

## AUSTRALIAN EPHEMEROPTERA.

### PART I. TAXONOMY OF NEW SOUTH WALES SPECIES AND EVALUATION OF TAXONOMIC CHARACTERS.

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(One hundred and one Text-figures.)

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### INTRODUCTION.

The Ephemeroptera or mayflies have attracted the attention of entomologists in Europe and America far more than in Australia, perhaps the main reason being the lack in Australia of the large swarms which have compelled notice elsewhere.

Linné first divided the Ephemeroptera into two groups within the genus *Ephemera*, basing the division on the presence or absence of the appendix dorsalis. Further subdivision was based on the presence or absence of hindwings (*Baëtis* and *Cloëon* Leach, 1815) and then on the combination of this and the character used by Linné (*Brachycercus* Curtis and *Caënis* Stephens). Later entomologists divided the order on the basis of cross veins (Burmeister, 1839) and the number of joints in the tarsi, and in 1843 Pictet based a scheme on venation and the condition of the eyes.

Eaton published the first monograph in 1871, upon which all later classification has been based; it is in this monograph that the first Australian species are described apart from two isolated descriptions—*Atalophlebia costalis* Burm. and *Atalophlebia australasica* Pict.

In his second monograph, "Monograph of Recent Ephemeridae" (1883-1888), Eaton described seven Australian species. Seventeen species are mentioned by Ulmer (1916) in his results of Dr. Mjöberg's Scientific Expedition, which collected mainly in Queensland.

No further work was published until Tillyard (1933) described the mayflies of the Mount Kosciusko region, which he followed with a redescription of the genotype of *Atalophlebia* and later listed thirteen Australian species from Tasmania (1935).

Phillips (1930) in describing the New Zealand Ephemeroptera has clarified the position of several genera which are represented in both Australia and New Zealand.

#### TAXONOMY.

##### EVALUATION OF TAXONOMIC CHARACTERS.

Many of the characters on which the classification of Australian Ephemeroptera has been based seem unsatisfactory. An evaluation of these characters is therefore made, being based on long series of specimens. Definition of terms used is given where it is thought necessary, otherwise all terminology is taken from Snodgrass (1935).

*Head.* The head is of the usual insect form, but the extraordinary reduction of the mouth parts and their accompanying musculature leaves a shelf-like projection above the space where the mouth parts would normally be. The nasal carina (a longitudinal ridge on the shelf in front of the middle ocellus) varies in size, as does the shelf itself, but it varies to a certain extent within a species.

The antennae are reduced, with an almost vestigial flagellum; the scape is usually short and stout, and the pedicel varies in length and form, being reduced in *Atalophlebia* and very stout in *Caënis*.

The compound eyes show a great range in size and form, those of the male being larger than the female in all described Australian species. The males of some species show subdivision of the eyes, the upper region being larger and lighter in colour than the lower. The extreme development is seen in *Baëtidae*, where "turban eyes" are present, the upper division being pedunculate on the lower. This development may have evolved from the habit of mating in the air, and the consequent necessity for the male to see the female above (Needham, Traver and Hsu, 1935).

Three ocelli are present, varying in size with sex to a certain extent. The middle ocellus tends to atrophy, while the spatial relations of all three vary generically. For example, they lie far apart in *Caënis*, close together in *Baëtis*, and become ascalophoid in *Atalophlebia*.

*Thorax.* The mesothorax is the largest division of the thorax, being itself subdivided into the antecosta, prescutum, scutum, scutellum and postscutellum (Needham, Traver and Hsu, 1935).

The morphology of the thorax has been little used as a taxonomic character, except for occasional reference to location of colour markings. But, although the colour and marking of the thorax are a useful guide in most cases, a good deal of variation occurs and the colour marking for any species described must not be followed as a rigid limit.

*Abdomen.* This consists of ten segments with paired genital openings and specialized genitalia pertaining to the ninth segment of the male. In the male the sternum bears the articulated styliger plate (forceps base), which in turn bears the forceps or appendicular clasping organs, each forcep consisting of two parts, the distal stylus (usually this alone is known as the forcep), and the basal coxopodite. There is evidence that the styliger plate is formed by the union of the median part of the sternum with the coxopodite, and the separation of this from the rest of the sternum (Snodgrass, 1935).

The styli themselves are commonly jointed, usually into three segments, but some show two or four, and those of *Caënis* are unjointed.

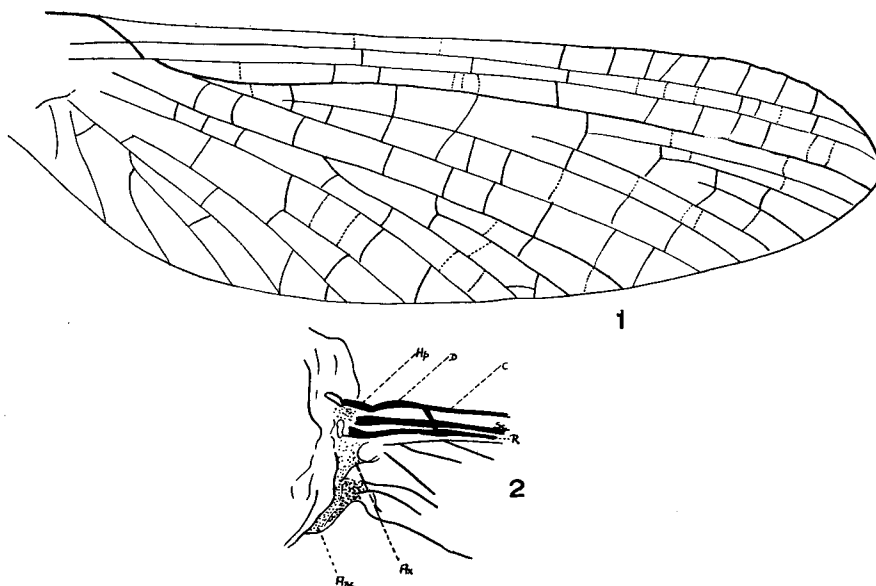
The basal part of the stylus can be easily confused with the coxopodite in some cases—the only way of determining the stylus is to trace the origin of the stylus muscles, which always arise in the coxopodite (Snodgrass, 1935). Many authors have not taken this into account, but it is urged that where the segmentation of the forceps is taken as a taxonomic character the correct evaluation of the styli should be recognized.

The penes are primitively two tubular processes, but usually are found to be united basally to some degree, and on the penes appendages are common and are chitinous and usually backwardly directed.

The genitalia are probably one of the most constant of characters, and therefore one of the most important; owing to the large number of descriptions from either pinned specimens or specimens in which the genitalia could not be adequately examined there has been insufficient use of the genitalia as a taxonomic character.

In the female the sternum of the ninth segment is extended backward, and although it varies in shape considerably it is fairly constant within a species.

*The Caudal Filaments.* These are two, or three, in number. The two lateral cerci are always present, but the appendix dorsalis may be present and equal in length to the cerci or be in various stages of abortion to complete absence. The presence or absence of the appendix dorsalis has been deemed more important than is warranted, as there is one case at least where it is absent in some specimens and present in others (*Atalophlebia australis*), yet it is a useful guide to species as long as the fact that it is only a guide is kept in mind.



Text-figures 1-2. *Atalophlebia parva*.

1, right and left forewings superimposed, cross-veins which appear in only one wing are dotted; 2, wing base, Ax axillary region, AxC axillary cord, D intermediary plate, HP humeral plate.

The lateral margins of the abdomen may show remarkable lateral extensions which are usually directed posteriorly; this is of most constant occurrence in Siphonuridae, but the shape of the lateral margins varies considerably in the Leptophlebiidae, and is important taxonomically.

*Legs.* All the legs are weak and in many genera are completely useless for walking, but they are nevertheless highly differentiated. The forelegs are most specialized, differing from the middle and hind pair, and in the male they are usually considerably lengthened and hold the female in copulation—the tarsi being turned backward for this purpose as the male approaches the female from underneath.

The relative proportions of the tibia and tarsus have been used by some authors and seem to be a constant character if kept to a reasonable comparison, that is a relative length comparison; this has been used as a generic characteristic by Tillyard in the Siphonuridae.

The tendency for fusion of the first tarsal joint with the tibia is of importance taxonomically, the fusion taking place most frequently in the hind leg, so that it is usually the hind leg which is used in comparisons. The relative proportions of the tarsal joints is another character used by Tillyard, but the variation found within a series of specimens was such that it is not used in this paper. The claws of the pair on each tarsus may be similar in form, both being hooked at the tip, or one may be blunt and flattened, or even both may take this latter form.

Specimens have been captured, and also bred in the laboratory, in which legs have been regenerated in the late nymphal stages and show varying degrees of reduction in the imago. When both legs have been damaged there is no indication that this has occurred. Thus, as damage to the nymphal appendages is not infrequent, discretion should be used in the comparison of measurements.

*Wings.* The terms applied to venation are those interpreted by Tillyard (1932). Table 1 shows systems used by other authors in specific descriptions.

TABLE I.

	TILLYARD 1932 AND THIS PAPER	NEEDHAM AND TRAVER 1935	TILLYARD 1926	TILLYARD 1923	MORGAN 1912	COMSTOCK AND NEEDHAM 1912	EATON 1883 (NUMBERS)	EATON 1883 (NAMES)	NEEDHAM AND MURPHY 1924
	C +	C	C	C	C	C	1	COSTA	C
	Sc -	Sc	Sc	Sc	Sc	Sc	2	SUBCOSTA	Sc
	R1 +	R1	R1	R1	R1	R1	3	RADIUS	R
	R2 -	R2	R2	R2a	M1	R2	—	BRANCHES OF SECTOR	M1
	R2 +	—	R2	2R2a	RS2	—	—		—
	R3a +	—	R3a	—	—	—	—		—
	R3b -	—	R3b	4R2a	—	—	—		—
	R3b +	—	R3b	SR2a	RS	R3	—	—	—
	—	—	—	—	INTERPOLATED VEIN 1.	R4	4	—	M2
	R4 + S	R3	R4 + S	R3	M2	RS	5	CUBITUS	—
	MA1 +	R4	MA1	R4a	M3	M1	6	PRAEARACHIAL	M3
	IMA -	O1	IWA	R4b	—	M2	—	—	—
	MA2 +	R5	MA -	R5	M4	M3	6	POBRACHIAL	M4
	MP1 -	M1	MP1	M1	Cu1	Cu1	7	—	Cu1
	IMP +	—	IMP	M2	INTERPOLATED VEIN 2	—	—	—	—
	MP2 -	M2	MP2	M3 + 4	Cu2	Cu2	7	—	—
	CuA1 +	Cu1	Cu1a	Cu1a	1A	1A	8	ANAL	A1
	ICuA -	—	ICu1	Cu1b	1A	1A	—	—	A2
	CuA2 +	Cu2	Cu1b	Cu1c	1A	1A	8	—	—
	CuP -	1A	Cu2	Cu2	2A	2A	9	—	—
	A1 -	1A	1A	1A	3A	3A	9	—	—
	1A +	—	2A	2A	3A	3A	9	—	—
	A2 +	—	3A	3A	3A	3A	9	—	—
	A3, A4 + (AXILLARIES)	—	—	—	—	—	—	—	—
AUTHORS FOLLOWING THIS SYSTEM						NEEDHAM (BEFORE 1932) MADDOUGH LESTAGE ULMER PHILLIPS			

The cross vein system has frequently, and incorrectly, been referred to as constant. Text-fig. 1 shows the right and left wings of one specimen superimposed, those cross veins which appear on only one wing being dotted; this reveals such a variation even in the same specimen that the use of cross veins as a diagnostic character is rejected.

Marginal veinlets between the longitudinal veins may be present, and the number of these is a distinct generic character. The wing base (Text-fig. 2) is unusual, the Ephemeroptera holding the wings vertical at rest and not flexing them as do most insects. At the base of each wing is a humeral plate between the costal vein and the tergite, the posterior part of the wing base is continuous with the posterior margin of the tergum, but the weak sclerites in the axillary region seem to have some homology with those of other insects.

The shading of the wing and its coloration are of value and are usually considered constant, at least in the subimago; however, the effect of physiological variation within the animal, particularly in the larva, alters the relative amount of pigmentation of the cuticle, and this may result in an effect on the wing shading.

The hindwing is of more importance in some respects than the forewing, particularly in reference to the shape of the anterior margin, which appears to be constant. The presence or absence of the hindwing is in some families used for generic segregations.

#### NYPH.

The nymphal characters can be used with possible advantage over those of the adult, as it is probably in the former stage that specific divergence occurs.

*Head.* The shape of the head varies considerably, and in its extremes is used to characterize families. The shape of the head is associated with the type of habitat and the habits of the larva. The position of the eyes varies with the shape of the head, being dorsal in *Atalophlebia*, which have flattened heads, and lateral in Siphonuridae, with hypognathous heads. The colour of the eyes is fairly constant and has at times a taxonomic significance; in the male the eyes become divided in the late instars. The antennae vary in diameter and in length, but they are so easily broken that little significance should be attached to them.

*Mouth Parts.* The labrum is present in all Australian forms so far described; it takes the form of a transverse, more or less rectangular plate with spines and hairs variously disposed over the surface, and the anterior edge varies in shape considerably and is often of specific importance.

The mandibles are divided into two distinct areas: the canine and molar areas. The canine area in particular has often been credited with taxonomic significance, but the variation in a series is extreme, and the development also varies considerably with the stage of development of the nymph. Between the canine and molar areas arises the prostheca (otherwise known as lacinia mobilis, mandibular palp, or mandibular endopodite); this varies between a large structure bearing a brush of hairs to a minute hairless spine.

The maxillae have a separate cardo and stipes, but the galea and lacinia are fused lengthwise and their fused "plate" often ends in a tooth or hook, or more often in a thick brush of hairs below which is a row of pectinate "rakes". The maxillary palp is modified in various ways; it is probable that the primitive form is three-segmented and covered with hairs, but these segments may be reduced to two or may be greater than three (fifteen in *Ameletopsis*), and any of the segments may lose their sensory hairs.

The labium is of primitive form and the palpal segments may differ in relative length and the form of the paraglossa is often a specific variant.

*Thorax.* The variation in the thorax appears to depend largely on the habitat; probably the variation is a function of the muscular development. The colour and markings are useful characters, but the same precautions must be taken as with the use of colour in the adult.

*Legs.* The legs vary greatly with habit. In forms which live in swift-flowing streams the front femora are often greatly thickened, and in other forms which flatten themselves against rocks the legs are flattened with the femora broad and the tibiae slender. All the legs bear a one-jointed tarsus with a single claw, which varies greatly in form.

*Gills.* Abdominal gills occur only on segments one to seven, being present on the dorsal side of the lateral margin, and their number and disposition are of considerable importance. The two principal types are lamelliform or plate-like and filiform or threadlike; one pair of gills may become enlarged to cover the others—this is a modification found in forms frequenting silty waters and creeks which partially dry up in summer.

From this discussion of the various parts of the insect it appears that very few characters are stable enough to be used as primary taxonomic characters; however, it is not by single characters that species are separated, but rather by combinations which only become recognizable when a long series of specimens is examined.

#### TYPES.

All type specimens have been deposited in the Australian Museum, Sydney, and paratypes are being deposited in the British Museum. Wherever possible, for each species a holotype (the male imago), allotype (female imago), morphotype (male sub-imago), allomorphotype (female sub-imago), and a nymphal morphotype have been selected. The terminology used is that defined by Davis and Lee (1944).

Tillyard has described several species for which the type specimens have not been able to be traced in any Australian Museum, the Commonwealth Scientific and Industrial Research Organization Entomological Branch, or the British Museum. It has not been found possible to recognize these species from the descriptions.

#### METHOD OF DESCRIPTION.

As text-figures are a clearer guide than verbal descriptions, the latter have been abbreviated.

*Measurements.* All measurements have been made from a series of a minimum of twenty specimens, unless otherwise stated. The measurement given is the average of these figures, and the range of the measurements is given in brackets.

*General Colour.* This has been ascertained by naked eye, being the general colour impression given by the mayfly.

*Wings.* Where the cross venation varies the text-figure shows the maximum number.

*Life Cycle.* Wherever possible, the imagines, subimagines and nymphs have been connected by breeding them from the nymphal stage; as a further check, it having been found that on no occasion has the egg differed in the late nymphal stage from that of the imago or subimago, the relationship of these stages has been shown by the eggs.

*Specimens Examined.* These have all been collected by the author unless otherwise stated.

*Text-figures.* These have all been drawn with the aid of a camera lucida.

*Females, Subimagines.* Where the male imago has been described in detail the following descriptions of other forms only give details in which they differ from the male.

#### KEY TO THE EPHEMEROPTERA OF NEW SOUTH WALES.

Families suspected or known to be present, but not actually described, are included in this key.

#### IMAGINES.

##### Superfamilies.

1. In forewing veins MP and CuA strongly divergent at base.  $MP_2$  strongly bent towards CuA basally. Hind tarsi with four movable joints or less; if a fifth is present it is immovably united to tibia ..... S.F. EPHEMEROIDEA.
- In forewing veins MP and CuA parallel at base or weakly divergent. Fork of MP nearly symmetrical ..... 2.
2. Hind tarsi with four movable joints, if a fifth is present it is immovably united to tibia ..... S.F. BAETOIDEA.
- Hind tarsi with five freely movable joints ..... S.F. HEPTAGENOIDEA.

[*Atopopus spadix*, sp. nov.]

##### Superfamily BAETOIDEA.

1. Forewing with tornus from two-fifths to half the length of the wing from the base, CuA nearly straight, with a descending series of pectinate branches. CuP curved concavely to CuA ..... SIPHLONURIDAE.
- Forewing with tornus at not more than one-quarter of wing length from base. CuP sigmoidly curved ..... 2.
2. In the forewing MA clearly forked ..... 3.
- In the forewing MA not forked, although behind it are two free veins which are not attached at base. Usually few cross veins. Hindwing small and narrow, sometimes absent, with at most 2 or 3 longitudinal veins ..... BAETIDAE.

3. Wings milky or infuscated, ciliate on hind margin. Hind wings absent, but may be occasionally present in subimago. No unattached intercalaries, frequently only few cross veins ..... CAENIDAE.
- Wings hyaline, hind wings nearly always present, wings with numerous cross veins .... 4.
4. In forewing CuP usually widely separated at base from CuA, but lying close to A<sub>1</sub>. No unattached intercalated veins between media and cubitus ..... LEPTOPHLEBIDAE.
- CuP in forewing approximating at base to CuA, but widely separated from A<sub>1</sub>. Several, usually two, unattached intercalated veins between media and cubitus, and also in front of the posterior branch of the media ..... EPHEMERELLIDAE.

## Family BAETIDAE.

1. Hind wing present, forewing small with marginal veinlets in sets of two or more .... *Baëtis*.
2. Hind wing absent, forewing with marginal veinlets single ..... *Cloëon*.  
[*Cloëon fluviatile* Ulm.]

## Family CAENIDAE (BRACHYCEROIDAE Lestage).

1. Wings not exceptionally broad, ratio of length to breadth approximately 3:1 ..... *Tasmanocoenis*.
2. Wings exceptionally broad near base, ratio of length to breadth 2:1 or less ..... *Caenis*.  
[*Caenis scotti* Till.]

Genus *Baëtis*.

1. Costal angulation of hindwing acute ..... *B. baddamsae*, sp. nov.
- Costal angulation of hindwing not acute ..... *B. confluens*, sp. nov.

## Family LEPTOPHLEBIDAE.

1. Tarsal claws all narrow and uncinat ..... 2.
- Of every pair of tarsal claws one broad and obtuse, the other narrow and uncinat .... 3.
2. Hindwing more or less obtusely subovate ..... *Atalophlebia*.
- Hindwing oblong, oblique; its marginal area abbreviated and relatively very broad ..... *Adenophlebia*.
3. Hindwing obtusely ovate or oval; its marginal area narrow throughout and extended .. 4.
- Hindwing strongly angulated in front; its marginal area narrow throughout and far extended ..... *Thraulius*.
4. Appendix dorsalis much shorter than caudal filaments ..... *Blasturus*.
- Appendix dorsalis equal to the caudal filaments ..... 5.
5. Penes separated almost to base; a long flap-like appendage, narrowed distally, is attached near apex of each and extends inwards between lobes of penes ..... *Leptophlebia*.  
[*L. crassa*, sp. nov.]
- Penes without flap-like appendage ..... *Deleatidium*.  
[*D. annulatum*, sp. nov.]

## Genus ATALOPHLEBIA.

## IMAGINES.

1. Forewing less than 8.0 mm. in length ..... 2.
  - Forewing more than 8.0 mm. in length ..... 3.
  2. No cross veins present in basal region of C-Sc area ..... *A. parva*, sp. nov.
  - Cross veins present in basal region of C-Sc ..... *A. marowana*, sp. nov.
  3. Sculpturing on the egg reticulate without any other marking being present ..... *A. albiterminata* Till.
  - Not as above ..... 4.
  4. Sculpturing on egg reticulate with circular markings at the angles of the "cellular lines" ..... *A. longicaudata*, sp. nov.
  - Sculpturing reticulate with raised circular areas also present ..... *A. incerta*, sp. nov.
- Female imago *A. maculosa* unknown.

The male imagines cannot be satisfactorily differentiated except on the genitalia (Text-figs. 19-27).

## SUBIMAGINES.

1. Forewing mottled ..... 3.
  - Forewing uniformly grey ..... 2.
  2. Cross veins absent in basal region C-Sc area ..... *A. parva*, sp. nov.
  - Cross veins present in basal region C-Sc area ..... *A. marowana*, sp. nov.
  3. Lambda mark almost complete ..... *A. incerta*, sp. nov.
  - Lambda mark incomplete ..... 4.
  4. Forewing darkly blotched, whole wing darkly shaded ..... *A. longicaudata*, sp. nov.
  - Forewing not so heavily shaded, little shading of cells ..... *A. albiterminata* Till.
- Subimago of *A. maculosa* unknown.

## Family SIPHLONURIDAE.

1. MP<sub>2</sub> and IMP attached basally to CuA. Tarsal claws alike. Costal angulation of hindwing near base, slight ..... *Ameletoides* Till.
- MP<sub>2</sub> and IMP normal in forewing of every pair of tarsal claws, one blunt and one acute ..... 2.

2. Tarsi four segmented ..... *Tasmanophlebia* Till.  
 Tarsi five segmented ..... *Coloburiscus* Eat.

## NYMPHS.

## Superfamilies.

1. Mandible with an external tusk projecting forward ..... S.F. EPHEMEROIDEA.  
 Mandibles without such a tusk ..... 2.  
 2. Head strongly depressed. Eyes dorsal. Upper member of each gill pair plate-like ..... S.F. HEPTAGENOIDEA.  
 Head not strongly depressed. Eyes lateral ..... S.F. BAETOIDEA.

## Superfamily BAETOIDEA.

1. Caudal filaments fringed on both sides ..... 2.  
 Caudal filaments fringed on inner border only ..... 3.  
 2. Seven pairs of gills inserted laterally at sides of abdomen, sometimes all filamentous or first pair reduced and others leaf-like ..... LEPTOPHLEBIIDAE.  
 Five or six pairs of gills, first pair very small, second enlarged, covering the following pairs, which bear a long fringe ..... CAENIDAE.  
 3. Body cylindrical, head bent downwards, hind corners of abdominal segments not produced ..... BAETIDAE.  
 Body more or less flattened, head held horizontally or nearly so, hind corners of abdominal segments produced backwards ..... SIPHLONURIDAE.

## Family BAETIDAE.

1. Gills—lamellae double on abdominal segments 1-6 ..... *Cloëon*.  
 2. Gills—lamellae single on all abdominal segments ..... *Baëtis*.

## Family LEPTOPHLEBIIDAE.

1. Gills single ..... *Dekatidium*.  
 Gills double ..... 2.  
 2. Gills on abdominal segment 1 deeply forked with slender linear divisions, on other segments oval, lamelliform and fringed around the entire margin ..... *Thraulius*.  
 Not as above ..... 3.  
 3. Gills lanceolate with narrowed tail-like tip. Lateral spines on abdominal segments 8 and 9 ..... *Leptophlebia*.  
 Gills either lanceolate or digitate, spines usually on abdominal segments 2 and 9 ..... *Atalophlebia*.

Genus *Atalophlebia*.

1. Gills digitate ..... 2.  
 Gills lanceolate ..... *A. parva*, sp. nov.  
 2. Gills multidigitate; 7-15 filaments ..... *A. albiterminata* Till.  
 Gills trifurcate ..... *A. incerta*, sp. nov.

## Family SIPHLONURIDAE.

1. Thorax humped, very broad. Gills deeply bifid ..... *Coloburiscus* Eat.  
 Thorax not humped. Gills lamellate ..... 2.  
 2. Dorso-ventrally flattened. Gills carried dorsally on abdominal segments ..... *Tasmanophlebia* Till.  
 Nymphs slightly laterally flattened. Gills carried laterally ..... *Ameletoides* Till.

## DESCRIPTIONS OF SPECIES.

## Genus ATALOPHLEBIA Eaton.

*Synonymy*: *Atalonella*\* Needham and Murphy, Bull. Lloyd Libr., 24, 4, 1924.

*Genotype*: *A. australis* Walk.

*Imago*.

"Hindwing in front somewhat arched, the summit of the arch obtusely sub-angular, situated usually before the middle of the curve; sub-costa strongly arched, meeting the margin very obliquely; radius usually nearly straight, constituting as it were the chord of the arc described jointly by the sub-costa and the portion of the margin included between its extremity and the radius; hence while the narrow marginal area is broadest at its base and acuminate at its termination, the sub-marginal area is broadest at the middle or a little before the middle, and tapers gradually to its oblique apex. Cross veins abundant in the forewing, those in the marginal area before the bulla well defined. At the terminal margin the longitudinal nervures are provided with curved simple branchlets and there are no isolated veinlets. The two intercalar nerves

\* See Appendix I, p. 30.



of anal-axillar interspace of the forewing have simple branchlets, and usually the hinder one, close to its proximal extremity, curves forward to unite with the other, which simply curves forwards to join the anal nervure . . . . Tarsal ungues all nearly alike, small, narrow and hooked at the tip . . . . Forcep limbs of male 3 jointed." (Eaton, 1881.)

#### *Nymph.*

Body flattened dorso-ventrally.

*Head:* The eyes are lateral and antennae long.

*Mouth Parts:* Both the maxillary and labial palps are three-segmented. The labium is notched medio-anteriorly and the maxillae bear a broad brush of terminal hairs.

*Legs:* The claws are all toothed.

*Caudal Filaments:* These bear short hairs at the intersegmental regions.

*Gills:* Paired and lanceolate or lamelliform gills are borne on the first seven abdominal segments.

#### ATALOPHLEBIA LONGICAUDATA, SP. NOV.

*Holotype* ♂, Tenterfield, 2,831', 10:1948.

*Allotype* ♀, Pine Forest, Armidale, 3,300', 9:1948.

*Morphotype* Subimago, Marowan Cr., Glen Innes, 3,520', 10:1948.

*Paratype, Alloparatype, Morphoparatype*, Marowan Cr., Glen Innes, 3,520', 10:1948.

#### DESCRIPTION.

##### *Male Imago.*

*Measurements:* Body length, 17 mm. (15-18 mm.). Cerci, 30 mm. (28-31 mm.). Appendix dorsalis, 20 mm. (16-32 mm.). Forewing, 16 mm. (14-17 mm.). Hindwing, 3.5 mm. (3.0-4.0 mm.).

*General Colour:* Black with lighter markings and with a distinct white line running beside the prescutoscutal suture.

*Head:* The head is black with ill-defined lighter markings, and bears antennae with black pedicels and dark brown flagellae. The lower lobes of the eyes are slightly darker than the dull orange-brown upper lobes and the ocelli are white with black bases.

*Thorax:* This is black with light markings and white outlines to the prescutoscutal sutures.

*Abdomen:* The abdomen is brown-yellow with dark brown markings, and in some specimens there is a white posterior edge to the last three segments.

*Wings:* In the forewing the pterostigma is shaded brown, all the veins are black, and the cross veins in the C and Sc area are shaded (Text-fig. 39). In the hindwing all the veins are opaque and colourless except those in the C-Sc region, which are brown.

*Legs:* The legs are yellow-brown with dark brown markings. The fore-femora bear one or two longitudinal brown markings, but the hind-femora darkens only at its proximal end, as do all the tibiae. The tarsal claws are all narrow and uncinat.

*Genitalia* (Text-fig. 20): The forceps are brown with lighter distal joints and the penes are uniformly brown.

*Caudal Filaments:* These are black, or in some specimens lighter towards the distal end, the tip ranging from white to a colour not appreciably different from that of the base. The cerci are longer and stouter than the appendix dorsalis.

##### *Female Imago.*

*Measurements:* Body length, 15 mm. (11.0-18.0 mm.). Cerci, 20 mm. (18-22 mm.). Appendix dorsalis, 13 mm. (11.0-15.0 mm.). Forewing, 14 mm. (11.0-17.0 mm.). Hindwing, 3.8 mm. (3.0-5.0 mm.).

*Egg* (Text-fig. 36): These shows a sculpturing of pentagonal figures with circular markings at the angles of each pentagon.

##### *Male Subimago.*

*Measurements:* Body length, 15.5 mm. (10.5-18.5 mm.). Cerci, 19.0 mm. (17.0-21.0 mm.). Appendix dorsalis, 13.0 mm. (12.0-18.0 mm.). Forewing, 15.0 mm. (11.0-18.0 mm.). Hindwing, 4.0 mm. (3.5-5.0 mm.).

*General Colour:* Yellow-brown with dark brown markings.

*Head:* The head is yellow-brown with dark brown markings, and bears yellow-brown antennae which are slightly lighter at the tips. The upper lobes of the eyes are yellow-brown and the lower dark brown to black. The ocelli are yellowish, and the lateral ones in particular are very prominent.

*Thorax:* The thorax is dark brown with light brown markings and a white or purplish tinge at the wing base.

*Abdomen:* This is yellow-brown with dark markings on either side of the median line, and the posterior edge of each segment is outlined with brown. The lateral margins of each segment come to a point at about two-thirds of their length, which gives the appearance of a serrated edge to the whole abdomen.

*Wings* (Text-fig. 38): The wings are creamy with dull brown irregular shadings and shading on all the cross veins, although the longitudinal veins are opaque and nearly colourless.

*Female subimago* (Text-fig. 7).

*Nymph unknown.*

*Specimens Examined.*

*Imago.* Serpentine R., Point Lookout, 4,000', 10:1948; Dumaresque Cr., Armidale, 3,000', 11:1948, 9:1948, 10:1948; Pine Forest Cr., Armidale, 3,000', 9:1948; Marowan Cr., Glen Innes, 3,520', 10:1948; Tenterfield, 2,831', 10:1948; Badga, 3,000', 12:1939, H. M. Stephens; Solitary Cr., Tarana, 4:1941, E. Garret; Mienna, Tas., 3,300', 12:1928; Shoalhaven R., 2,500', 12:1929, H. M. Stephens; Bolaro, 3,400', 12:1928, H. M. Stephens.

*Biology.*

This species has only been found in the vicinity of flowing streams, over which it flies in a characteristic manner. This flight covers about two hundred yards and consists of a gliding motion in the downstream direction and a rapid dart upstream. In the downstream flight both males and females trail their caudal filaments in the water and are made conspicuous by the habit of holding the filaments at right angles to the body.

ATALOPHLEBIA ALBITERMINATA Till.

Proc. Roy. Soc. Tasmania, 1935.

*Holotype* ♂, Lake Echo, Tasmania, 2:1933, Tillyard.

*Allotype* ♀, *Morphotypes* Subimagines and Nymphs, Lake Echo, Tasmania, 2:1933, Tillyard.

*Note.*—It has not been possible to trace any of these types, so a neotype has been selected. The neotype is not, however, topotypical, as no further specimens have been collected from Lake Echo to my knowledge.

*Neotype* ♀, Marowan Cr., Glen Innes, 3,520', 9:1947.

DESCRIPTION.

To the original description by Tillyard the following features are added.

*Male Imago.*

No male imagines have been collected by the author, but pinned specimens are present in the Australian Museum collection. As these pinned specimens are useless for an adequate description only measurements are given.

*Measurements:* Body length, 16.5 mm. Cerci, 39 mm. Appendix dorsalis, absent. Forewing, 15 mm. Hindwing, 3 mm. Foreleg, 3.0, 3.6, 6.0 mm. Hindleg, 3.6, 7.5, 3.0 mm.

*Female Imago* (Text-fig. 3).

*Measurements:* Body length, 15 mm. Cerci, 11 mm. (10–15 mm.). Appendix dorsalis, 11 mm. (10–15 mm.). Forewing, 15 mm. (13–17 mm.). Hindwing, 4.0 mm. (3.5–4.5 mm.). Foreleg, 2.5, 2.4, 2.0 mm. Hindleg, 3.0, 2.0, 2.0 mm.

*General Colour:* Dark brown.

*Head:* Dark brown with yellow markings, and grey-brown eyes and grey ocelli.

*Thorax:* This is yellow-brown with dark brown markings.

*Abdomen:* The abdomen is yellow-brown with very distinct dark brown markings.

*Wings* (Text-fig. 40): The wings are hyaline except in the costal and subcostal area of the forewing, which is brown with darkly shaded cross veins; all the venation is black.

*Legs*: The hindlegs are lighter than the dark brown forelegs, and their tarsi are almost white.

*Cerci*: These are dark coloured, but in some specimens may end in a white tip.

*Egg*: The eggs show a hexagonal sculpturing and are laid in a gelatinous substance which dissolves as it passes through water.

#### *Female Subimago.*

*General Colour*: Yellow with distinct brown markings.

*Head*: The head is yellow with brown markings, black eyes, and white ocelli borne on black bases.

*Thorax*: This is yellow with dark brown to black markings.

*Wings* (Text-fig. 41): The wings are yellowish with black veins and have all cross veins shaded dull grey. In the hindwings Sc reaches almost to the apex, Rs is forked and arises about half-way along MA, and MP is forked and an intercalary is present.

*Caudal Filaments*: These are dark brown with black annulations and a broad black band at the end of each fourth segment.

#### *Nymph.*

*Measurements*: Body length, 10–16 mm.

*General Colour*: This varies considerably with the environment, more so than in any other nymph known to the author; generally it is dark brown, grey, greenish brown or pale cream.

*Head*: This is cream or light brown with brown markings, and the antennae are approximately one and a half times as long as the head and thorax, with the basal segment light brown, and the following segments transparent. The eyes are brown or black.

*Mouth Parts* (Text-figs. 64–66): The labrum has a median incision on its anterior border which bears five to seven flat, dentate processes; recurving spines are also present on this border and bend in towards the central line; posterior to these is another row without recurving tips. On the lateral angles spines are present and directed at an angle following the curve of the labrum. In the mandibles the outer canines have three or four teeth and the inner two, the prosthecas are sigmoid in shape with a brush of well-developed, inwardly directed hairs. The molar surfaces are well developed with 10–13 parallel serrated ridges, and a few scattered hairs are present on the outer surface of the mandible. The maxillae bear three-segmented palps, of which the middle segments bear spines on the inner surface and the apical segments are covered with hairs on the outer surface. A row of pectinate "rakes" is present below the brush of terminal hairs on the plate. The labium bears three-segmented yellow palps of which the first segments carry hairs, but the second are practically bare. The paraglossae have hairs present on the anterior edge and the glossae, which are rectangular with rounded corners, bear a dark patch lengthwise in a central position and very few hairs, those which are present being mainly on the basal surface. A single row of spines is present close to the distal end of the glossae.

*Legs*: Creamish-yellow, and on the inner surface of the tibia there are rows of branched hairs.

*Gills*: These are double and present on the first seven abdominal segments, decreasing in size posteriorly.

#### *Biology.*

The nymphs live among debris and clinging to the bottom of rocks in running streams, frequently in the more sluggish parts. The early instar nymphs often lie partially buried among the sand or debris of the bottom, while the older nymphs run backwards and sideways with great agility seeking shelter in crevices rather than swimming.

*Specimens Examined.*

*Imagines.* Marowan Cr., Glen Innes, 3,520', 9:1947.

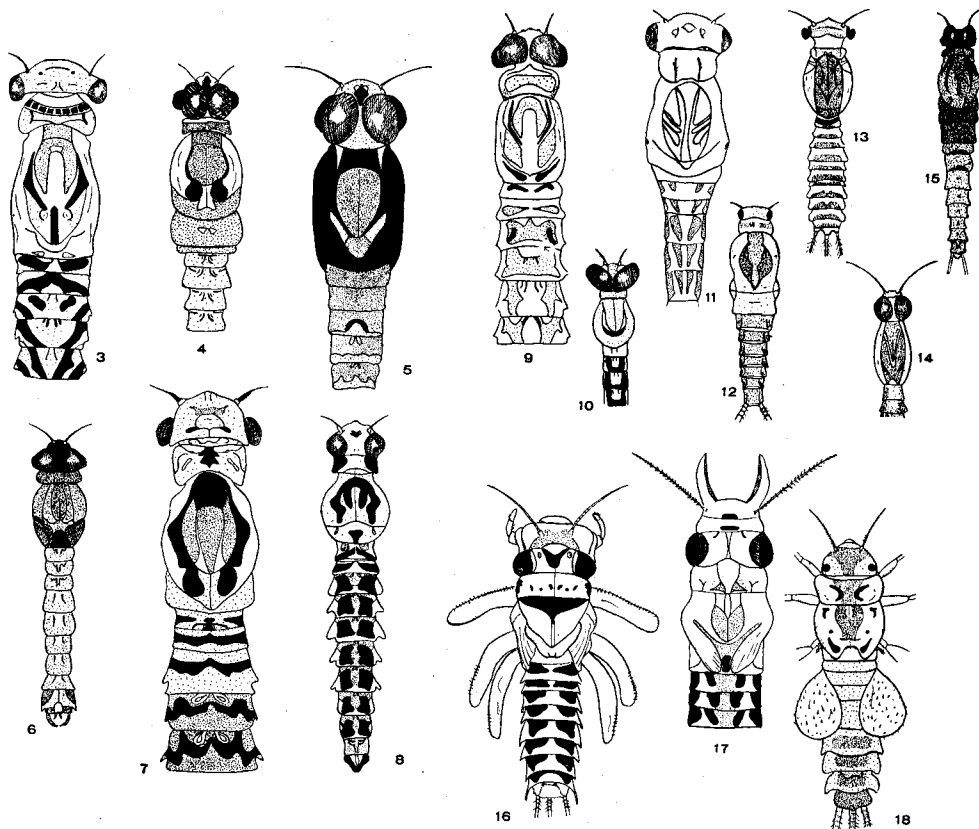
*Nymphs.* Dumaresque Cr., Armidale, 3,300', 9:1948, every month 1947; Pine Forest Cr., Armidale, 1947, Commissioners Waters, Armidale.

*ATALOPHLEBIA MAROWANA*, sp. nov.

*Holotype* Subimago ♂, Marowan Cr., Glen Innes, 3,520', 10:1948.

*Allotype* Subimago ♀, as above.

*Paratypes* Serpentine R., Point Lookout, 4,000', 10:1948.



Text-figures 3-18. Imagines.

3, *Atalophlebia albiterminata*, female; 4, *Atalophlebia incerta*, male; 5, *Atalophlebia maculosa*, male; 6, *Atalophlebia parva*, male; 7, *Atalophlebia longicaudata*, female subimago; 8, *Atalophlebia marowana*, female subimago; 9, *Leptophlebia crassa*, male subimago; 10, *Deleatidium annulatum*, male imago; 11, species described in Appendix II, female imago; 12, *Baëtis baddamsae*, female subimago; 13, *Caenis scotti*, female subimago; 14, *Baëtis confluens*, male imago; 15, *Baëtis baddamsae*, male imago. Nymphs. 16, *Leptophlebia crassa*; 17, species described in Appendix II; 18, *Caenis scotti*. (Various magnifications.)

## DESCRIPTION.

*Male Subimago.*

*Measurements:* Body length, 9.2 mm. (7.0-10.0 mm.). Cerci, 15.0 mm. Appendix dorsalis, 15.0 mm. Forewing, 6.8 mm. (4.0-8.0 mm.). Hindwing, 1.3 (1.0-1.8 mm.). Foreleg, 2.0, 3.0, 1.0 mm. Hindleg, 2.0, 2.0, 1.0 mm.

*General Colour:* This is yellow-brown with dark brown markings and almost black annulations on the abdomen.

*Head:* The head is yellow-brown with black antennae, and eyes of which the upper lobes are grey-brown and the lower dark brown. The ocelli are large, bulging, and dark brown.

*Thorax*: This is yellow-brown with dark brown markings.

*Wings* (Text-figs. 51, 61): The wings are grey with clear longitudinal veins and brown or black cross veins.

*Legs*: The legs are yellow-brown with dark brown areas surrounding the femoro-tibial articulation. The tarsi are four-jointed and the tarsal claws all narrow and uncinat.

*Caudal Filaments*: These are yellow-brown with dark annulations on the first proximal segment.

*Female Subimago* (Text-fig. 8).

*Head*: The eyes are black and the ocelli are white on a black base and widely separated.

*Eggs*: The egg is spindle-shaped and sculptured with irregular star-shaped markings with a central pit (Text-fig. 30).

*Imago, nymph* unknown.

*Specimens Examined.*

*Subimagines*. Tillbuster Cr., Armidale, 3,300', 11:1947; Serpentine R., Point Lookout, 4,000', 10:1948; Marowan Cr., Glen Innes, 3,520', 10:1948; The Creel, Thredbo R., 3,000', 11:1928, H. M. Stephens.

*ATALOPHLEBIA MACULOSA*, sp. nov.

*Holotype* ♂, Serpentine R., Point Lookout, 4,000', 10:1948.

*Allotype* ♀, *Paratypes*, Serpentine R., Point Lokout, 4,000', 10:1948.

DESCRIPTION.

*Male Imago* (Text-fig. 5).

*Measurements*: Body length, 11.5 mm. (10.0–13.0 mm.). Cerci, 24.0 mm. Appendix dorsalis, 24.0 mm. Forewing, 11.4 mm. (10.0–15.0 mm.). Hindleg, 3.0, 3.0, 1.0 mm.

*General Colour*: This is black with yellow or yellow-red stripes running transversely on the abdomen.

*Head*: The head is black with eyes of which the upper lobes are orange and the lower black, and the ocelli are white on black bases.

*Thorax*: The thorax is black with white bands beside the prescutoscutal suture.

*Abdomen*: This is dark brown with a yellow or yellowish-red band on the posterior margin of each segment, except the last three, which often bear a white margin. The lateral margins are smooth and rounded.

*Wings* (Text-fig. 43): The wings are clear with very dark venation, and about half-way along Sc, usually in the region of the bulla, a striking black spot occurs which covers two or three cells.

*Legs*: The forelegs are dark brown, and some specimens show a slightly lighter line marking the tarsal joints. The mid- and hindlegs are yellow to orange, with one black mark about half-way along the femur and another on the femoro-tibial joint. In all the legs the tarsi are darker than the other segments.

*Genitalia* (Text-fig. 22): The forceps are light yellow, and the penes, which are dark brown, are large and distinctive.

*Caudal Filaments*: These are uniformly black, and the appendix dorsalis may be similar to the cerci or may be slightly thinner.

*Female Imago.*

The body is often stouter than that of the male.

*Subimago and nymph* unknown.

*Specimens Examined.*

*Imagines*. Serpentine R., Point Lookout, 4,000', 10:1948; Marowan Cr., Glen Innes, 3,520', 10:1948.

*ATALOPHLEBIA INCERTA*, sp. nov.

*Holotype* ♂, Gara R., Armidale, 3,330', 4:1947.

*Allotype* ♀, *Morphotype* subimago, *Paratypes*, Gara R., Armidale, 4:1947.

## DESCRIPTION.

*Male Imago* (Text-fig. 4).

*Measurements*: Body length, 10.0 mm. (7.5–12.0 mm.). Cerci, 30 mm. (17–45 mm.). Appendix dorsalis, 25 mm. (17–30 mm.). Forewing, 10 mm. (8.0–12.5 mm.). Hindwing, 2.5 mm. Foreleg, 8.0 mm. (6.5–10.0 mm.). Hindleg, 5.5 mm. (4.5–6.0 mm.).

*General Colour*: This is dark brown.

*Head*: The eyes are black and the ocelli white.

*Thorax*: This is dark brown with black markings and a white outline to the prescutoscutal suture.

*Abdomen*: The abdomen is of slightly lighter colour than the thorax and has black markings.

*Legs*: The legs are yellow-brown with dark brown markings on the femora, four-segmented tarsi, and tarsal claws which are all narrow and uncinat.

*Wings*: These have brown venation and are clear except in the C-Sc region of the forewing, which is opaque, particularly towards the apex, in which the cross veins are all shaded.

*Genitalia*: The genitalia are similar to *A. australis*, but the penes are more separated than in this species.

*Caudal Filaments*: These are dark brown.

*Female Imago*.

*Egg* (Text-fig. 29): On the egg are hexagonal markings separated by circular areas.

*Male Subimago*.

*Wings*: The forewing is heavily shaded with dull brown, giving in some cases the complete lambda pattern described for this genus by Tillyard (1933), but in others the shading is much less noticeable so that it gives a superficially complete brown colour to the wing.

*Nymph*.

*Measurements*: Body length, 9.0 mm.

*General Colour*: This is light brown to greenish-brown.

*Mouth Parts* (Text-figs. 68–71): The labrum bears a median concavity with five dentate incisions on the anterior border, and sparse hairs on the outer anterior angles. The mandibles show a variable number of teeth in both the right and left canines, the minimum being five in the outer canine; and the molar area of the left mandible is larger than that of other *Atalophlebia*. The labium bears a two-segmented palp and the paraglossae are large, with two distinct rows of spines, while the glossae are small and ovate with three encircling rows of spines.

*Abdomen*: In the abdomen the lateral margins are produced into striking recurving spines.

*Gills* (Text-fig. 67): The gills are trifurcate, the three finger-like processes on each gill of a pair arising from a broad lamellate process.

*Specimens Examined*.

*Imagines*. Lake Leake, Tas., 2,000', 1:1929, H. M. Stephens; Dumaresque Cr., Armidale, 3,300', 2:1947; Gara R., Armidale, 3,000', 3:1948.

*Nymphs*. Dumaresque Cr., Armidale, 3,300', 4:1947.

*ATALOPHLEBIA PARVA*, sp. nov.

*Holotype* ♂, Gara R., Armidale, 3,333', 3:1948.

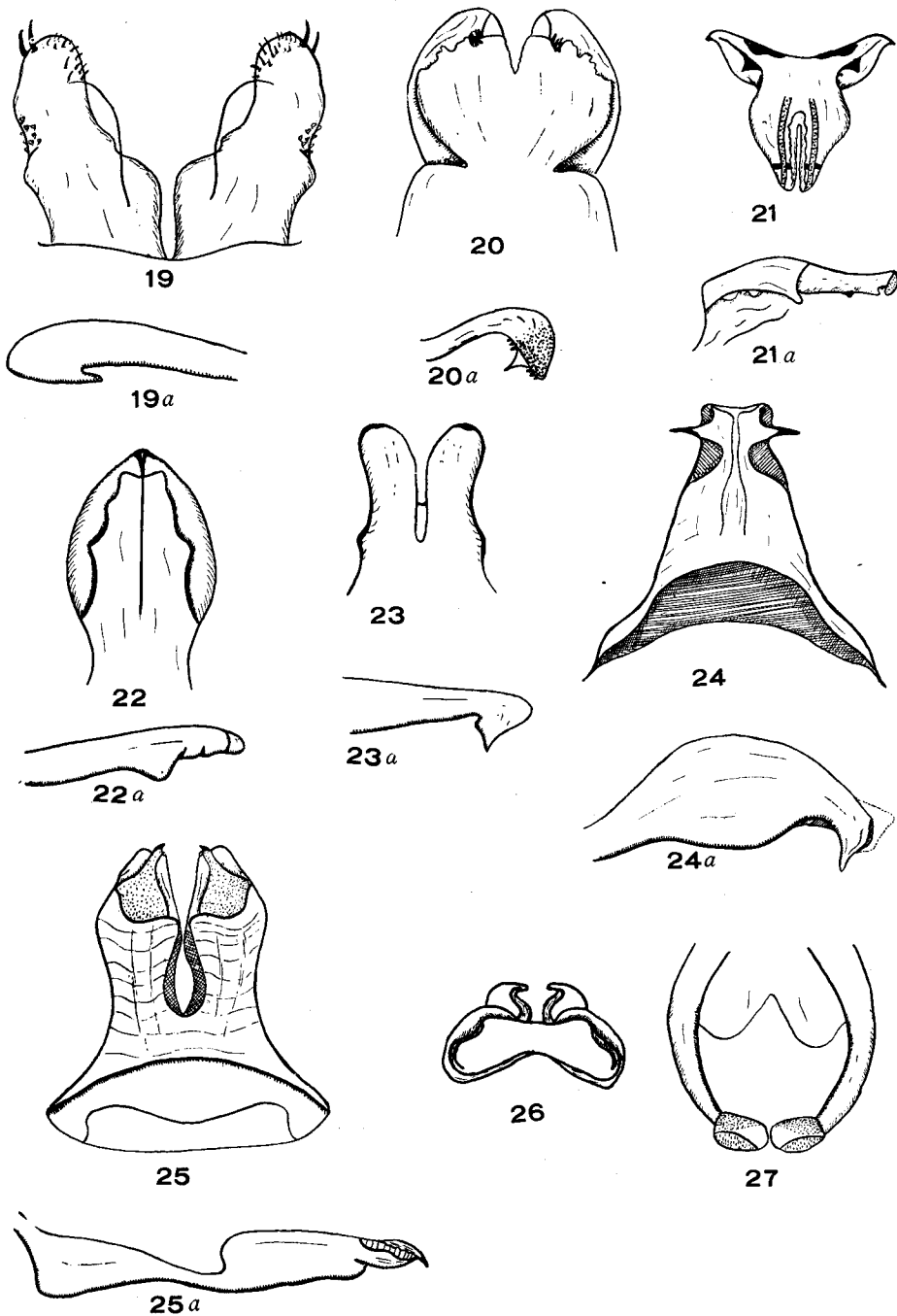
*Allotype* ♀, and *Morphotype*, Gara R., Armidale, 3,333', 3:1948.

*Paratypes*, Dumaresque Cr., Armidale, 3:1948.

## DESCRIPTION.

*Male Imago* (Text-fig. 6).

*Measurements*: Body length, 7.0 mm. (6.5–8.5 mm.). Cerci, 7.0 mm. Appendix dorsalis, absent. Forewing, 7.0 mm. (6.5–8.0 mm.). Hindwing, 1.2 mm. Foreleg, 1.5–2.3, 2.5 mm. (Tarsi, 0.8, 0.09, 0.09, 0.15 mm.). Hindleg, 1.4, 2.0, 0.5 mm. (Tarsi, 0.09, 0.09, 0.09, 0.15 mm.).



Text-figures 19-27. Penes. ("a" after a number indicates lateral view.)

19, *Atalophlebia marowana*; 20, *Atalophlebia longicaudata*; 21, *Atalophlebia parva*; 22, *Atalophlebia maculosa*; 23, *Atopopus spadix*; 24, *Deleatidium annulatum*; 25, *Leptophlebia crassa*; 26, *Baëtis confuens*; 27, *Baëtis baddamsae*. (All figures  $\times 25$ .)

*General Colour:* This is a yellowish-brown, except for the thoracic region, which is black.

*Head:* The head is black with short colourless antennae and white ocelli. The eyes are divided into an upper yellow to orange-brown region and a lower dove-grey or black.

*Thorax:* This is dark brown with black markings and a distinct white line which runs down beside the prescutoscutal suture.

*Abdomen:* The abdomen is dull brown with lighter brown markings and lighter intersegmental areas.

*Wings:* These are transparent with creamy venation, except in the costal area of the forewing, which is opaque, particularly in the pterostigmatic region (Text-figs. 45, 57).

*Legs:* The forelegs have reddish-brown femora with dark brown markings and yellow-brown tibiae and tarsi. The mid- and hindlegs are yellow-brown with dark brown markings. The tarsal claws are all narrow and uncinata.

*Genitalia* (Text-fig. 21): The forceps are three-jointed; the basal joint is dull brown changing to white distally, and the two distal joints are white.

*Caudal Filaments:* The appendix dorsalis is absent. The cerci are yellow-brown with dark brown annulations.

#### *Female Imago.*

*Measurements:* Body length, 6.5 mm. (5.5–9.0 mm.). Cerci, 7.0 mm. Appendix dorsalis, absent. Forewing, 6.2 (5.5–6.5 mm.). Foreleg, 1.0, 1.0, 0.5 mm.

*General Colour:* This is dark reddish-brown with the thorax showing distinctly darker brown.

*Head:* The eyes are greyish-black.

*Abdomen:* This is more uniform in colour than that of the male imago, being dark reddish-brown with a lighter coloured mid-dorsal line.

*Eggs:* The eggs are very distinctive. They bear two rows of appendages at either pole and the immature eggs show a sculpturing of hexagonal figures each with a central pit, while the mature eggs show radiating lines from the pit to the angles of the hexagon (Text-fig. 35).

#### *Male Subimago.*

The presence of uniformly grey wings distinguishes this stage from the imago.

#### *Female Subimago.*

In the majority of female subimagines the appendix dorsalis is present. Measurement, 7.0 mm. (6.5–8.5 mm.).

#### *Nymph.*

*Measurements:* Body length, 8.0 mm.

*General Colour:* This is chocolate-brown.

*Head:* The head is rectangular in shape when viewed from the dorsal surface. The eyes are black and the ocelli black with white bases.

*Mouth Parts:* The labrum (Text-fig. 75) is slightly concave on its anterior margin, the concavity being dentate. The mandibles (Text-figs. 73, 74) bear outer and inner canines with a variable number of teeth. The molar surface of the left mandible tapers to a sharp point on the inner edge and a chitinized angular projection is present on the inside edge below the molar surface. The prostheca is present in both mandibles, but is both more acuminate and more heavily chitinized apically in the right. The maxillae (Text-fig. 77) bear three-segmented palps, of which the basal two segments are about equal in size while the distal segment is much shorter. The anterior edge of each maxilla is fringed with a thick brush of brown hairs, below which is a row of about twenty parallel pectinate "rakes". The labium (Text-fig. 76) bears two three-segmented palps, the distal two segments being much narrower than the proximal segment. Spines occur on the basal segment, particularly on the outer margin, and



also on the distal portion of the middle segment. The paraglossae bear a group of spines on the anterior margin, while the glossae are densely covered with hairs.

*Thorax*: This is yellow-brown with curving, dark-brown markings.

*Abdomen*: The abdomen is dull brown with yellowish-brown markings.

*Legs*: The femur and tarsus each bear one dark band, and the claws are prominent and hooked at the tips.

*Caudal Filaments*: These are yellow-brown with dark annulations.

*Gills* (Text-fig. 72): These are paired and lanceolate in shape. The outer member of each pair narrows at about two-thirds of its length and then expands to a lamelliform tip.

### Biology.

The subimago of this species is very sluggish and apparently attracted to light colours, as it will settle on the clothing of the collector and shows no tendency to fly away.

### Specimens Examined.

*Imago*. Queanbeyan R., 1,901', 2:1948; Gara R., Armidale, 3,300', 4:1948, G. Davis; Dumaresque Cr., Armidale, 3,000', 3:1948; Commissioners Waters, Armidale, 3,000', 4:1948; Serpentine R., Point Lookout, 4,000', 10:1948; Mienna, Tasmania, 3,000', 12:1928, H. M. Stephens.

*Nymphs*. Queanbeyan R., 1,901', 2:1948; Gara R., Armidale, 3,000', 4:1948, G. Davis; Dumaresque Cr., Armidale, 3,000', 3:1948.

### Genus LEPTOPHLEBIA Westwood.

Intro. Mod. Classif. Ins., 2: 31, 1840.

*Synonymy*: *Euphyurus* Bengtsson, Ent. Tidskr., 38:177, 1914.

*Genotype*: *L. marginata* Linn.

### Male Imago.

*Wings*: In the forewing the posterior branch of Rs sags posteriorly; in the hindwing the costal margin is very flatly arcuate with a shallow depression in the middle region. Cross veins are abundant in both wings.

*Genitalia*: The forceps are three-segmented, but a fourth may be present. The penes usually each bear an acuminate spine at the tip, and a reflex spur reaching down to the base of the central notch.

*Legs*: One of each pair of tarsal claws on a tarsi is blunt and the other hooked.

### Nymph.

The gills are lanceolate and double, and there are well-developed lateral spines on the abdominal segments.

### LEPTOPHLEBIA CRASSA, sp. nov.

*Holotype* Subimago ♂, Dumaresque Cr., Armidale, 3,300', 3:1947.

*Allotype* Subimago ♀, Dumaresque Cr., Armidale, 3,300', 8:1947.

*Morphotype* Nymph, Barrington Tops, 4,750', 3:1948, B. McMillan.

*Paratypes*, as above.

### DESCRIPTION.

#### Male Subimago (Text-fig. 9).

*Measurements*: Body length, 11.5 mm. Cerci, 20.0 mm. Appendix dorsalis, 19.0 mm. Forewing, 13.0 mm. Hindwing, 3.0 mm. Foreleg, 3.0, 2.5, 1.5 mm. Hindleg, 3.5, 2.0, 0.8 mm.

*General Colour*: This is yellow with brown markings.

*Head*: The head is yellow with chocolate-brown markings and brown antennae. Both regions of the eyes are dark brown and the ocelli are white.

*Thorax*: The thorax is yellow with definite brown markings.

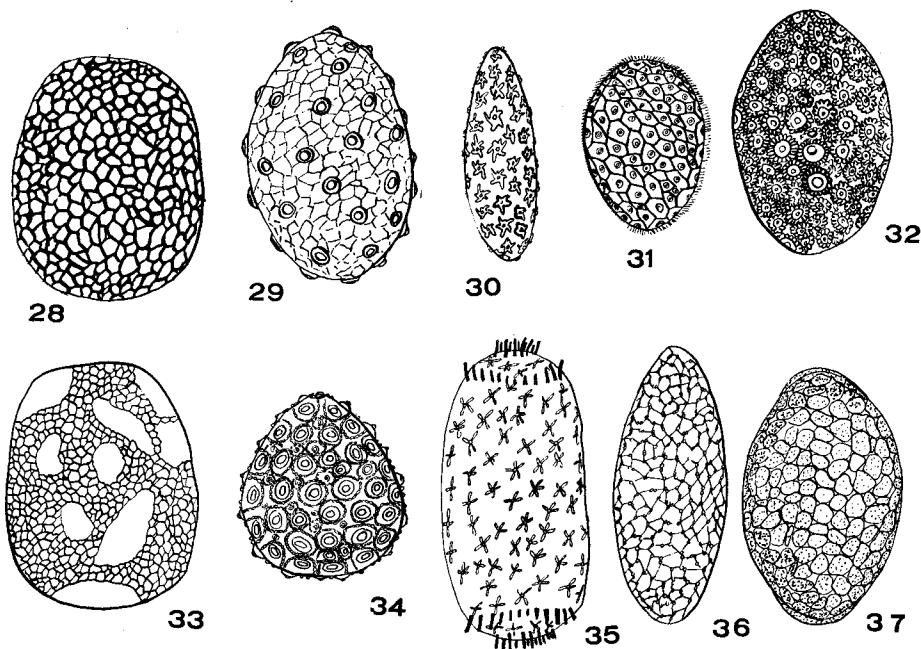
*Abdomen*: This is yellow with dark brown to black markings; on the lateral margin, which is slightly acute, there is a distinct black spot.

*Wings* (Text-fig. 60): The wings are grey with slightly darker veins, and in the hindwing the costal margin shows a slight concavity near the middle.

**Legs:** These are yellow with brown markings, the tarsi being four-segmented and bearing tarsal claws, of which one of each pair is narrow and acuminate and the other blunt.

**Genitalia:** The forceps are three-segmented, and from the tip of each penis projects a weak acuminate spine.

**Caudal Filaments:** These are yellow with a single brown band at the distal end of the basal segment. The appendix dorsalis is slightly shorter than the cerci.



Text-figures 28-37. Eggs.

28, *Atalophlebia albiterminata*; 29, *Atalophlebia incerta*; 30, *Atalophlebia marowana*; 31, species referred to in Appendix II; 32, *Deleatidium annulatum*; 33, *Cloëon fluviatile*; 34, *Leptophlebia crassa*; 35, *Atalophlebia parva*; 36, *Atalophlebia longicaudata*; 37, *Caënis scotti*. (All figures  $\times 60$ .)

#### Female Subimago.

**Measurements:** Body length, 12.5 mm. (9.0–14.0 mm.). Cerci, 20.0 mm. Appendix dorsalis, 19.0 mm. Forewing, 11.0 mm. (9.0–12.0 mm.). Hindwing, 2.5 mm. (2.0–4.0 mm.). Foreleg, 3.0, 2.0, 0.8 mm. Hindleg, 3.0, 2.5, 0.8 mm.

**Head:** The head is darker than that of the male.

**Egg:** The egg is almost spherical and bears raised knobs, each one of which is surrounded by a circle of minute knobs.

#### Nymph.

**Measurements:** Body length, 9.0 mm. Cerci, 9.0 mm. Appendix dorsalis, 10.0 mm.

**General Colour:** Yellow with dark markings on the abdomen.

**Head:** The head is dark brown to black with white ocelli and short antennae.

**Mouth Parts** (Text-figs. 79–83): The labrum has no median concavity but bears a row of minute hairs along the anterior border; the lateral margins are extended and incurved. The left mandible has both the outer and inner canines bearing only one tooth, which is sharply pointed apically, and a prostheca which is acuminate and chitinized apically; the right mandible has serrated canines and no chitinized process in the prostheca. The maxillae bear three-segmented palps, of which the two distal segments bear hairs. The “plate” region is flattened and disc-shaped, and bears a tuft of brown hairs intermingled with which are recurving pectinate “rakes”. The labium

bears three-segmented palps, the segments of which decrease in size distally. The paraglossae are egg-shaped, with the narrow end facing inwards towards the glossae, and bear spines along the anterior borders and the latero-anterior angles. The glossae are narrow, with almost parallel sides, and bear a few hairs at the tips.

*Thorax*: The thorax is light brown with darker markings, and the wing buds are generally black.

*Abdomen*: The lateral margins of the abdomen are produced into spines, of which those of the ninth segment are the longest.

*Legs*: The legs are almost colourless, but may be tinged with brown along the ventral portion of the femora and tarsi. The tarsal claws bear large denticles.

*Gills*: The gills are paired, lanceolate, and seven in number. The gills on the third abdominal segment are largest and the following pairs decrease in size with order (Text-fig. 78).

*Specimens Examined.*

*Subimagines*. Serpentine R., Point Lookout, 4,000', 10:1948; Marowan Cr., Glen Innes, 3,520', 10:1948; Mienna, Tas., 3,300', 12:1928, H. M. Stephens.

*Nymphs*. Dumaresque Cr., Armidale, 3,300', 7:1948; Tumut R., Talbigo, 1,200' (under rocks), 3:1948, B. McMillan; Barrington Tops, 4,750', 3:1948, B. McMillan.

Genus *DELEATIDIUM* Eaton.

Trans. Ent. Soc. London, 1899.

*Genotype*: *D. illi* Eat.

*Imago.*

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

*Nymph.*

Body flattened dorso-ventrally.

*Head*: Square in shape, with eyes borne laterally. Mouth parts similar to *Atalophlebia*.

*Gills*: Single.

*DELEATIDIUM ANNULATUM*, sp. nov.

*Holotype* ♂, Serpentine R., Point Lookout, 4,000', 10:1948.

*Allotype* ♀, *Morphotype* Subimago, *Paratypes*, Talbigo, 1,200', "at dusk", 12:1947, B. McMillan.

DESCRIPTION.

*Male Imago* (Text-fig. 10).

*Measurements*: Body length, 10.0 mm. Cerci, 11.0 mm. Appendix dorsalis, 11.0 mm. Forewing, 9.0 mm. Hindwing, 1.5 mm. Foreleg, 1.5, 3.0, 0.5 mm. Hindleg, 2.0, 1.0, 0.5 mm.

*General Colour*: This is tan.

*Head*: The head is orange with brown markings, while the upper region of the eyes is pale reddish-brown, and the lower and the ocelli are grey.

*Thorax*: Creamish-orange with light brown markings.

*Abdomen*: The abdomen is creamish-orange with definite markings which change in the posterior segments from dark brown to red-brown.

*Wings*: The forewing is faintly opalescent in the C-Sc region, in which the cross veins are unevenly shaded; elsewhere the wings are clear with brown venation.

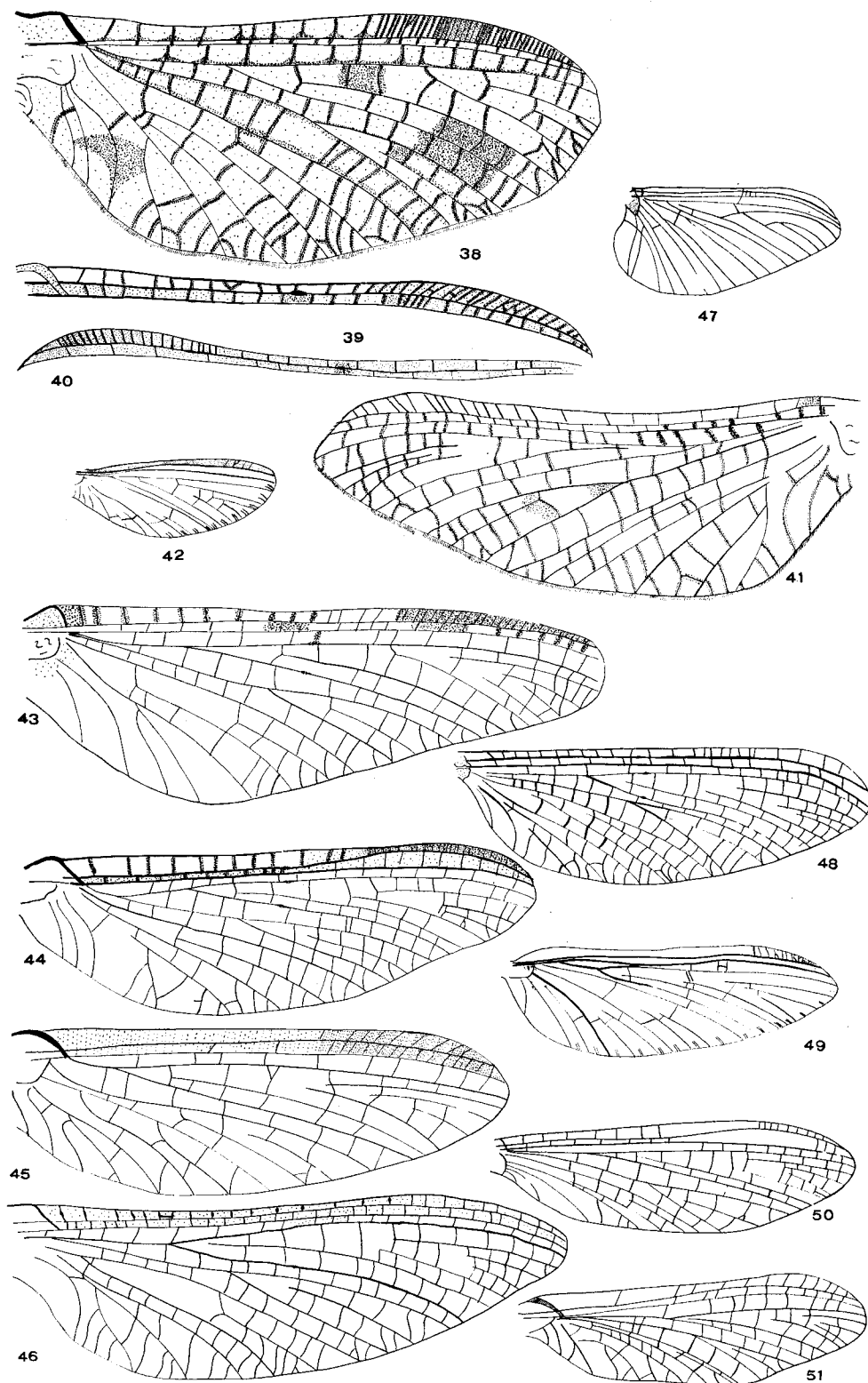
*Legs*: The legs are cream with two red-brown bands on the femora, and on each tarsus one claw of the pair is narrow and acuminate and the other is blunt.

*Genitalia*: The forceps are yellow and the penes red-brown.

*Caudal Filaments*: These are cream with definite brown annulations.

*Subimago.*

*Wings*: The wings are grey-brown in colour.



*Specimens Examined.*

*Imagines.* Juanama Cr., Talbigo, 1,200' (at dusk), 12:1947, B. McMillan; Tumut-Talbigo, 900'-1,200' (in rain), 12:1947, B. McMillan; Marowan Cr., Glen Innes, 3,500', 10:1948; Serpentine R., 4,000', 10:1948.

## Family BAETIDAE.

*Imago.*

*Head:* In the male the development of the compound eye is outstanding and is known as a "turban eye"; the upper part is raised on a broad pedestal and is lighter in colour than the lower, normally rounded, portion.

*Thorax:* The pronotum of the female is narrow, closely connected to the mesonotum and receding behind.

*Wings:* In the forewing the cross veins are usually greatly reduced, and along the margin is developed a series of short marginal veinlets between the branches of the main veins. The middle branches of all the treads are disconnected, except occasionally IR<sub>3</sub>b and ICuA, and the anal area is greatly enlarged, with a reduction of anal venation. The hindwings are greatly reduced or absent.

*Caudal Filaments:* The appendix dorsalis is aborted.

*Nymph.*

*Mouth Parts:* The maxillary palps are three-segmented.

*Gills:* Seven pairs are present, all being exposed and lamelliform.

## Genus BAËTIS Leach.

Brewst. Edinb. Encycl., 9:137, 1815.

*Synonymy:* *Brachyphlebia* Westwood; Introd. Mod. Classif. Ins., 2:25, 1840. *Cloë* Pictet; Hist. Nat. 2 Ephem. Neurop., 1843 *Acentrella* Bengtsson; Ent. Tidskr., 1912.

*Genotype:* *B. binoculatus* Linn.

*Imago.*

*Wings:* The forewing is 2-9 mm. and has marginal intercalaries occurring in pairs and basal costal cross veins are entirely wanting. In the hindwing there are only two or three longitudinal veins.

*Genitalia:* The forceps are four-segmented, the basal segment being the stoutest but contracting at its distal end, and the third segment being the longest.

*Nymph.*

*Head:* The head is hypognathous.

*Mouth Parts:* The labrum bears a notch in a median position on its anterior margin. The mandibular canines are large with blunt teeth. The maxillary palp may be three- or two-segmented.

*Gills:* Single, obtusely ovate or obovate gills are present on abdominal segments 1-7.

## BAËTIS BADDAMSAE, sp. nov.

*Holotype* ♂, Guyra, 4,300', 9:1948, G. Baddams.

*Allotype* ♀, Guyra, 9:1948.

*Morphotypes* Subimagines, nymphs, Billy's Cr., Grafton-Armidale Rd., 3:1948.

*Paratypes*, Marowan Cr., Glen Innes, 3,520', 10:1948.

## DESCRIPTION.

*Male Imago* (Text-fig. 15).

*Measurements:* Body length, 6.5 (6.0-7.0 mm.) or 11.6 mm. (11.0-12.0 mm.). Cerci, 10.2 mm. or 16.0 mm. Appendix dorsalis, absent. Forewing, 6.3 mm. (5.5-7.0 mm.) or 9.9 mm. (9.0-11.0 mm.). Hindwing, 2.0 mm. or 3.0 mm. Foreleg, 1.5, 2.0, 2.5 mm. Hindleg, 4.0, 4.0, 2.0 mm.

## Text-figures 38-51. Forewings.

38, *Atalophlebia longicaudata*, subimago; 39, costal area imago, *Atalophlebia longicaudata*; 40, *Atalophlebia albiterminata*, costal area imago; 41, *Atalophlebia albiterminata* subimago; 42, *Baëtis confluentis*; 43, *Atalophlebia maculosa*; 44, *Atalophlebia incerta*; 45, *Atalophlebia parva*; 46, species referred to in Appendix II; 47, *Caënis scotti*; 48, *Deleatidium annulatum*; 49, *Baëtis baddamsae*; 50, *Atopopus spadix*; 51, *Atalophlebia marowana*. (All figures × 4.)

*General Colour:* Black with conspicuous orange eyes.

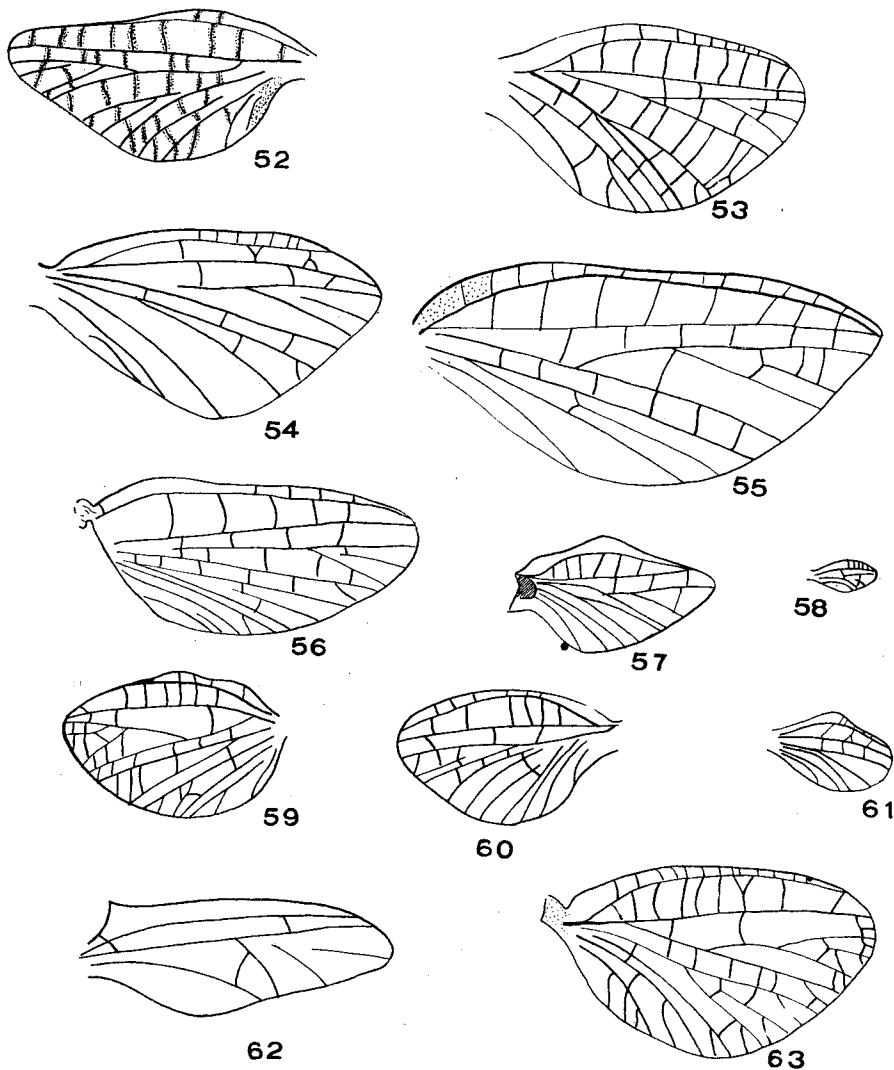
*Head:* This is black with very short antennae and eyes of which the upper lobes are bright orange and the lower dark brown or black.

*Thorax:* The thorax is black with very narrow yellow markings.

*Abdomen:* In the abdomen the anterior two segments are black with yellow markings and the following segments are brown with slightly darker markings in small areas; a distinct white line runs along the lateral margins.

*Wings:* These are colourless with yellow-brown venation, and in the hindwing the anterior margin rises to an acute peak close to the base.

*Legs:* The legs are grey-brown and the fore-tarsi have a distinctly crenulate outline. The tarsal claws of each pair are dissimilar, one being narrow and acuminate and one blunt and ovate.



Text-figures 52-63. Hindwings.

52, *Atalophlebia albiterminata*, subimago; 53, *Atalophlebia maculosa*; 54, *Atopopus spadix*; 55, species referred to in Appendix II; 56, *Deleatidium annulatum*; 57, *Atalophlebia parva*; 58, *Baëtis confluens*; 59, *Atalophlebia incerta*; 60, *Leptophlebia crassa*; 61, *Atalophlebia marowana*; 62, *Baëtis baddamsae*; 63, *Atalophlebia longicaudata*. (All figures  $\times 16$ .)

*Genitalia*: The forceps are four-jointed.

*Caudal Filaments*: Basally these are brown with lighter annulations, but distally they are cream with dark annulations.

*Female Imago.*

*General Colour*: This is brown with a black head and thorax.

*Head*: The eyes are grey.

*Thorax*: This is dark brown with a distinctive yellow pattern.

*Eggs*: The eggs are of a distinctly greenish colour when first laid, but darken after the first day; there is no sculpturing on the egg at all. The eggs are laid in masses which stick together by means of a gelatinous substance which adheres closely to the substratum.

*Subimago* (Text-fig. 12).

*General Colour*: Creamy-yellow with darker thorax.

*Wings*: The wings are faintly grey with yellow venation.

*Legs*: These are yellow with segments outlined with dark brown.

*Nymph.*

*Measurements*: Body length, 10.0 mm. or 6.0 mm.

*General Colour*: Grey-brown.

*Head*: The head is cream with dull brown markings, black eyes and grey ocelli.

*Mouth Parts* (Text-figs. 84-88): The labium is deeply notched in the middle region of the anterior margin, which also bears a row of spines.

The mandibles bear blunt canines, the inner one bearing three teeth and the outer not being toothed, and a prostheca being present only in the right mandible. The maxillae bear two-segmented palps, of which the distal segments are the longest. The galea-lacinia narrows anteriorly, the galea region terminating in an acuminate point while the lacinia region is much broader and ends in a row of spines. On the labium the palps are two-segmented, the basal segments being the longest and broadest and the distal segments bearing spines on the outer surface; the distal segment also appears to have an inner lobe, which is deeply incised from the outer lobe. The paraglossae and glossae are of similar dimensions and are both pointed, the glossae bearing a row of spines on the inner surface.

*Biology.*

These Baëtids are seldom found flying over water; they appear to emerge and fly almost perpendicularly upwards out of sight. The nymphs are present among algae, where they can be seen gently raising and lowering their caudal filaments as they feed.

There appear to be two distinct physiological races present in this species. From a large series which was collected from one location in a stream all the imagines, subimagines and nymphs could be divided into two distinct groups on size, the groups not overlapping.

*Specimens Examined.*

*Imagines*. Gara R., Armidale, 3,300', 12:1947; Guyra, 4,300', 9:1948, G. Baddams; Tillbuster Cr., Armidale, 3,300', 9:1948; Marowan Cr., Glen Innes, 3,520', 10:1948; Mienna Cr., Tasmania, 3,300', 12:1928, H. M. Stephens.

*Nymphs* as above and Billy's Cr., Armidale-Grafton Rd., 1,800', 3:1948.

*. BAËTIS CONFLUENS, sp. nov.*

*Holotype* ♂, Dumaresque Cr., Armidale, 3,300', 9:1947.

*Allotype* ♀, *Paratypes*, Dumaresque Cr., Armidale, 3:1948.

DESCRIPTION.

*Male Imago* (Text-fig. 14).

*Measurements*: Body length, 4.5 mm. Cerci, 9.0 mm. Forewing, 4.0 mm. Hindwing, 0.5 mm. Foreleg, 1:1:2 (2.9 mm.). Hindleg, 3:2:2 (1.5 mm.).

*General Colour*: Light brown to orange-brown.

*Head*: The head is light brown with "turban" eyes, of which the surfaces are orange and the pedestal yellow, and the ocelli are slightly stalked.

*Thorax*: This is light brown with darker brown and yellow markings.

*Abdomen*: This is light brown with sparse markings and the lateral margins are slightly concave, especially in the posterior segments.

*Wings* (Text-fig. 42): In the forewing the costal and apical area of the subcostal region is slightly milky, Rs forks close to the base and IR<sub>1</sub>b commences close to the fork, MA is unfolded. In the hindwing very few cross veins are present and the anterior margin is convex.

*Legs*: The legs are light brown and the tarsal claws of each pair on a tarsus are dissimilar, one being narrow and acuminate and one blunt and ovate.

*Subimago and nymph* unknown.

*Specimens Examined.*

Dumaresque Cr., Armidale, 3,300' (rain), 9:1947.

CLOËON FLUVIATILE Ulm.

Archiv. für Naturgeschichte, 11, 1919.

To the original description all that need be added is a description of the egg.

*Egg*: Slightly ovate, cream in colour. Sculpturing reticulate; the markings surround almost circular smooth areas (Text-fig. 33).

*Specimens Examined.*

Armidale, 3,300', 9:1948.

Family CAËNIDAE.

(*Brachycercidae* Lestage.)

The type genus of this family, genus *Caënis*, was suppressed by Lestage as a synonym of *Brachycercus* Curtis, which changed the family name to *Brachycercidae*. Since then no other authors have followed this alteration, and there seems some doubt as to the true synonymy of these two genera. Therefore until further evidence can be put forward it is proposed to use the name in general usage, *Caënis*.

*Imago.*

*Head*: The compound eyes are button-shaped and widely spaced in both sexes, the antennal second joint is at least twice as long as the first, usually longer, and the posterior margin of the head is nearly straight.

*Wings*: The anal area is well rounded and usually has only one anal vein. The cross vein system is greatly reduced and no free marginal veinlets are present. The forewing is 2-5 mm. in length and the hindwing is nearly always absent.

*Nymph.*

The gills of the second abdominal segment are enlarged and form a gill cover for the succeeding gills.

The only genus recorded from Australia is the Type genus.

Genus CAËNIS Stephen.

Ill. Brit. Ent., 6:61, 1835.

*Synonymy*: *Ordella* Campion, Ann. Mag. Nat. Hist., 11, s. 9, 64:515. *Ordella* Lestage, Ann. Soc. Ent. Belg., 65:61.

*Genotype*: *C. halterata* Fab.

*Imago.*

*Wings*: Exceptionally broad near the base (a feature which distinguishes *Caënis* from the Tasmanian genus *Tasmanocaënis* Lestage). The cross veins usually occur singly in each intercalary region.

*Antennae*: The second joint of the antennae is not more than twice the length of the basal joint.

*Appendix dorsalis*: Always present and may be slightly longer than the caudal filaments.



*Nymph.*

The nymph is important in distinguishing this genus from the closely related *Brachycercus* and *Tricorythodes*, so that although these two genera have not been found in Australia they are mentioned in comparison with *Caënis*, as it is very likely both of the former genera are present in Australia.

*Mouth Parts:* These are similar in all three genera, but the labrum is less broad in *Caënis* than *Brachycercus* and its apical margin is slightly concave. The glossae and paraglossae are fused in *Tricorythodes* but differentiated in the other genera.

*Gills:* The gills on segments 3-6 are single in *Caënis* and *Brachycercus*, but double in *Tricorythodes*.

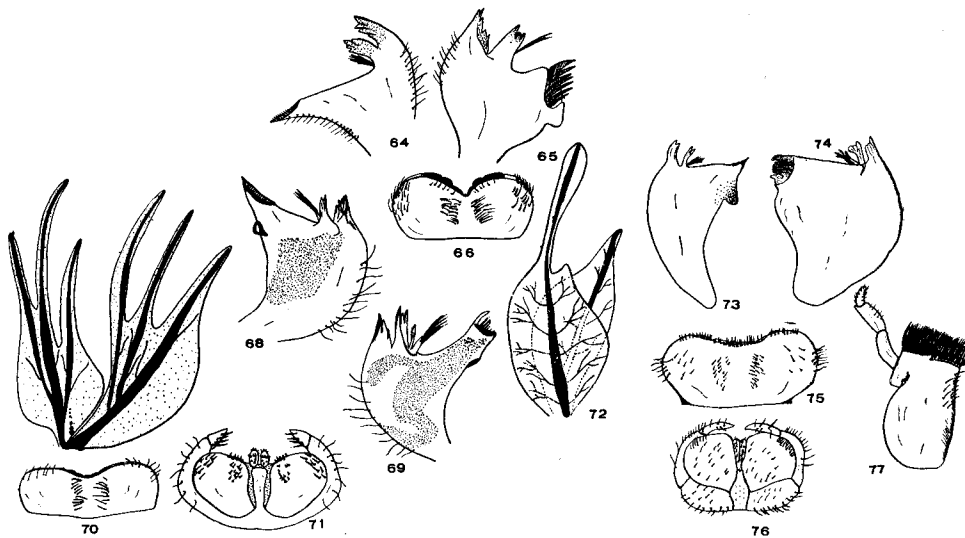
The postero-lateral spines of the abdominal segments are upcurved in *Brachycercus* but not in the other genera.

## CAËNIS SCOTTI Till.

Proc. Roy. Soc. Tasmania, 1935 (published 1936).

*Holotype* Imago, Esk River, Clarendon, Tasmania, 3:1933.

Tillyard has only described the male imago of this species. The imago has not been found at all in Australia, and the five specimens taken were unfortunately placed in spirit and not allowed to undergo their final ecdysis.



Text-figures 64-77.

*Atalophlebia albiterminata* nymphal mouth parts. 64, right mandible; 65, left mandible; 66, labrum. *Atalophlebia incerta* nymph. 67, gill; 68, right mandible; 69, left mandible; 70, labrum; 71, labium. *Atalophlebia parva* nymph. 72, gill; 73, right mandible; 74, left mandible; 75, labrum; 76, labium; 77, maxilla. (All figures  $\times 4$ .)

*Female Imago.*

*Egg:* (Text-fig. 37.)

*Female Subimago* (Text-fig. 13).

Five specimens only in the series.

*Measurements:* Body length, 6.4 mm. Cerci, 2.5 mm. Appendix dorsalis, 3.5 mm. Forewing, 5.0 mm. Hindwing, absent.

*General Colour:* Cream with dark brown markings, grey-brown antennae and dark brown eyes and ocelli.

*Thorax:* This is cream with dark brown markings and a dull brown mesonotum.

*Abdomen:* The abdomen is cream with brown stippled markings, a light cream venter with black markings, and the lateral margins are gently curved.

*Wings* (Text-fig. 47): The wings are opaque with dark brown venation. The hindwings are absent.

*Legs*: In the foreleg the femur is white with a brown outline and the tibia and tarsus light grey; the mid- and hindlegs are white with black markings. The tarsal joints are four-segmented, but the divisions are very indistinct. Of each pair of tarsal claws one is blunt and rounded and the other curved and pointed.

*Nymph* (Text-fig. 18).

*Measurements*: Body length, 5.5 mm.

*General Colour*: Cream with dull brown markings giving an impression of light dull brown.

*Head*: This is cream with brown markings, black eyes and short antennae.

*Mouth Parts* (Text-figs. 92-96): The labium is slightly concave on its anterior margin, the lateral margins of the concavity being slightly dentate. The mandibles bear two groups of canines with a varying number of teeth in each group; the molar surface is strongly chitinated and a prostheca is present. In each maxilla the plate (fused galea and lacinia) is almost pointed, being strongly convex on its inner surface and concave on its outer, with just the distal portion convex; a few spines are present at the distal extremity and the distal end of the outer surface is hairy. The palp is three-jointed, the proximal segment being the longest, and spines are present on the inner edge of the distal segment. The labium bears three-jointed palps, the basal joints of which are stout and short and the third joints are very short; all three joints bear stout spines. Both glossae and paraglossae are almost oblong and also bear stout spines.

*Thorax*: This is cream with brown markings, there being two large semi-circular markings on the pronotum and scattered markings on the mesothorax; the pronotum is narrow and collar-like.

*Abdomen*: The abdomen is cream with brown markings, the venter is creamy white with a dark line following the alimentary canal, and the lateral margins are convex with slightly incurving tips.

*Legs*: The legs bear black markings and rows of spines are present around the tibio-tarsal joint. The tarsal claws bear fine denticles.

*Gills*: There are only six gills present. The first (Text-fig. 89) is extremely small and of remarkable form, being apparently jointed into three segments, or sometimes four, and bearing hairs. The second gill (Text-fig. 90) is modified to form a gill cover for the remaining pairs and is heavily chitinated all over. The last four pairs are filamentous and very flexible (Text-fig. 91).

### *Biology.*

The nymph is distributed widely, occurring in every district from which mayflies have been collected. It has been found below the surface of gravel bottoms of the running streams, but more often is found in the muddy banks or the silted edges of a stream. It is often present in streams which are drying up, usually either in the mud bottom or under and amongst any algae which may be present. In the laboratory it has been kept alive under a small clump of *Spirogyra*, which retained some moisture, for a period of five weeks; it has also been found under the caked surface of the muddy bottom of dishes which have dried out.

The adult appears not to be as prevalent as the abundance of larvae would lead one to expect, but this may be a result of collecting at the wrong times; however, it is the only nymph which has not been able to be bred through in the laboratory.

### *Specimens Examined.*

*Imago*. Dumaresque Cr., Armidale, 3,000', 8:1947.

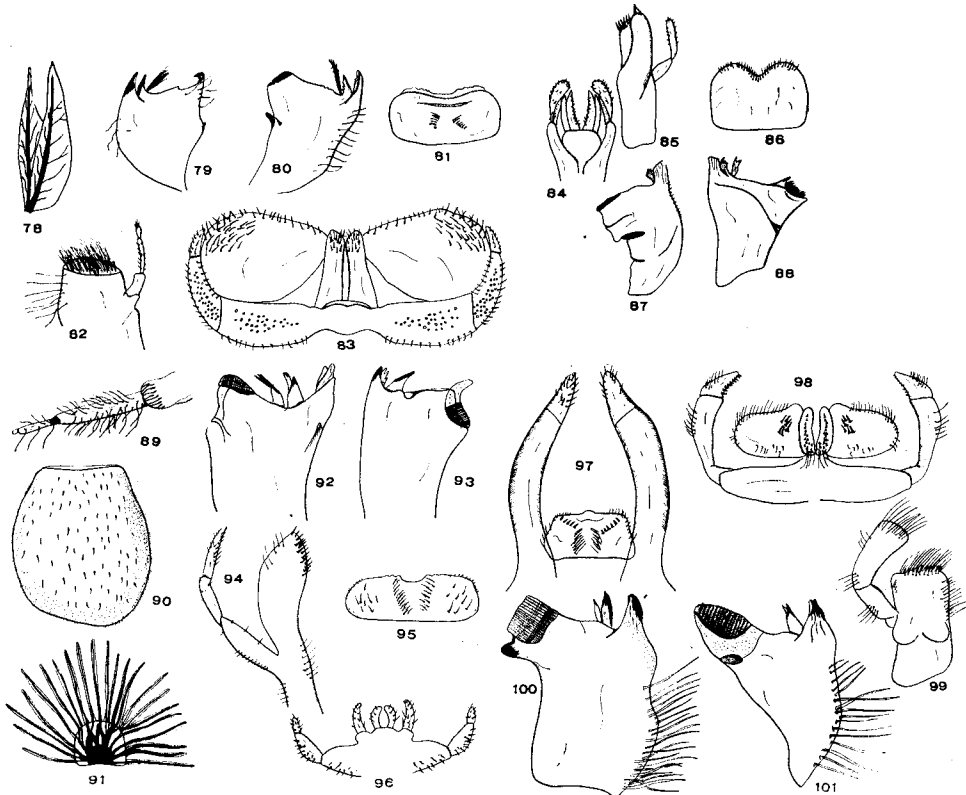
*Nymphs*. Umberumberka Dam, Silverton Shire, 983', 8:1947, A. Stokes; Gara R., Armidale, 3,000', 2:1948; Queanbeyan R., 1,901', 2:1948; Pine Forest, Armidale, 2,000', 10:1947.

Genus *ATOPOPUS* Eaton.

Ent. Mo. Mag., 17-18:191-197, 1881.

Genotype: *A. tarsalis* Ent.*Imago Male.*

"Foreleg about as long as body; tarsus about 1.4 as long as tibia, and this nearly 1.2 as long as femur. The tarsal joints in order of shortening rank 1, 2, 3, 4, 5, and the first about 1.3 as long as the second, and nearly half as long as the tibia. Hind-tarsus as long as second, and nearly 0.6 as long as femur. The first joint about 3.4 as long as the second, and upward of 1.1 as long as the tibia. Ungues unlike each other in every tarsus. Forceps limbs 3 jointed . . ."



Text-figures 78-101.

*Leptophlebia crassa* nymph. 78, gill; 79, right mandible; 80, left mandible; 81, labrum; 82, maxilla; 83, labium. *Baëtis baddamsae* nymph. 84, labium; 85, maxilla; 86, labrum; 87, right mandible; 88, left mandible. *Caënis scotti* nymph. 89, gill from 1st abdominal segment; 90, gill from 2nd abdominal segment; 91, gill from 3rd abdominal segment; 92, right mandible; 93, left mandible; 94, maxilla; 95, labrum; 96, labium. Species referred to in Appendix II, nymph. 97, frontal process of head; 98, labium; 99, maxilla; 100, right mandible; 101, left mandible. (Various magnifications.)

*ATOPOPUS SPADIX*, sp. nov.

Holotype ♂, Armidale, 3,300', 10:1948.

Allotype ♀, Paratypes, Badja, 3,000', 11:1929, H. M. Stephens.

## DESCRIPTION.

*Male Imago.*

*Measurements:* Body length, 9.5 mm. Cerci, 12.0 mm. Appendix dorsalis, absent. Forewing, 9.0 mm. Hindwing, 2.0 mm. Foreleg, 1.8, 3.2, 4.0 mm. Hindleg, 2.0, 1.0-2.5 mm.

*General Colour:* Red-brown with clear black markings.

*Head:* This is red-brown with dark brown markings, eyes which are dark brown and undivided, and white ocelli.

*Thorax:* This is dark brown with black margins to the sutures except that of the prescutoscutal, which is white.

*Abdomen:* The abdomen is yellowish-red to red-brown with clear-cut brown marking.

*Wings:* The wings are clear with yellow venation, and the cross veins in the C-Sc area of the forewing are tinged with reddish-brown.

*Legs:* The legs are yellow with two dark markings on the femora. The hind- and midlegs, as is usual in this genus, are remarkable for their proportions, and the tarsal claws on each tarsus are dissimilar.

*Genitalia:* The forceps are three-segmented and yellow in colour.

*Female Imago.*

As only pinned specimens were examined no eggs could be described.

*Nymph unknown.*

*Specimens Examined.*

Armidale, 3,300', 10:1948; Badja, 3,000', 11:1929, H. M. Stephens.

Although the practice of describing species from pinned specimens is not followed in general, in the case of this species, where a sufficient number of specimens in spirit were not obtainable for a good series, the series has been completed with pinned specimens from the H. M. Stephens collection, which are in very good condition.

CHECK LIST OF AUSTRALIAN SPECIES.

(Including Tasmania.)

Superfamily BAETOIDEA.

Family LEPTOPHLEBIIDAE.

ATALOPHLEBIA Etn., 1881; Tillyard, 1933. Type *A. australis* Walk.

*albiterminata* Till., 1935. Proc. Roy. Soc. Tasmania. Type location unknown.

*australasica* Pict., 1843, in *Baëtis*; *Leptophlebia* Eaton, 1871; Eaton, 1888; Ulmer, 1917. Synonym: *A. costalis* Burm. Type location: British Museum.

*australis* Walk., 1853, in *Ephemera*; *Leptophlebia* Etn., 1871; Etn., 1888; Till., 1933. Type location: British Museum.

*brunnea* Till., 1935. Type location: British Museum.

\**costalis* Burm., 1893, in *Baëtis*; *Potomanthus* Pict., 1853; *Leptophlebia* Etn., 1871; Etn., 1888; Hutton, 1898, Trans. N.Z. Inst., Vol. 31; McLachlan, 1894, Ent. Mo. Mag.; Ulmer, 1920. Synonym of *A. australasica* Pict.

*delicatula* Till., 1935. Type location unknown.

\**furcifera* Etn., 1871, in *Leptophlebia*; Etn., 1888. Synonym of *Deleatidium furcifera*.

Type location: National Museum of Victoria.

*fuscata* Till., 1935. Type location unknown.

*hudsoni* Till., 1935. Type location unknown.

*ida* Till., 1935. Type location: British Museum.

*inconspicua* Etn., 1871, in *Leptophlebia*; Etn., 1888. Type location: Hope Museum, Oxford.

*lucida* Ulm., 1917. Type location: Stockholm Museum.

*sexfasciata* Ulm., 1917. Type location: Stockholm Museum.

*simillima* Ulm., 1919. Type location: Stockholm Museum.

*superba* Till., 1935. Type location: British Museum. Var. *pallida* Till., 1935.

\**strigata* Etn., 1871, in *Leptophlebia*; Etn., 1888; Ulmer, 1920, in *Deleatidium*.

*uncinata* Ulm., 1917. Type location: Stockholm Museum.

LEPTOPHLEBIA Westwood, 1840. Genotype: *L. marginata* Linn., in *Ephemera*.

\**australis* Etn., 1871; Etn., 1888, in *Atalophlebia*.

\**furcifera* Etn., 1871; Etn., 1888, in *Atalophlebia*.

\**inconspicua* Etn., 1871; Etn., 1888, in *Atalophlebia*.

\**strigata* Etn., 1871; Etn., 1888, in *Atalophlebia*.

\* Denotes synonymy.

- DELEATIDIUM Etn., 1899. Genotype: *D. lilli* Etn.  
*strigatum* Etn., 1899. Synonym: *Euphyurus bicornis* Ulm.  
*furcifera* Etn., 1871, in *Leptophlebia*; Etn., 1888, in *Atalophlebia*.

## Family SIPHLONURIDAE.

- TASMANOPHLEBIA Till., 1921. Genotype: *T. lacustris* Till.  
*lacustris* Till., 1921. Type location: British Museum.  
*lacus-coerulei* Till., 1933. Type location unknown.  
*nigriscens* Till., 1933. Type location unknown.  
AMELETOIDES Till., 1933. Genotype: *A. lacus-albinae* Till., 1933.  
COLOBURISCUS Eat., 1864, Ent. Mo. Mag. Synonym: *Coloburis*. Genotype: *C. humeralis* Walk., in *Ephemera*.  
*giganticus* Till., 1933. Type location: C.S.I.R.O., Canberra.  
*haleuticus* Eat., 1871. Type location: National Museum of Victoria.  
*munionga* Till., 1933. Type location: C.S.I.R.O., Canberra.  
*tonnoiri* Lest., 1935. Type location unknown.

## Family BAËTIDAE.

- BAËTIS Leach., 1815, Brewst. Edinb. Encycl. Genotype: *B. binoculatis* Linn.  
*\*australasica* Pict. Synonym of *Atalophlebia costalis* Burm.  
*frater* Till., 1935. Type location: British Museum.  
CLOËON Leach, 1815. Genotype: *C. dipterum* Linn., in *Ephemera*. Synonyms: *Cloë* Pictet, 1843; *Cloëopsis* Vayssière, 1882.  
*fluvatile* Ulm., 1919. Type location: Stockholm Museum.  
*tasmaniae* Till., 1935. Type location: British Museum.  
*virens* Klap., 1905. Synonym: *C. viridis* Till., 1935; Ulm., 1916.

## Family CAËNIDAE.

- CAËNIS Steph., 1935, Ill. Brit. Ent. Genotype: *C. halterata* Fab. (in *Ephemera*).  
*scotti* Till., 1936. Type location: British Museum.

## NEW SPECIES DESCRIBED IN THIS PAPER.

## ATALOPHLEBIA.

*incerta.*  
*longicaudata.*  
*maculosa.*  
*marowana.*  
*parva.*

## ATOPOPUS.

*spadix.*

## BAËTIS.

*baddamsae.*  
*confluens.*

## DELEATIDIUM.

*annulatum.*

## LEPTOPHLEBIA.

*crassa.*

## GEOGRAPHICAL DISTRIBUTION OF GENERA OCCURRING IN AUSTRALIA.

- Atalophlebia*: New Zealand, Chile, Ceylon, Cape of Good Hope, Japan, South Africa.  
*Leptophlebia*: Europe, North America, Chile.  
*Deleatidium*: New Zealand, Chile.  
*Tasmanophlebia*:  
*Ameletoides*:  
*Coloburiscus*: New Zealand, North America.

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\* Denotes synonymy.

*Baëtis*: Europe, Canada, Greenland, Egypt, North America, Central and South America, Indo-Malayan Region.

*Cloëon*: Europe, Indo-Malayan region, Japan, Chile, China, North America.

*Caënis*: Europe, Egypt, Morocco, Cape Colony, Ceylon, North America.

*Atopopus*: Borneo.

#### TECHNIQUES.

##### *Preservation.*

All stages are fixed in Carnoy's fluid and preserved in 70% alcohol. Pinned specimens are extremely unsatisfactory, as the colour darkens and body markings usually become indistinguishable, due to the shrivelling of the specimen. By fixing the specimen it is ensured that if new taxonomic techniques are evolved entailing histological examination the paratype will be in a suitable condition.

##### *Preparation.*

*Genitalia.* The terminal segments of the male are dissected away and the forceps and penis dissected apart prior to any preparation—this was found to be the surest way of preventing the parting of the two halves of the penis. The parts are then boiled in KOH until the flesh dissolves, rinsed in water, allowed to stand for a minute in glacial acetic acid, and washed again in water. If they are not perfectly cleared the process can be repeated. It was found that if slides were prepared of the genitalia some detail was lost in that only one view of the penis could be observed; therefore the parts were mounted on a glass slip in glycerine jelly and placed in the same jar as the insect from which they were taken. The advantage of this method is that the preparation can be moved into any position with a warm needle, and there can be no confusion as to which insect they refer.

*Wings.* When necessary wings were mounted by removing and placing in a drop of alcohol on a glass slide, the alcohol allowed to evaporate and a cover slip sealed on. Care must be taken to prevent the mounting medium from covering the wing itself, as some of the veins become invisible.

*Mouth Parts.* These were prepared in a similar fashion to the genitalia, but mounted in Canada balsam.

*Eggs.* These were dissected out and stained with neutral red or Orsein, and examined with an oil-immersion lens.

#### APPENDIX I.

Genus *ATALONELLA* Needham and Murphy.

Bull. Lloyd Libr. 24, Ent. Ser., 4:1-79, 1924.

The erection of this genus has been criticized by Lestage (1931); to his arguments the following points are added and cases cited.

##### *Forewing.*

1. Costal cross veins in basal half of Sc space supposed *numerous* in *Atalophlebia* and wanting in *Atalonella*. It has been found in several series of forewings that the cross veins in some species may be present or absent in this area, e.g., *Atalophlebia fuscula* Till.

2. Costal veins of stigmal region erect in *Atalophlebia*, aslant in *Atalonella*; this varies within a series, but not very noticeably. Intermediate forms occur and it would be difficult to differentiate between erect and slanting.

3. Bisector of MA, MP fork at its proximal end nearer MP<sub>2</sub> in *Atalophlebia*, in the middle of the fork in *Atalonella*. This has been found to vary so much that the two types have even been found on the right and left wings respectively of the same specimen.

4. CuA<sub>1</sub> straight in its apical third in *Atalophlebia*, curved in *Atalonella*. This, too, has been found to vary in a series.

*Hindwing.*

1. Tip of subcostal vein at nine-tenths of wing length in *Atalophlebia*, three-quarters in *Atalonella*. This is a constant character in all the specimens examined.

2. Upper lobe of median vein normal in *Atalophlebia*, disconnected at base in *Atalonella*. This again has been found to occur in both forms, one in each wing of a single specimen. However, the apparently missing piece can be distinguished if the wing is stained so that care is needed in the use of such a character.

3. Cross veins between the anal veins present in *Atalophlebia*, absent in *Atalonella*. These may vary within a series.

Table 2 gives species showing combinations of *Atalonella* and *Atalophlebia* characters.

TABLE 2.

Species.	<i>Atalonella</i> Characters.	<i>Atalophlebia</i> Characters.
<i>Atalophlebia brunnea</i> Till.	Number cross veins in costal area. Cross veins in stigmal region aslant. $CuA_1$ straight apically. Tip Sc at three-quarters wing length. Bisector lower fork MP absent. Cross veins between anal veins absent.	Bisector MA, MP closer to $MP_2$ . Upper fork of median vein normal.
<i>Atalophlebia delicatula</i> Till.	Cross veins in stigmal area aslant. Bisector MA, MP in middle. Tip Sc at three-quarters wing length. Upper fork median vein detached. Bisector of lower fork MP absent.	Cross veins in basal half of Sc-C area present. $CuA_1$ vein straight at tip.
<i>Atalophlebia longicaudata</i> , sp. nov.	Bisector of MA, MP fork medianly placed. $CuA_1$ curved all the way to the tip.	Cross veins in the basal half Sc region numerous. Stigmal cross veins erect. Tip Sc at nine-tenths wing length.

*Nymph.*

In distinguishing between the nymph of *Atalophlebia* and *Atalonella* Needham and Murphy apply characters which not only appear in combination within each genera, but these characters are also applied in two conflicting descriptions of *Atalophlebia* characters.

To *Atalophlebia* nymphs are assigned the character "Posterior lateral angles of rear abdominal segments not tipped with thin flat lateral spines" (page 11), whereas on page 36, in comparing *Atalophlebia* and *Atalonella*, lateral spines are said to be present on abdominal segments 5-9.

Again on page 11, "Femora not dilated"; page 36, "Femora dilated, *Atalonella* femora slender"; and in reference to *Atalonella*, page 11, "Femora dilated".

## APPENDIX II.

A specimen has been collected from Dumaresque Cr., Armidale, with unusual characters. As only one adult has been bred out the author cannot describe a new species, but it seems likely that this specimen cannot be included in any of the known genera.

## DESCRIPTION.

*Female Imago.*

*Measurements:* Body length, 13.0 mm. Cerci, broken. Forewing, 13.0 mm. Hindwing, 3.0 mm. Foreleg, 3.0, 3.0, 1.5 mm. Hindleg, 3.0, 2.5, 1.0 mm.

*General Colour:* Cream with red-brown marks on the abdomen.

**Head:** The head is cream with brown markings, black eyes, short antennae (0.3 mm.), and cream ocelli with brown bases.

**Thorax:** The thorax is cream with very faint light brown outlines to the thoracic sclerites.

**Abdomen:** This is cream with red-brown markings, and the lateral margins are rounded.

**Wings:** The wings have dark brown or red-brown veins which in the C-Sc region of the forewing are slightly shadowed, the wing itself in this region being opaque.

**Legs:** These are cream or white without any markings, and the claws of each pair on a tarsus are dissimilar, one being hooked and the other blunt.

#### *Nymph.*

**Measurements:** Body length, 14 mm.

**General Colour:** Yellow with darker markings.

**Head** (Text-fig. 97): This is triangular with two small projections arising from the head on either side of the labrum (*not* from the mandibles) 1.4 mm. long and each bearing hairs at the tip. The head is light golden-brown with chocolate-brown markings. The eyes are brown and the antennae are quite stout and bear whorls of longish hairs.

**Mouth Parts** (Text-figs. 98-101): The labrum bears a small convex protuberance in the middle region of the anterior margin, and hairs and small spines are present on the antero-lateral angles together with a row of stout spines which slant inwards towards the mid-line. The mandibles are stout with long hairs on the outer margin. The outer canines bear two teeth, and the inner, one; a prostheca is present and the molar region is very broad. The maxillae bear two-segmented palps, of which the distal joints are almost rectangular with broad anterior edges bearing hairs; only a few hairs are present at the distal end of the plates, below which are single rows of pectinate spines. The labium bears two-segmented palps, of which the distal segments are short and conical, and each bears a row of stout spines on the inner surface. The paraglossae are broad and bear a clump of stout spines in the centre of the ventral surface, the glossae are slightly kidney-shaped with a mid-longitudinal line of spines.

**Thorax:** The prothorax is oblong and golden-brown with chocolate-brown markings.

**Abdomen:** This is similar to the thorax, but with black markings; the venter is white with a single median black line following the alimentary canal.

**Legs:** The legs bear long hairs.

**Gills:** These are double and lanceolate with a long filamentous distal end, and hairs all over the surface of the gill. They are white with black tracheae.

**Caudal Filaments:** These are colourless with whorls of hair at the end of each segment. The appendix dorsalis is slightly longer than the cerci.

#### *Biology.*

The nymph lives under the surface of the stream bed and can only be found by dredging.

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#### *References.*

- BENGTSOON, S., 1914.—Undersökningar ofver äggen hos Ephemeriderna. *Ent. Tidskr.*, 1-39.  
 ———, 1930.—Kritische Bemerkungen ueber einige nordische Ephemeropteren, nebst beschreibung neuer Larven. *Lunds Univ. Arssk.*, N.F., Avd. 2, Bd. 26: 1-27.



- BRADLEY, J. C., 1931.—A laboratory guide to the study of insect wings. New York.
- BRUES and MELANDER, 1932.—*Mus. of Comp. Zool.*, 73.
- BURMEISTER, H. C. C., 1832.—Handbuch der Entomologie, Bd. li, Abth. ii: 796-804.
- DAVIS, H. C. F., 1941.—Taxonomic categories. *Aust. Journ. of Sci.*, iv, No. 2: 49-52.
- , and LEE, D. J., 1944.—The type concept of Taxonomy. *Ibid.*, vii, No. 1: 16-19.
- EATON, A. E., 1871.—A monograph on the Ephemeridae. *Trans. Ent. Soc. London*, 1-158.
- , 1881.—An announcement of the new genera of Ephemeridae. *Ent. Mo. Mag.*, 17-18: 192-197, 21-27.
- , 1883-87.—A revisional monograph of recent Ephemeridae or mayflies. *Trans. Linn. Soc. London*, Sec. Ser. Zool., 3: 1-352.
- FERRIS, G. F., 1928.—Principles of systematic entomology. *Stanford Univ. Publ. Ser. Biol. Sci.*, 5: 101-269.
- HUXLEY, J., 1932.—Problems of Relative Growth.
- IDE, F. P., 1930.—Contributions to the biology of Ontario mayflies with descriptions of new species. *Canad. Ent.*, 62: 204-213.
- KIMMINS, D. E., 1941.—Key to British Species of Ephemeroptera. *Sci. Publ. Freshwater Biol. Assoc. Brit. Emp.*, No. 7: 1-64.
- LEACH, 1815.—Brewst. Edinb. Encycl., 9: 137.
- LESTAGE, J. A., 1917.—Contribution à l'étude des larves des Ephémères paléarctiques. *Ann. Biol. Lacustre*, 8: 213-456; 1918, 9: 79-182; 1924, 13: 227-302.
- , 1935.—Contribution à l'étude des Ephéméroptères. IX. Le Groupe Siphonuridien. *Bull. Ann. Soc. Ent. Belg.*, 75: 77-139.
- , 1939.—Les *Cloeon* des régions Indo-Malaise, Polynésienne et Australienne. *Ann. Soc. Ent. France*, xcvi.
- , 1930.—Notes sur le première Brachycercidien découvert dans la faune Australienne *Tasmanocoenis tonnoiri* sp. nov. et remarques sur la famille des Brachycercidae Lest. *Mém. Soc. Ent. Belg.*, xxiii: 49-60.
- MORGAN, ANN, 1912.—Homologies in the wing veins of mayflies. *Ann. Ent. Soc. America*, 5: 89-106.
- , 1913.—Contribution to the biology of mayflies. *Ann. Ent. Soc. Amer.*, 6: 371-413.
- , and GRIERSON, MARGARET, 1932.—The functions of the gills in burrowing mayflies. *Physiol. Zool.*, 5: 230-245.
- MURPHY, H., 1922.—Notes on the biology of Baëtis. *Lloyd Libr. Bull.*, 22, Ent. Ser., No. 2: 1-46.
- NEEDHAM, J. G., 1918.—Aquatic insects, Ward and Whipple. *Fresh Water Biology*, pp. 867-946.
- , and LLOYD, J. T., 1916.—Life of inland waters. Ithaca, N.Y.
- , and MURPHY, H., 1934.—Neotropical mayflies. *Bull. Lloyd Libr.*, 24, Ent. Ser., 4: 1-79.
- , and NEEDHAM, P. R., 1927.—A guide to the study of freshwater biology. New York and Albany. Pp. 10-14.
- , TRAVER, J. R., and HSU, Y., 1935.—The biology of mayflies. Ithaca, N.Y.
- PHILLIPS, J. S., 1930.—A revision of the New Zealand Ephemeroptera. *Trans. N.Z. Inst.*, 61: 271-390.
- , 1931.—Studies of New Zealand mayfly nymphs. *Trans. Ent. Soc. London*, 79.
- PICTET, J. F., 1843.—Histoire Naturelle, générale et particulière des Insect Neuroptères. Famille des Ephémérines. Geneva and Paris. 1-300.
- SCHENK, E. J., and MCMASTERS, J. H., 1935.—Procedure in Taxonomy.
- SELLARDS, E. H., 1967.—Types of Permian insect. Pt. 2. Plectoptera. *Amer. J. of Sci.*, 23: 345-355.
- SPEITH, H. T., 1933.—The phylogeny of some mayfly genera. *Jour. New York Ent. Soc.*, 41: 55-86.
- SNODGRASS, J., 1935.—Principles of insect morphology. New York. Pp. 1-667.
- , 1936.—Morphology of the insect abdomen. Pt. iii. Male genitalia. *Smithsonian Misc. Coll.*, 195, No. 14: 73-78.
- TILLYARD, R. J., 1917.—The biology of dragonflies. Cambridge, 1-396.
- , 1921.—A new genus and species of mayfly from Tasmania belonging to the family Siphuridae. *PROC. LINN. SOC. N.S.W.*, 46: 4, 409-412.
- , 1923.—Descriptions of two new species of mayfly from New Zealand. *Trans. N.Z. Inst.*, liv.
- , 1923.—The wing venation of the order Plectoptera. *Journ. Linn. Soc. London*, 35: 143-162.
- , 1924.—Plectoptera. *Australian Encycl.*, 309-310.
- , 1926.—Insects of Australia and New Zealand. Angus and Robertson, Sydney, 1-560.
- , 1933.—Mayflies of the Mount Kosciusko region. *PROC. LINN. SOC. N.S.W.*, 58: 1-32.
- , 1932.—Kansas Permian insects. Pt. 15. The order Plectoptera. *Amer. Journ. Sci.*, 23: 97-134, 237-272.
- , 1936.—The Trout-Food Insects of Tasmania. Part ii. Monograph of the Mayflies of Tasmania. *Proc. Roy. Soc. Tas.*, 1935, 23-59.
- ULMER, G., 1916.—Results of Dr. Mjöberg's Swedish Scientific Expeditions to Australia. *Arkiv. f. Zool.*, x, No. 4: 1-18.

ULMER, G., loc. cit., No. 13:1-23.

———, 1920.—Uebersicht ueber die Guttungen der Ephemeropteran, nebst Bemerkungen ueber einzelne Arten. *Stett. Ent. Zeit.*, 81:97-144.

———, 1930.—Key to the genera of Ephemeroptera. *Bull. Dept. Biol. Yenching Univ.*, Vol. i, No. 3.

VAYSSIÈRE, A., 1882.—Reserches sur l'organization des larves des Ephémèrines. *Ann. Sci. Nat. (6) Zool.*, 13:1-137.

WALKER, F., 1853.—Catalogue of the species of Neuropterous insects in the collections of the British Museum. Pt. 3:533-585.