A Revision of New Zealand Ephemeroptera.

PART 1.

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CONTENTS.

THE order EPHEMEROPTERA is a small division of insects, previously included under the heading of NEUROPTERA.

Mayflies spend almost the whole of their existence under water and in the nymphal stage.

The majority of species prefer the fast-flowing or moderately fast-flowing type of waters, and so New Zealand, with its abundance of hill streams, is a particularly favourable country for their existence.

As far as is known at present, our mayflies are entirely endemic, but they show affinities to Australian species.

Some of our larger flies of the family SIPHLONURIDAE are of great interest, as they are of an archaic type and unlike any found outside Australasia.

The only economic importance of this order is as the food of fresh-water fish and, as I have shown elsewhere (15) they form about ten per cent. of the food of the acclimatised brown trout (*Salmo fario*) in New Zealand.

In this connection, it has been stated that our larger and less agile mayflies, notably *Oniscigaster,* are being exterminated by the trout. Whilst it is certain that they have been very seriously depleted, the stream beds are so very uneven that there will always be plenty of refuge places for the nymphs of mayflies, inaccessible to trout and indeed I have found *Oniscigaster* in streams which abound in trout.

A far more serious danger is the acclimatised bird, and to a lesser extent the native bird, now that the river banks have been cleared of bush in most places, for in the winged stages—particularly in the sluggish sub-imaginal one—the mayfly falls an easy prey.

Past Work.

Apart from one or two isolated examples (19), (24), (25), (26), (27) and (28), New Zealand EPHEMEROPTERA were first described by Eaton, who in 1871 (17) published an account of four of our species.

Later, in his monumental work (4), Eaton included descriptions of six New Zealand mayflies, and in 1899 (5) these descriptions were amended, enlarged and new species added, so that this last paper dealt with ten species. Altogether, Eaton described eleven of our species, but with the exception of *Oniscigaster wakefieldi,* he did not give any accounts of the nymphal stages, which at that date were mainly unidentified.

Hutton, writing in 1898 (2), included short notes of seven species among accounts of the local NEUROPTERA, but among these was an Australian species, not found here, *Atalophlebia costalis,* which McLachlan thought would probably be found here as well; and Lillie, writing in 1898 (3) and 1901 (18), dealt with three species. The latter writer bred his flies from the nymphal stage, and was, therefore, able to include the nymphs in his descriptions. His unknown nymph (18) is *Coloburiscus humeralis.*

In 1904, Hudson published a book on *New Zealand Neuroptera* (1), which included short accounts of twelve mayflies with one new species, *Atalophlebia cruentata*: it included brief descriptions of many of the nymphs, extracts from Eaton describing the winged stages and much original information concerning habitat and life history.

For nearly twenty years, no further work was published till in 1923, Tillyard (6) described some of the stages of two new mayflies, *Ichthybotus bicolor* and *Ameletus flavitinctus.*

In the same year appeared his paper on *The Wing Venation of the Plectoptera* (16), a work which greatly altered all pre-existing ideas on the subject. His studies were made on New Zealand mayflies of the family Siphlonuridae.

Since then, his wing-vein designations have been slightly modified and the remodelled nomenclature appears in his book (7). This also gives a key to families and some remarks on the species.

The present paper is an attempt to fill up the gaps. It deals with twenty species, some of them new, and gives particulars of the undescribed (generally nymphal) stages of adults known for many years.

The nymphs were collected in the neighbourhood of Wellington for three consecutive seasons and bred in separate compartments of an aquarium at Victoria University College.

Life Cycle.

The egg stage, which is spent under water, generally either attached to some stone or other object in the bed of the stream or wedged in some sub-aqueous crevice, probably lasts some two or three weeks. Eggs of *Deleatidium vernale* incubated under laboratory conditions in tap water, hatched in fifteen days, those of *Coloburiscus humeralis* in eighteen days and those of *Ameletus flavitinctus* in twenty-seven days.

Heymons (21) hatched *Ephemera vulgata* in ten to eleven days, but mentions that, according to Joly, *Polimitarcys* requires six to seven months for incubation.

The water temperature has a marked effect on the time needed for hatching.

The number of eggs laid by different species varies greatly. *Deleatidium vernale* oviposits 600-800, whereas *Oniscigaster distans* is at least ten times as prolific.

The method of attachment and appearance of individual eggs is equally diverse. In some cases, e.g., *Coloburiscus humeralis, Ameletus flavitinctus, Atalophlebia versicolor,* they are fixed to the substratum by means of some attached cement-like substance, in others, e.g., *Deleatidium vernale,* the cement is absent and they are either lodged in some sub-aqueous cranny or anchored to vegetable or mineral matter by means of cables or projections attached to the egg.

Morgan (20) found that all the eggs of the American species she examined were viscid and adhered to the bottom. In many New Zealand species this is not the case, in fact in one or two cases, the eggs appear to be enveloped in some viscid material as they leave the oviducts and this dissolves off in the water as the eggs drop through it.

The shape of the egg is ovoid, sometimes almost a regular oval, sometimes exceedingly irregular. The chorion is usually intricately sculptured, covered with small protuberances and with minute pits: often there are micropylar masses and anchoring strands as in *Coloburiscus humeralis,* some have net-like cushions at four corners, e.g., *Deleatidium sepia.* In others this network surrounds the entire egg as in *Atalophlebia versicolor* and a number of species have anchoring strands, e.g., *Atalophlebia nodularis.* Many seem to be entirely devoid of all attachments, e.g., *Atalophlebia dentata, A. cruentata, Deleatidium lillii,* etc. The anchoring threads are coiled up at first and uncoil in the water: sometimes at the distal end of each thread is an adherent blob. Plates 50-52, Figs. 1-5, show microphotographs of the eggs of some of our species.

The size of an egg is microscopic. The following are the dimensions of the eggs of some New Zealand mayflies:—

Ichthybotus hudsoni, .37 × .19 mm.
Ameletus ornatus, .21 × .11 mm.
Oniscigaster distans, .29 × .16 mm.
Atalophlebia nodularis, .20 × .10 mm.
Deleatidium sepia, .19 × .12 mm.
Deleatidium lillii, .17 × .9 mm.
Coloburiscus humeralis, .20 × .18 mm.
Ameletopsis perscitus, .21 × .15 mm.

The minute larvules which emerge through a longitudinal rent in the egg envelope, though about twice as long as the egg that housed them—for they lay coiled up in it—are generally less than half a millimetre long. They breathe cutaneously, for the tracheae and gills do not make their appearance till after two or three moults. The alimentary tract is incomplete, the mouth-parts are not yet fully formed and the antennae and caudal setae have only a few segments. Both

these latter parts, as well as the thin legs, bear a few bristles. The compound eyes are undeveloped and are smaller than the ocelli.

Every few days (the number varies but is usually between three and ten), the insect moults, becomes darker, more complete and larger until the true nymphal form is attained.

The changes are gradual. A specimen of *Coloburiscus humeralis,* ten days old (Text-Fig. 37) did not appear very different from one newly-hatched. It was .50 mm. long, excluding setae. The outer setae, which were apparently five-segmented and ended in a pair of bristles, were about .30 mm. long, the median one being three-segmented and much shorter. [When newly-hatched, the larvule measures .35 mm. and its outer setae .20 mm.] The antennae, also five-segmented and ending in a pair of bristles, were about half as long as the outer caudal setae. The alimentary tract was complete and in working order, but there were no signs of gills: the late appearance of gills in this species may be due to the fact that it lives in the highly-oxygenated water of rapids and so cutaneous respiration may be practicable for longer than in slower waters. Wiebe (23) found that gill rudiments appeared in *Hexagenia bilineata* after the fourth day, Gros (22) in *Ecdyurus forcipula* after the fifth day, Heymons (21) in *Ephemera vulgata* after four days, and Lestage (10a), in general, from eight to ten days.

Very minute individuals are seldom taken when netting streams for specimens, and I am inclined to the opinion that, in many species, they live slightly below the bed of the stream, often in fine gravel. The early stages of *Oniscigaster* may be found in such situations.

In the nymphal stage, the insect varies considerably in appearance according to species, but the general type is as follows:—It has a small head (except *Ameletopsis*) with well-developed mouth-parts of the biting type and filiform antennae about twice as long as the head. The eyes of male nymphs are each double, consisting of an upper and a lower part and the eyes are set closer together than those of the female, where the eyes are simple. The thoracic segments are well differentiated, but the meta-thorax is welded to the first abdominal segment: after the wingpads are fairly well-grown, they hide the posterior two segments. Attached to each thoracic segment is a well-developed leg, consisting of coxa, trochanter, femur, tibia and tarsus, each composed of a single segment; at the apex of each leg is a curved, acuminate claw.

Towards the end of the nymphal life, wingpads develop on the dorsum of the meso-thorax and meta-thorax.

The abdomen, which sometimes broadens in the middle and always tapers posteriorly, consists of ten segments. Attached latero-posteriorly to each of the anterior seven of these segments is a pair of gills, which are held laterally or dorsally. These gills are the insect's respiratory organs.

In the case of *Ichthybotus* the gills of the first pair and in that of *Oniscigaster* those of the last pair are not visible to the unaided eye, but microscopic investigation shows that they are there.

At the posterior extremity of the abdomen are three caudal setae: in *Coloburiscus,* the median one is vestigial only. In some cases these

setae assist propulsion, in others they appear to be mainly aids to balance.

The nymphal life lasts some months, usually about eleven. Though as yet no New Zealand species has been followed throughout the whole of its life cycle, it is evident that one year is the normal period, though one or two species, e.g., *Ichthybotus hudsoni,* may have a two year life cycle, and a few others, possibly, less than a year. *Deleatidium lillii,* for instance, is found in all stages throughout the year, though it is more numerous in the winged stages in spring and autumn.

Towards the end of its sub-aqueous life, the wing-pads of the insect grow larger and the organs of reproduction develop internally: a full-grown female nymph is already full of eggs. When the time for metamorphosis arrives, the nymph becomes very sluggish and bubbles of air appear below the skin, usually at or near the pronotum.

In the SIPHLONURIDAE, the nymph crawls out of the water on to a stone or boulder at the edge of the bank or sometimes on to a protruding boulder in the middle of the stream: in the other families, the transformation is made very suddenly from the surface of the water.

The skin of the thorax splits longitudinally along the dorsum and the sub-imago emerges, shakes out its folded wings which soon dry, and in a few moments flies away to shelter in some shady spot near the river-bank. Here it stays motionless, unless disturbed, its wings held upright over the dorsum.

Mayflies are the only insects that have two winged stages, though Carpenter in his ' *Biology of Insects* ' suggests that it was of general occurrence among primitive winged insects in past ages. The preparatory winged period is a short one, lasting about a day in the LEPTOPHLEBIIDAE and usually two days in the other families. In *Oniscigaster,* however, the sub-imaginal stage lasts three days.

The sub-imago differs from the perfect insect only very slightly. The integument is duller, particularly that of the wings. These are generally coloured and bear little hairs along the edges. The forelegs are shorter, as are the caudal setae. The eyes are duller and not so protuberant, the genital organs are not quite fully-developed and their armature is shorter and stouter.

At the end of this brief stage, the insect moults again and transforms into the imago or perfect insect.

The duration of this period, the ultimate one in the life of a mayfly, is about the same as that of the foregoing stage.

The general form of the imago does not differ very greatly from that of the nymph, but the head is smaller, the eyes more brilliant, the antennae shorter, the mouth-parts atrophied and non-functional—as is also the alimentary tract, which has now an aerostatic function and is apparently closed posteriorly. The gills have disappeared, the insect breathing in the normal manner through stigmata. The body is slimmer and glistening, the legs much thinner and longer, the tarsus being now four or five-segmented and armed with two claws apically, which are sometimes alike, sometimes dissimilar. The forelegs of the male are exceedingly long, their use being accessory to the genital act. The caudal setae are usually longer than those of the nymph and sometimes the median seta is vestigial only in the adult

but fully-developed in the nymph. In this connection, I should like to point out that out mayflies would seem to disprove the theory of Joly, apparently accepted by Vayssière (9), that the number of tails in the newly-hatched larvule and in the winged stages is the same, for in *Ameletus flavitinctus* specimens just out of the egg have three caudal setae of about equal length, whereas in the imago, the median seta is vestigial, as it is in the case of all the New Zealand species of the family SIPHLONURIDAE. The setae of the imagines of these families are never heavily fringed with hairs as they sometimes are in the nymphal stages.

The genitalia visible externally consist, in the case of the male, of accessories in the shape of a pair of three or four-segmented, incurved claspers, attached ventrally to the posterior of the abdomen, which are curved round the abdomen of the female during copulation: interior to these are the paired penes, the distal parts of which are bent upwards and bear ventrally-placed orifices near the apex. In the accompanying illustrations, the tenth tergite has been omitted for the sake of clearness.

The two oviducts of the female terminate each at a latero-ventral opening between the seventh and eighth segments; the openings are covered by a thickly-chitinised ventral flap.

The wings are fragile; they are triangular and furrowed with numerous veins and cross-veins.

The hindwings are much smaller than the forewings: in the LEPTOPHLEBIIDAE they are very minute. So far, no species has been found in this country without hindwings.

The wings of the female are usually larger than those of the male: *Deleatidium vernale* is exceptional, in that the reverse is the case.

A curious and somewhat confusing circumstance—and one that I have not seen mentioned elsewhere—is that the same species of mayfly may often be found to vary very considerably in dimensions not only in different districts but in the same district at different times, and, in this connection, I have noticed that flies at the end of their season are often smaller than the normal size.

An excellent diagram of a mayfly's wing, showing the different systems of venation, variously charactered, is given by Chopra (29).

NOTES ON TERMINOLOGY.

In the following descriptions, I use certain terms, which may not be in accord with those applied to similar parts of mayfly nymphs by writers in other countries.

To avoid any possible misunderstanding, the terms, together with the sense in which they are used, are as follows:

Prostheca applied to the small finger-like process on the mandible, proximal to the inner canine. This term is used by Lestage and Imms. The prostheca is the *endopodite* of Eaton and the *lacinia* of American writers.

Superlinguae applied to the lateral lobes of the Hypopharynx. Imms uses this term. American writers use the expression *lateral lobes,* Lestage *pièces laterales* and Eaton calls them *paraglossae.*

Glossae and *Paraglossae* applied to the internal and external paired lobes, which occur on the labium and are appended anteriorly to the mentum.

These terms are used by Imms and also by American writers on Mayfly nymphs. Lestage, however, calls them *lobes internes* and *lobes externes* and Eaton refers to them as the lobes of the *labium.*

Legs.—The terms *anterior* and *posterior, dorsal* and *ventral* are used in the same sense as they are used anatomically, irrespective of the actual position of the portion of the limb visible.

Thus, the femur, tibia and tarsus of the limb of a mayfly nymph may be held with the *anterior* surfaces turned over so that they appear *dorsal*—as is very frequently the case—and may be figured so; nevertheless these surfaces will be described as *anterior surfaces;* the real *dorsal* surface will be described as such in the text, but in the case instanced will appear in the specimen—and probably the illustrations—as turned over so that it faces *posteriorly.*

CLASSIFICATION.

The Classification adopted has been arranged so as to conform with that of Tillyard, the key to families (adults) is taken from his book (7).

The generic key (adults) has been adapted from Hutton (2) in the light of later knowledge.

As the keys to nymphal characters of both Needham (8) and (9) and Lestage (10) and (10a) are not adaptable to New Zealand families and genera, I have designed one more suited to local conditions.

KEY TO FAMILIES AND GENERA OF N.Z. EPHEMEROPTERA.

Adults.

A. Forewing with tornus at from 1/3 to 2/5 of wing length from base, with Cu 1 ending just beyond it and being sigmoidally curved (Text-Fig. 14) — EPHEMERIDAE

Median caudal seta abortive in the male, subequal to the outer ones in the female — *Ichthybotus* Eaton

B. Forewing with tornus at from 2/5 to nearly ½ the length of the wing from base, the nearly straight Cu 1 ending up just beyond it and having a descending series of pectinate branches: Cu 2 curved concavely to Cu 1 (Text-Fig. 15) . — SIPHLONURIDAE

1. *Hind tarsi shorter than tibiae—*

(*a*). One tarsal claw sharp, the other blunt: Cross-veins in the ptero-stigmatic region reticulate.

(*i*) Humeral angle of hindwing sharp . — *Coloburiscus* Eaton

(*ii*) Humeral angle gently rounded .. — *Ameletopsis* n. g.

(*b*). Both tarsal claws sharp and hooked: Cross-veins in the ptero-stigmatic region simple.

Femora with heavy dark median bar . — *Ameletus* Eaton

2. *Hind tarsi longer than tibiae* ... . .. — *Oniscigaster* McLachlan

C. Forewing with tornus at not more than ¼ of wing length from base. Cu 2 sigmoidally curved, ending not far short of tornus (Text-Fig. 16) .... — LEPTOPHLEBIIDAE

1. *Tarsal claws alike, narrow and hooked at tip* . . — *Atalophlebia* Eaton

2. *Tarsal claws unlike, one narrow, hooked and pointed at tip, the other broad and blunt* . . — *Deleatidium* Eaton

Nymphs.

A. Mandibles with tusklike extension, protruding in front of head (Text-Fig. 9) . . . . . With six pairs of gills, visible to the unaided eye: these are feathery and lie on the dorsum (on 2nd to 7th abdominal segments) (Text-Fig. 1) (NOTE: There is another pair on the first abdominal segment, but it is microscopic).	EPHEMERIDAE *Ichthybotus* Eaton
B. Mandibles short, not extending in front of head—	
I. Caudal setae densely haired throughout their length.* Tarsal claws not toothed underneath† (Text-Fig. 12)	SIPHLONURIDAE
1. *Gills held upright over the dorsum*—	
(i) Gills forked and with numerous spines (Text-Fig. 3) . . . . . (Median caudal seta very short).	*Coloburiscus* Eaton
(ii) Gills lamellate and recumbent on dorsum (Text-Fig. 2) . . . . . (7th pair microscopic).	*Oniscigaster* McLachlan
2. *Gills held extended laterally*: *lamellate* (Text-Figs. 4 and 5).	
(i) Head small (Text-Fig. 10): palps three-jointed: outer setae haired on both sides	*Ameletus* Eaton
(ii) Head large and skull-like (Text-Fig. 11): palps many-jointed: outer setae haired on both sides	*Ameletopsis* n. g.
II. Caudal setae with whorls of a few thin, short hairs at joints; Tarsal claws toothed underneath (Text-Fig. 13)	LEPTOPHLEBIIDAE
1. *Gills double* (Text-Fig. 8) . . .	*Atalophlebia* Eaton and sub-genus *Atalophlebiodes* of the genus *Deleatidium*
2. *Gills single* (Text-Figs. 6 and 7) . .	remainder of genus *Deleatidium* Eaton

* Except *Coloburiscus*.

† The claws of *Ameletus ornatus* have a number of very minute serrations underneath, but these are very much smaller than those of a *Leptophlebid* claw.

Family EPHEMERIDAE.

This family is identical with Lestage's (10) family EPHEMERIDAE and Needham's (8) sub-family EPHEMERINAE. The nymphs are of the digging type and live in burrows made in sand or sandy clay in the beds or submerged parts of the banks of streams.

In New Zealand, the family is represented by only one genus, *Ichthybotus* Eaton. The nymph very greatly resembles the type *Ephemera* of Eaton (4), having the characteristic digging tusk projecting in front of the head, the modified fossorial forelegs and the double feathery gills, which are held over the dorsum and keep aerated water circulating in the burrow.

It differs from *Ephemera* in that the head does not narrow anteriorly, the tusks are shorter, broader and curve *inwards* not outwards,

apically: the clypeus is not deeply incurved anteriorly: the setae are shorter in proportion to the length of body and the labrum is wider in proportion to its length and has concave lateral margins.

The adult shows differences from *Ephemera* in the caudal setae, the claws of the male fore-legs and the genitalia.

There are two species, *I. hudsoni* (McLachlan) and *I. bicolor* Tillyard.

Genus ICHTHYBOTUS Eaton (1899).

Adult.—"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 sub-equal in length to the outer setae 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 *Siphlurus* (cf. *S. lacustris*). The forceps-basis subquadrate 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 fish*." (Eaton).

Nymph.—Mandibles prolonged in front of the head in the form of tusks, which curve inwards apically. Maxillary palp of three segments. Labial palp of two segments. Antennae long, filiform. Body elongated, tapering posteriorly, convex dorsally. Legs robust, densely haired: order of length, 3, 1, 2: anterior pair adapted for digging: claws untoothed. Six pairs of double feathery gills held upright over dorsum on the second to seventh abdominal segments and one minute, rudimentary pair, each gill of which is in the form of a bifid lash, on the first abdominal segment. Caudal setae short, densely haired on both sides: median seta slightly longer than the others.

Ichthybotus hudsoni (Eaton).

IMAGO.

Length (excl. setae)—male, 19-21 mm.; female, 20-22 mm.

Head—male, fawn with brown markings; female, yellow with brown markings. Eyes of female olive; of male, upper part reddish-brown, lower part olive. Ocelli brown.

Thorax.—Prothorax fawn: meso- and metathorax light-brown with yellow (female) and fawn (male) markings.

Abdomen.—Dorsum of male, dull reddish-brown; of female, bright orange-brown and broader than that of the male. There is a small tooth on each pleuron, two-thirds of the way towards the posterior edge: on the eighth segment it is absent, on the ninth and tenth it is more acuminate and almost at the latero-posterior corner.

Venter paler; on each segment is a reddish-brown circumflex-like mark placed medio-anteriorly and a pair of dots posteriorly.

Penes yellow, "bifid with thin or flattened lobes of equal width: concave beneath, truncate at the tips and divergent." (Eaton). Claspers (Plate 4) yellow, becoming greyish distally.

Caudal setae fawn, becoming lighter distally; black-ringed at joinings: outer ones, male, 23 mm.; female, 20 mm.; median one, male, 1 mm.; female, 19 mm.

Legs (Text-Fig. 35).—Femora: anterior pair light yellow, tinged with olive; other pairs light yellow; Tibiae, light yellow. Tarsi, light-yellow, tinged apically with dull-olive; five-segmented in male foreleg, apparently four-segmented in female foreleg and in all hindlegs. Claws dissimilar.

Wings (Pl. 53, Fig. 7).—Expansion of male, 20 mm.; female, 22 mm. Marginal and sub-marginal areas burnt-umber: the rest of the wing-surface is hyaline in the male and light yellowish-green in the female. Neuration black but brown at wing-base.

Sub-Imago (Pl. 53, Fig 8).

Wings.—Surface pearly in the male, lemon-yellow in the female: marginal and sub-marginal areas raw-umber, except at wing-base, where it is yellow. Both fore- and hindwings have two dusky zig-zag bands running transversely, but in some specimens, these bands are absent. Cross-veins very numerous, especially near the wing-margin.

Duration of sub-imaginal stage, about two days.

Nymph.

This nymph (Pl. 52, Fig. 6) belongs to the only genus of burrowing mayflies found in New Zealand. The genus consists of two species, *I. bicolor,* discovered a few years ago by Tillyard (6), who described the imago and sub-imago, and *I. hudsoni,* described by McLachlan (11) in 1894, Eaton (5) in 1899, and Hudson (1) in 1904.

The nymph of the former species has not yet been described, that of the latter only briefly and with insufficient detail to distinguish it from nymphs of this family in other countries: for this reason, it is described more fully below.

Incidentally, the opportunity is taken of pointing out that gills are present on the first *seven* abdominal segments, not on the first *six,* previous describers having apparently mistaken the second abdominal segment for the first, which is fused with the metathorax and bears very minute, reduced gills.

Moreover, the writer would like to submit the opinion that Lestage (10), in describing the family Ephemeridae, was mistaken in regarding the mandibular tusk as a canine, for both outer and inner canines are present in addition to the tusk in our species, as they are indeed in American [see Murphy (12), Text-Fig. 1, p. 16] and European species [Eaton (4) Plates], and Needham (13) Plates.

This nymph burrows in the sandy or muddy banks of streams, below water level.

It swims with dorso-ventral, undulating movements of the body.

If disinterred from its tunnel, it will bury itself in the nearest sandy patch, burrowing with its forelegs and mandibular tusks and digging itself in with remarkable rapidity.

When about to transform, nymphs in the writer's aquarium left their burrows and floated for some time, unmoving on the surface of the water, rarely agitating their gills.

A quantity of air was noted under the skin of the thorax and of the anterior part of the abdomen.

FIG. 1.—Egg of *Ichthybotus hudsoni*. × 170.

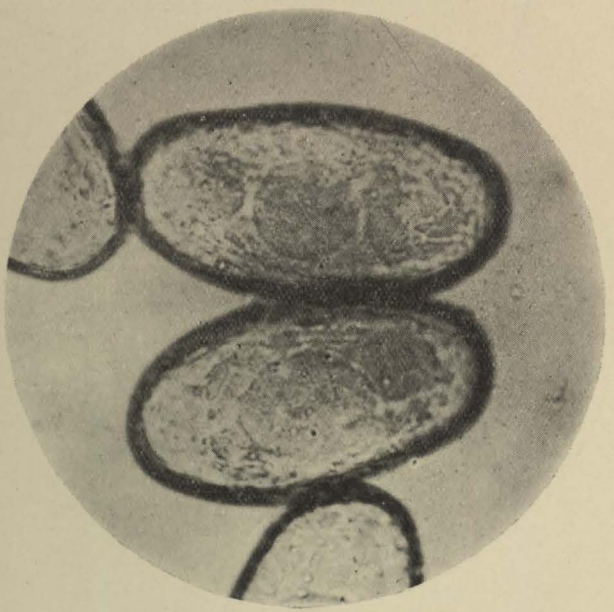


FIG. 2.—Eggs of *Oniscigaster distans*. × 170.

Face p. 280..

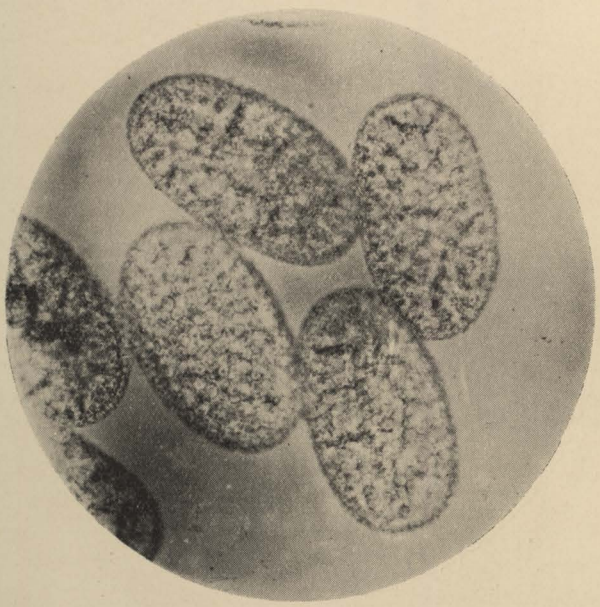


FIG. 3.—Eggs of *Ameletus ornatus*. × 170.

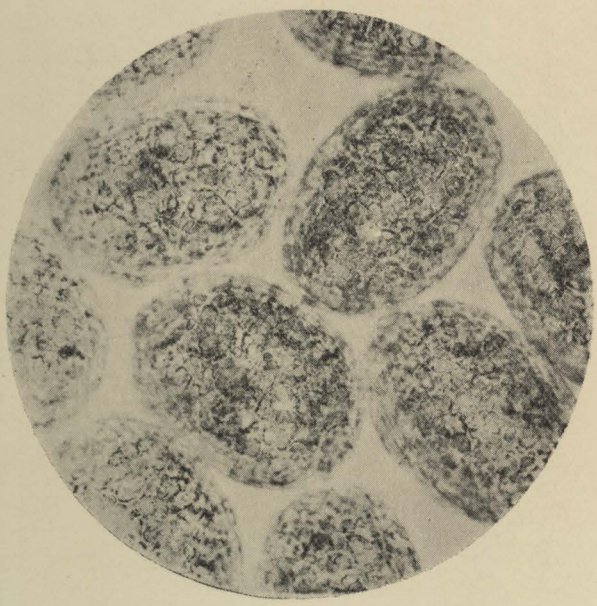


FIG. 4.—Eggs of *Ameletopsis perscitus*. × 170.

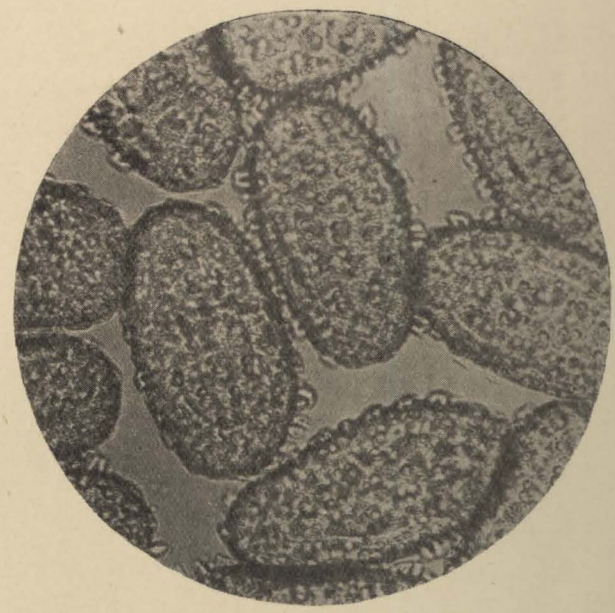


FIG. 5.—Eggs of *Atalophlebia cruentata*. × 170.

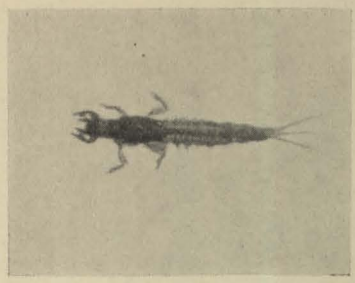


FIG. 6.—Nymph of *Ichthybotus hudsoni*.

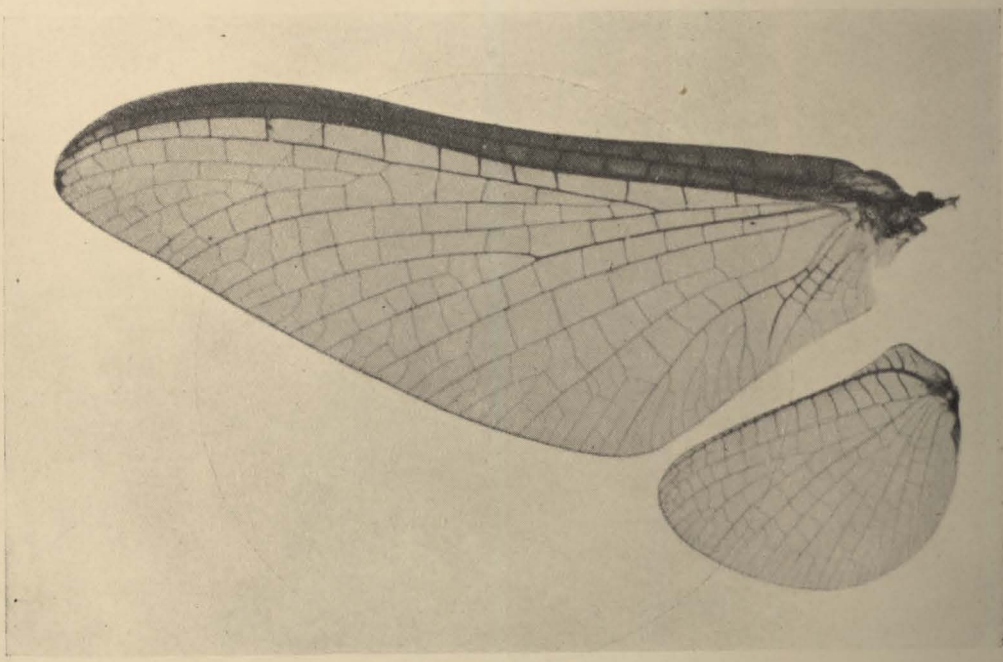


FIG. 7.—*Ichthybotus hudsoni*: ♂ Imago.

FIG. 8.—*Ichthybotus hudsoni*: Female Sub-imago, ca. × 2.

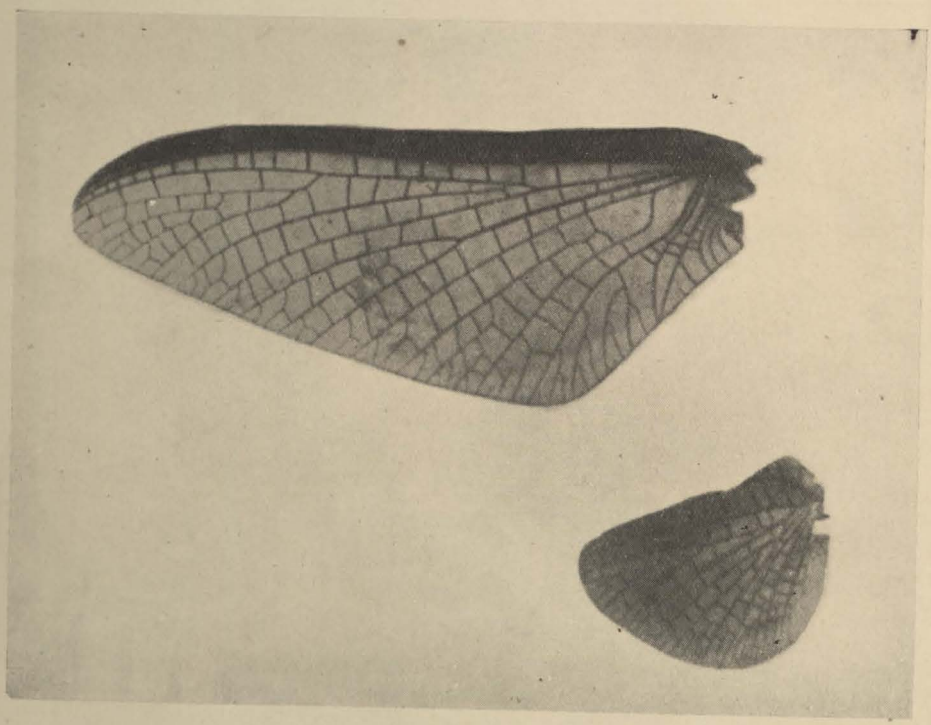


FIG. 9.—*Ichthybotus bicolor*: ♂ *Imago.* × 4.

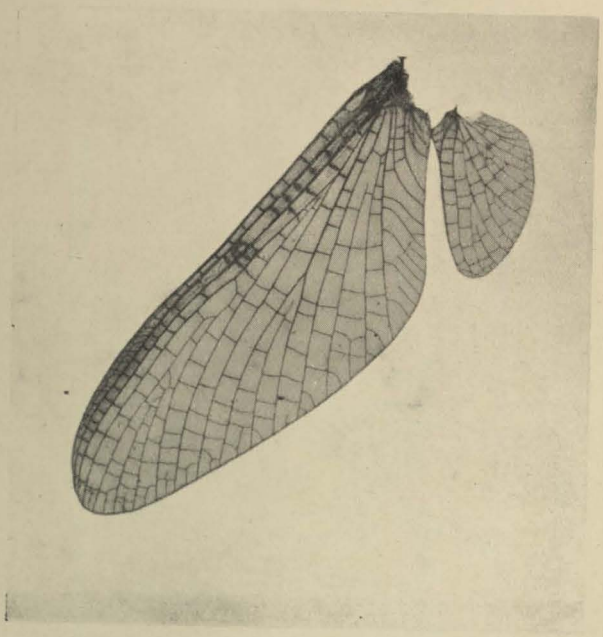


FIG. 10.—*Coloburiscus humeralis*: ♂ Sub-imago. × 5.

FIG. 11.—*Omisigaster intermedius*: ♀ Imago, lateral view, ca. × 5.

FIG. 12.—*Oniscigaster intermedius*: ♀ Imago, dorsal view, ca. × 3.

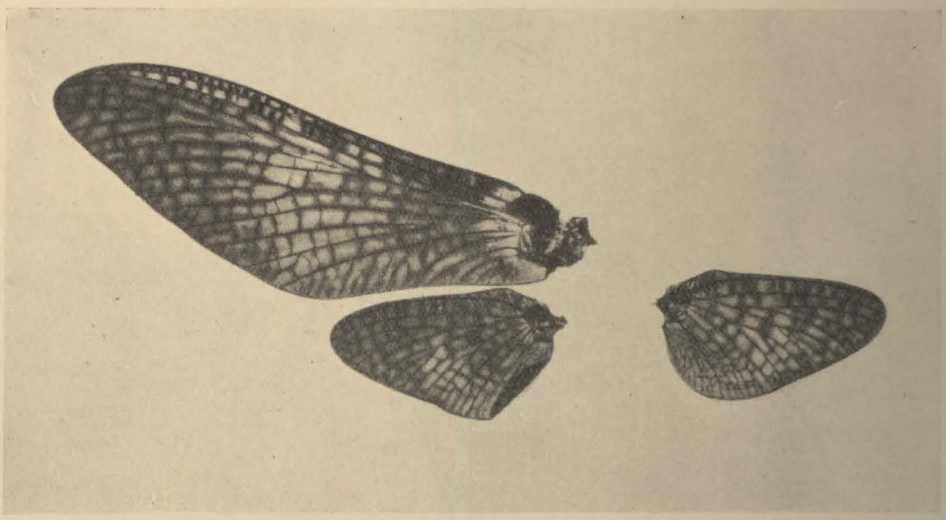


FIG. 13.—*Oniscigaster intermedius*: ♂ Sub-imago. × 5.

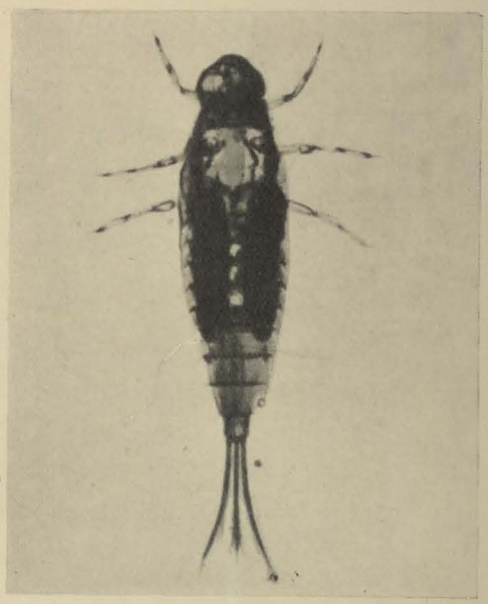


FIG. 14.—Nymph of *Oniscigaster intermedius*. × 2½.

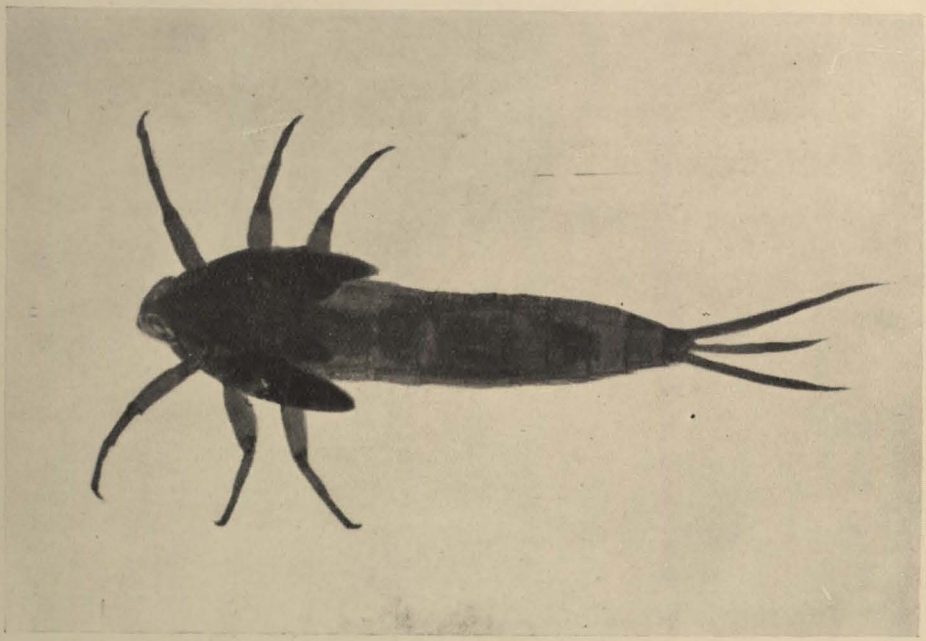


FIG. 15.—Nymph of *Ameletus ornatus*. × 5.

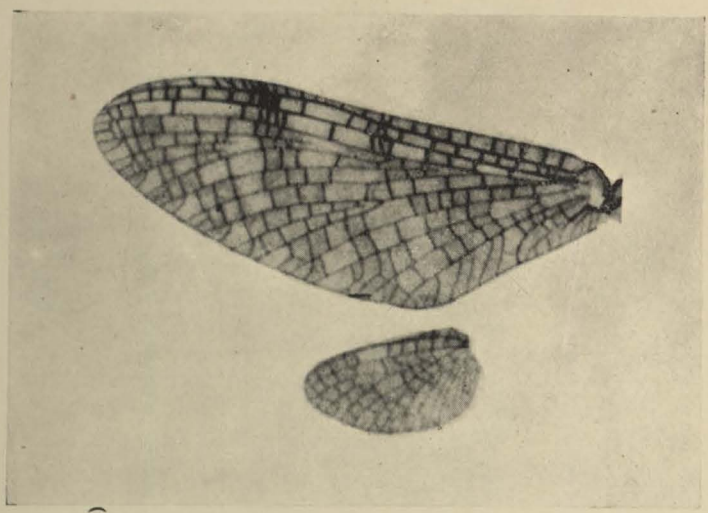


FIG. 16.—Wings of *Ameletus ornatus*: ♀ Imago. × 5.

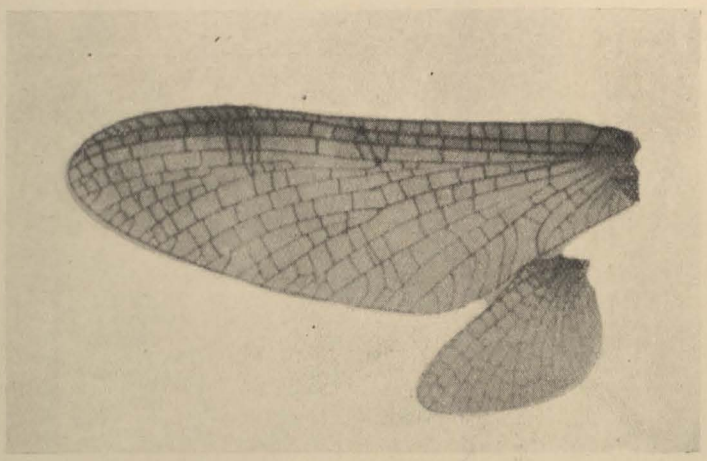


FIG. 17.—*Ameletus flavitinctus*: ♀ Imago. × 5.

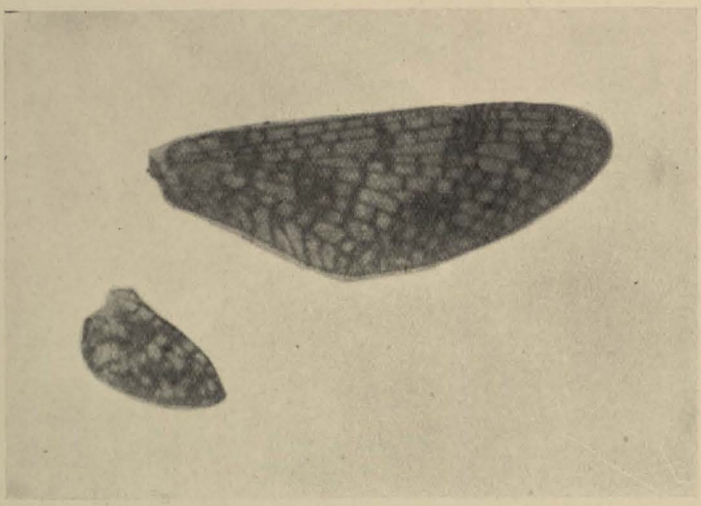


FIG. 18.—*Ameletus flavitinctus*: ♂ Sub-imago. × 5.

FIG. 19.—Nymph of *Ameletopsis perscitus*, ca. ½ natural size.

FIG. 20.—Gills of *Ameletopsis perscitus* (much enlarged).

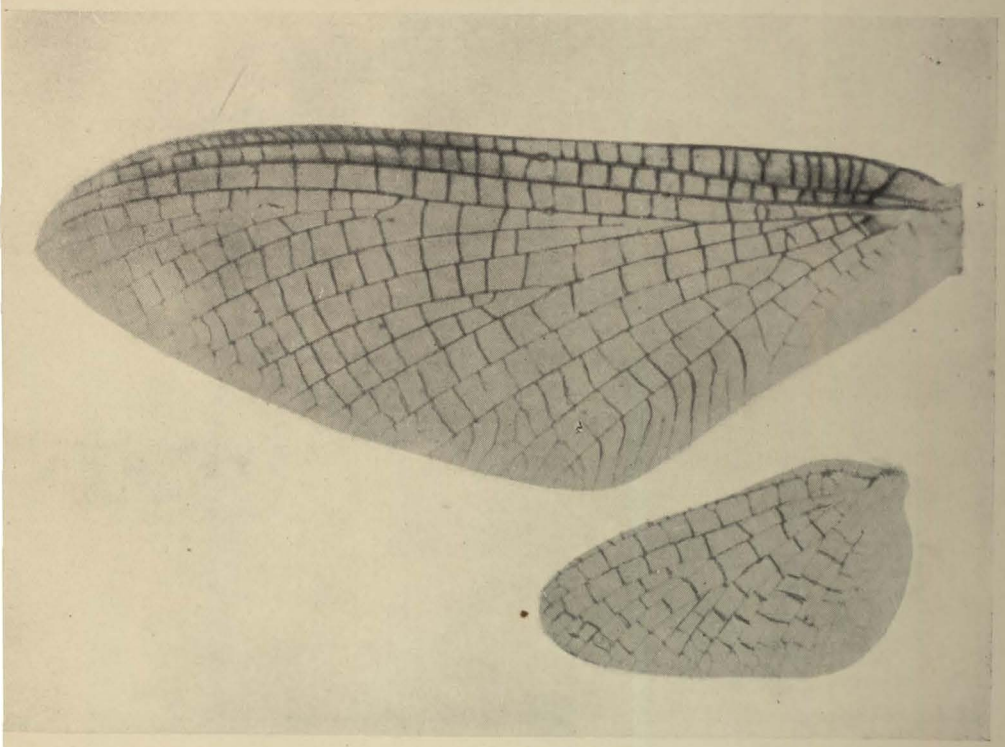
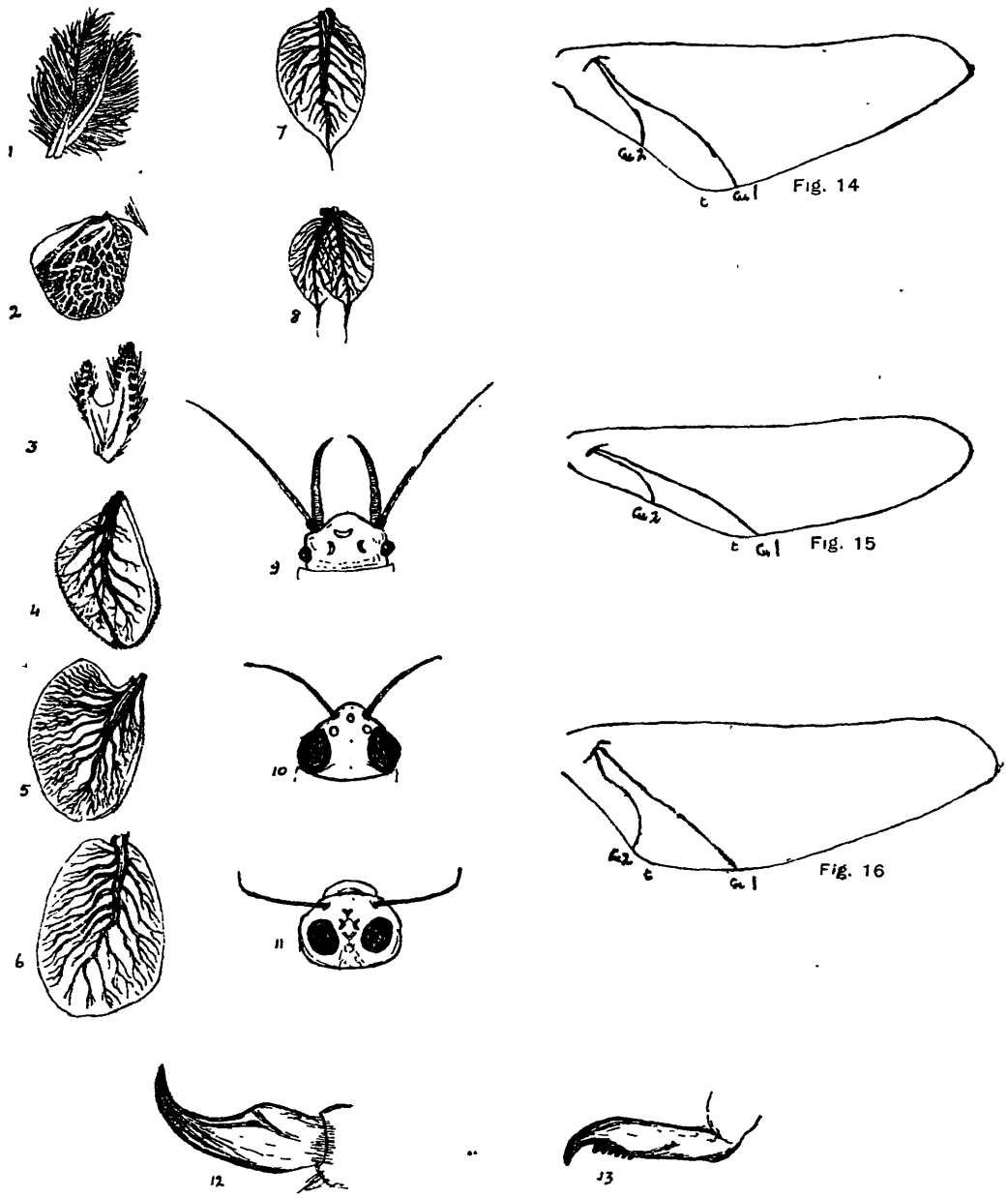


FIG. 21.—*Ameletopsis perscitus*: ♀ Imago. × 6½.



FIGS. 1 to 13.—Key to Families and Genera.—*Nymphs.*
FIGS. 14 to 16.—Key to Families and Genera.—*Adults.*

The actual metamorphosis, which occurred as usual through a longitudinal rent in the dorsum of the thorax, was extraordinarily swift, in marked contrast to the long time (sometimes hours) spent on the surface waiting for the change.

This protracted wait may have been due to the unnaturally still condition of the water present in the aquarium.

The winged stages appear in December, January and February, but as nymphs of various sizes are seen at this time, it is likely that this fly has a two-year or even possibly a three-year life-cycle.

Description of Nymph:

Length (including setae).—About four centimetres.

Head (Text-Fig. 27).—Reddish-brown; *Epicranium* convexly arched. There are patches of hair at the postero-lateral angles and also—accompanied by areas of small spines—on the lateral edges between the eyes and the antennal pits and at the latero-anterior edges of the clypeus.

Eyes.—Dark brown, and of moderate size.

Antennae.—Long, filiform, becoming slenderer apically, with a whorl of fine short hairs at joints, emerging from a pair of truncated prominences.

Mouthparts—Labrum (Text-Fig. 31).—Length, about three-fifths of width. The anterior and lateral edges are heavily chitinised. The general shape of the anterior edge is convex, but there is a gentle median concavity. The anterior corners are rounded and the lateral

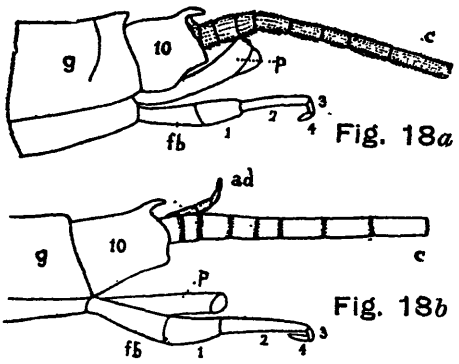


Fig. 18*a*

Fig. 18*b*

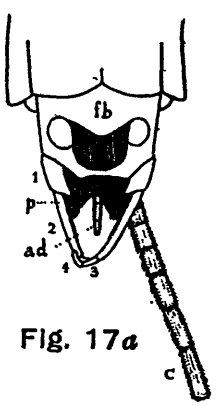


Fig. 17*a*

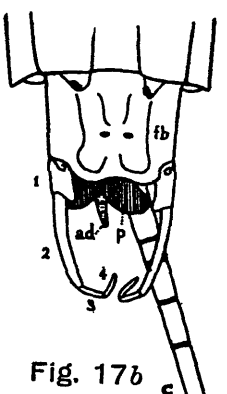


Fig. 17*b*

Fig. 19*a*

Fig. 19*b*

FIG. 17.—Ventral view of male appendages in the genus *Ichthybotus* Eaton: *a*, in *I. bicolor* n. sp.; *b*, in *I. hudsoni* McL. × 14. 1, 2, 3, 4, the four segments of the forceps; 9, 10, the last two abdominal segments; *ad*, appendix dorsalis; c, cercus (the right cercus is omitted); *fb*, forceps basis; *p*, penis.

FIG. 18.—Left lateral view of male appendages in the genus *Ichthybotus* Eaton: *a*, in *I. bicolor* n. sp.; *b*, in *I. hudsoni* McL. × 14. Right cercus and right forceps omitted. (For lettering see Fig. 3).

FIG. 19.—Outline of ventral valve in the female of *a*, *Ichthybotus bicolor* n. sp., and *b*, *I. hudsoni* McL. × 14.

(*From Tillyard*).

edges slope inwards posteriorly, more sharply so at a point about two-thirds of the way from the anterior edge. The postero-lateral corners are obtusely-angled. The surfaces and edges (except the posterior edge) are densely covered with long hair.

Hypopharynx (Text-Fig. 24).—Superlinguae rounded anteriorly and densely haired at the edges, except the exterior ones. Median lobe with concave anterior edge haired and a number of spines on anterior portion of surface.

Maxilla (Text-Fig. 30).—Palp three-jointed: the distal joint is the longest, the second one the shortest: all are covered with long hairs. The galea-lacinia is very small, being slightly shorter and much narrower than the basal joint of the palp. It is chitinised apically. On the interior edge is a fringe of spinose hairs, and anteriorly are a number of long spines of varying thickness. There is a row of long hairs, rooted medianly on the surface of the anterior portion and lying anteriorly-interiorly.

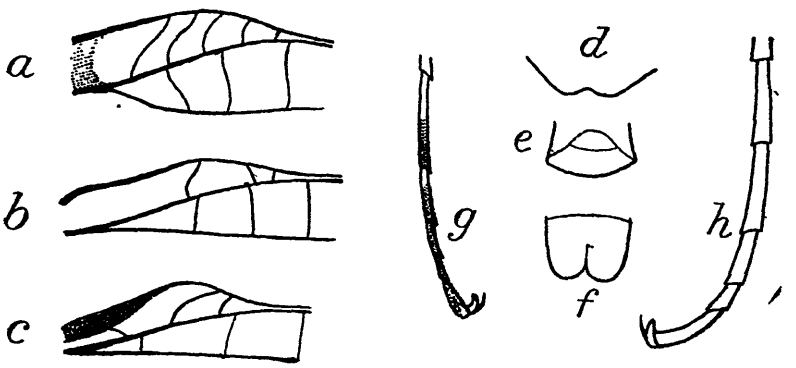


FIG. 20.—Details of the morphology of the female imago in the three New Zealand species of *Ameletus*: *a*, *A. perscitus* Eaton, humeral angle of hindwing; *b*, the same in *A. ornatus* Eaton; *c*, the same in *A. flavitinctus* n. sp.; *d*, *A. perscitus* Eaton, ventral valve; *e*, the same in *A. ornatus* Eaton; *f*, the same in *A. flavitinctus* n. sp.; *g*, *A. flavitinctus* n. sp.; hind tarsus; *h*, *A. ornatus* Eaton, hind tarsus. All figures × 14.

(*From Tillyard*).

See Vol. 54, *Trans. N.Z. Inst.*

Mandible (Text-Fig. 29).—The mandible is prolonged anteriorly into an enormous tusk, which is curved slightly inwards and bluntly pointed at the apex; it is held by the nymph in front of the head. This tusk is densely haired along its exterior edge and along here, too, are a number of short, thick spines: it is also haired and spined upon its surface—mainly the exterior-anterior portion. At the posterior-interior corner of the tusk and at the base of the mandible are irregularly-shaped, chitinised prominences (Text-Fig. 29, p^1, p^2). Outer and inner canines (c), each with three crenate teeth (in some specimens the third tooth appears double, making 4 teeth). Prostheca (p) long, slender and lightly-chitinised. Prosthecal brush very small. Molar surface (m) with eight or nine parallel, serrated ridges.

Labium (Text-Fig. 28).—Palps two-jointed. Basal palp narrow-

ing somewhat anteriorly, with a fringe of long hair near the interior edge and at the base. (The left-hand palp, shown in figure, is distorted). Distal joint falcate with a fringe of long hair round the edges. Placed distally are a number of basiconic sensillae. Paraglossae triangular with rounded angles, the apex placed anteriorly: they are densely covered throughout with spinose hairs.

Glossae are somewhat similar in shape to the paraglossae; they are as long, but not so wide: they are also covered all over with spinose hairs. (The glossae are shown somewhat displaced—in particular the right-hand one—in the labium figured).

Thorax.—Dark-brown, with a thin light median line, running anterior-posteriorly: fringed with hair laterally: slightly wider than the abdomen.

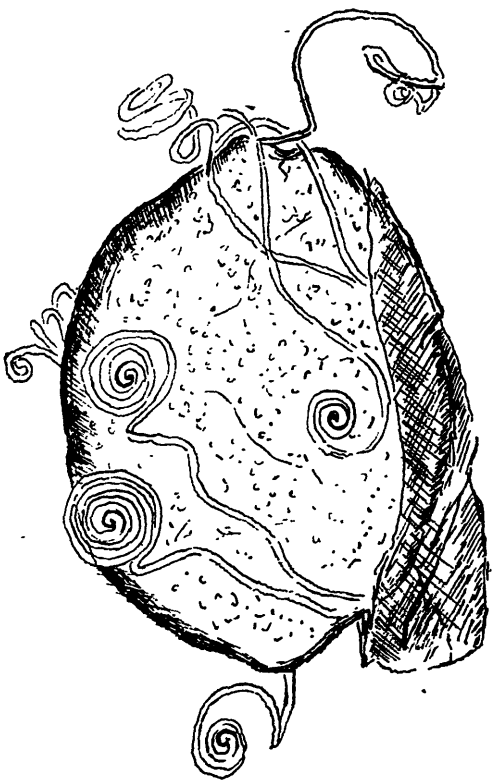


FIG 21.

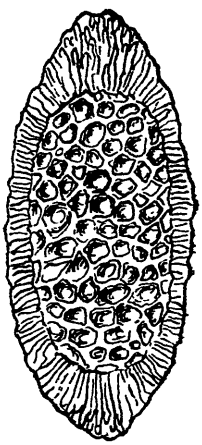


FIG. 22.

FIG. 21.—*Coloburiscus humeralis*: Egg. × 320.
FIG. 22.—*Atalophlebia versicolor*: Egg. × 320.

Prothorax about two-thirds as wide as it is long: mesothorax as long as the prothorax: metathorax shorter than either of the other thoracic segments.

Wingpads.—Dark-brown, and of medium size.

Abdomen.—Dingy yellowish-white: narrowing posteriorly: first segment fused with metathorax: segments lengthening posteriorly as

far as the eigthth segment: segment nine, though almost as long as segment 8, is noticeably narrower and the tenth segment is much narrower and only half as long as the ninth. Median tufts of hair occur dorsally and hairs project laterally from the pleura.

Setae.—Length, 6.5 to 7 mm.; median one a shade the longest. They are thickly fringed with long hairs on both sides. These hairs

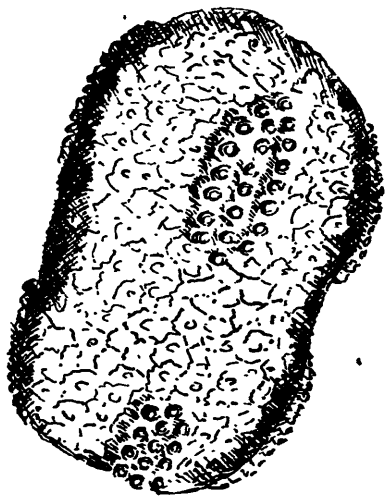


FIG. 23.—Egg of *Dolcatidium* (*Atalophlebioides*) *sepia*. × 320.

become shorter and sparser distally till in the last few segments they are only represented by a whorl of short, fine hairs at the joints.

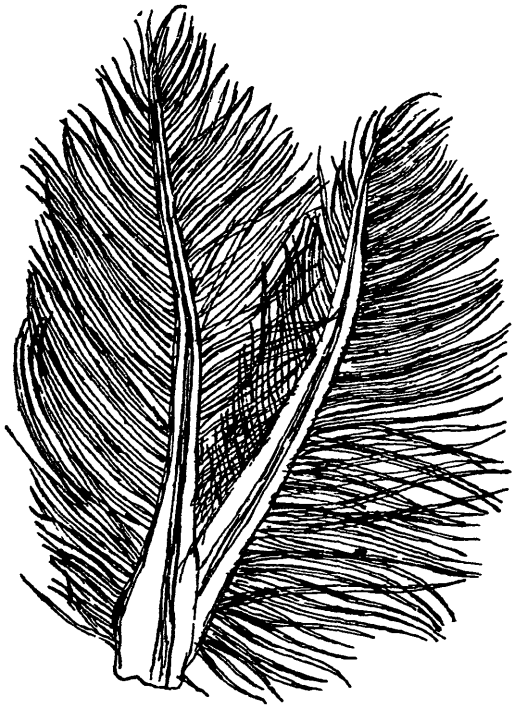
Gills.—There is a pair of gills present on each of the first seven abdominal segments. The gills of the first pair (Text-Fig. 25) are vestigial only and are each in the form of a bifid lash: careful scrutiny with a microscope is necessary in order to find them: they are near the latero-posterior edges. The six pairs present on the second

Nymph of *Ichthybotus hudsoni*.
FIG. 24.—Hypopharynx. × 60.

Nymph of *Ichthybotus hudsoni*.
FIG. 25.—Gills of first abdominal segment. × 24.

to seventh abdominal segments are held recumbent on the dorsum. Each gill (Text-Fig. 26) is double and resembles a pair of feathers with rhachides swelling out basally, and long, thin barbs, diminishing in length towards the apex. These ' barbs,' the gill filaments, are minutely serrated on each edge and from each serration, a small spine projects forwards and outwards.

Each filament contains a tracheal branch running through the middle of it.



Nymph of *Ichthybotus hudsoni.*

FIG. 26.—Gills of second abdominal segment. × 24.

Legs (Text-Fig. 34).—Dissimilar: in each leg the femur is shorter than the tibia and longer than the tarsus. The legs of the third pair are the longest; those of the middle pair are the shortest.

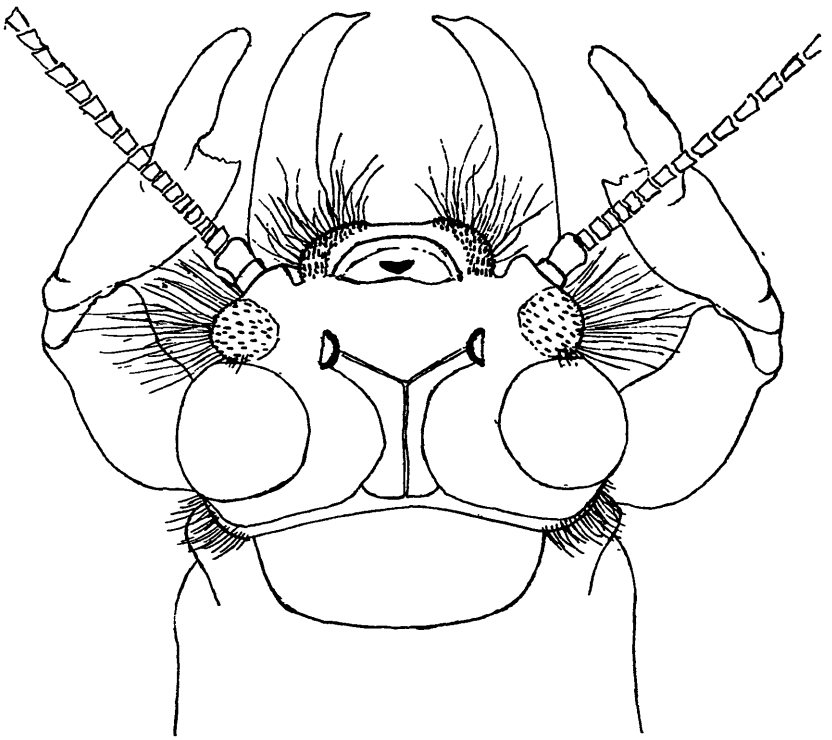
Anterior pair.—Femora greatly dilated, ovoid, covered with long hair and studded at the ventral and dorsal edges with a number of short, stout spines.

Tibiae dilated distally, with a V-shaped depression in the distal margin; the ventral arm of the V, which is equipped with an extra row of close-set spines at right angles to the margins, projects sharply and is probably an aid in digging. The greater part of the surfaces and the edges are thickly set with short, stout spines. Long hairs occur on the margins and a few on the surface; there are a few feathered hairs (Text-Fig. 32) on the distal margin in the bay of the V.

Tarsi slightly incurved: there is a row of short, stout spines near the ventral edge, and a fringe of long hairs on the dorsal edge, a few on the ventral one and some scattered over the surface: short feathered hairs occur on the basal part of the ventral edges.

Middle pair.—Femora ovoid, dilated, smaller than those of the first pair: covered with long hair, but without spines.

Tibiae becoming wider distally, but not markedly dilated as in those of the anterior pair: distal margin of normal contour: covered



Nymph of *Ichthybotus hudsoni*.
FIG. 27.—Head (dorsal view). × 24.

with long hairs; there are a number of short, thick spines on the distal half of the surface and along the dorsal and distal edges. The ventral part of the distal margin is—as in the first pair of legs—a veritable ' chevaux-de-frise '-like structure.

Tarsi very slightly incurved; fringes of hair arise on the dorsal and ventral edges and a few shorter hairs on the anterior surface. A few short feathered hairs occur distally-ventrally on the tibiae and tarsi.

Posterior pair.—Femora ovoid, dilated, longer than those of the other two pairs. They are covered with long hair: along the ventral margin are a number of rows of short feathered hairs.

Tibiae similar in shape to those of the second pair, but longer: covered with long hairs on the edges, and in among these, on the ven-

Fig. 30

Fig. 29

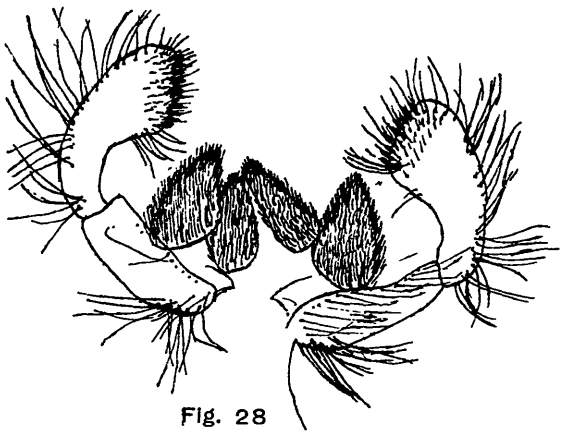


Fig. 28

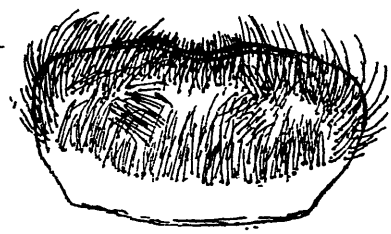


Fig. 31

Nymph of *Ichthybotus hudsoni.*

FIG. 28.—Labium. × 60.
FIG. 29.—Mandible. × 60.
FIG. 30.—Maxilla. × 60.
FIG. 31.—Labrum. × 60.

tral margin, are a number of the short feathered hairs. On the distal margin, these peculiar hairs replace, for the most part, the spines which are found in the same position on the other legs; there are, however, a few stout spines, notably one at each end of the distal margin, the one at the ventral end being especially prominent and projecting forwards and outwards.

Tarsi slightly incurved, with a fringe of long hairs on the ventral and dorsal margins and a few on the surface. Feathered hairs occur on the distal-ventral portion near the edges; from the ventral edge, near the apex, a thick formidable spine projects forwards and outwards.

Claws (Text-Fig. 33) alike in each leg: curved and hooked at tips: not toothed underneath: dark brown. They become progressively more sharply-pointed and more acuminate posteriorly, those of the last pair (illustrated) being very sharply-pointed, the anterior ones blunt—possibly through being used for digging.

N.B.—The feathered hairs (one is figured Text-Fig. 32) which occur on certain parts of the legs of this nymph are extremely curious.

They have been noticed by the writer on only one other mayfly nymph, *Atalophlebia cruentata* (Hudson), an entirely unrelated species, which is described later.

What is still more curious is the fact that in the case of *A. cruentata,* these hairs appear on the anterior pair of legs only.

Ichthybotus bicolor Tillyard.

"IMAGO, male.

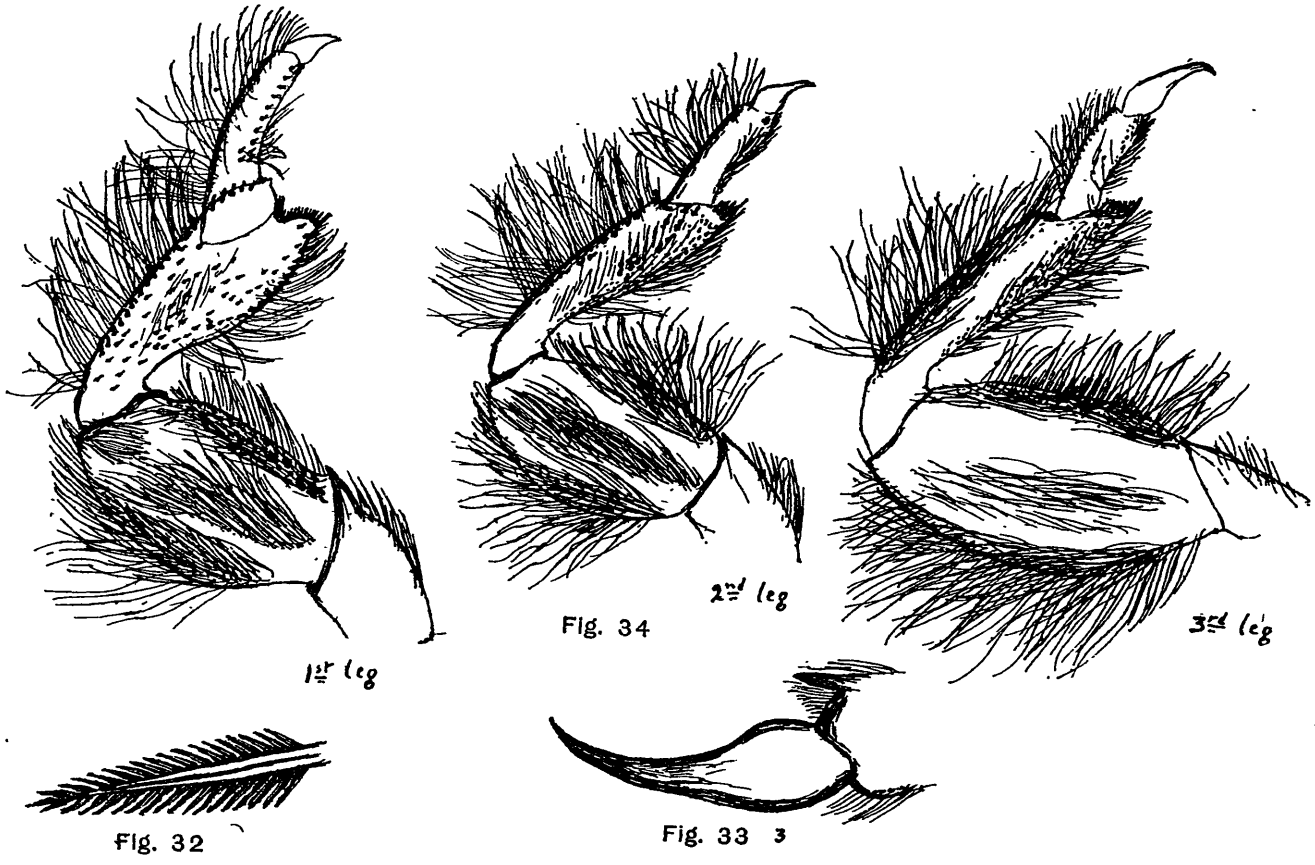
Total length, 19 mm.; forewing (Plate 54, Fig. 9), 16 mm.; hindwing, 6 mm.; expanse, 33 mm.

Head, deep chocolate-brown; eyes, blackish.

Thorax, deep chocolate-brown; legs the same colour, except coxae and the bases of the femora, which are paler; foreleg, 10.5 mm. long.

Abdomen, deep chocolate-brown, faintly mottled with somewhat paler brown; in shape slender subcylindrical, slightly narrowed at 5-7, broadening again at 8-9; 9 much wider than 10, broader apically than basally. Cerci, 23 mm. long, dark chocolate-brown, strongly formed, slightly hairy, the segments cylindrical with narrow black basal rings. Appendix dorsalis vestigial, 1 mm. long, with few segments. Appendages of the same type as in *I. hudsoni* McL., but with the following differences: forceps basis slightly shorter and cut off obliquely on either side of its posterior margin, which, between the bases of the forceps, is cut straight off, not double-curved as in *I. hudsoni,* McL. but more sharply angulated apically on the inner side; segment 2 very long (but not so long as in *I. hudsoni* McL.), narrower, and with a row of minute hairs along the basal two-thirds of the inner margin; segments 3-4 very short, sub-equal. Penis more prominently lobed than on *I. hudsoni* McL., each lobe carrying a set of minute stiff hairs. Cerci 23 mm. long, dark chocolate-brown, strongly formed, slightly hairy, the segments cylindrical with narrow black basal rings; those of *I. hudsoni* McL. are quite hairless, yellowish-brown or orange-brown, with broad dark basal rings. Appendix dorsalis vestigial 1 mm. long, with few segments.

In order that a careful comparison may be made between the appendages of the males of the two species, I have figured them both ventrally in Text-Fig. 17, and laterally in Text-Fig. 18.



Nymph of *Ichthybotus hudsoni*.

FIG. 32.—Feathered hair from leg, greatly enlarged.
FIG. 33.—Claw of third leg, greatly enlarged.
FIG. 34.—Legs, × 24.

The male may at once be distinguished from that of *I. hudsoni* McL. by its very dark coloration and its brown hindwings, as well as by the morphological differences given for the appendages."

The legs are illustrated in Text-Fig. 36.

" SUB-IMAGO, female.

Total length, 16.5 mm.; forewing, 19 mm.; hindwing, 7mm.; expanse, 40 mm. Generally resembling the same stage in *I. hudsoni*, but with the following differences: The whole body, legs and appendages are a dull earthy greyish-brown; the forewing has the ground colour pale greyish tinged with yellowish, the pale basal patch pale orange, the costal band dull purplish-brown, and the two oblique clouds a medium fuscous and more sharply angulated below R_1 than is the case in *I. hudsoni;* the hindwing is dull purplish-brown, paler towards the base and posterior margin. (In *I. hudsoni* the hindwing is pale greyish with two oblique clouds of medium fuscous). Ventral valve entire, not bilobed as in *I. hudsoni* (Text-Fig. 19b). Cerci, 8 mm.; appendix dorsali, 6.5 mm. long.

Locality—Matai River, Nelson; taken 29th December, 1920." (Tillyard).

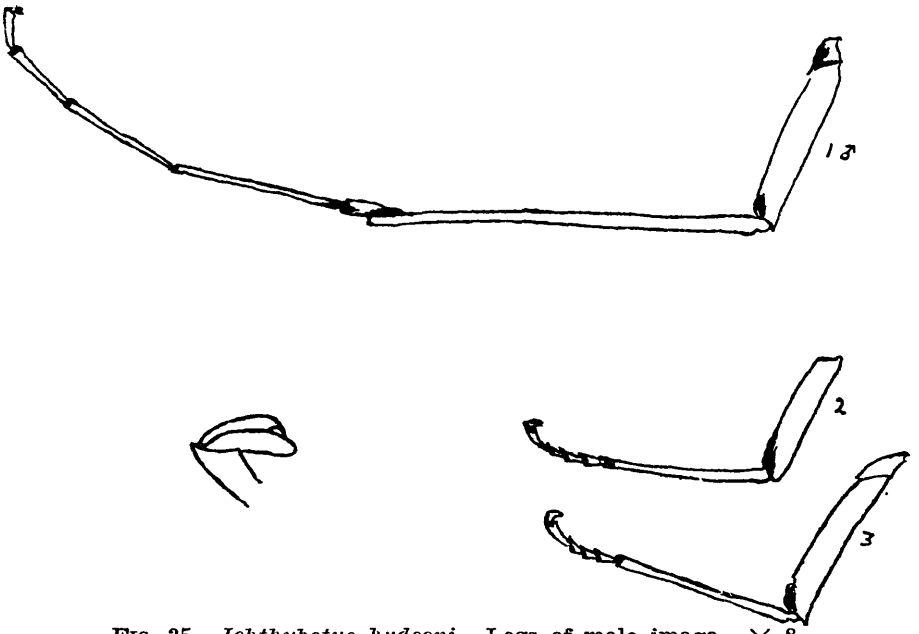


FIG. 35.—*Ichthybotus hudsoni.* Legs of male imago. × 8.

NYMPH.

Of this stage, Dr. Tillyard writes*. . . .

" This latter larva does not differ very much from the larva of the North Island species, *I. hudsoni,* but is smaller and darker in colour. The specimens which we found were in loose, coarse, mixed shingle and mud in the river bed, not actually tunnelling in clay, though the latter is the usual habit of the North Island species."

A single specimen, captured recently in the Gowan River, Nelson Province, was practically indistinguishable from *I. hudsoni,* save for a reddish tinge dorsally on the head, mandibular tusks and canines.

*In a recent letter.

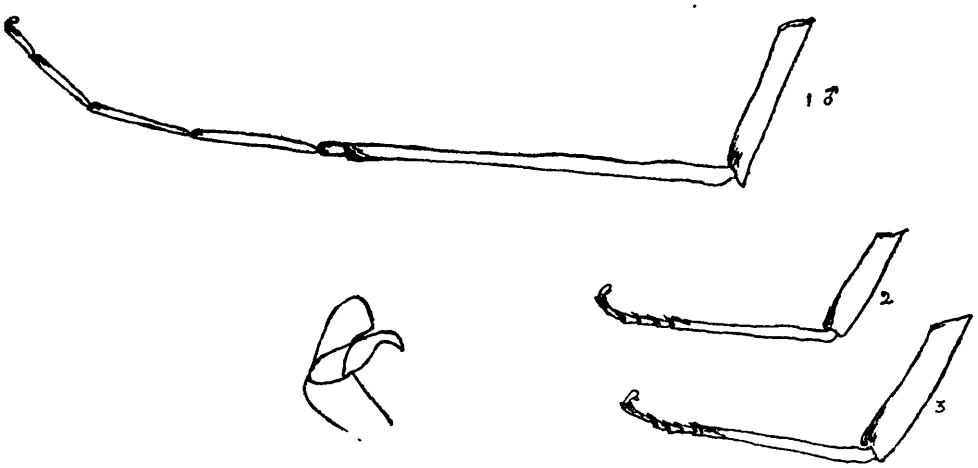


FIG. 36.—*Ichthybotus bicolor*. Legs of male imago. × 8.

Family SIPHLONURIDAE.

The genera, which this family contains, are of especial interest, particularly as regards the nymphs as these possess many unique features, quite unlike those of any mayfly nymphs found outside Australasia.

Because of this, it is impossible to adopt, in their entirety, at all events for the nymphs, the characters for the Sub-family BAETINAE given by Needham (8), or to adopt those of Lestage's sub-family SIPHLONURINAE, with both of which the family about to be described corresponds to a considerable degree.

Needham in his classification (8) states—"Sub-family BAETINAE: a very heterogeneous series, only definable as lacking the characteristics of the other two" (i.e., sub-families EPHEMERINAE and HEPTAGENINAE) " and including five fairly distinct groups ". . . .

(It should be pointed out that Needham's sub-families would correspond to present-day families, as his work was written before mayflies had been accorded ordinal rank).

In spite of the wide range which Needham's statement allows and the small number of sub-family characteristics—

> 'Mandibles without projecting tusk-like ramus
> Gills not as in EPHEMERINAE
> Eyes lateral: form of body various: claws smooth or toothed below,'

the fact that one of our genera (*Ameletopsis*) has the eyes placed dorsally would prevent our adopting this classification; moreover, the range of BAETINAE is so wide that it would include the New Zealand members of the family LEPTOPHLEBIIDAE as well.

Lestage (10) is rather more detailed in his keys: for his family BAETIDAE he gives—

> 'Branchies externes, dorsales ou latéro-abdominales, mais toujours visibles.'

'Mandibles très courtes sans aucun prolongement antécéphalique: pattes grêles ou dilatées mais inaptes à fouir; branchies jamais plumeuses': 'Yeux latéraux; corps peu ou pas aplati dorso-ventralement, généralement cylindrique.'

and for the sub-family SIPHLONURINAE—

'Ongles jamais plus longs que les tibias, parfois bifides. . . . . parfois ongles simples et alors branchies simples, bi- ou mono-lamellaires, mais sans branchies auxiliares, et les pattes faiblement ciliées.'

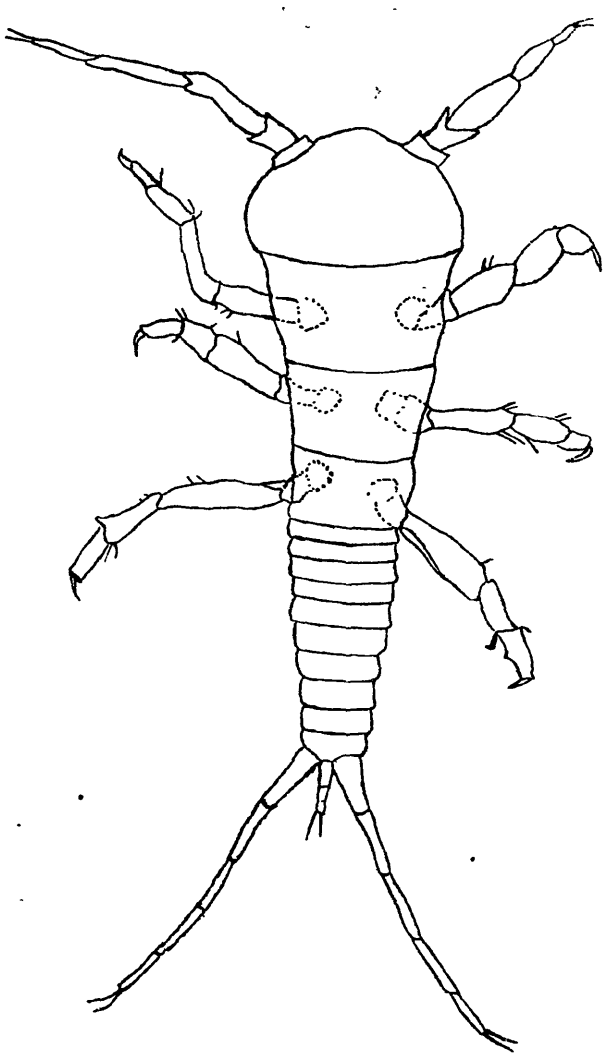
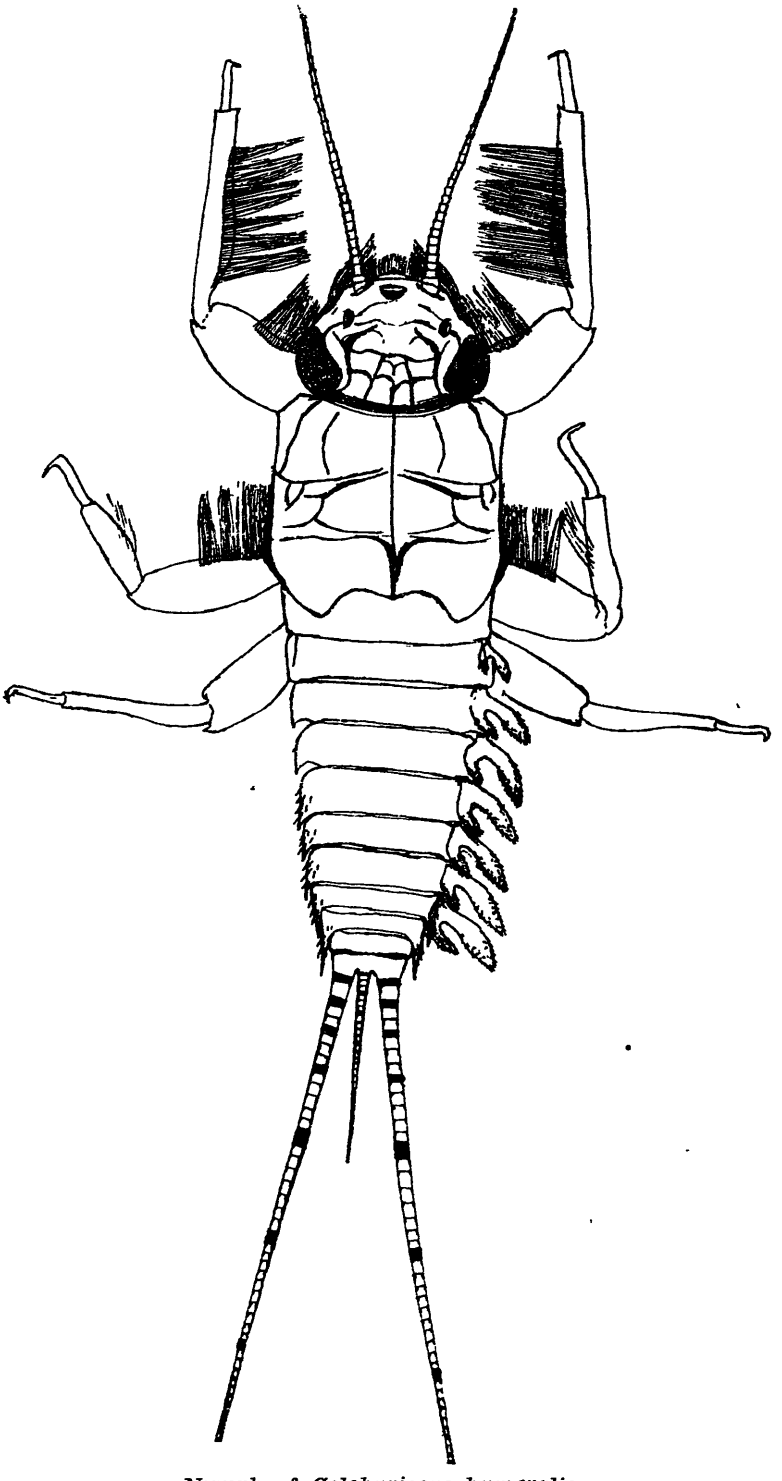


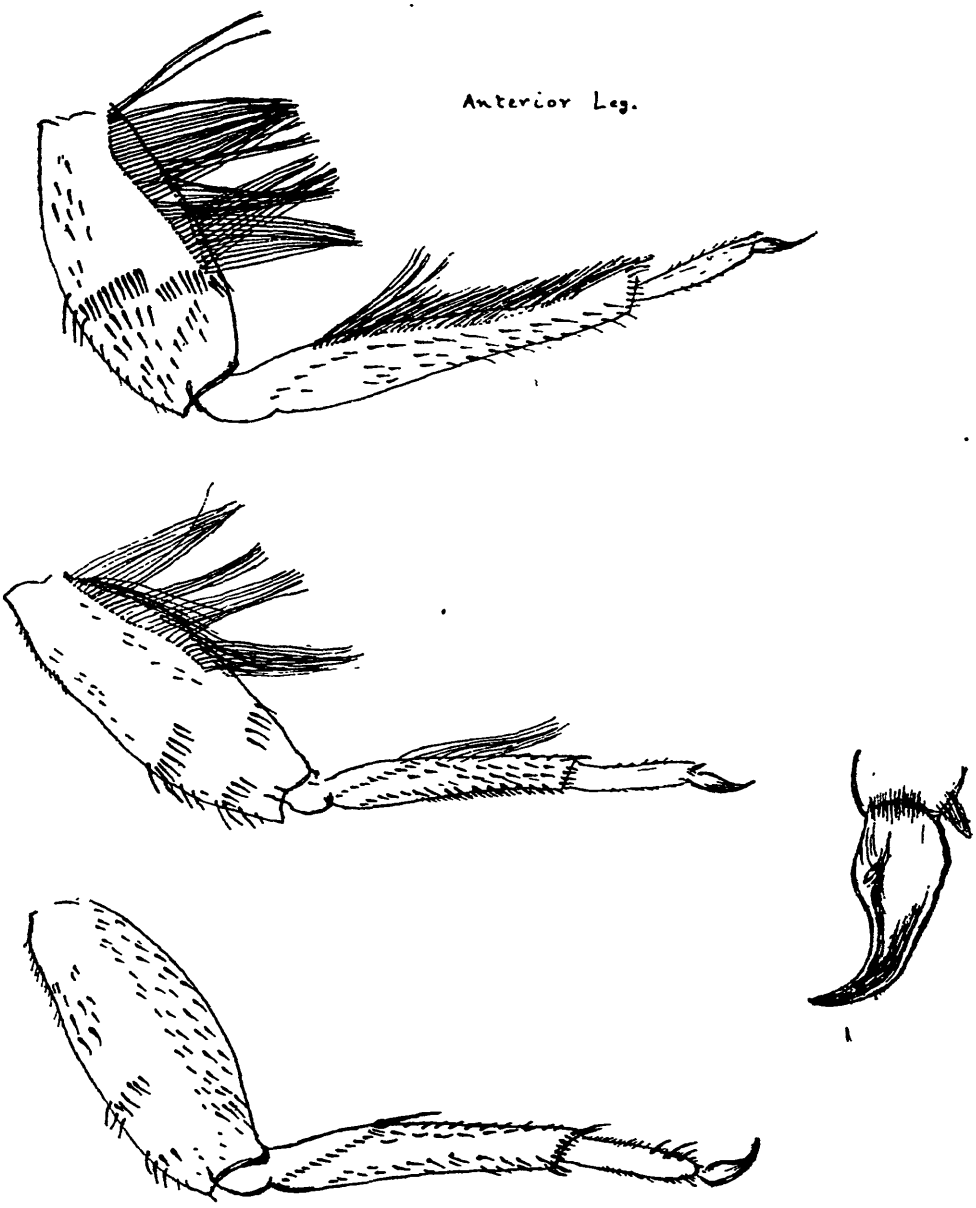
FIG. 37.—*Coloburisus humeralis*, 10 days' old larvule.

Here again *Ameletopsis* does not conform to a number of these conditions. The body is rather pronouncedly flattened dorso-ventrally, the eyes are dorsal, the lateral tails are haired on *both* sides.



Nymph of *Coloburiscus humeralis.*

FIG. 38.—Immature nymph. × 24. (Gills shown on right side only).



Nymph of *Coloburiscus humeralis.*

FIG. 39.—Legs, × 24; and tarsal claw, much enlarged.

And *Coloburiscus* could also not be included here, for its legs are not thin and the first two pairs carry long fringes of hair: moreover, the gills are not lamellate and the tails have very short hairs in whorls on both sides.

I therefore propose the following as the nymphal characters for the family SIPHLONURIDAE:

Description.—Nymph of the swimming type; body usually somewhat cylindrical. Eyes generally lateral. Mandibles short, not extending in front of head. With seven pairs of single gills, inserted dorsally or latero-abdominally. Legs short. Claws seldom toothed underneath. Caudal setae *either* strongly fringed with long hair throughout, all three sub-equal in length and shorter than the body, *or* with very short hair in whorls, in which case the lateral setae are about equal in length to the body and the median one is very short.

The adult differences are by no means so great and are all covered by Tillyard's characters for this family, as shown by the preceding key.

There are four genera: *Coloburiscus* Eaton, *Oniscigaster* McLachlan, *Ameletus* Eaton and *Ameletopsis* n. g.

Genus COLOBURISCUS Eaton (1887).

Adult.—"Forelegs of male about as long as the body (when dried, 1 1-10 as long); tarsus about as long as the tibia, and this about 1⅝ as long as the femur; diminishing sequence of tarsal joints 2, 3, 4, 5, 1, the first joint nearly ⅓ as long as the second. Foreleg of the typical female about 7/11 as long as the body; tarsus about ⅝ as long as the tibia, which is about 1½ as long as the femur; tarsal joints in lessening length rank 5, 2 subequal to 3, 4, 1, the first joint about ½ as long as the second. Hind tarsus of the typical male about 5/12 as long as the tibia, and this about 1⅛ as long as the femur; the first joint is about ⅔ as long as the second, but both of them are short. Ungues in every tarsus each unlike the other. Hindwings well developed, oblong-oval, with the dilatation of the marginal area acute in front, and with relatively scanty neuration in the narrow axillar region. In the female abdomen the relative lengths of the 2nd-9th dorsal segments may be formulated approximately thus: 5, 8, 10, 12, 13, 13, 8/8, 8, 5; the first segment is thoracoid. The squarely truncate pleurae of segments 7 and 8 are minutely mucronate; those of segment 9 are produced posteriorly each into a short acute triangular point. Forceps-basis of male divided almost completely into two broad divisions; the limbs 3-jointed, the proximal joint subcylindrical, slightly enlarged or gibbous at the extreme base, and not much longer than the remaining joints combined. Ventral lobe of female bifid and acutely excised. Penis-lobe narrow, obliquely pointed; orifices of the seminal duct placed in proximity to the extreme points of the lobes; .... Median caudal seta rudimentary, only 1/10 to ¼ as long as the outer setae; these are about twice as long as the body in the male, and 1½ as long as in the female. Oculi of male contiguous, or nearly so, above, obsoletely ascalaphoid, with the upper segments hemispherical and the lower relatively very small. Vertex of female head transverse; the occipital border raised in the middle above the level of the posterior orbits of the oculi. Median ocellus smaller than the others; not isolated, but situated upon the foremost prominence of the upper surface of the head. Pronotum of female broadly reflexed upon the mesopleurae, and in the middle deeply excavated behind." (Eaton).

NYMPH.

Head convex dorsally and with fringe of hair anteriorly. Eyes lateral. Maxillary and labial palps two-segmented and greatly en-

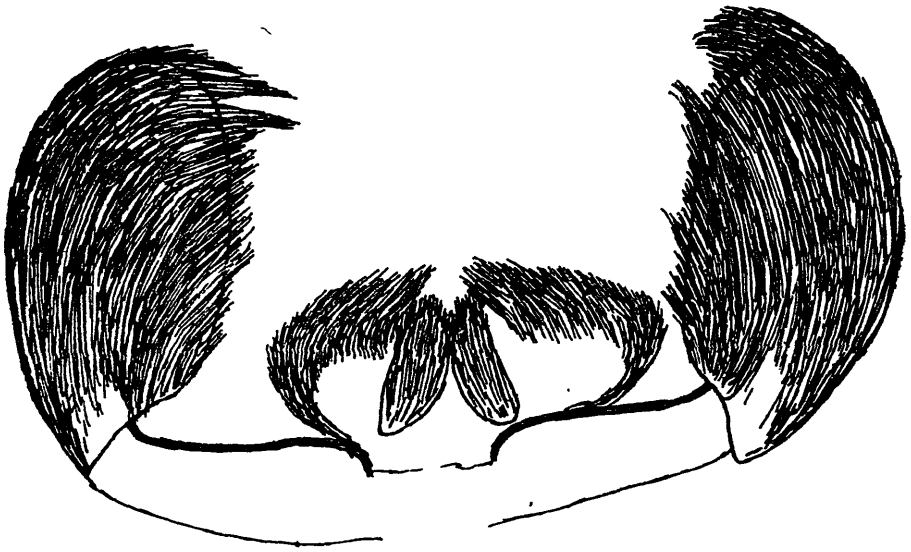


Fig. 43

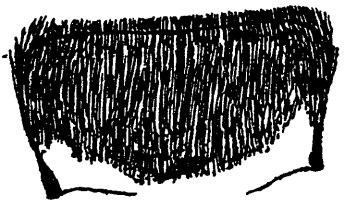


Fig. 41

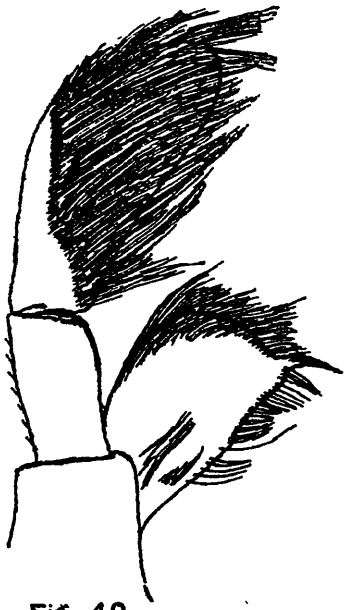


Fig. 40

Fig. 42

Nymph of *Coloburiscus humeralis*.

FIG. 40.—Maxilla, Ca. × 50.
FIG. 41.—Labrum, Ca. × 50.
FIG. 42.—Gill. × 24.
FIG. 43.—Labium, Ca. × 50.

larged. Thorax very large and prominent. Anterior and middle pairs of legs with long fringe of hair anteriorly: order of length of legs 1, 3, 2. Claws not toothed. Latero-posterior angles of 3rd to 9th segments of abdomen project backward as sharp teeth. Caudal setae with very short hairs in whorls at joinings of segments. With a pair of gills on each of the first abdominal segments, held upright over the dorsum. Each gill composed of a divergent fork with a connective membrane basally and covered with spines.

Habitat in rapids and fast-flowing parts of streams.

There is only one species, *C. humeralis* (Walker), which is widely distributed throughout New Zealand.

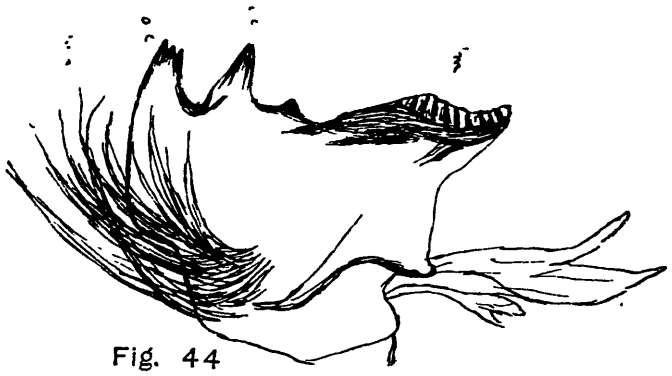


Fig. 44

Fig. 45

Nymph of *Coloburiscus humeralis.*
FIG. 44.—Mandible, ca. × 50.
FIG. 45.—Canines, greatly enlarged.

Coloburiscus humeralis (Walker).

IMAGO.

Length (excluding setae), 13.5 mm.

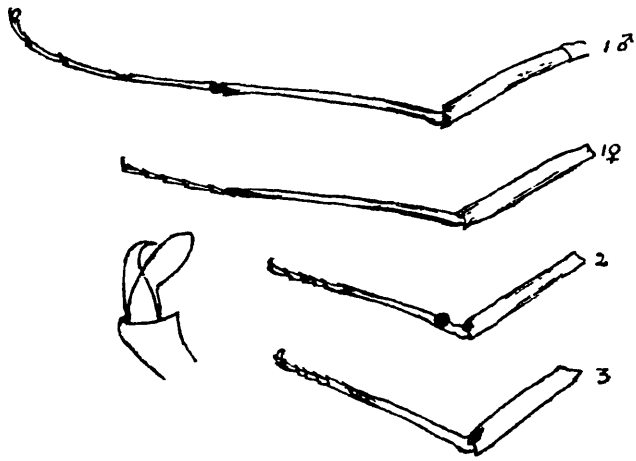
Head brown. Eyes of female olive, of male—upper part brown, lower part olive.

Thorax—notum burnt-umber: sternum reddish-brown, sometimes with pinkish areas round coxae.

Abdomen—burnt-umber with dark bands at posterior edges of segments: venter reddish-brown, last segment light fawn. Postero-lateral angles of segments seven, eight and nine strongly toothed backwards. Claspers (Text-Fig. 47) light fawn, becoming darker distally; three-segmented. Penes light fawn, short, well-separated. Caudal setae dull fawn, with black rings at joinings: median one very short, outer ones—male, 17 mm.; female, 15 mm.

Legs (Text-Fig. 46)—Anterior pair—Femora dark brown; tibiae dark fawn or pale yellow, banded dark brown at each end; tarsi dark fawn or pale yellow with distal end of each segment dark brown.

Other pairs—Pale yellow, touched with dark brown distally in all segments. Tarsi five-segmented; basal joint very short. Claws dissimilar, one sharp and hooked, the other broad and blunt.



Coloburiscus humeralis.

FIG. 46.—Legs of male imago and female foreleg. × 8.

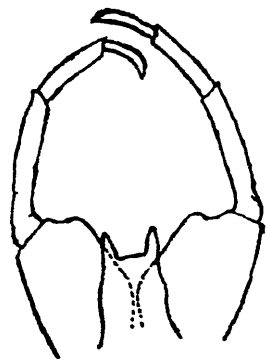


FIG. 47.—*Coloburiscus humeralis.* Genitalia of male imago. × 25.

Wings—Forewing vitreous: there is a yellow patch at the wing-base and the costal and sub-costal areas are pale yellow, deepening to bistre brown in the ptero-stigmatic region. In these anterior areas, the cross-veins are blurred and in the ptero-stigmatic region, they form a close reticulation. Hindwing vitreous, with yellow patch at wing-base. Humeral angle sharp.

Sub-Imago.

Wings (Pl. 54, Fig. 10)—Costal and sub-costal areas yellow, with vivid yellow patch at wing-base. The rest of the wing-surface is pearly. Veins dark grey, but lighter in the costal area. Cross-veins of costal area edged irregularly with grey, especially about half-way along.

The sub-imaginal stage lasts about two days.

The winged stages are in evidence from about the middle of October to the beginning of February.

Nymph.

Short descriptions of the winged stages of this insect have been written by Walker, Eaton (4) and (5) and Hutton (2). Hudson (1) includes the nymphal stage too, but a more detailed description is necessary.

This nymph (Text-Fig. 38) lives among the rapids and swiftly-flowing portions of the streams, though it occurs occasionally in more slowly-flowing parts. It is found attached to stones, rocks or boulders and among the vegetable debris, which is often lodged among the boulders in rapids. Here, it will cling with remarkable tenacity despite the force of the current, helped doubtless by the many spines with which its legs and the ventral surface of its abdomen are armed.

It is a poor swimmer, moving its legs in unison jerkily backwards and forwards, and there is at the same time a slight dorso-ventral movement at the tip of the abdomen: after a few spasmodic jerks, it often stops and curves the hinder part of its abdomen upwards and forwards.

The fringes of hair on its forelegs and mouthparts (Text-Figs. 38, 39) would seem to form a plankton straining apparatus, which enables it to secure food from the rapidly passing water without undue exertion, while its peculiar gills—unlike those of other mayfly nymphs—are held motionless, as it is unnecessary for the insect to move them to obtain fresh oxygen in the swift currents of its habitat. No other species of this order in New Zealand has succeeded so well in adapting itself to torrential aquatic conditions, and consequently it is the predominant nymph of the rapids.

Metamorphosis to the sub-imaginal stage occurs at the end of spring and throughout summer: before transforming, the insect seeks a stone or boulder above water level, on which the larval exuvia is left.

Description:

Length (excluding setae)—ca., 15 mm.

Head—Dark brown. Epicranium convexly arched and with a network of fine dark lines as shown in figure 1G.

Eyes—Very dark brown.

Antennae—About two and a half times as long as the head: filiform: segments of flagellum narrowing and lengthening from base to apex.

There is a row of minute spinules at each joint, pointing forwards and outwards.

Labrum (Text-Fig. 41)—1½ times as wide as it is long. Almost rectangular, but slightly broader anteriorly than posteriorly. Anterior and posterior margins straight and entire. Anterior-lateral corners rounded; posterior-lateral ones are strongly chitinised and form approximate right angles. Anterior margin and both surfaces strongly haired.

Maxilla (Text-Fig. 40)—Palp very much enlarged; 2-jointed; the apical one is the largest; it is falcate and very profusely haired. The galea-lacinia is considerably shorter than the palp; its outer edge is rounded, its inner one is straight: both are densely haired and from the anterior inner corner a prominent spine projects inwards.

Mandible (Text-Figs. 44, 45)—Outer canine (o.c.) with three teeth, and inner one (i.c.) with three teeth: the middle tooth of the inner canine is small, and often hidden by the teeth on each side of it.

Prostheca (p.) with blunt tip, chitinised, with inwardly-directed brush of long brown bristles at base.

Labium (Text-Fig. 43)—The palps are 2-jointed and very large. Lower joint a little broader basally than distally; upper joint much broader than the lower one, ovoid and profusely haired. Paraglossae with outer edges curved convexly, inner edges straight: profusely haired anteriorly.

Glossae much narrower than paraglossae and covered with long hair (they are somewhat displaced in the labium figured).

Thorax—Colour—Windsor and Newton's permanent brown. The lateral edges and a median tract are darker than the ground colour of the rest of the dorsum, which latter is patterned with a tracing of darker lines. The segments are broader than those of the abdomen. The meso-thorax, as usual, is the largest segment and is wider than it is long: the pro-thorax and meta-thorax are somewhat shorter, being about one-third as long as they are wide: the latter is fused with the first abdominal segment.

The whole thorax is convex dorsally.

Wingpads rather small. Same colour as thorax.

Abdomen—Narrowing somewhat posteriorly. Dark umber-brown, becoming tinged with red posteriorly in immature specimens. Covered with hair dorsally.* Posterior edges of segments minutely denticulated, the denticales being directed backwards.* Latero-posterior angles of the third to ninth segments project backwards as sharp teeth, which lengthen progressively towards the posterior.

The pleura of these segments bear spines, which project outwards and backwards.

Ventrally—Somewhat lighter in colour. The surface is covered with small hairs and spines, becoming more numerous and larger posteriorly, and in the fifth to ninth segments, the posterior edges bear a row of stout spines: the sternum of the ninth segment bears a couple of large backwardly projecting spines medianly and immediately exterior to these is a pair of smaller ones.

Caudal setae—Median one, 5 mm.; outer ones, 14 mm.

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*Not shown in figure.

Colour—burnt umber: there are a number of dark bars at irregular intervals, mostly in the basal half and, in some specimens, there are broader dark sections in the middle of the outer setae: the distal half becomes gradually somewhat lighter. In immature nymphs the proximal half has a reddish tinge.

There are whorls of short hairs and backward-projecting spines at the joints of segments: underneath these and terminating the segments distally are whorls of flat-lying larger spines.

Gills (Text-Fig. 42)—Tracheal gills are borne on each side of the first seven abdominal segments—a previous writer (1) states 'six pairs of gills,' but I have only found this to be the case where one pair was missing through obvious injury. They are inserted lateroposteriorly, and are held by the nymph upright over the dorsum.

The gills become larger posteriorly, the increase in size being noticeable in the outer fork of each gill only: the first pair is considerably smaller than the rest.

Each gill is pedunculate and consists of a divergent fork, united in the basal half by a thin lamella. They are armed with numerous short spines, which occur mainly round the edges and towards the distal part. These spines are jointed at the base and can be made to lie flat along the gill surface but spring up when pressure is removed.

The writer suggests that this stout yet elastic armament protects the gills from damage by current-borne debris.

On the surface of the lamella are a number of fine hairs, which are recurved apically; under the surface lies an extensive ramification of tracheoles: a tracheal branch runs through the middle of each of the forks.

Legs (Text-Fig. 39)—Dissimilar. Those of the anterior pair are the longest, the median ones are the shortest. The tarsus is the shortest joint in each leg. In the anterior pair, the femur is shorter, in the second pair longer than the tibia; in the posterior pair these segments are sub-equal.

Claws (Text-Fig. 39)—Alike in each leg, curved and hooked at tip: not toothed underneath.

Anterior pair—Femur greatly dilated; ovoid; there are two long fringes of hair on the proximal two-thirds of the ventral edge and a few small spines on the anterior surface of the proximal portion. The distal third of this surface is covered with large spines of which there are two half rows, in echelon, which start from the place where the ventral fringes of hair end; from here to the distal end, the surface is profusely spined.

Tibia with long fringe of hair on the ventral edge: the anterior surface is covered with short, thick spines and there is a row along the distal edge.

Tarsus has the anterior surface covered with short hairs and a fringe of them on the distal edge.

The function of the fringe of long hairs on the ventral edges of the femur and tibia is most probably that of a plankton strainer, for the nymph must find movement precarious in the swift water in which it lives, and consequently has to feed on whatever the water brings it.

Second pair—Femur not so dilated as in anterior pair; cuticular outgrowths similar, but the spines are not quite so numerous in the distal part.

Tibia covered with stout spines, some short, some long: no fringe of hairs, but a few straggly ones in places.

Tarsus as in anterior pair.

Third pair—Femur covered with stout spines: no fringe of hairs; ovoid, similar in contour to that of the second pair.

Tibia—No fringe: covered with thick spines; one, rather larger than the others, projects prominently from about the middle of the ventral edge forwards and outwards.

Tarsus as in anterior pair, and, in addition, there are a few stout spines on the ventral edge.

Genus ONISCIGASTER McLachlan.

In this genus are probably the most archaic types of mayfly now in existence. It has been studied by Eaton (4) and (5) and Vayssière (19) many years ago, though they had only dried or preserved specimens for examination. Eaton's description of the genus and of *O. wakefieldi* (4) has been included here.

Although three species have been described, it seems a little doubtful if *O. intermedius* is sufficiently distinct to be allotted specific rank.

The nymph appears to be indistinguishable from that of *O. distans*: both the imago and the sub-imago are also similar to those of *O. distans,* except for the lateral dilations of the 8th and 9th abdominal segments, which are sometimes very marked, sometimes less so. Moreover, in the Canterbury Museum there is a specimen of *O. wakefieldi* with the 6th segment laterally dilated in addition to the 7th, 8th and 9th as is usually the case, which would seem to indicate that these expansions are a variable feature.

The winged stages of *O. intermedius* are slightly larger than those of *O. distans,* though I have found one specimen of the latter, which was as large as *O. intermedius.*

With regard to *O. wakefieldi,* though I have never seen a living specimen, I am informed that it is still occasionally to be seen in the vicinity of Mount Grey, Canterbury.

The Canterbury Museum specimens of the imago show slight but constant differences from those of the imago of *O. distans,* viz., the latero-abdominal dilations, yellow caudal setae in place of brown ones and the proximal half of the forewing tinged with brown instead of the whole being hyaline.

Description:

"*Adult.*—foreleg of ♂ shorter than the body nearly in the proportion of 14 to 17; tarsus almost one and a third times as long as the tibia, and this nearly seven-eighths as long as the femur; gradation of the tarsal joints in the order of lessening length, 1, 2, 3, 4, 5, the first about one and a fifth times as long as the second joint. Foreleg of ♀ little less than half (9/20) as long as the body; tarsus about 1⅓ as long as the tibia, and this § as long as the femur; the rank of the tarsal joints in order of diminution is 1, 2 equal to 5, 3, 4, and the first is twice as long as the second joint. Hind

tarsus of ♀ about 1½ as long as the tibia, and this little more than ½ as long as the femur; the joints in order of shortening rank 1, 5, 2, 3, 4, and the first is twice as long as the second. Ungues each unlike the other in every tarsus. Hindwing well developed, obtusely subovate; dilatation of the marginal area obtuse in front; axillar region well developed, largely occupied by numerous long anastomosing veinlets from the inner margin. In the ♀ abdomen the relative lengths of segments 2-10 may be formulated thus:—6, 8, 8, 8, 8, 10, 11, 10, 6; the first is thoracoid. Pleurae of segments 2-5 in squarely truncate behind; those of segments 6-9 in ♀, or 5-9 in ♂, broadly and oniscoidally dilated, each narrowed and rounded off obtusely in front, and each produced behind into a short acute point separated by a small sinus from the hind border of the segment, so that this part of the abdomen is flanked by very conspicuous serratures; the pleural projections of segment 5 in the ♂ are narrower than the others. The 9th ventral segment is unprovided with a lobe in the ♀. Forceps-basis bipartite; the divisions, explanate, quadrangular, longer than broad, and remote from one another, might be reckoned as basal joints of the forceps-limbs. Forceps-limbs dactyloid, 4-jointed; the first joint short, tapering from the base; the second curved, longer than the others, and very slightly gibbous inside at the base. Penis small, perhaps retracted partially in dried examples. Median caudal setae of ♂ about ¼, of ♀ one-sixth as long as the body; outer setae of ♂ about eight-ninths as long as the body. In the ♀ sub-imago the median seta is about one-third and the outer setae nearly three-quarters as long as the body. Oculi of ♂ remote above, oval and very prominent. Vertex of ♀ head about as long as broad, slightly wider in front than behind; the occipital border raised suddenly above the level of the posterior orbits of the oculi. Median ocellus of ♀ much smaller than the others, isolated in a broad descending groove in front of and below the anterior edge of the upper surface of the head. Pronotum of ♀ rather broadly reflexed upon the mesopleurae; its posterior border (viewed from above) arched, with a very shallow median recess, which is not noticeable when viewed from in front.

"*Nymph.*—Abdominal tracheal branchiae recumbent upon the dorsum borne by segments* 1-6, diversiform and single, each inserted in a notch in the hind margin of the segment adjacent to the pleura; the foremost oblique, and somewhat resembling a truncate triangle with obtusely rounded angles, placed with the longest side inwards; the remaining five are formed each of a somewhat broadly obovate or oval pergamentose lamina with a large roundly expanded foliated lobe produced from its inner edge (defective in Fig. 18), the margins of which are irregularly erose and incised. The tracheation of the lamina gives it a curiously marbled appearance. Antennae shorter than the head, about 12-jointed in adolescence. Mandibular lobes strong and fang-like; the endopodite well developed; stipes well developed, circumscribed distally by a shallow constriction. Palpus of maxilla I. a little longer than the lacinia; the third joint gradually tapering, pungent, about as long as the second and little shorter than the first, but not quite as stout as either of them; lacinia somewhat lanceolate, with very few hairs on the oblique crown close to the point, and with short ciliae mingled with a few slender curved spines on the inner edge preceded by a few very short hairs nearer the stipes. Laciniae of maxillae II. falcate, nearly of the same breadth as the narrowly ovate-lanceolate lobes of the labium; first joint of the palpus stout; second joint less stout and slightly curved, very little enlarged and almost squarely truncate distally, about as long as the first joint; third joint about half as long as the second, less stout, and somewhat elongate-oval. Median lobe of the tongue subquadrangular, with the distal corners rounded, longer than broad and slightly retuse, subequal in length to the paraglossae, of which the terminal margins with that of the median lobe constitute together an arcuate curve; paraglossae dilated distally very moderately. Hind leg a little longer than the fore leg; tarsus (claw excluded) nearly 1½ as long as the tibia. Abdomen carinate above longitudinally in the middle; the carination in segments 2-9 produced into short

*Eaton had not seen nymphs of *O. distans* and *O. intermedius*. In these, at all events, there is a pair of microscopic gills on the seventh abdominal segment.

points, each projecting a little over the base of the next segment; pleurae in segments 1-9 oniscoidally dilated, forming recurved acuminate serratures. Median seta plumose, the others ciliate inside, each in its distal three-fifths; outer setae about ½ as long as the body.

"Type—*O. wakefieldi* McLach.

"Distribution—New Zealand." (Eaton).

Oniscigaster wakefieldi McLach.

"*Sub-Imago* (dried).—Wings, in opaque view, light sepia-grey; neuration generally piceous, but the principal nervures become pale basewards; the cross veinlets situated in the portions of the forewing bounded posteriorly by the inner and terminal margins, and in front by the outer half of the sector (4) and the inner half of the pobrachial (7) nervures, and all of the cross veinlets in the hindwing are narrowly edged with faint nebulous dark bordering; those in the anterior portion of the forewing (with the exception of those in the extremity of the pterostigmatic space) are edged more or less broadly with piceous—most broadly so in the marginal, submarginal, and the next adjoining areas—and their bordering in the basal halves of the first two areas is confluent to a variable extent; between the great cross vein and the last-mentioned cross veinlets the membrane is pale, contrasting conspicuously with the adjacent parts; and in proximity to the wing-roots the base of the forewing from the radius (3) to the inner margin is somewhat pale, both membrane and nervures; and so again to a small extent is the membrane in proximity to the bifurcation of the praebrachial (6) nervure. Setae dull pale yellowish.

"*Imago* (dried)—♀.—Notum dark pitch-brown. Abdomen of a duller colour than the notum on the dorsum, but nearly as dark, probably discoloured considerably in drying; in segments 2-6 the trachae appear to be pale and the joinings of the segments dark; the sides of every segment in proximity to the pleurae are more or less dark; segments 6-9 are traversed lengthwise by a fine median black line, and are marked each by a pair of elongated dark spots or short streaks, one on each side of the line, at the base; the pleural expansions of these segments, and in 9 and 8 a forked longitudinal streak just above them on each side, are also dark. Venter light yellowish-brown, with black or piceous markings; the markings comprise in each of segments 2-7 a large blotch on each side, gradually rounded off towards the base of the segment, intersected by the pale descending trachae near its anterior termination, and leaving only the joining pale; also a transverse streak at the joining, tapering to a point from the middle in both directions, whence is produced a short pointed streak or triangular cusp pointing forwards in the middle of the hind border of the segment; also a pair of small dots or oval spots, one on each side of the middle of the segment and in proximity to the point of the cusp; also the ventral ganglion nearer the base of the segment in the median line; and, lastly, another pair of larger oval spots set obliquely, and rather wider apart than the smaller spots, one on each side of the middle near the base of the segment; in segment 8 the smaller pair of dots is extremely small, and in 9 they appear to be totally absent, the larger pair alone remaining. Setae whitish-yellow, sometimes discoloured at the base. Wings vitreous, faintly tinted with light brownish (excepting sometimes towards the tips of the forewings, perhaps in consequence of their having been seized between finger and thumb at the time of capture); neuration piceous; cross veinlets dark-edged, nearly in correspondence with their edging in the sub-imago. Legs in opaque view dull light brown-ochreous, all with the base of the femur, a broad band before its extremity, one at the base of the tibia, one embracing the tip of the tibia and the basal half of the first tarsal joint, and all with the extreme tips of the joints of the tarsus and with the ungues black; in transmitted light the ochre changes to dull amber.

"♂. Very similar to the ♀, but perhaps rather lighter in colour. Setae pale dull yellowish. Forceps pale yellowish-brown. Length of body, 16-21; wing, ♂ 16, ♀ 19-21; setae, ♂ im. 17 and 5, ♀ subim. 13 and 7 mm." (Eaton).

Oniscigaster intermedius Eaton.

(Plates 55-56, Figs. 11 and 12).

Length (excluding setae)—Male, 20 mm.; female, 24 mm.

Head—Dark brown. Eyes dark brown with a tinge of olive. Ocelli dark brown.

Thorax—Dark brown with a few lighter markings.

Abdomen—Dorsum shining dark brown, becoming lighter and tapering posteriorly; the median portion of the posterior edge of the ninth segment is light. On each of the first eight segments is a light pair of crescent-shaped marks, horns pointing inwards. The eighth and ninth segments are dilated laterally and are toothed backwards at the latero-posterior corners, the teeth being more prominent in the ninth segment than in the eighth. The lateral margins of the ninth segment are convex.

Venter somewhat lighter than the dorsum. A dark marking, in shape like the ' broad arrow ' mark of the British Government, placed antero-medianly and pointing forward, is found on each segment.

Claspers (Text-Fig. 55)—Dark brown, becoming much lighter distally. They appear to be five-jointed, but Eaton considers the basal portion to be part of the forceps-basis and defines them as four-jointed. Penes dark brown; small.

Caudal setae fawn with dark brown markings at joinings: outer ones—male, 22 mm.; female, 21 mm.: median one—male, 6 mm.; female, 7 mm.

Legs (Text-Fig. 54)—All segments light brown, tipped with dark brown at both ends. Claws dissimilar; one hooked and sharp, the other broad and blunt.

Wings—Vitreous, except for ptero-stigmatic region of forewing, which is light fawn: veins dark brown, in marginal and sub-marginal areas heavily bordered with dark brown, giving them a blurred appearance. There is a light brown blotch at the anterior of the wing-base in both wings, becoming dark brown in the marginal and sub-marginal portions, i.e., those proximal to the humerus. Wing expanse—♀, 39.5 mm.; ♂, 35 mm.

Habitat—Wellington and Hawkes Bay provincial districts, North Island of New Zealand. Tableland of Mount Arthur, South Island.

The adult may be found from November to January.

Sub-Imago.

Wings (Plate 57, Fig. 13)—Blackish-grey; black neuration, thickly and darkly-edged in marginal and sub-marginal areas of forewing and anterior half of hindwing and faintly-edged with grey in posterior half of hindwing and the rest of the anterior half of forewing. In the forewing is a light space, just distal to the humerus and a light transverse band from the middle of the costa across to the tornus.

Duration of sub-imaginal stage is three days.

Nymph.

The nymph (Pl. 57, Fig. 14) is rather uncommon: it is extraordinarily local in distribution, but where it does occur, a number of specimens may be obtained readily.

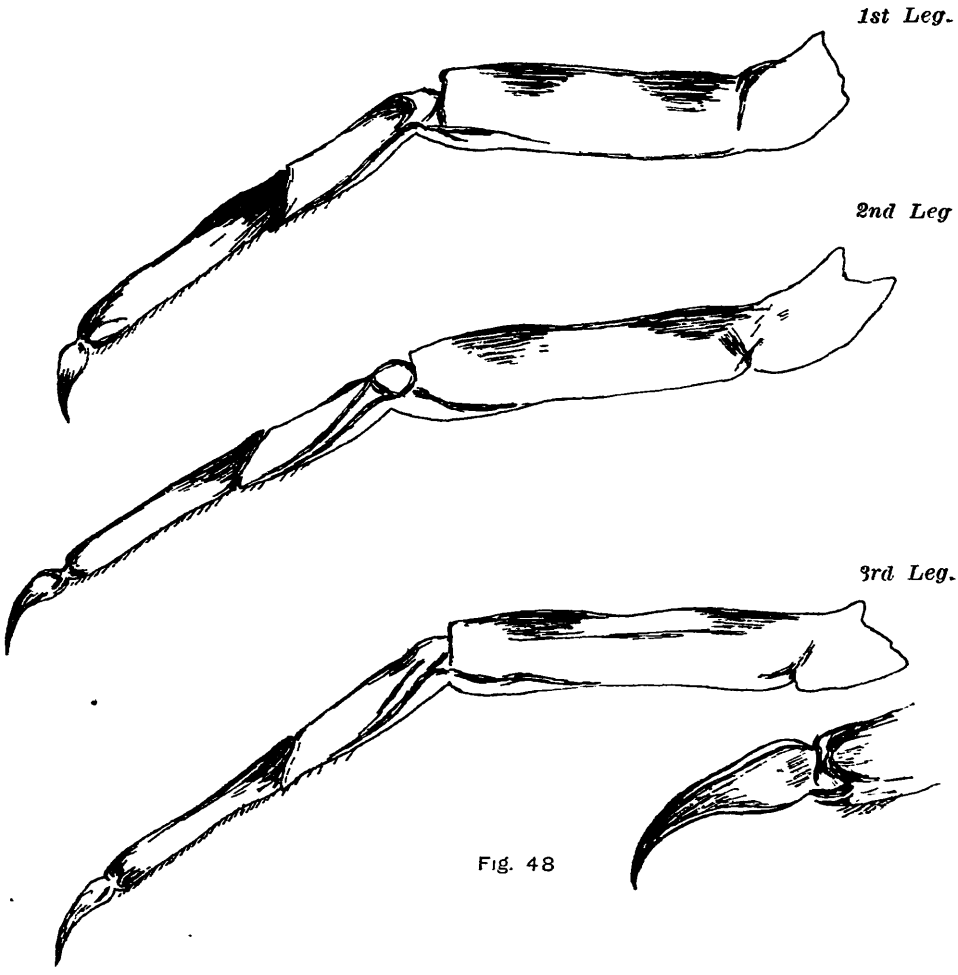

Fig. 48

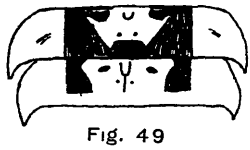

Fig. 49

Nymph of *Oniscigaster intermedius.*

FIG. 48.—Legs, × 20; and claw, × 45.

FIG. 49.—Diagram of types of ventral abdominal segments.

Its sluggish habits and marvellous camouflage make it very difficult to find: furthermore, it often buries itself in the gravel. Young specimens may be found in very fine gravel, but more mature nymphs occur on coarse gravel and boulders. It prefers pools and slow currents, but not stagnant water.

A curious trait is its preference for particular spots; thus, I have taken over twenty specimens from one small pool, whereas a protracted hunt over a hundred yards of adjacent stream-bed, containing many apparently precisely similar pools, has yielded a bare half-dozen.

The colour variation of this nymph is remarkable: it is sometimes brown, sometimes greyish-green, sometimes whitish, sometimes reddish, but the legs and venter show two clearly-defined types, referred to below as type A and type B.

Head—Small: held almost at right angles to the body: greyish-green, mottled with light brown.

Antennae—Short; twelve-jointed.

Eyes—Placed laterally; large; olive green.

Labrum (Text-Fig. 50a)—Nearly twice as broad as it is long. Anterior edge nearly straight—only slightly curved medianly; profusely covered with inwardly-pointing spines, their tips curved inwards; this fringe extends along the lateral edges three-quarters of the way towards their posterior angles. These angles are somewhat oblique and very dark in colour. There are additional incurved spines on the anterior region of the dorsal and ventral surfaces.

Mandible (Text-Fig. 50)—Both outer (o.c.) and inner (i.c.) canines have four teeth, but so placed that the examination of a slided specimen seldom reveals more than three. Prostheca (p) narrow and shorter than the canines, with rounded, non-chitinised tip and covered with fine, short hair. Placed interiorly and curving inwards is a brush of long light brown hair. Molar surface (m) with about 10—the number varies—parallel ridges with serrated edges.

Maxilla (Text-Fig. 51)—Palp three-jointed; somewhat longer than the galea-lacinia: the basal joint is the broadest, the distal one the narrowest: they are all about the same length, the middle joint being very slightly shorter than the two others. There are a few spines on the edge of each joint and a number situated apically on the distal one. The galea-lacinia narrows anteriorly to a point; from the places where it begins to narrow to the apex, it is fringed with hair.

Hypopharynx (Text-Fig. 52a)—Median piece projecting slightly beyond the superlinguae anteriorly, lateral angles rounded, lateral margins somewhat gibbous. The surface appears corrugated but unhaired. Superlinguae, each about half as wide as the median piece, becoming narrower basally. The anterior and interior margins are heavily fringed with hair.

Labium (Text-Fig. 52)—Palp three-segmented: basal segment broadest and longest, very dingy and covered with short incurved spines: second segment with a few spines: distal segment much shorter and somewhat narrower than the others, its apex pointed and covered with spines. Paraglossae falcate with numerous spines anteriorly. Glossae a little but not very much smaller than the para-

glossae, their inner edges somewhat concave, touching each other distally; their outer edges are slightly convex, the curvature increasing anteriorly; the inner anterior angles are quadrangular with the extreme corners, only, rounded. The glossae bear a number of marginal spines.

Thorax—Greyish-green, mottled with light brown. Pronotum narrow: mesonotum very broad, V-shaped, almost covering metano-

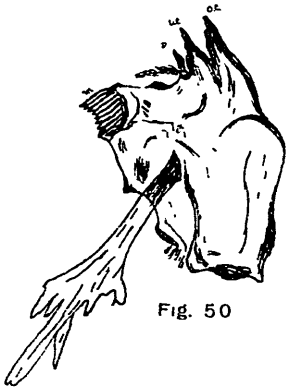

Fig. 50

Fig. 51.

Fig. 52

3. 4 5. 6. 7.

Fig. 53

Nymph of *Oniscigaster intermedius.*

FIG. 50.—Left mandible and labrum. × 30.
FIG. 51.—Right maxilla. × 30.
FIG. 52.—Labium and hypopharynx. × 30.
FIG. 53.—Dorsal crest (2nd to 7th segments). × 20.

tum. Wingpads small, greyish-green, covering the first two abdominal segments only.

Legs (Text-Fig. 48)—Short; robust. Order of length, 3, 2, 1: this is accounted for by the differing length of femur, the tarsi and tibiae not varying in length. The tarsus is longer than the tibia. The claw is about half the length of the tarsus, swollen at the base, and pointed and hooked apically: it is untoothed. There is a row of spines on the ventral edges of the tarsus and tibia.

Eaton in his plate 51, vol. 3, *A Revisional Monograph of Recent Ephemeridae, Trans. Linn. Soc., Lond.,* describing the nymph of *Oniscigaster wakefieldi,* shows a row of spines on the dorsal edge of the leg. Either this is an error, or it offers a means of distinguishing the two species in their nymphal stages, and apart from this difference, his description appears to tally, so far as it goes, with the species described in this paper.

Colouration—Type A—Femora greenish-white, with brown bar two-thirds of the way towards the distal end. Tibiae white, with tinge of green. Tarsi white, with dark greenish-grey mark at proximal end and dark brownish-grey mark distally.

Type B—Femora yellowish-white, with brown bar two-thirds of the way towards distal end. Tibiae light yellow, with brown mark at each end. Tarsi light brown, darker at each end. In both types the claws are stout, brown and strongly curved.

Abdomen—Type A—Greyish-green with brown markings. Type B—Light brown, mottled with light yellow. The first nine segments have whitish pleurae laterally flanged, the posterior lateral angles of which curve backwards and terminate in sharp, black points. The tenth segment has no flanges, but the posterior edge, which is dark-rimmed, slopes back medianly, terminating in a rounded point; there is a pair of medianly placed brown dots on this segment. The first nine segments are keeled longitudinally along the median line, and produced into sharp points, projecting over the next (posterior) segment (Text-Fig. 53).

Venter (Text-Fig. 49) Type A—Ground colour dingy white with maroon markings, placed laterally on each of the 2nd to 9th segments and a thin band joining them running along the anterior edge. There are also two median markings of this colour, one quarter of the way from the anterior edge, and two smaller dots closer to the median line and half way towards the posterior edge. The flanges are dingy white and the markings on each segment somewhat resemble a horned owl.

Type B—Ground colour light chocolate, lateral flanges flavescent: the second to seventh segments have a prominent whitish W mark medianly (eighth and ninth segments faintly so), with two paired brown markings inside the apices of the arms of the W and two small brown dots within the lower part. Faint indefinitely-shaped brown areas jut out into the flanges.

In both types the tenth segment is very dingy and emarginate posteriorly.

Caudal setae—Short; white, except for a small area towards the tip, which is black. Median one with a long fringe of hair on both sides, outer ones fringed on inside only: there are circles of minute

black spinules at the posterior edges of each segment. The outer setae are slightly longer, curving inwards somewhat towards the tip. There is a narrow proximal area, which is also black. Length, 6 mm.

Gills—On the first six abdominal segments. They are single, lamellate but diversiform. Their general shape is roundish, their colour olive green* beautifully marbled with white. The first four are about the same size, the fifth is smaller, and the sixth very small. They are held lying inwards over the dorsum and almost meet along the median line. They appear to correspond exactly with those of *O. wakefieldi,* wonderfully well illustrated in Eaton's plate, mentioned above.

Attached to the posterior edge of the seventh abdominal segment is a minute pair of gills, which have been overlooked by previous writers. The discovery of this microscopic pair was made by Professor Percival of Canterbury College, Christchurch, New Zealand, who drew my attention to them in a letter dated 1/10/29.

Oniscigaster distans Eaton.

This species appears to be indistinguishable from *O. intermedius* in the nymphal stage, but the winged stages are without lateral abdominal flanges on any of the segments.

This species is far commoner than the preceding ones and can be found in many of the well-bushed and more inaccessible streams of both Islands. I have not found specimens in streams, the banks of which have been denuded of vegetation, and it is probable that in such places it has been exterminated by birds.

Genus AMELETUS (New Zealand Type).

In all stages of the New Zealand species of *Ameletus,* a number of small differences from the generic type may be found, and it will probably be necessary to found a new genus for them. Dr. Tillyard is investigating some related species in Australia and, as he is also conversant with the New Zealand species, he will probably redefine the genera of the SIPHLONURIDAE for the whole Australasian region. Until then, the following may be taken provisionally as generic characters—

ADULT.

Foreleg of male sub-equal to length of body, of female $\frac{1}{2}$ to $\frac{1}{3}$ as long as the body: femora with heavy dark median bar: hind tarsi slightly shorter than the tibiae: †claws alike narrow and hooked in each tarsus. Median caudal seta very short, outer caudal setae about as long as the body. Genital forceps four-segmented, basal segment very short, second segment longer than all the others combined: penes well separated, narrow, acuminate. Forewing with tornus about $^2/_5$ the length of wing from wing-base: cross-veins in pterostigmatic area simple, not reticulated. Hindwing with humeral angle a gently-curved obtuse angle.

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*In some specimens the gill surface is red.

†Eaton (4) at first included *A. ornatus* in the genus *Chirotonetes,* which has the claws alike, but later (5) transferred the species to the genus *Ameletus,* stating the claws were dissimilar.

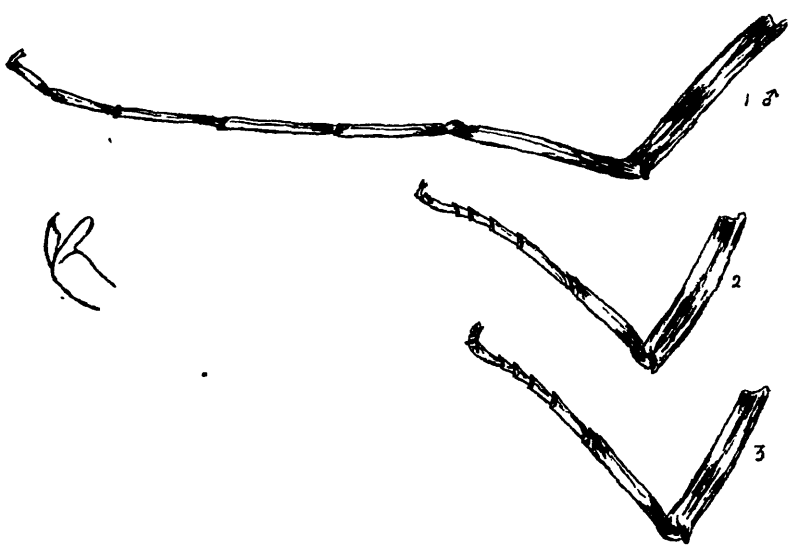


FIG. 54.—*Oniscigaster intermedius.* Legs of male imago. × 8.

NYMPH.

Nymph torpedo-shaped. Head small. Antennae short. Eyes lateral. Labial and maxillary palps three-jointed. The canines coalesced. Wingpads large and conspicuous. Legs short, robust, subequal. Claws minutely toothed underneath. Abdomen tapering posteriorly. Postero-lateral angles of segments sharply-toothed backwards. Caudal setae about half as long as body; the median seta is slightly shorter than the others and is plumose; the outer setae are

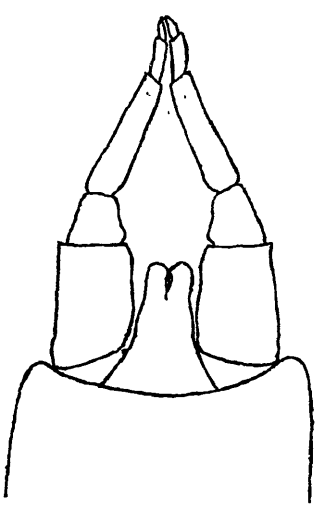
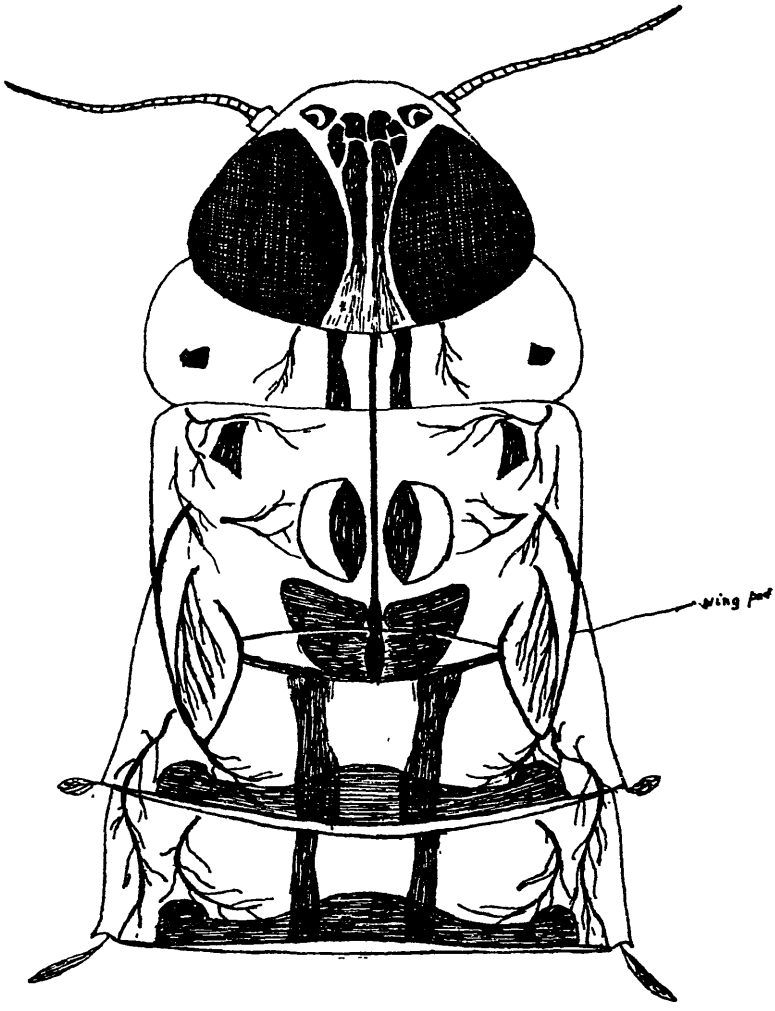


FIG. 55.—*Oniscigaster intermedius.* Genitalia of male imago. × 25.

thickly-fringed with hair on the inner margins only. Simple lamellate gills are borne on the first seven abdominal segments: they are held laterally. The edges of the lamellae are finely-toothed and the venation is pinnate.

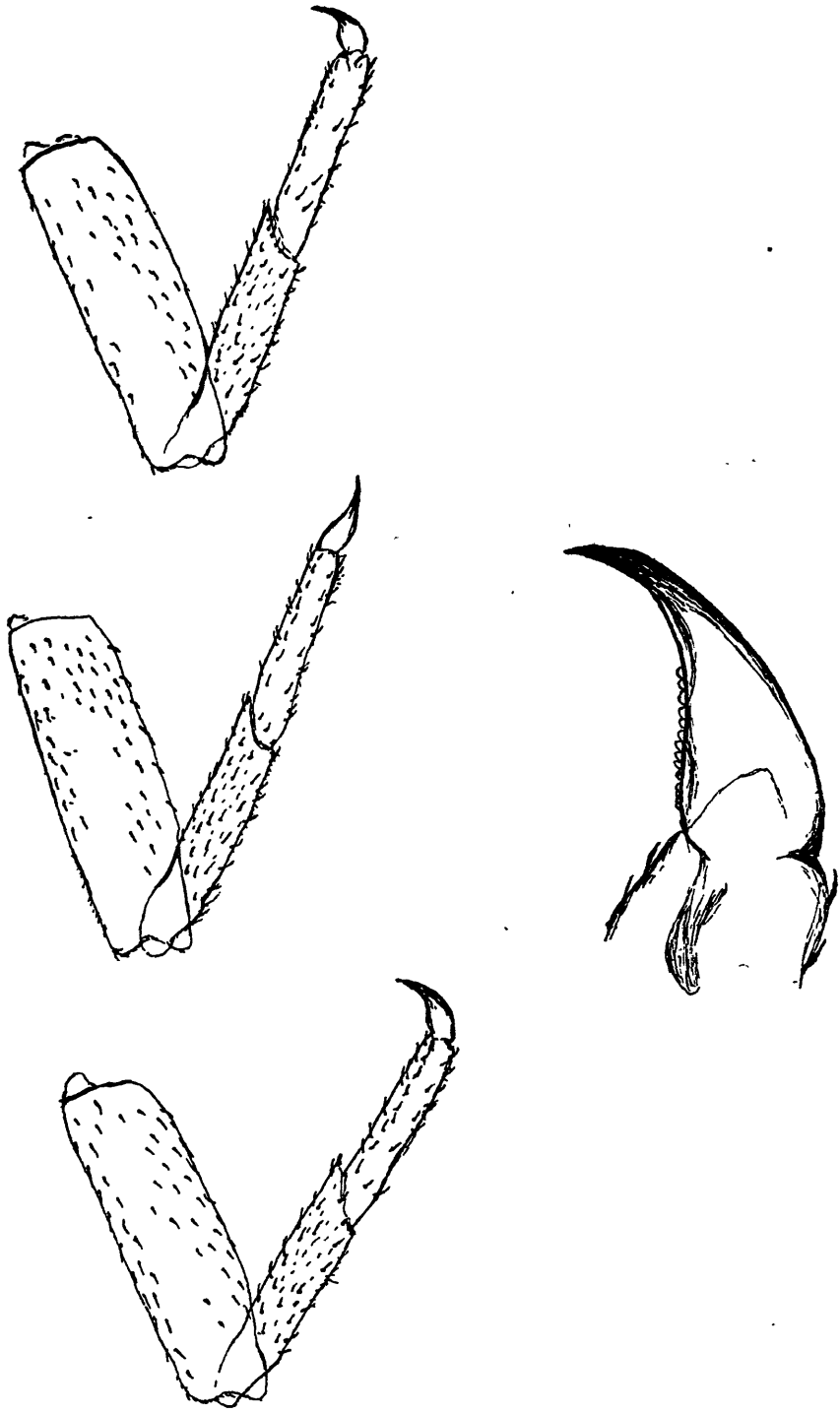
It will be noticed that the mouthparts in the species described are quite different from those of *Ameletus* species in the Northern Hemisphere and when the adult characters of local *Ameletus* species have been thoroughly re-examined, it is quite likely that a new genus will have to be established for them.

There are two species—*A. ornatus* (Eaton), described below, and *A. flavitinctus* Tillyard.



Nymph of *Ameletus ornatus.*

FIG. 56.—Thorax and first two abdominal segments. × 25. (Immature nymph; wingpads undeveloped.)



Nymph of *Ameletus ornatus.*

FIG. 57.—Legs, × 25: tarsal claw, greatly enlarged.

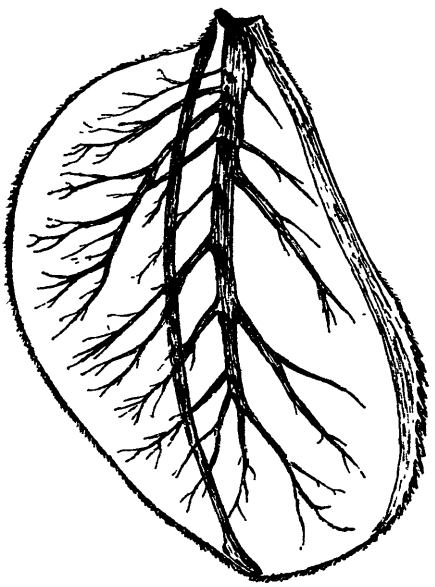


Fig. 58

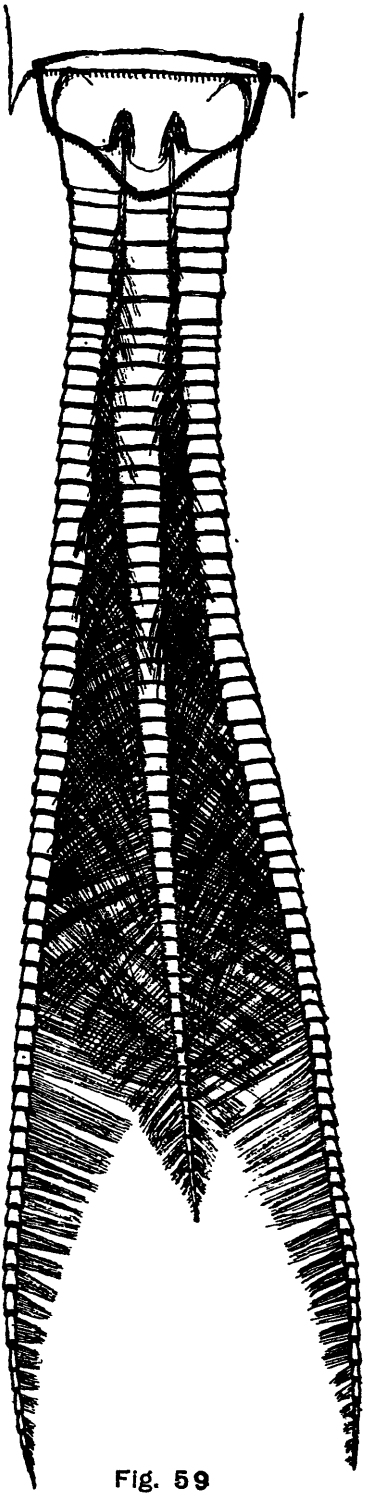


Fig. 59

Nymph of *Ameletus ornatus.*

FIG. 58.—Gill. × 25.

FIG. 59.—Caudal setae, × 25, and segment of one, much enlarged.

A female sub-imago of this latter species was taken at Waihi, near Lake Taupo, on November 26th, 1919, by Dr. Tillyard, who named it and described it and its later (imaginal) stage (6).

It was not till November 23rd, 1929, that I found several strange looking *Ameletus* nymphs in the River Wainui-o-mata and its tributary George's Creek, near Wellington. On November 26th, exactly ten years after Dr. Tillyard's discovery, one of the nymphs changed to a female sub-imago, and I was able to recognise it from Dr. Tillyard's paper and thus identify the nymph.

Ameletus ornatus (Eaton).

Imago.

Length (excluding setae)—14 to 15 mm.

Head—Dull brown. Eyes of female, olive; of male, olive in upper part, fawn in lower part. Ocelli black.

Thorax of male, pitch brown dorsally; of female, brown.

Abdomen—First segment almost hidden by metathorax. Ground colour dark fawn, becoming somewhat lighter distally, except in the ninth segment, which has a greenish tinge: third to ninth segments have paired brown longitudinal markings medianly: posterior edges of fourth, fifth and sixth segments are dark-rimmed. Venter, light ochreous with greenish tinge. Claspers (Text-Fig. 66), light fawn, four-segmented. Penes, light brown, becoming darker distally. Caudal setae, light fawn, banded with dark brown, becoming lighter distally: outer ones, 16 mm.; median one, 1 mm.

Legs (Text Fig. 65)—Forelegs brown ochreous: femora banded with dark brown medianly and apically: tibiae and tarsi fawn, with dark markings apically. Other pairs flavescent with black or dark grey markings, viz., a band in the middle and another at the tip of the femora, a band at the tip of the tibiae, at the joinings of the tarsi and to some extent on the last three segments of the tarsi. Tarsi five-segmented.

Wings (Pl. 58, Fig. 16)—Expanse—male, 28 mm.; female, 34 mm. Surface of both wings yellow with some areas hyaline. In the forewing, the cross-veins are simple, and rather thick in the costal and sub-costal areas. Neuration black or dark brown. In the pterostigmatic area, the cross-veins are more closely set and there is a slight brownish tinge. Bullae on Sc., R1 and R2a.

Wings of Sub-Imago—Wings clouded with whitish-grey, mottled with black in the male, green in the female: wing-base yellowish. Veins brown. Cross-veins bordered with brownish-grey, their borders confluent in places, forming irregular-shaped areas.

Duration of sub-imaginal stage, two days.

Winged stages are in evidence from November to February.

Nymph.

This is the best example of the ' swimmer ' type of mayfly nymph in New Zealand, its powers in this respect far exceeding those of any other Ephemerid in the country.

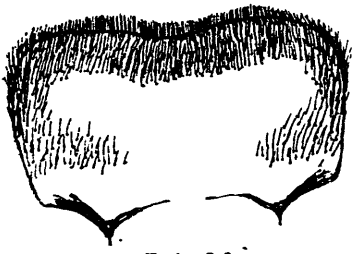


Fig. 60

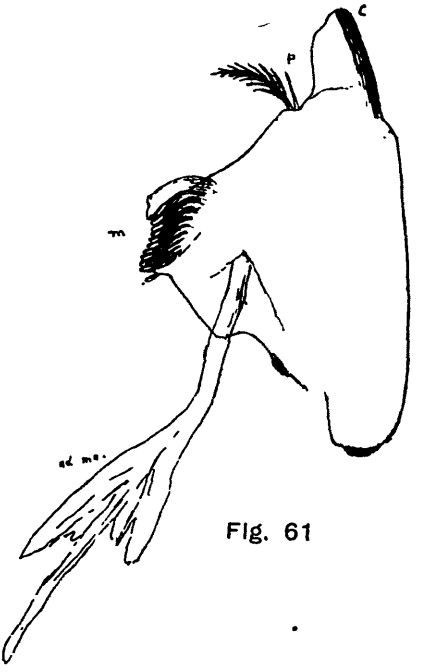


Fig. 61

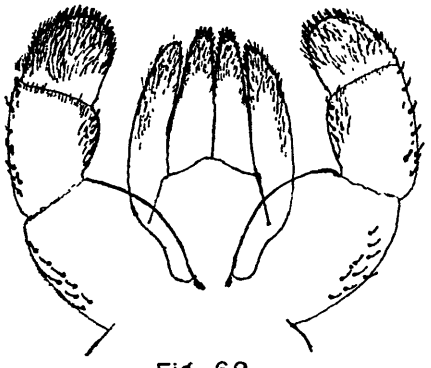


Fig. 62

Fig. 64

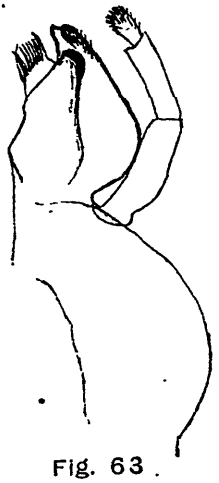


Fig. 63

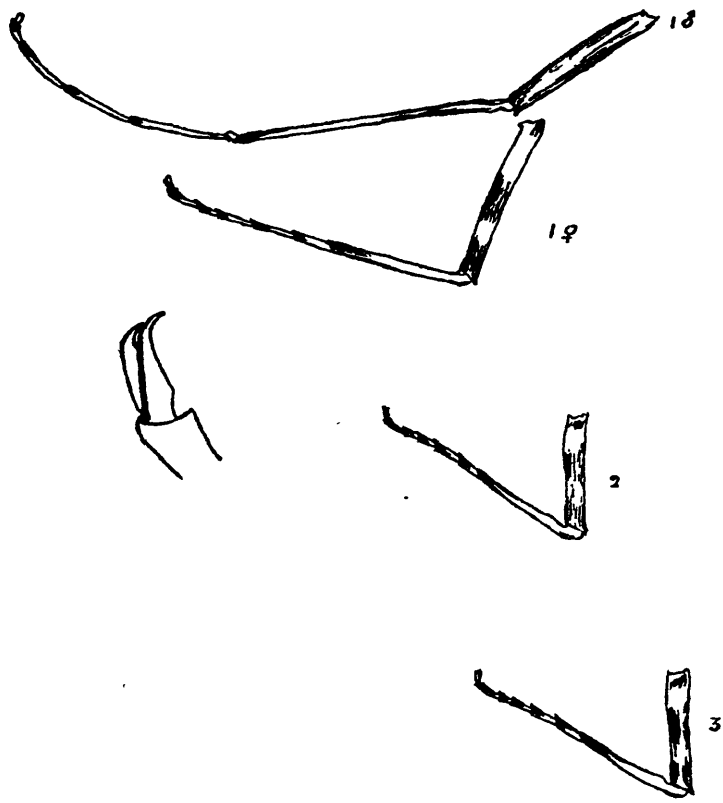
Nymph of *Ameletus ornatus*.

FIG. 60.—Labrum. × 40.
FIG. 61.—Mandible. × 40.
FIG. 62.—Labium. × 40.
FIG. 63.—Maxilla. × 40.
FIG. 64.—Tip of glossa, greatly enlarged.

Its distribution is widespread, as it occurs in most streams except the very sluggish ones.

The nymph of *A. ornatus* (Pl. 58, Fig. 15) can exist either in swift currents or in the pools between rapids: it is found both on the upper and lower surfaces of boulders, as well as on their vertical edges: it is also found on vegetation at the edges of streams.

When at rest, it has, more than any other mayfly nymph, the curious habit of swaying its setae and the hinder part of its abdomen gently, at intervals, in a dorso-ventral arc.



Ameletus ornatus.

FIG. 65.—Legs of male imago and foreleg of female. × 8.

Its movement is so rapid that to the eye it appears as a swift wriggling dart, of which the component motions cannot be perceived. Careful and prolonged observation, however, shows that the movement is made by rapid dorso-ventral shakes of the ' tail ' and of the posterior part of the abdomen, through a short arc. The legs appear to be used to assist movement and are not held folded back against the body, as in the case of the American *A. velox* Dodds (Dodds and Hisaw (14)).

Nymphs in captivity will often turn over on their backs if disturbed, and appear as if dead: whether this is a simulation of death

or an actual disturbance of balance, due to unknown conditions, is a matter of question: after an interval—which may vary from a few seconds to some minutes—they recover. When narcotised with chloral hydrate, they assume a similar posture.

The nymph becomes full-grown during the summer months, when it leaves the water and changes into the sub-imaginal stage on a stone or boulder.

It will be noted that there are considerable differences in structure, notably in the mouth parts, between *A. ornatus* and the species of Ameletus found in Europe and America; and, if further study reveals pronounced differences in the winged stages, it will be necessary to establish a new genus as Tillyard (6) suggests in his description of *A. flavitinctus* Tillyard.

The colouring of this nymph varies considerably in different localities.

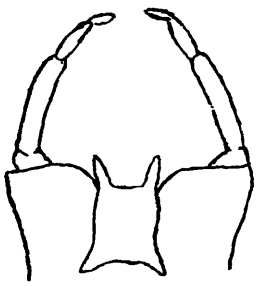


FIG. 66.—*Ameletus ornatus*: Genitalia of male imago. × 25.

Description:

Length (including setae)—Ca., 2 c.m.

Head—Small; greyish-green: axis at right angles to that of body. All the margins appear convex, viewed from above, and the head narrows somewhat anteriorly. The greater part of the dorsal surface is occupied by the compound eyes.

Eyes—Dark fawn or dark greyish-green: large: set close together.

Ocelli—Black.

Antennae—Short: subulate: sixteen-jointed: scape and pedicel colourless; flagellum flavescent at base and becoming greyish-green distally.

MOUTHPARTS:

Labrum (Text-Fig. 60)—About twice as wide as it is long. The anterior edge is densely haired and has a gentle inward bend medianly; the latero-anterior edges are rounded and from the sides extend backwards and very slightly inwards to the latero-posterior corners, which are obtuse-angled. The posterior edge has two backwardly-directed salients, one near each end, where the adductor muscles are attached. Numerous spines occur on the surface and round the edges, placed as shown in the accompanying figure.

Mandibles (Text-Fig. 61)—The canines (c) have coalesced and form a wide flattened projection with a ragged distal edge. The outer edge of this projection is strongly chitinised. The prostheca (p) is

a thin, pale, non-chitinised, finger-like process, interior to the canines, and accompanying this is an inwardly-directed brush of light brown hair; this is considerably larger than the prostheca.

The molar surface (m) bears ten parallel serrated ridges. The irregular, inner posterior, projecting tissue is part of the adductor muscles (ad. mu.).

Maxilla (Text-Fig. 63)—Palp three-jointed. Basal joint broadest and longest: middle joint somewhat shorter and narrower: the third joint is very much shorter than the other two; on it are several spines and in the distal part a number of small finger-like sensillae, shorter and broader than the spines.

The galea-lacinia is irregularly-shaped and has a fringe of hairs anterior-interiorly; there is a row of bristles rooted near the anterior-exterior edge.

Labium (Text-Fig. 62)—Palps three-jointed: very stout. The joints decrease in length and width from the base upwards. The two lower segments of each palp bear a number of spines: most of these are slightly curved, but a few are somewhat shorter, considerably thicker and straight. The distal joints are more densely spined, and placed apically are a number of the curious sensillae, mentioned above when describing the maxillary palp. The apices are slightly chitinised.

Paraglossae narrow, elongated, curving slightly inwards anteriorly and densely haired distally.

Glossae (Text-Fig. 64) a little longer than in the paraglossae. They are shaped like elongated cones with the tips truncated. Their interior edges touch posteriorly. The anterior parts bear spines and towards the tips, which are chitinised, are several of the afore-mentioned sensillae.

Thorax (Text-Fig. 56)—Ovoid in section.

Prothorax—Very short, being about one-third as long as it is wide at the sides and only about one-fifth as long as it is wide in the middle. The anterior edge is concave, the posterior one straight and the lateral ones slightly convex. The ground colour is greenish-white: there is a dark green line medianly with a brown ochreous band on each side of it: exterior to these bands are thin green linear markings: in addition, there is a brown ochre dot near each of the latero-posterior corners.

Mesothorax—Straight-margined anteriorly and posteriorly: it is nearly as long as it is wide: the lateral edges are slightly convex. The ground colour is greenish-white: the surface is elaborately marked with fine dark green lines: there are two pairs of brown ochre splodges, the first placed anteriorly and half way between the median line and the lateral edges, the second pair—somewhat larger—at the posterior edge, one mark on each side of the median line. The median line is dark green, and on each side of it, just anterior to the brown markings, are conspicuous oval ones, golden laterally, brown medianly, their major axes running anteriorly-posteriorly.

The *metathorax* is almost completely hidden by the meso-thorax, except for a narrow strip of the convex posterior edge, which is brown ochre, with a dark green median line.

Wingpads—Large: dark slate grey in colour: they cover the dorsum about as far back as the posterior edge of the second abdominal segment.

Abdomen—Tapers posteriorly: posterior-lateral angles of second to ninth sterna project backwards as sharp teeth.

Dorsum (Text-Fig. 56)—Ground colour faintly greenish-white in first eight segments. There are paired brown ochre longitudinal bands placed medianly and a similarly coloured band along the posterior edge of each segment. The extreme rim, which is darker, bears minute backwardly directed spines. All these markings become less pronounced posteriorly. Appearing in dorsal view as contiguous to each of these posteriorly-placed bands, but in reality beneath and partly overlapped by them, lies a narrow olivaceous softer portion in the anterior part of the next segment. The ends of the posterior bands terminate near the lateral edges as golden brown blobs. Exterior to these are the latero-posterior angles of the terga, which are blackened, and from below these, in the first seven segments, the gills project. The ground colour of the ninth and tenth segments is greyish-green, becoming darker posteriorly in each segment: as usual, the posterior edge of the tenth segment is not straight, but is in the form of a truncated triangle.

Venter—White.

Caudal setae (Text-Fig. 59)—Outer ones, 7 mm.; median one, 6 mm. The median seta is fringed with hair on both sides, the outer ones are fringed internally only.

(A previous writer (1) describes and figures the outer setae as fringed with hair on both sides, but I have never met with a specimen of this description).

The hair fringed are black in the proximal, white in the distal portion: the hairs become shorter distally.

There is a row of minute backwardly-pointing spinules near the posterior edge of each segment and just behind, closely adpressed to the surface, a compactly-set row of small, spinose, backwardly-directed hairs.

The colour of the setae is flavescent, becoming light brown distally.

Gills (Text-Fig. 58)—Pairs of gills occur, inserted laterally, on the first seven abdominal segments.

The gills become larger in size posteriorly as far as the fourth pair; then progressively smaller; those of the first abdominal segment are by far the smallest.

At intervals, the first five pairs are vibrated rapidly, the sixth pair very slightly, the seventh pair not at all.

The first pair are held vertically over the points of insertion, the lamella surfaces facing anteriorly and posteriorly. The other pairs are inclined more and more laterally, i.e., downwards, so that the main tracheal branches of the gills are almost horizontal; at the same time, the gills are directed progressively backwards and also the gill surfaces of posterior pairs become tilted so that their upper edges are thrown backwards, the lower edges forward. The lamellae are ovate with rounded distal edges; their edges are finely-toothed in the upper

distal portion and bear minute hairs all round, except in a small upper proximal section.

The venation is black, pinnate, and well ramified. Below the main tracheal branch, a thick, chitinised, curved band runs longitudinally throughout the gill. It is conjectured that this acts as a brace, strengthening the lamella.

Occasionally in this and other nymphs, an abnormally small gill is found on some segment, in place of one of the normal size: this rather suggests that gills may be regenerated between ecdyses.

Legs (Text-Fig. 57)—Alike: short: robust.

The femora are one and a half times as long as the tibiae, which are slightly longer than the tarsi.

Femora—Short and stout: greenish-white with olive markings distally. Anterior surfaces covered with short spines and a few hairs.

Tibiae—Almost colourless: covered with short spines and a few hairs; the latter are more numerous on the dorsal edges.

Tarsi—Light brown at proximal end; median part with only a tinge of brown; distal end very dark brown. Covered with numerous short spines and a few hairs; the dorsal edges, more especially distally, are noticeably haired.

Claws—Brown, curved, prominent. There are a number of very small teeth on the under-side of each claw.

Ameletus flavitinctus Tillyard.

" IMAGO—female.

"*Total length*—18 mm.

"*Head* (somewhat shrivelled)—Small, dull medium brown; eyes, dull blackish.

"*Thorax*—Pro- and meso-thorax rich umber brown above; meta-thorax dark chocolate brown above; sides dull brown shading to pale brown beneath; mesonotum with two blackish marks placed close up on either side of the median suture posteriorly. Legs short, pale brown, the femora with a broad black median band and a narrower black band at apex; tibiae marked with black apically; tarsi blackish, except for the bases of the first three segments, which are pale brownish. Text-Fig. 20g shows the tarsus of the hind leg, for comparison with that of *Ameletus ornatus* (Text-Fig. 20h), an insect of somewhat smaller size but with much larger legs.

"*Abdomen* narrow, sub-cylindrical, tapering posteriorly. Segments 1-6 dark brown, heavily marked with dull-blackish in the form of a transverse basal band, from which project two elongated, longitudinal marks, one on either side of the median line, and reaching to within a short distance of the apex of each segment; 7-8 paler brown, with similar blackish basal band, but with shorter longitudinal projecting marks, reaching only about half-way along each segment; 9 pale brown, with very narrow blackish basal band and slender longitudinal projecting markings; 10 pale brown, with narrow blackish basal band and no marks. Ventral valve cleft in middle, its margin forming two rounded lobes (Text-Fig. 20f); those of the other New Zealand species are shown for comparison in Fig. 2, d, c. Cerci (partially shrivelled) somewhat longer than abdomen, brown, with darker segmental rings. Appendix dorsalis much reduced, only 3 mm. long, much shrivelled, with numerous minute obsolescent segments.

"*Wings* (Plate 59, Fig. 17)—Forewing, 19.5 mm.; hindwing, 7 mm.; expanse, 41 mm. Wings brilliant, most of the membrane a pale transparent yellowish, but with certain areas absolutely hyaline." ... "where the very irregularly-placed cross-veins lie farthest apart. Veins blackish. Forewing with two groups of thickened black cross-veins between Sc, R1, and R2, one set being

about half way along the wing, the other below the proximal part of the pterostigma. There is a series of five definite spots or bullae on the forewing, on Sc, R1, R2, R3 and R4 respectively, the first three being large and situated in the midst of the first set of thickened cross-veins already mentioned, while the last two are smaller and situated below them. In shape the forewing is similar to that of *A. ornatus*. Hindwing with the humeral angle as shown in Text-Fig. 20c; the same portion of the hindwings of *A. perscitus* and *A. ornatus* are shown for comparison in Fig. 2a, b.

"*Locality*—Stream above high waterfall at Wahi, near Tokaanu, southern end of Lake Taupo, 26th November, 1919 (R.J.T.)." (Tillyard).

From specimens caught this season (1929/30), it has been possible to supplement this description—

SUB-IMAGO.

Wings (Pl. 59, Fig. 18)—Shape and venation as described for imago. Wing-surface with greenish-brown tinge; costal and subcostal areas clear yellowish-green: veins yellow at edges, black centrally: cross-veins edged irregularly with greyish-brown, forming dusky areas in parts and notably two dark zig-zag bands as in *Atalophlebia versicolor*. The dark areas are most numerous in the posterior part of the forewing and the distal part of the hindwing. Abdomen as in imago but with greenish tinge, the eighth tergite is much lighter than the others and this makes it conspicuous, the ninth and tenth are much darker. The lighter parts of the legs are greenish, not brown as in the imago.

IMAGO.

Male as female, with the following differences: Length (excluding setae), 14 mm.; forewing, 16 mm.; hindwing, 5 mm.; wing expanse, 36 mm.

Eyes green. Genitalia (Text-Fig. 68)—Claspers flavescent, becoming dingy distally, four-segmented, the basis obliquely truncated pos-

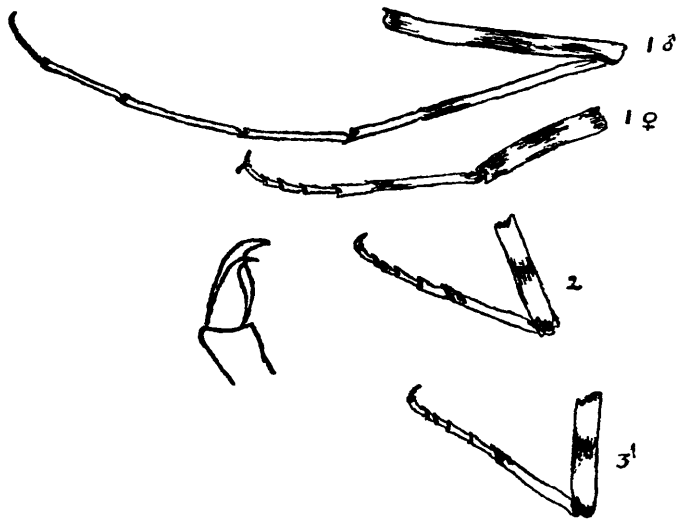


FIG. 67.—*Ameletus flavitinctus*:
Legs of male imago and female forelegs. × 8.

teriorly at each side but nearly straight medianly. Penes flavescent, pointed apically but not so narrow nor so wide as in *A. ornatus*. The legs (Text-Fig. 67) are illustrated and also the wings of the female imago. (Pl. 59, Fig. 17).

Nymph.

The nymph of this species closely resembles that of *A. ornatus*, but it is dark brown in colour and somewhat larger, being about 25 mm., when fully-grown. The abdomen becomes noticeably broader in the middle, before tapering posteriorly and the venter is dingy brown, not white as in *A. ornatus*. The legs have all their segments heavily marked with dark brown.

Besides the locality previously mentioned, I have found this insect in the Whakatiki and Little Wainui Rivers, Wellington district, and in the Gowan River, Nelson district.

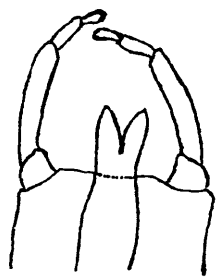


Fig. 68.—*Ameletus flavitinctus*: Genitalia of male imago. × 25.

Genus Ameletopsis, n. g.

One other insect has been included hitherto in the New Zealand *Ameletus* spp. as *A. perscitus*, but for the reasons given below in the description of the species, I have placed it in a new genus.

Tillyard (6) had already suggested that this might have to be done and in a recent private letter suggested *Ameletopsis* as the name he would himself have used had he been able to carry on his work in New Zealand and acted on his tentative opinion that a new genus was necessary.

A comparison of the generic characters of *Ameletopsis* with those of *Ameletus* is also included.

Characters.

Adult—Foreleg of male longer than the body.

Claws mutually dissimilar in each tarsus, the one narrow and pointed, the other broad and blunt.

Tibiae of hinder legs longer than tarsi.

Hind tarsi with four freely-movable segments, the basal one being fused with the tibia.

Eyes of the male approximated.

Median caudal seta rudimentary.

Outer caudal setae of female only half as long as those of male.

Posterior prolongation of the sternum of the ninth abdominal segment of female emarginate at tip.

Claspers of ♂ Genitalia three-segmented.

Cubital and anal veins divergent distally.

Numerous intercalary veins between Cu 1 and Cu 2. (Tillyard notation), many of which are unconnected proximally.

Veins IM forks proximally, the ends running into M 1 and 2 and M 3 and 4.

Veins and cross-veins very numerous and regularly spaced in the forewing.

Veins and cross-veins particularly numerous near the posterior margin of hindwings, forming a network of elongated cells in the area of the tornus.

Costal dilation of hindwing very obtuse.

Nymph—Structure adapted partly for swimming, partly for creeping. Body more or less flattened dorso-ventrally; head in much the same plane as body.

Caudal setae short, sub-equal, fringed with hair on both sides; three in number.

Gills on first seven pairs of abdominal segments, consisting of large, round, entire, single, simple leaflets with central pinnate trachea.

Latero-posterior angles of abdominal segments prolonged backwards as sharp teeth.

Eyes of male unlike those of female.

Legs alike and sub-equal.

Mouthparts strongly developed; canines very long; palps multiarticulate.

Imago—Notae eadem quae Ameleti his exceptis.

Seta media caudae rudimentaria; setae exteriores feminae in longitudine dimidio minores quam maris. Prolatio posterior sterni segmenti noni abdominalis ad extremitatem emarginata.

Venae venulaeque transversae numerosissimae et in a la anteriore ordinatim dispositae.

Prolatio costalis alae posterioris obtusissima.

Larva—Tres setae caudales braves et quasi aequales utrimque capillis fimbriatae.

Paria branchiarum septem; unum quodque folium orbiculatum cum trachea media pinnata.

Anguli exteriores posteriores segmentorum abdominalium retro prolati denticulatique.

Crura similia et subaequalia.

Oris partes maxime dilatatae; dentes canini longissimi; palpi multis articulis.

IMAGINAL CHARACTERS.

Genus AMELETUS.	Genus AMELETOPSIS.
Median caudal seta completely aborted (Eaton, *T.L.S.* 1888, p. 210). Revis. Monog. on Recent Ephem.	Median caudal seta rudimentary.
Outer caudal setae as long as body in both sexes. (Eaton, *op. cit.*, p. 210).	Those of ♀ only half as long as ♂.
Genital forceps four-segmented.	Genital forceps three-segmented.
Posterior prolongation of the sternum of the 9th abdominal segment of ♀ entire at tip. (Needham, p. 25, Key to Genera, Mayflies of N. America, *N.Y.S.M. Bull.* 58).	Emarginate at tip.
Femora with heavy dark bar medianly.	Femora *without* dark median bar.
Tarsal claws alike in each leg.	Tarsal claws dissimilar.
Wings — Intercalaries between A_1 and A_2 of forewing (i.e., Cu_1 and Cu_2, Tillyard's notation) represented by a series of veinlets often sinuous or forking, extending directly from wing margin to Cu_1. (Needham, p. 25, *op. cit.*).	A number of the intercalaries start from the wing margin but do not extend as far as Cu_1.
Vein IM of forewing, unconnected proximally.	Vein IM forks proximally, the branches running into M_1 and $_2$ and M_3 and $_4$.
Cross-veins of ptero-stigmatic region simple.	Cross-veins of ptero-stigmatic region reticulate.
Veins less numerous and more irregularly-spaced.	Veins very numerous and regularly-spaced in the forewing: in the hindwing they are particularly numerous near the posterior margin so that the tornus area appears a network of elongated cells.
Costal dilation of hindwing nearly right-angled. (Eaton, p. 201, *op. cit.*; Needham, p. 25, *op. cit.*).	Costal dilation of hindwing very obtuse.

Note.—The notation of the veins, except where otherwise stated, is that of Tillyard.

Ameletopsis perscitus (Eaton).

IMAGO.

Length (excluding setae)—18 mm.

Head—Light lemon yellow with a burnt-umber area between the eyes and a like-coloured longitudinal median line down frons. Eyes of female, buff; of male, buff below, yellow above. Ocelli, greenish-black.

Thorax—Light yellow with burnt-umber areas dorsally and ventrally.

Abdomen—Ground colour fawn, with burnt-umber median markings on the first nine segments. On each segment the markings resemble a bell, which becomes thinner successively on posterior segments. The ' clapper ' is represented by a light yellow dot on the first seven segments. On the eighth and ninth segments, it is not visible. The tenth has no brown marking, but a rounded median posterior projection. Posterior lateral angles of the ninth segment project backwards markedly, those of the tenth slightly. Venter pale yellow. Claspers (Text-Fig. 77) pale yellow, three-segmented. Penes pale yellow, closer together than in *Ameletus*. Caudal setae flavescent, grey at joinings: outer ones—male, 22 mm.; female, 12.5 mm.: median one—male, 3 mm.; female, 2 mm.

Legs (Text-Fig. 76)—Femora and tibiae lemon yellow, lightly tipped with grey distally: fore-femora slightly darker than the others. Tarsi five-segmented; first four segments flavescent, tipped with grey distally; fifth joint greyish.

Wings—Expansion—male, 33 mm.; female, 40 mm. Surface brilliant yellow: veins black except Sc, R_1 and R_2a, which are flavescent: cross-veins pitch black and very numerous, especially round the wing-margin, those in the ptero-stigmatic region are reticulate. Bullae on Sc. and R_2a.

SUB-IMAGO.

Wings (Pl. 60, Fig. 21)—Semi-opaque, brilliant yellow. There are three greyish blobs, in line longitudinally, in the anterior-distal part of the forewing, the proximal blob being about half way along the wing from wing-base.

The sub-imaginal stage lasts two or three days.

The winged stages appear from the end of December to March.

NYMPH.

The nymph (Pl. 59, Fig. 19) of this mayfly is unique in many respects. Its structure differs so markedly from that of the genus *Ameletus* and moreover from that of the Sub-family to which this genus belongs, that there can be little doubt that it has been incorrectly placed.

Indeed Tillyard (6), in his description of *Ameletus flavitinctus*, states:

> " It seems advisable here to point out that *A. perscitus* Eaton differs very greatly from both *A. ornatus* Eaton and *A. flavitinctus* n. sp. in the shape of its wings, the density and regularity of their cross-

venation, and in the remarkable structure of its large-headed larva. These characters, taken together, suggest that it is not really congeneric with them. Further than this, a study of the three New Zealand species shows that they differ considerably from the genotype, *A. subnotatus* Eaton, from North America, and it appears probable that they may have to be placed in two new genera."

Hitherto, the larva does not appear to have been described, studied and compared with other larvae of the same genus, and the only notes on it are a few lines by Eaton (5), p. 291, and Hudson, *N.Z. Neuroptera,* p. 40.

Needham (8) considers the mayflies to be a single family, and divides them into three sub-families, whereas Lestage (10) ranks them as an order and groups them in five families. However, Needham's sub-family BAETINAE corresponds very closely to Lestage's family BAETIDAE—*not* to be confused with his sub-family BAETINAE, for it is to his sub-family SIPHLURINAE that he assigns the genus *Ameletus.* Needham has no subdivision corresponding to this.

The species under discussion, *A. perscitus,* can be included in Needham's sub-family BAETINAE or alternatively Lestage's family BAETIDAE, but that is as far as we can go. It cannot be included in Lestage's sub-family SIPHLURINAE, to which he assigns the genus *Ameletus,* for this sub-family has the outer caudal setae fringed internally only, whereas *A. perscitus* has them fringed on both sides. It does not agree with his generic characters for *Ameletus,* in that the head is not vertical but horizontal, the external edges of the gills are not toothed or haired but smooth and their ramification is considerable—not little ramified; moreover, the palps are not 3-jointed but multi-articulate: this, by the way, takes it out of Eaton's nymphal groups (p. 317 (4)) on which most of the work of Lestage and Needham is based, and puts it in a group with his unknown Chilian nymph, to which alone the mouth-parts of *A. perscitus* bear some resemblance, but the structure of other parts of these two are totally different.

Needham, also, groups various genera, among which is *Ameletus,* as having the outer caudal setae fringed only on the inner side, and also states that the end of the maxillae are fringed with pectinated hooks. *A. perscitus* does not correspond to this description.

In addition to these differences, the extraordinarily developed mouth-parts and the shape of the head and also, the insect's curious habits are quite unlike those of any species of *Ameletus* and indeed those of any other mayfly nymph.

DESCRIPTION OF NYMPH.

Length—Ca., 2 cm.

Head (Text-Fig. 69)—This is sub-rotund, anteriorly, and extremely large in proportion to the body; the posterior margin is straight. The head of the male is shorter than that of the female.

Antenna—About as long as the head; subulate; flagellum 18-jointed. They are extended outwards in front of the head at an angle of about 45 degrees.

Eyes—female—Brownish-black, oval with longer axis running anteriorly-posteriorly; *male*—sub-rotund, more approximated than in

Fig 71

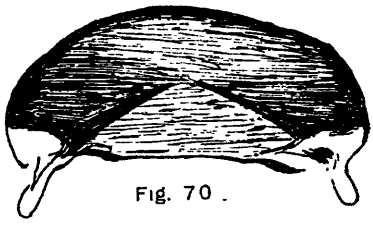


Fig. 70.

Fig. 72

Fig 73

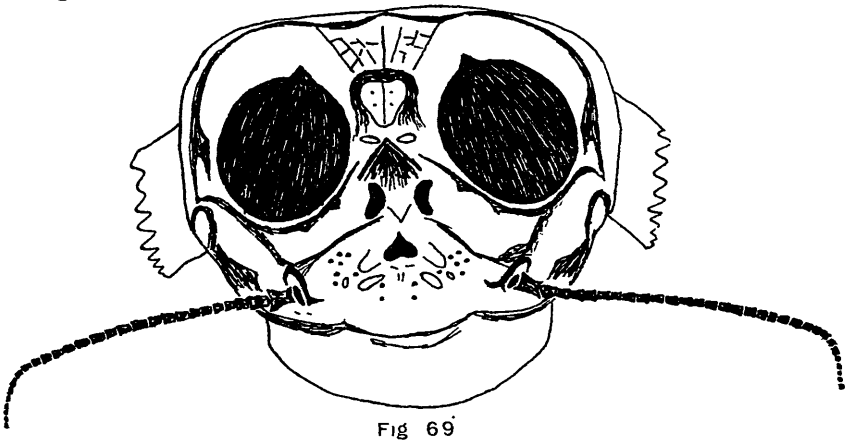


Fig 69

Nymph of *Ameletopsis perscitus.*

FIG. 69.—Head. × 16.
FIG. 70.—Labrum. × 20.
FIG. 71.—Left mandible. × 20.
FIG. 72.—Labium and hypopharynx. × 20.
FIG. 73.—Left maxilla. × 20.

the female, each eye consisting of a green upper and proximal portion and a dark brown lower and distal portion; this latter portion is the larger. Occasionally, the upper portion is light brown, and the lower portion white. Both parts are composed of numerous small facets. In each case, the margin of the outer half is more or less regularly rounded, whereas the curve of that of the inner half becomes a rounded angle medianly; this angle is more pronounced in the upper portion of the eye than in the lower.

Ocelli—Brownish-black; cordate.

Labrum (Text-Fig. 70)—Rounded anteriorly; this margin has a fringe of very short hairs. Umber-brown, glabrous, covered with minute pits on both dorsal and ventral surfaces.

Mandibles (Text-Fig. 71) — The canines are extraordinarily developed and the molar portion seems to be aborted. The armature, which has an inward curve, is as follows: Distally is a heavily-chitinised, unsymmetrical, incurved, bifid fang, of which the outer limb is the longer. Next is a similar somewhat smaller sharp tooth, straight, but sloping inwards and somewhat pyramid-shaped, and finally a lobe with a chitinised, acuminate tip, considerably shorter than the tooth exterior to it. The interior (i.e. proximal) margin of the lobe, as well as both surfaces, is armed with stout, sharp, long, luteous spines. This lobe, with its spines, represents the prostheca.

Maxilla (Text-Fig. 73)—The lacinia terminates in five long, chitinised, incurved, spinose teeth, of which the inside one is smaller than the others. The stipes is dull white, dingy in places and covered with small pits. Palp subulate, light fawn, 15-jointed, the second joint longer and broader than the others (the one illustrated has lost its terminal two joints).

Labium (Text-Fig. 72)—Palps very long and held extended in front of the head; they are 19-jointed, the basal joint being three times as broad and nearly half as long as the flagellum formed of the 18 other joints. Paraglossae broadly falcate, pilose, not quite as broad as the internal lobes. Glossae sparsely haired, sub-quadrangular with their exterior-anterior margins rounded in an arc, the interior ones with only the corners rounded.

Hypopharynx (Text-Fig. 72)—Almost colourless, glabrous, covered with small pits. Superlinguae gently rounded anteriorly and projecting straight forward.

Thorax—Sepia-brown mottled with yellow, with chestnut tinge in the median area. There is a thin light median line. Pro-thorax and meta-thorax short and wide; meso-thorax same width but longer than both combined. Wingpads are comparatively small and coloured dusky olive.

Legs (Text-Fig. 74)—Sub-equal, but the third pair of tibiae is slightly longer than the other two pairs. Pale yellowish-brown, sometimes with greenish tinge, with thick median bars of dark brown on the femora and tibiae and another spreading over the proximal half of the tarsi. Surface glabrous, covered with minute pits. Rows of hair on the ventral side of tarsi and tibiae; Tarsal claws yellow, dilated at base, acuminate but not hooked; not toothed.

Abdomen—dorsal—Each segment (Text-Fig. 75) has a chitinised plate which is sepia-brown, mottled with yellow (as figured) and be-

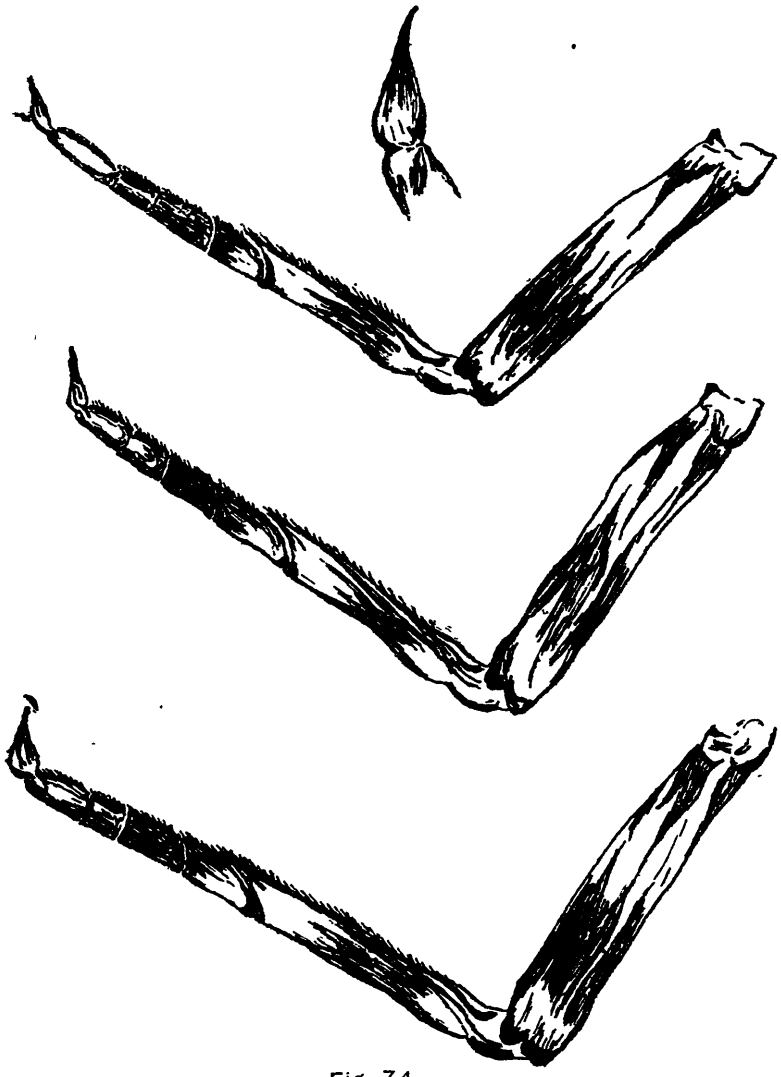


Fig. 74

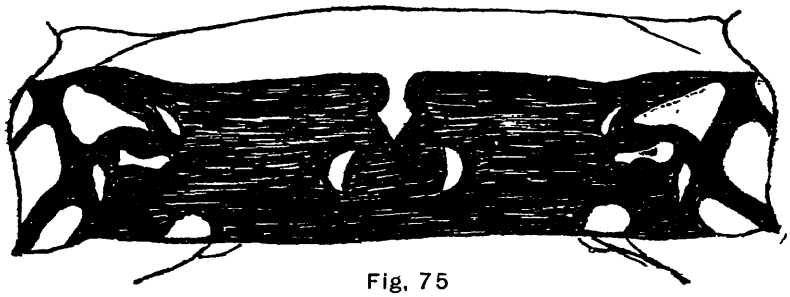


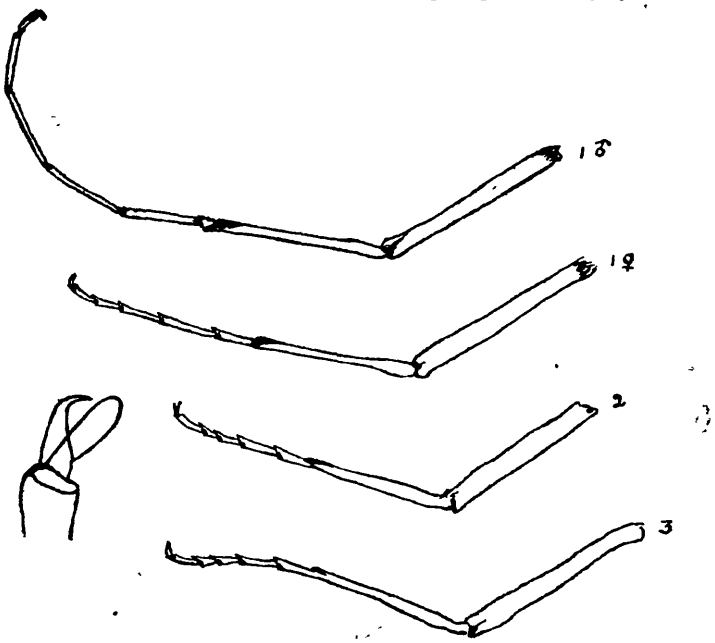
Fig. 75

Nymph of *Ameletopsis perscitus.*

FIG. 74.—Legs. × 20.

FIG. 75.—Dorsum of sixth abdominal segment. × 20.

tween these plates are narrow, non-chitinised strips, which are yellow with a pair of burnt-umber median markings (not shown in segment illustrated). Comparatively wide; the fourth and fifth segments are the widest and from these it tapers posteriorly. The latero-posterior angles of segments are produced backwards into sharp teeth, the angles of the ninth segment being particularly acuminate. The posterior edge of the tenth segment first slopes slightly forward from the exterior angles and then curves more sharply backwards to a median truncation; it carries a row of short and very small spines pointing backwards, as does the posterior edge of the ninth segment, which is concave. The sixth dorsal segment is illustrated. Younger specimens are much paler, the brown being replaced by yellow.



Ameletopsis perscitus.

FIG. 76.—Legs of male imago and female foreleg. ×8.

Ventral—Dingy ochreous, greyish at the edge and becoming darker posteriorly.

Caudal setae—Three short luteous ones, strongly fringed on both sides with hair of a rather lighter shade. The median seta is symmetrically pectinate; the outer ones have the outer hair fringes shorter than the inner ones. Length, 5 mm.

Gills (Pl. 60, Fig. 20)—Seven pairs of very large single leaf-like, rounded gills on the first seven segments of abdomen. Their edges are entire and the anterior edge of each is strengthened with a rib. They are fairly frequently vibrated but held still for considerable periods. The first pair are held upright (edges upwards) over the body, the second pair nearly so; the remaining pairs are held obliquely outwards. The venation is pinnate with a stout central trachea and many branches, frequently much ramified.

I am indebted to Capt. Hayes, of the Marine Department, Wellington, for the drawings of the gills, the first three from a half-grown specimen, the fourth from a full-sized one.

Habits—This nymph is carnivorous, feeding on small specimens of Leptophlebiid nymphs and other organisms.

Though found under stones in rapid water, its favourite haunt is some dark still backwater or a shallow, slowly-flowing portion at the edge of a stream. Here it will lie perfectly still on a stone or in a crevice, except for an occasional movement of the gills, its camouflage colouring making it very difficult to detect. At times, it will walk forward with a gliding motion for a few inches, ' freeze ' for

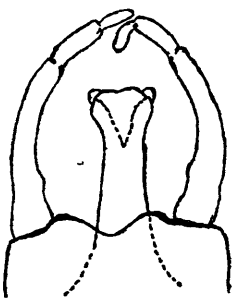


FIG. 77.—*Ameletopsis perscitus.* Male imago, genitalia. × 25.

some seconds, and then move forward again. It has a habit of brushing its mouth-parts with its anterior pair of legs. Another characteristic is its trick of peering cautiously round the edge of a stone and stalking slowly forward.

Though sluggish, when thoroughly disturbed it can move with considerable rapidity, swimming strongly with quick, somewhat jerky movements of its body.

It becomes full-grown from December to March, when it crawls on to a stone above water-level to transform to the sub-imaginal stage.

It occurs throughout the Wellington district, moderately distributed, and I have also found it in Hawkes Bay and in Canterbury.

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