow, the apex longly acuminate as in the anterior, very acute; the costal margin strongly elbowed near the base; sector simple, superior cubitus apparently with a small fork at the apex, a distinct median transverse nervule.

"Distribution.—Europe" (Hutton).

OXYETHIRA ALBICEPS.

Hydroptila albiceps, McLachlan, Trans. Ent. Soc. London, 1862, p. 4. *Oxyethira albiceps*, Eaton, Trans. Ent. Soc. London, 1873, p. 145 (?); Hudson, Trans. N. Z. Inst., vol. 18, p. 213.

(Plate XI., fig. 1, 2 larva, 3 pupa, all much magnified.)

This minute insect must be very common in the neighbourhood of Wellington, but, owing to its small size and inconspicuous appearance, is, no doubt, constantly overlooked.

The expansion of the wings is about $\frac{1}{2}$ inch.

"Male.—Antennæ grey, faintly annulated with darker; head clothed with dense greyish-white pubescence. Thorax fuscous. Abdomen brown above, silvery beneath. Legs pale-grey. Anterior wings dark greyish-fuscous, irrorated with pale grey, the extreme apex conspicuously whitish. Posterior wings pale grey, the cilia concolorous. Length of the body, 2 mm.; expanse of wings, 5 mm." (Hutton).

The larva of this species, although, of course, very small in size, is extremely interesting. On examination with the microscope the case will first arrest attention, being of unique structure. Its shape is best described as closely resembling that of a minute flask, very much flattened at the lower end, with sloping shoulders and almost transparent; its surface is slightly corrugated, and the neck of the flask composed of much denser material than the rest. It is open at both ends, the posterior end being perforated by a long, shallow slit, which extends for nearly the whole width of the case, thus admitting a free circulation of water around the enclosed insect. The larva is also able to turn round and project its head and anterior segments through the lower aperture of the case, when it occupies the reverse

position to that shown in the figure. It is, however, prevented from actually leaving the case by its abdomen, which is too large to be withdrawn from either end.

The larva has the head and thorax horny, and pale brown in colour; the two anterior legs are rather short, and apparently prehensile in function; the other two pairs are very long and slender, and employed exclusively in walking. The abdomen is very large, soft, dark green in colour, with the segments very deeply excised. At the extremity of the body there are two large breathing orifices, surrounded by a number of long bristles. Two convoluted tracheæ are plainly visible extending upwards from these organs, and ramifying through the body of the insect in all directions.

This larva is very active, pulling its comparatively large and heavy case through the green slime weed, amongst which it always lives, and no doubt feeds upon. When alarmed, the insect can entirely retreat into its case, which is very roomy, and enables the occupant not only to turn round and project its head and anterior segments through the lower aperture, but also to move about quite freely, whilst entirely within the case.

The methods, followed by the larva in the construction and subsequent enlargement of its case, are not known at present; but there is no doubt that the case is made of a viscous fluid, which hardens when exposed to the water. This material is secreted by the larva, and is analogous to silk.

When about to change into a pupa, the insect fixes its case down by four ligaments, two at each end, the extremities of these being firmly fastened to a stone; the small aperture is then closed, and after this the larva constructs an arch-shaped partition of dense material inside the case, a short distance from its broad end. In about a week the insect is transformed into a pupa, having the limbs free from the body, but incapable of motion. The fixing down of the case prior to the change is easily performed by the larva through each of the apertures, which are, for that purpose, left open until the last. When mature, the pupa breaks through the partition at the broad end of the case, and wriggles to the surface, the imago ascending a blade of grass to dry and expand its wings. The little skins of the pupæ may often be noticed floating on the water, and the empty cases are very conspicuous on the sides of a glass aquarium, where the insects generally fix them down when in captivity. These fixed cases may often be found in thousands attached to the stones in the streams.

They are usually commonest in the late summer, when the rivers are generally very low, and in consequence a luxuriant growth of the green slime weed is present.

This caddis-fly must be tolerably common during the summer, but owing to its small size would not be likely to attract attention. I have seldom observed it in a state of nature, my specimens having been reared from the larva.

Another larva, closely related to the above insect, which feeds on the same green weed, is figured, much magnified, on Plate IX., fig. 11. This species constructs an oval case, which is always kept in an erect position. Both of its apertures are identical in size and shape, and are employed quite indifferently by the larva, which projects itself sometimes from one end of its abode and sometimes from the other. When mature this larva fixes its case to a stone by its edge, always keeping it in a vertical position, and employing for this purpose two strong bands of viscous material. Whilst engaged in thus anchoring its dwelling, the larva extends itself from the case through each of the above-described orifices.

The caddis-fly, which results from this larva, is undescribed at present, but as it is very inconspicuous and closely resembles *O. albiceps* in general appearance, the chief interest of the insect will always centre in its preparatory stages.

APPENDIX.

NOTES ON THE FOOD OF TROUT IN NEW ZEALAND.

THE following tables have been prepared to assist anglers and others interested in the culture of trout in this country to determine on the precise species of insects, &c., which form the staple food-supply of these fish in our New Zealand streams and rivers. Although not by any means exhaustive, the results arrived at are probably of fair average value. It must, however, be remembered, when consulting these tables, that the importance of the caddis-worms as food is probably slightly exaggerated, owing to their easy identification when found in the trout's stomach. This is chiefly due to the fact that the fish always swallows the case, as well as the contained larva. On the other hand, the value of May-fly nymphs as trout food is probably understated, these insects having no cases and being so exceedingly fragile, that they soon dissolve after passing into the trout's stomach.

Results of the examination of the contents of five stomachs taken from trout captured in the South Karori Stream in September, 1901.

1. NEUROPTERA.

	Larvæ of <i>Olinga feredayi</i>	77
	„ <i>Pycnocentria evecta</i> or <i>aureola</i>	12
97 Caddises	„ <i>Hydropsyche colonica</i>	6
	„ <i>Hydrobiosis umbripennis</i>	1
	Pupa of „	1
1 “Black creeper,”	larva of <i>Chauliodes diversus</i>	1
	Total.....	98

2. OTHER ORDERS OF INSECTS.

Diptera (1 larva of <i>Stratiomida</i> , 1 <i>Lucilia cæsar</i>)	2
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Contents of seven stomachs taken from trout captured in the same stream by Mr. A. E. Waterson during December, 1899.

1. NEUROPTERA.

307 May-fly nymphs	{ Larvæ of <i>Atalophlebia</i>	306
	„ <i>Coloburiscus humeralis</i>	1
1 Stone-fly larva	„ <i>Stenoperla prasina</i>	1
	{ Larvæ of <i>Olinga feredayi</i>	48
	„ <i>Pycnocentria evecta</i> or <i>aureola</i>	47
117 Caddises	„ <i>Pseudonema amabilis</i>	4
	„ <i>Hydropsyche colonica</i>	14
	„ <i>Hydrobiosis umbripennis</i>	2
	„ <i>Helicopsyche</i>	2
2 "Black creepers," larvæ of <i>Chauliodes diversus</i>		2
Total.....		427

2. OTHER ORDERS OF INSECTS.

Coleoptera (1 <i>Elater</i> , 1 <i>P. festiva</i> ,* 1 small beetle).....	3
Diptera (5 <i>Calliphora</i> ,† 2 <i>Phora</i> , 2 <i>Eurigaster</i> , 1 <i>Sapromyza</i> , 1 pupa <i>Tipula</i> , 1 larva <i>Helophilus</i>).....	12
Hemiptera (1 <i>Cicada</i> , 1 <i>Aphrophora</i>)	2

3. NOT INSECTS.

1 Snail, 1 Spider	2
Total.....	19

Contents of seven trout stomachs taken from fish captured from the same stream in January and February, 1902 (Mr. A. E. Waterson).

1. NEUROPTERA.

33 May-fly nymphs	{ Larvæ of <i>Atalophlebia</i>	30
	„ <i>Coloburiscus humeralis</i>	3
	{ Larvæ of <i>Hydropsyche colonica</i>	4
	„ <i>Hydrobiosis umbripennis</i>	2
172 Caddises	„ <i>Olinga feredayi</i>	80
	„ <i>Pycnocentria evecta</i> or <i>aureola</i>	43
	„ <i>Pycnocentria</i> — ?	35
	„ <i>Helicopsyche</i>	8
1 Stone-fly, larva of <i>Stenoperla prasina</i>		1
3 "Black creepers," larvæ of <i>Chauliodes diversus</i>		3
Total.....		209

* Small green beetle.

† Blow-flies.

2. OTHER ORDERS OF INSECTS.

Coleoptera (<i>Pyronota festiva</i>)	1
Diptera (larva of <i>Stratiomidae</i>)	1

3. NOT INSECTS.

1 Crustacean, 12 Snails, 2 Spiders.....	15
Total.....	17

Contents of three trout stomachs taken from fish captured in the Mungaroa Stream on April 1, 1902 (Mr. A. E. Waterson).

1. NEUROPTERA.

1 May-fly nymph, larva of <i>Coloburiscus humeralis</i>	1
102 Caddises { Larvæ of <i>Olinga feredayi</i>	51
" <i>Pycnocentria evecta</i> or <i>aureola</i>	17
" <i>Pycnocentria</i> — ?	7
" <i>Pseudonema amabilis</i>	14
" <i>Hydropsyche colonica</i>	9
" <i>Helicopsyche</i>	4
1 "Black creeper," <i>Chauliodes diversus</i>	1
Total.....	104

2. OTHER ORDERS OF INSECTS.

Coleoptera (<i>Elater</i> 1)	1
-------------------------------------	---

3. NOT INSECTS.

Snails 5	5
Total.....	6

Contents of eight stomachs taken from trout captured in the Waikanae River by Mr. A. J. Rutherford, October, 1900.

1. NEUROPTERA.

2,440 Caddises { Larvæ of <i>Pycnocentria evecta</i>	1,825
" <i>Pycnocentria</i> — ?	83
" <i>Pycnocentria</i> — ?	21
" <i>Olinga feredayi</i>	404
" <i>Helicopsyche</i>	100
" <i>Pseudonema obsoleta</i>	7
10 Stone-flies { " <i>Stenoperla prasina</i>	8
" <i>Leptoperla opposita</i>	1
Imago of " "	1

7 "Black creepers," larvæ of <i>Chauliodes diversus</i>	7
1 May-fly nymph, larva of <i>Ichthybotus hudsoni</i>	1
Total.....	2,458

2. OTHER ORDERS OF INSECTS.

Coleoptera (<i>Navomorphia lineatum</i> 2)	2
Diptera (Larva of <i>Stratiomide</i> 2)	2
Total.....	4

Contents of nine stomachs of trout captured in South Canterbury, October 12, 1901. Received from Captain Hutton, F.R.S.

1. NEUROPTERA.

58 May-fly nymphs, larvæ of <i>Coloburiscus humeralis</i>	58
221 Caddises { Larvæ of <i>Olinga feredayi</i>	122
" <i>Pycnocentria evecta</i> or <i>aureola</i>	84
" <i>Hydropsyche colonica</i>	2
" <i>Helicopsyche</i>	13
1 "Black creeper," larva of <i>Chauliodes diversus</i>	1
Total.....	280

2. OTHER ORDERS OF INSECTS.

Coleoptera (Beetles)	8
Hymenoptera (<i>Ichneumon-fly</i> 2, ant 1)	3
Hemiptera (<i>Corixa zealandica</i> 13)	13
Diptera (<i>Tipula</i>)	1

3. NOT INSECTS.

1 Fish, 1 Spider, 2 Snails	4
Total.....	29

A considerable amount of unrecognisable material occurred in these stomachs, and probably consisted of the residuum of the larvæ of *atalophlebia* or allied May-flies.

Contents of twelve stomachs taken from trout captured in the Upper Selwyn River, Canterbury, by Mr. H. F. Wigram, November 23, 1901.

1. NEUROPTERA.

5	May-fly nymphs, larvæ of <i>Atalophlebia</i>	5
245	Caddises {	Larvæ of <i>Olinga feredayi</i> 115
		„ <i>Pycnocentria evecta</i> or <i>aureola</i> 5
		„ <i>Hydropsyche colonica</i> *..... 39
		Pupæ of „ 81
3	“Black creepers,” larvæ of <i>Chauliodes diversus</i>	3
1	Stone-fly, larva of <i>Stenoperla prasina</i>	1
Total.....		254

2. OTHER ORDERS OF INSECTS.

Coleoptera (<i>Pyronota festiva</i> 15, <i>Pterostichus antarcticus</i> 1, <i>Elaters</i> 3, <i>Anchomenus</i> 1).....	20
Diptera (Larva of <i>Stratiomys</i> 2)	2
Total.....	22

Contents of seven stomachs taken from trout captured by Mr. David Thompson at Wainui-o-mata, December 22, 1901.

1. NEUROPTERA.

847	Caddises	{	Larvæ of <i>Pycnocentria evecta</i> or <i>aureola</i>	780
			„ <i>Hydropsyche colonica</i>	35
			„ <i>Olinga feredayi</i>	26
			„ <i>Hydrobiosis umbripennis</i>	1
		{	Pupæ of „ „	1
			Imagines of „ „	2
88	May-fly nymphs {	„ <i>Hydropsyche colonica</i>	2	
		Larvæ of <i>Atalophlebia</i>	66	
		„ <i>Coloburiscus humeralis</i>	21	
		„ <i>Aneletus ornatus</i>	1	
3	Stone-flies	„ <i>Stenoperla prasina</i>	2	
		Imago of <i>Perla</i> — ?	1	
Total.....				938

* Or allied species.

2. OTHER ORDERS OF INSECTS.

Coleoptera (<i>Hydora</i> * 500, <i>P. festiva</i> 12, <i>Colaspis</i> 4, Beetles, undetermined, 12, <i>Odontria</i> 12)	540
Diptera (<i>Empis</i> 20, larva of <i>Stratiomys</i> 2)	22

3. NOT INSECTS.

1 Fish, 1 Snail	2
Total.....	564

Contents of two stomachs taken from trout captured high up the river in the Waingawa Gorge Tararua Ranges by Mr. A. J. Rutherford, March, 1902.

1. NEUROPTERA.

36 May-fly nymphs, larvæ of <i>Atalophlebia</i>	36
---	----

2. OTHER ORDERS OF INSECTS.

Coleoptera (<i>P. festiva</i> 15)	15
Hymenoptera (Ant 1).....	1
Orthoptera (Grasshoppers 3).....	3
Hemiptera (Cicadas, <i>Melampsalta</i> 8)	8
Total.....	27

* A small water-beetle occasionally found in swarms on stones in rivers.

GENERAL SUMMARY OF THE FOREGOING TABLES.

BEING A STATEMENT OF THE CONTENTS OF SIXTY TROUT STOMACHS.

	Larvæ of <i>Pycnocentria evecta</i> or <i>aurrolo</i>	2,813
	“ “ ——— ?	146
	“ <i>Olinga feredayi</i>	923
4,241 Caddises	“ <i>Hydropsyche colonica</i>	192
	“ <i>Helicopsyche</i>	127
	“ <i>Hydrobiosis umbricennis</i>	15
	“ <i>Pseudonema obsoleta</i>	7
	“ “ <i>amabilis</i>	18
	“ <i>Atalophlebia</i> (various species)	443
529 May-fly nymphs	“ <i>Coloburiscus humeralis</i>	84
	“ <i>Ameletus ornatus</i>	1
	“ <i>Ichthybotus hudsoni</i>	1
18 “Black creepers”	“ <i>Chauliodes diversus</i>	18
	“ <i>Stenoperla prasina</i>	13
16 Stone-flies	“ <i>Leptoperla opposita</i>	3
	Total Neuroptera	4,804
<hr/>		
Coleoptera (Beetles), including 44 <i>P. festiva</i> and 500 specimens of <i>Hydora</i>		590
Diptera (Flies, &c.)		42
Hymenoptera (Ichneumon-flies, Ants, &c.)		4
Orthoptera (Grasshoppers, &c.)		3
Hemiptera (Cicadas, &c.)		23
	Total other insects	662
<hr/>		
Snails		21
Spiders		4
Fish		2
Crustacea		1
	Total not insects	28
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