Fauna of New Zealand
Ko te Aitanga Pepeke o Aotearoa

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'FAUNA OF NEW ZEALAND'

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Leptophlebiidae
(Insecta: Ephemeroptera)

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Mayflies (in part)

The Leptophlebiidae are the largest group of mayflies in New Zealand, comprising 30 species in 12 genera, all unique to New Zealand. Closely related genera occur in New Caledonia, southern South America, Australia, and Madagascar.

Juvenile mayflies (nymphs) inhabit relatively unpolluted running and standing waters. New Zealand species are generally found only in flowing water. Few species inhabit ponds, lakes, or deep, slow-flowing rivers. Most nymphs feed on detritus and algae, which they sweep from rocks, wood, and leaves with brush-like mouthparts.

Nymphs grow and moult for up to a year, then transform into two winged stages: a subimago, which has incompletely developed reproductive structures and usually lasts for 24 hours, and finally an imago with functional reproductive structures. Neither the subimago nor the imago has a functioning digestive system or mouthparts.

Nymphs living in fast-flowing water are often flattened, with adaptations such as sucker-like gills for firm anchorage. Other species have the gills fringed, thread-like, or flattened. Nymphs living on plants that trail in the water often have large claws or modified legs to help them maintain a firm grip. Few nymphs are brightly coloured, but the imagos may have wings tinted yellow or red. Imagos of different species vary from 5 mm to 15 mm in length.

Mayflies of the family Leptophlebiidae are often the most abundant organisms living in clean, flowing streams in New Zealand. They are important food for trout, as is well known to anglers, but also for a wide range of native insects, birds, and fishes. Because of their abundance in clean water with a high oxygen content, and their sensitivity to pollution, mayflies are often used to assess changes in the quality of water in New Zealand streams and rivers.

All the rarest New Zealand mayflies are Leptophlebiidae, and up to one-third of the species are known only from restricted areas. Some of the species may only appear to be (continued overleaf)

Illustration / Whakaāhua: Zephlebia spectabilis, nymph / tūngoungou (Illustrator / Kaiwhakaāhua: David Towns)

Ko Leptophlebiidae te rōpū tino iNiu Tireni nei ka huihuitia e toru tekau momo i roto i nga tātai tekau mā rau, tuturu ake no Niu Tireni nei. Ko nga whanaunga e pātata mai ana ko nga tātai i New Caledonia i nga whenua tonga i te Tonga o Āmerika, Ahitereiria, me Madagascar.

Ko nga mayflies e kōhungahunga tonu ana ka nohonono ki nga wāhi wairere, wai maanu, kihai e paru ana. Ko nga momo i Niu Tireni ka kīte noatia ki te wairere anahe. Ko ētahi momo na noho ki nga wai maanu, nga roto, ā, ki nga wai hōhonou o nga awa āta rere. Ko te maringa o nga kaikai he detritus me te algae. I a puruma mai e rātou i nga tokatoka, wahie, me nga raurau i nga paraia huruhuru i o rātou māngai.

Ko nga kōhungahunga ka tupu, ka tuku kiri tae atu ki te tau kotahi, ka whiti atu ki te rua wāhanga parirau ait: he subimago kahore anō kia oti tika te tupu o nga whēkau tuku bēki o roto, ko noho tēnei āhua mo te rua tekau mā whā hāora, ā, a muri atu he imago kua whakatinana katoa nga whēkau whānautanga. Kahore ia subimago me imago he whēkau e mahi ana mo te āhua kai he wehewehe nga māngai rānei. Ko te imago ka ora hehi anō mo te rua tekau mā whā hāora anahe, ā ka mahimahi hoki, kamirara katoa ka huihui i runga i te wāi i nga tūhua whenua rānei, pēnei i te wāhi rākau, Ka whanautia nga bēki ki roto i nga wai awawa.

(ara haere tonu)
rare because there have been few reliable guides to the identification of even the most common forms. Our work (Fauna of New Zealand no. 36) provides the first comprehensive guide to identification of all life stages of New Zealand Leptophlebiidae.

A few mayflies can be identified with the naked eye, but for most species identification will need to be checked using either a stereoscopic microscope for structures on the body and wings, or a compound microscope for structures on the mouthparts of nymphs.

Contributor David Towns is scientist in charge of the Auckland Regional Science Unit of the Department of Conservation. David became involved with mayflies when studying the invertebrates that inhabit kauri forest streams near Auckland as part of his PhD thesis. This work led to a research project with Professor William L. Peters of Florida A & M University between 1977 and 1979, in which they described several new species and genera identified during the kauri forest studies. Further collecting in New Zealand, with funds obtained while he was Senior Teaching Fellow at the University of Adelaide between 1979 and 1982, enabled David to begin a comprehensive revision of the entire fauna of Leptophlebiidae. This revision was largely completed in collaboration with Bill Peters at Tallahassee in 1993, while David was on study leave.

Contributor William L. Peters is Professor of Entomology and Director of the Center for Studies in Entomology at Florida A & M University, in Tallahassee, U.S.A. He has been a faculty member there since completing his PhD at the University of Utah in 1966. He studies the Leptophlebiidae and other Ephemeroptera worldwide, and has published over 100 research papers. His travels to collect and rear mayflies have included New Caledonia, Australia, Southeast Asia, Europe, and North, Central, and South America.

Ko te kaitahi a William L. Peters he Ahorangi no Entomology he Tūmākū hoki no te Center for Studies in Entomology te Wharewānanga o A and M Florida, i Tallahassee, Amerika ko ia anō te mana whakahere i nga tauamata i reira, mai anō i te mutungo o tana tohu PhD i te Wharewānanga o Utah i te tau 1966. E tauira ana ia i a Leptophlebiidae me ētahi atu Ephemeroptera te ao katoa. Ko ana pepa rangahau kua tāhui kuri atu i te kohi rau i roto i āna nei hikoi kahe e kohikohi, e whakatupu mayflies lroto i ēnui hikokongka kustae iki New Caledonia, Ahitereiria, Ahia South East, Uropa, ā ki te Rakiki Waanga o nga whenua o Amerika.

Ko nga kōhunga ka nobo i te wairere kaha ētahi wā ka purarahi, ka tupu te āhua o nga taeata ngotengote i nga hawa kia ā ti te puriri.

Ko ētahi atu mōna ka whai hawa he maka haeere anō, e purarahi anō rānei. Ko nga kōhungahunga e kaikaia mea anā i nga rākau e tere haeere anō i te wai, kia rātou nga matamiti mānui, wae rerekere rānei he awhina i a rātou kia ā tika ai. Tahi tahi noa iho he karakara māpura pura ana e ngari kōnga imagos ka putaputa te kōwhai te me te whero i nga paricar. Ko nga imagos i a mōno rerekere ka rima mirumita ki te kaua mā rimu mirumita te roa.

Ko nga mayflies te whānau Leptophlebiidae no rātou anō te mōna o nga ārio no ko noho i te wai rere ma i nga awaawaa o Niu Tīreni nei. He tino kai nui anō tēnei ki te ika nei te kōkōpu o mōhiotia ana e nga kaihī i tenei ika (he kai) anō hoki na te mōna o nga ārio, mana, iho i kei konei anō. Na te mahama hai te wai ma te nui hoki o te hau pūmau me te hanga ohooho noa iho i kia te tāte mea nga mayflies he irotake te te āhua o te pai te mā o te wai i Niu Tīreni i nga wai o nga awaawaa hoki.

Ko nga mōna takitahi o nga mayflies i Nui Tīreni nei ko Leptophlebiidae mā ā kei ruego atu i te koitahi tonuanga mōno ka mōhiotia i nga wāhi e tepu tapu ana. Ko ētahi anō o nga mōna takitahi te kītea te te āhua o te mea kihai anō kia āta tohuhuia mai he aha pū nga mōna tae atu ki nga mōna e kaha anā te kītea. Kite mātou mahi ka whakarato mai i nga tohuhu tuhataki i āta mōhiotia ai nga poutama oranga o nga Leptophlebiidae i Niu Tīreni nei.

He iti noa ka taeā te mōhio te mātou te tātou e te kano, ko te mōna anō o nga mōna kia mōhiotia ai te tātou anō ko nga kanahoe putia pōnei i te compund microscope mō te āhua whakatūmanga i nga honohono māngai o nga kōhungahunga.

Ko te kaimahi ko David Towns he putia ao he rangatira whakahaere i te Auckland Regional Whare Pūtāiao o Te Pāka Atawhā i Ākārana nei. Ka ariki atu David ki te tiroiro i nga mayflies i a ia e tauira ana i nga invertebrates e noboneho an kia awhaawaa ngahere kauri e pātata ana ki Ākārana mo tana tukutu roa tohungatanga (PhD). Ka huri taua mahi nei ki tētahi kete rangahau me te Ahorangi nei a William L. Peters i Florida (Amerika) me te Wharewānanga o A and M maite te tau 1977 ki 1979. Narātou i whakamārama mai e hia noa atu mōna hou me nga tātalā ka kītea te te wā i rangahau anā i nga mahi i nga rākau kauri o te ngahere. I te pūtea moni ka riro mai a ia i te tauara akou i te Wharewānanga o Auckland i te tau 1979 ki 1982. Ka kohikohia anō ētahi i Niu Tīreni, i taeā a e David ki te tāmata i nga whānuitanga wēwehe o te kātaki o Leptophlebiidae mahi. Ko tēnei mahi ko te mōna anō ko ia oia i a ia e māhita ana me Bill Peters i Tallahassee i te tau 1993 te wā i a David e wātea marika mai anō mo anā mahi tauira.
ABSTRACT

The mayflies (Ephemeroptera) of New Zealand in the Leptophlebiidae (Atalophlebiinae) are revised. A new family diagnosis is provided. Short descriptions are provided for genera and species previously revised by us, and full descriptions are given for 14 species, including 8 new species, and 2 new genera. The fauna now comprises 30 species in 12 genera. A new genus, Tepakia, is established for *T. caligata* n.sp., in a phyletic lineage previously unknown from New Zealand and related to genera in Madagascar and the Seychelles. A new genus and combination, *Austronella planulata*, are provided to accommodate an ephemerellid-like species previously assigned to *Zephlebia*. All life stages are associated and described for species of *Deleatidium*, which is divided into two subgenera. *Deleatidium* sensu stricto contains eight species, of which *D. angustum* and *D. magnum* are new. *Penniketellum* is reduced to a subgenus within *Deleatidium* and a new species, *D. (P.) cornutum*, is described. *Mauiulus aquilus* n.sp. is described. The previous subdivision of *Zephlebia* into two subgenera is revoked, and three new species — *Zephlebia nebulosa*, *Z. pirongia*, and *Z. tuberculata* — are described. The relationships of all genera and species are discussed, keys are provided for imagos and nymphs, and diagnostic taxonomic characters are illustrated.

CHECKLIST OF TAXA

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<td><em>tuberculata</em> new species</td>
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INTRODUCTION

Mayflies (Ephemeroptera) are regarded as one of the most primitive orders of winged insects extant (Peters & Campbell 1991), and the Leptophlebiidae are one of the more ancient families of the order.

Four of the seven families of Ephemeroptera in New Zealand are cosmopolitan and one is Australasian in distribution. All our mayflies are endemic to genus level, and one family (Baetidae) has an endemic subfamily. Within all families except the Leptophlebiidae, the New Zealand elements are so distinctive that their classification at family and subfamily level has provoked considerable debate (e.g., McCafferty & Edmunds 1979, Landa & Soldán 1985, Tomka & Elpers 1991, McCafferty 1991). The classification used here follows Peters & Campbell (1991) and Kluge et al. (1995).

All the New Zealand mayflies have phylogetic affinities with other fragments of Gondwana (Australia, S. America, southern Africa, southern India, Sri Lanka, Madagascar, and New Caledonia). These relationships are not necessarily straightforward, but the fauna in question comprises families whose relationships are consistent with ancient rather than modern contacts between land masses. The widespread families Caenidae and Baetidae apparently post-date the separation of New Zealand from Gondwana, and are either absent (Caenidae) or have a few highly distinctive representatives (Baetidae: Siphlaenigmatinae).

The Leptophlebiidae are divided into two subfamilies, Leptophlebiinae and Atalophlebiinae (Peters 1980). The Leptophlebiinae are the more primitive members of the family and are confined to the Northern Hemisphere, whereas the Atalophlebiinae have global distribution but are particularly diverse in the Southern Hemisphere (Peters 1988). The 30 New Zealand species of Leptophlebiidae in 12 endemic genera are all Atalophlebiinae. Both lepto- phlebines and atalophebiine mayflies are preserved in Baltic amber, and therefore diverged more than 50 my BP (Hubbard & Savage 1981). However, since the more derived lineages of Atalophebiinae are well represented in New Zealand, the divergence between Atalophebiinae and Leptophlebiinae apparently pre-dated the fragmentation of Gondwanaland c. 80 my BP (Stevens et al. 1988).

All mayfly species have aquatic nympha that live in relatively unpolluted running and standing waters (Peters & Campbell 1991). There are two terrestrial stages: a winged subimago with incompletely developed reproductive structures usually transforms into an imago in 15 hours and then reproduces, deposits eggs in water, and dies. Reproduction is achieved in aerial mating swarms over water or nearby landmarks. Neither the subimago nor the imago has functioning mouthparts or an alimentary system (Peters & Campbell 1991).
Nymphs of Leptophlebiidae are dorsoventrally compressed, with the head prognathous or hypognathous and with variously shaped gills on abdominal segments 1–7, 1–6, or 2–7 (Peters & Campbell 1991). The gills, which are mobile, have either single or double lamellae. New Zealand species have gills that range from greatly expanded (as in some species with single gills in Deleatidium) to thread-like or flattened and fringed. All nymphs have brush-like mouthparts used for gathering algae or fine detritus, and many of them are most active near dusk, when they may enter stream drift (e.g., Cadwallader 1975). The life history of nymphs is univoltine in some species, and multivoltine with overlapping generations in others (Towns 1985).

Large mating swarms have been reported in most parts of the world, but seem to be a rare event in New Zealand. However, flight by both subimagos and imagos is most commonly observed during the early evening.

Eggs of all species are distinctive in their variety of shape and surface ornamentation, and many species also have ornate adhesion structures.

**SYSTEMATICS**

The first leptophlebiid mayfly known from New Zealand was Baeus scita (now referred to Neozephlebia), which was described by Walker (1853). In 1871 Eaton described two mayflies from New Zealand, one as Leptophlebia dentata and the other as L. nodularis (now considered to be a synonym of Neozephlebia scita). Eaton (1899) also described Deleatidium lillii and Atalophebia versicolor. Unfortunately, Lillie (1898) confused D. lillii with N. scita, so by 1900 the identity of the four known species of New Zealand leptophlebiid mayflies was already clouded by confusion. The problems increased when Hudson (1904) described the distinctive Atalophebia cruenta (now in Acanthophlebia) without designating a type specimen or type locality; these were later inferred by Towns (1983a). Further difficulties were generated by Phillips (1930), who described seven new species, none of them with type material designated. These latter descriptions lacked diagnostic detail, and were accompanied by rudimentary sketches of genitalia. Unfortunately, five of the species are in Deleatidium, among the most widespread and abundant of all New Zealand running-water invertebrates.

A semblance of order was applied to the family with generic revisions started by Penniket (1961) and continued by Peters (1971), Towns & Peters (1978, 1979a, b), and Towns (1983a), but the chaos surrounding Deleatidium has remained a "taxonomist's nightmare" to this day (Winterbourn 1977).

In their phylogeny of New Zealand leptophlebiids Towns & Peters (1980) identified five generic lineages. Modification of that phylogeny following the description of several new genera (Towns 1983a, Towns & Peters 1979a, b) now provides for six lineages (A–F, below). Each of the six New Zealand generic lineages can be identified throughout much of the Southern Hemisphere (Pescador & Peters 1980a) (Text-fig. 1).

**A: Atalophebioides and Deleatidium** appear to be part of a lineage with representatives in South America (Meridialaris and Massartellopsis), Australia (Australophebioides), Celebes (Celebesia), Sri Lanka and southern India (Petersula), and Madagascar (Petersophlebia) (Pescador & Peters 1980a, b). Cephalolebia of the Auckland Islands may have affinities with this group.

**B: Austroclima and Maiaulus** are apparently part of a lineage with representatives in South America (Dactylophlebia and Magallaneula) (Pescador & Peters 1980a, b).

**C: Arachnoculus, Zephlebia, and Austronella n.gen.** appear to be part of a lineage with representatives in South America (Demouliniellus) and in New Caledonia (Lepeorus, Celiphebia, Poya, Tindea, Peloracantha, Coula, Ounia, Notachalcus, and Tenagophila) (Pescador & Peters 1982, Peters & Peters 1980a, b, 1989, 1990). Suggested affinities with this group.

**D: Isothraulus and Tepakia n.gen.** appear to have affinities with group C.Isothraulus may be related to undescribed genera in New Caledonia (Hapsiphlebia) and in New Caledonia (Hapsiphlebia, Lepeorus, Celiphebia, Poya, Tindea, Peloracantha, Coula, Ounia, Notachalcus, and Tenagophila) (Pescador & Peters 1982, Peters & Peters 1980a, b, 1979–80, Peters et al. 1978, 1990, and in press).

**E: Neozephlebia** appears to be part of a lineage with representatives in New Caledonia (Simplacala and Fasciamirus) (Peters et al. 1990). Suggested affinities with southern South America and Australia (Nosia) may need to be reinterpreted (Pescador & Peters 1980a, 1985, Campbell & Suter 1988; J.G. Peters, pers. comm.).

**F: Acanthophlebia** appears to be part of a lineage represented in Africa (Aprionyx), South America (Hapsiphlebia), Australia (Atalophebia, Atalomicra, Jappa, and Ulmerophebia), and New Caledonia (Papposa) (Pescador & Peters 1980a, Peters & Peters 1981b).
Text-fig. 1 Proposed phylogeny of the genera of New Zealand Leptophlebiidae, with derived character states identified (numbered) for each lineage (A–F). An outline of character states used is provided in Appendix 1. Note that no derived character states have yet been identified that separate part of lineage C and lineages E and F from the rest of the fauna.
Family Leptophlebiidae

Diagnosis. Eyes of male divided into a lower portion with small facets and an upper portion with medium to large facets (undivided in one genus), on a long narrow stalk or a short wide stalk, or sessile; eyes of female not divided, composed entirely of small facets. Forewings: vein MA2 attached at base to MA1; 1 intercalary vein between MA1 and MA2; vein MP2 free at base, or attached at base to MP1, or attached at base to CuA; 1 intercalary vein between MP1 and MP2, none between MP2 and CuA; vein IC5 parallel to CuA to strongly divergent distally; vein CuP moderately to strongly curved; anal veins numbering 1–4. Hind wings absent or, if present, then moderately large to reduced; costal projection well developed to absent; vein Sc from slightly less than half to nine-tenths maximum length of wings. Foretarsi of male 5-segmented, with segment 1 shortest; middle and hind tarsi 4-segmented; claws of a pair similar or dissimilar. Genitalia: male forceps 2–4-segmented; penes divided to fused, with or without spines or appendages. Female with or without an ovipositor or egg guide; 9th sternum entire to deeply cleft apically. Caudal filaments well developed; terminal filament from shorter to longer than cerci.

Nymph with head hypognathous to prognathous. Clypeus fused basally with frons, the fusion occasionally incomplete. Labrum with or without an anteromedian emargination; emargination with or without denticles. Mandibles with outer margin straight to angular, naked or with hair on proximal half to two-thirds or distal half. Maxillae with galea-lacinia bearing a subapical row of pectinate spine-like setae, an apical row of sparse to dense long narrow setae, and on inner margin a row of long hair-like setae. Mandible with or without spinelike setae on anterolateral margins. Tarsal claws with or without denticles. Abdominal segments 1–7, 1–6, or 2–7 with plate-like to slender gills; ventral portion of gills present or absent. Caudal filaments three, well developed.

Subfamily Atalophlebiinae

Diagnosis. Eyes of male with square facets in upper portion. Styliger plate of male fused, entire. Nymphs: maxillae with hair or spines evenly arranged in rows on crown; labrum usually with denticles on anteromedian emargination, rarely straight or cleft; hypopharynx usually with lateral projections of lingua.

DISTRIBUTION

The distribution patterns of mayflies around New Zealand are poorly known. This is more a reflection of imprecise identifications (lack of definitive identification guides) than a lack of research effort in streams. At present it is possible to make only broad generalisations about the distribution of leptophlebiid mayflies. Maps provided here reflect collecting effort, and underestimate the geographic range of most species. Towns (1987) found some regional differences in the leptophlebiid fauna, with more species recorded from North Island streams (up to 21) than in similar streams in the South Island (no more than 6). Within the North Island, more species were recorded in lowland streams (19–21) than in high-altitude ones (8). These figures may be affected by lumping of Deleatidium species in the South Island examples, but the apparent differences between the two islands have since been confirmed in surveys (by DRT) using equivalent methods in all areas.

The following broad regional differences in distribution are apparent.

- **Known only from the North Island**: the species in Acanthophlebia, Arachneoculus, Austronella, Isothraulus, Tepakia, and five species of Zephlebia.
- **Known only from the South Island**: all species of Penniketellum sensu stricto.
- **Known only from the subantarctic islands**: the only known species of Cryophlebia.

The remaining species are found on both the North and South islands.

HABITATS IN NEW ZEALAND

New Zealand leptophlebiid mayflies occupy a wide range of aquatic microhabitats, but most are found in flowing waters. Few species occupy the standing waters inhabited by genera in Australia (e.g., Atalophlebia). Comparison of habitat use by 24 species of leptophlebiid nymphs in lowland forest streams on Great Barrier Island indicated a variety of flow and habitat preferences (Towns 1987). Distinctive assemblages were found on wood and leaves in very small first-order streams, on wet rock faces, and on aquatic mosses in rapid flow. More widely dispersed and more diverse assemblages were on wood, leaves and cobbles in first- and second-order streams, and members of Deleatidium dominated on cobbles in third-order streams (Table 1). These assemblages are distinctive for the large numbers of congeneric species found within the same stream catchment, a pattern which is repeated on the North Island mainland. Six species of Zephlebia were recorded.
Table 1  Relative abundance (in parentheses) of 12 species of Leptophlebiidae that predominated in different habitat types on Great Barrier Island (after Towns 1987).

<table>
<thead>
<tr>
<th>Habitat</th>
<th>Species</th>
</tr>
</thead>
<tbody>
<tr>
<td>Runs, falls and wet rock faces</td>
<td><em>Zaphlebia nebulosa</em> (42%), <em>Z. dentata</em> (19%), <em>Deleatidium angustum</em> (16%), <em>Austroclima sepia</em> (15%)</td>
</tr>
<tr>
<td>Wood and leaves in first order pools</td>
<td><em>Zaphlebia borealis</em> (45%), <em>Isothraulus abditus</em> (29%), <em>Arachnocolus phillipsi</em> (21%)</td>
</tr>
<tr>
<td>Wood, leaves, and gravel in low-moderate flow in second-order streams</td>
<td><em>Zaphlebia borealis</em> (16%), <em>Z. dentata</em> (14%), <em>Deleatidium angustum</em> (13%), <em>D. lilli</em> (10%), <em>Arachnocolus phillipsi</em> (9%), <em>Acanthophlebia cruentata</em> (7%), <em>Neozaphlebia scita</em> (7%)</td>
</tr>
<tr>
<td>Hard substrata with algae in moderate flow</td>
<td><em>Deleatidium angustum</em> (56%), <em>Zaphlebia dentata</em> (16%), <em>Austroclima sepia</em> (72%), <em>A. jollyae</em> (9%), <em>Mauiulus luma</em> (13%)</td>
</tr>
<tr>
<td>Hard substrata with moss in rapid flow</td>
<td><em>Deleatidium angustum</em> (56%), <em>Zaphlebia dentata</em> (16%), <em>Austroclima sepia</em> (72%), <em>A. jollyae</em> (9%), <em>Mauiulus luma</em> (13%)</td>
</tr>
</tbody>
</table>

from some streams on Great Barrier Island, mostly in the slower-flowing regions of small streams. Co-occurrence of such a large range of species within a morphologically similar group is most unusual, and seems to be possible through divergence into specific microhabitats (Table 1). *Deleatidium* species were almost the only mayflies found on Great Barrier Island in a stream on unstable, eroding substrates caused by a massive landslip. The genus also predominates in large unstable braided rivers of the South Island (e.g., Sagar 1986).

Unlike *Zaphlebia*, which often predominates in the slow-flowing portions of lowland streams (especially in the North Island), most *Deleatidium* nymphs inhabit fast-flowing waters. *Deleatidium* species in cascades and torrents have greatly enlarged gills to provide maximum adhesion to the substrate. In addition to enlarged gills, some nymphs in the subgenus *Penniketellum* also have a dense cover of hairs on the ventral abdomen, and these may assist with adhesion in rapidly flowing waters. Species in *D. (Penniketellum)* are found in the coldest streams in the South Island, often fed by glaciers or snow melt. At the other extreme, *Isothraulus abditus* has heavily fringed gills which may assist with oxygen uptake, and often inhabits pools (sometimes connected only by subterranean flow) in intermittent streams in the northern North Island, including Great Barrier and Little Barrier islands (Towns 1987).

CONSERVATION

Freshwater invertebrates have only recently been identified as requiring conservation effort in New Zealand, even though aquatic habitats have long been modified by habitat loss and degradation due to changes in water quality and river flows, deforestation of catchments, water pollution, and the introduction of alien fishes, many of which are predators of invertebrates (Collier 1993). Mayflies appear to be particularly sensitive to changes in water quality and degradation of catchments. In many parts of New Zealand the most diverse assemblages of Leptophlebiidae are in little-disturbed forested streams (e.g., Towns 1987), although some morphologically distinctive species have recently been found in high-altitude streams in the South Island. Stream ecosystems reflect processes that occur throughout whole catchments (Hynes 1970), so forest clearance and catchment modification in lowland areas has already destroyed much mayfly habitat (Collier 1993).

Much of the material referred to in this review has originated in Scenic Reserves, Forest Parks, and National Parks, largely because these are the only areas where habitat modification is minimal. Where this protection fails, entire interactive systems may be lost. For example, hydroelectric dams across braided rivers in the South Island have affected invertebrate communities (often dominated by mayflies in *Deleatidium*) that were the main food of a unique assemblage of birds, including black-fronted terns (*Sterna albostriata*), wrybills (*Anarhynchus frontalis*) and black stilts (*Himantopus novaezeelandiae*) (Robertson et al. 1983, Pierce 1986). The last-named species has declined in numbers to the point where it is now regarded as one of the world’s rarest waders (Pierce 1985).

In a review of the conservation status of New Zealand aquatic invertebrates, Collier (1993) identified six species of mayflies, all Leptophlebiidae, that had restricted distributions (i.e., were found in less than three Ecological Regions). As a result of our revision the list of restricted species can be updated to include nine species, as follows. Known from only one collection – *Deleatidium (Penniketellum)* insolitum; known from one group of offshore islands – *Cryophlebia aucklandensis*; known from only
Mayfly nymphs are often caught during stream invertebrate surveys that disturb gravel in front of a fine-mesh net (such as a hand net or Surber sampler). Because no free-swimming species of Leptophlebiidae occur in New Zealand, they can also be collected by gently lifting and brushing stones or wood and by rinsing packs of leaves. Standard collecting techniques, such as Surber sampling, tend to produce a relatively small number of widely distributed species. Many additional species can be obtained by sweeping through tree roots and other vegetation hanging in the water, on wet rock faces in very small streams, on moss or other aquatic plants (although not amongst dense algal cover), and amongst decomposing leaf material in quiet pools. Large nymphs in excellent condition may also be caught in nets set downstream of electro-fishing operations.

Some species emerge during daytime to transform from nymph to subimagos and can be caught at the water’s surface or on the dry surfaces of rocks. More commonly emergence occurs in the late afternoon or early evening at around sunset (e.g., Phillips 1930). During the day subimagos and imagos can be swept into hand nets from vegetation. Both stages are highly attracted to bright lights (mercury vapour lamps or "black" UV fluorescent lights) at dusk and in the early hours of darkness. Imagos may be caught while swarming, but this has been observed for only a few New Zealand species. *Acanthophlebia cruentata* and *Neozephlebia scita* have been observed swarming in mid-afternoon above pools (McLean 1967).

### Preparation of specimens

Definitive identification may require rearing of nymphs through to subimagos or eventually imagos. Rearing of nymphs is often more easily achieved in the field than in the laboratory. Suitable rearing containers can be made from plastic 'Lily' cups fitted with mesh-covered windows (to provide water circulation) floating through a polystyrene tray (Edmunds et al. 1976). A nested series of rearing cages is useful for raising subimagos to imagos, but dry 'Lily' cups are also effective.

Imagos and subimagos can be pinned, but dry mounts are extremely fragile. Specimens last better when preserved in 80% ethanol. Nymphs should be sorted into 80% ethanol and then the fluid decanted off after 24 hours and replaced. This avoids material decomposing in a dilute ethanol cell that may form near the base of the specimen tube.

Wings of imagos and subimagos can be mounted from ethanol onto slides while wet, flattened under a square cover slip, and the cover slip taped down with narrow strips of gummed paper. The remaining ethanol will evaporate in dry air or in a drying cabinet. Other body parts of adults and nymphs are best permanently mounted on slides, and can be mounted directly from ethanol to Canada balsam.

Body parts and eggs can be prepared for scanning electron microscope (SEM) examination by passing the specimen through an alcohol series to 100% ethanol where the required parts are removed, then placed in small porous containers and taken through 50:50 ethanol: amyl acetate, critical-point dried, mounted, and sputter-coated with gold-palladium (Towns & Peters 1978).

### Presentation of descriptions

For each genus the type species is listed first and other species are listed subsequently in alphabetical order.

Half the species listed here have been described or redescribed by Towns & Peters (1978, 1979a, b) and Towns (1983a). Full descriptions or redescriptions are provided for all species in *Deleatidium* and new species in *Maulius*, *Tepakia*, and *Zephlebia*. Species descriptions in *Deleatidium* are based only on material from those collection areas where nymphs were associated with male...
imagos. Where species have been revised previously by us, the descriptions given here mainly use diagnostic characters of particular relevance to New Zealand members of the family. Measurements are listed as a range which is followed by the mean measurement in parentheses if more than three specimens were available.

Association of nymphs and imagos was by rearing, unless otherwise indicated. SEMs of morphological structures and egg ornamentation provided in our previous publications are not repeated here. However, we have provided SEMs of eggs for species and genera described or revised for the first time.

All descriptions are based on specimens in ethanol unless otherwise stated.

Diagnoses and keys

Family divisions in the Ephemeroptera used here are based on Peters & Campbell (1991), except that Nesameletidae and Railiellidae, previously subfamilies in Siphlonuridae, are now raised to family status (McCafferty 1991, Kluge et al. 1995). The diagnosis for the Leptophlebiidae (p. 11) is based on unpublished work of H.M. Savage and W.L. Peters, whereas the diagnosis of the Atalophlebiinae is based on the original description by Peters (1980) and on Peters & Gillies (1995).

Morphology

A nymph is illustrated in Fig. 1, and an imago in Fig. 2. Structures used in descriptions and in phylogeny are identified in Fig. 3–9 for imagos and Fig. 10 and 11 for nymphs.

Morphology of the thorax follows Kluge (1994), except that indentations along the parapsidal sutures are here referred to as the 'notal furrows'.

Keys to nymphs and descriptions are based on late instars with well-developed wing pads, because the morphology of abdominal gills changes as nymphs mature.

Descriptions of pre-imaginal life stages are typically presented as a comparison with the succeeding stage of the same sex, unless otherwise indicated. Similarly, the female imago is contrasted with the male except as indicated.

Illustrations

Illustrations are by D.R. Towns except as otherwise specified in acknowledgments.

Abbreviations

• Collection data

Collection localities are identified using the abbreviated system of areas and codes proposed by Crosby et al. (1976). A map identifying the abbreviations is given on p. 140.

Full collection data are provided only for species not previously described or redescribed by one of us; for other species, collection data are summarised under Material Examined, with a reference to the full published data.

Specimens marked JAM Colln are from the J.A. McLean Collection (New Zealand Arthropod Collection), but lack an identified collector.

• Collectors

ACM, A.C. McLean
AJQ, A.J. Quimm
BAH, B.A. Holloway
BWH, B.W. Hayward
GCH, G.C. Hayward
ELT, E.L. Towns
GK, G. Kuschel
IMD, I.M. McLellan
JAM, J.A. McLean
JE, J. Elsom
JIT, J.I. Townsend
JSD, J.S. Dugdale
MGB, M.G. Black
MNC, M.N. Clout
PGT, P.G. Towns
PS, P. Summerhayes
RGO, R.G. Ordish
WJC, W.J. Crawford

• Repositories

AMNZ Auckland Institute and Museum, Auckland, New Zealand
ANIC Australian National Insect Collection, Canberra, A.C.T., Australia
BMNH British Museum (Natural History), London, U.K., now The Natural History Museum
BPHM Bernice P. Bishop Museum, Honolulu, Hawaii, U.S.A.
CMNZ Canterbury Museum, Christchurch, New Zealand
DRTC D.R. Towns collection, Auckland, New Zealand
FAMU Florida A&M University, Tallahassee, U.S.A.
LFML Limnologische Flussstation des Max-Planck-Instituts für Limnologie, Schlitz, Germany
MNZN National Museum of New Zealand, Wellington, New Zealand (now Museum of New Zealand)
NZAC New Zealand Arthropod Collection, Landcare Research, Auckland, New Zealand
Types previously deposited at the University of Utah, Salt Lake City, U.S.A., have since been transferred to FAMU.

—14—
KEYS TO TAXA
(A) FAMILIES OF EPHEMEROPTERA
KNOWN FROM NEW ZEALAND

The following key is based on New Zealand specimens, but for several characters also draws on keys and illustrations in Peters & Campbell (1991). The couplets are not intended to separate members of the listed families outside New Zealand.

Imago and subimago
1 Hind wings small, one-third or less length of forewings
   —Hind wings large, exceeding one-third length of forewings

2(1) Males and females with terminal filament of equal thickness and longer than lateral cerci; hind wings without pointed costal projection on anterior margin
   ... Leptophlebiidae (see key B, below)
   —Males and females with terminal filament thinner and subequal to or shorter than lateral cerci; hind wings with a pointed costal projection on anterior margin
   ... Baetidae (Siphlaenigma)

3(1) Hind wings with anterior margin extended into a large, pointed costal projection
   ... Coloburiscidae (Coloburiscus)
   —Hind wings with anterior margin either straight or with a small, blunt costal projection

4(3) Tarsal claws similar, each with a hook
   ... Nesameletidae (Nesameletus)
   —Tarsal claws dissimilar, with a hook and a club

5(4) Eyes of male with upper portion clearly separated from lower; female with terminal filament as long as lateral cerci
   ... Ephemeridae (Ichthybotus)
   —Eyes of male with upper portion merged into lower; male and female with terminal filament much shorter than lateral cerci

6(5) Hind legs with separation of 1st tarsal segment from tibia identified by a dark brown band
   ... Rallidentidae (Rallidens)
   —Hind legs with 1st tarsal segment partially fused to tibia, without any band

7(6) Hind legs with fused portion of 1st tarsal segment less than half as long as tibia; male genitalia with forceps 4-segmented
   ... Ameletopsidae (Ameletopsis)
   —Hind legs with fused portion of 1st tarsal segment a little shorter than tibia; male genitalia with forceps 5-segmented
   ... Oniscigastridae (Oniscigaster)

Nymph
1 Mandibles with tusk-like projections; abdominal gills with dense, feathery, hair-like tracheoles
   ... Ephemeridae (Ichthybotus)
   —Mandibles without tusk-like projections; abdominal gills without dense, feathery, hair-like tracheoles

2(1) Mouthparts, forelegs, and middle legs modified with hairs for filter feeding; abdominal gills bifid and sclerotised; terminal filament shorter than lateral cerci
   ... Coloburiscidae (Coloburiscus)
   —Mouthparts not modified for filter feeding; abdominal gills plate-like, broad, narrow or fringed (not as above); caudal filaments all of approximately equal length

3(2) Body dorsoventrally flattened; nymph not free-swimming; caudal filaments very elongated and lacking swimming hairs...
   ... Leptophlebiidae (see key B, below)
   —Body streamlined in shape; nymph free-swimming; caudal filaments shorter than abdomen and densely fringed with hairs

4(3) Head enlarged, wider than maximum width of thorax; maxillae modified at apex, spine-like
   ... Ameletopsidae (Ameletopsis)
   —Head not wider than maximum width of thorax; maxillae without spine-like modifications

5(4) Abdomen with mid-dorsal projections and prominent posterolateral projections on all segments
   ... Oniscigastridae (Oniscigaster)
   —Abdomen without dorsal projections; posterolateral projections small, absent, or largest on segments 8 and 9

6(5) Antennae long, more than twice length of head; abdomen without posterolateral projections; abdominal gills with smooth margin
   ... Baetidae (Siphlaenigma)
   —Antennae short, less than length of head; abdominal segments 2–9 with posterolateral projections; abdominal gills with dorsal margin sclerotised and serrated, and with a median sclerotised brace

7(6) Gills without accessory fibrillar tufts
   ... Nesameletidae (Nesameletus)
   —Gills with accessory fibrillar tufts
   ... Rallidentidae (Rallidens)
KEY TO GENERA OF LEPTOPHLEBIIIDAE
KNOWN FROM NEW ZEALAND

Imago
1 Forewing vein MP2 not attached at base to CuA (Fig. 34); restricted to Auckland Is... (p. 26) ... Cryophlebia
— Forewing vein MP2 attached at base to CuA ... 2

2(1) Tarsal claws similar, both hooked (Fig. 12, 20) ... 3
— Tarsal claws dissimilar, with a hook and a pad (Fig. 13, 14) ... 4

3(2) Forewing with membrane unpigmented; hind wing about one-third as long as forewings
... (p. 46) ... Deleatidium (Penniketellum)
— Forewing with membrane pigmented in costal margin and/or with clouds of pigment at cross veins; hind wings less than one-third as long as forewing ... 7

4(2) Hind wing less than one-fifth as long as forewing (Fig. 46, 47), with vein Sc usually less than four-fifths length of wing ... (p. 49) ... Mauiulas
— Hind wing one-fifth to one-third as long as forewing, with vein Sc more than four-fifths length of wing ... 5

5(4) Hind wing without visible cross veins in posterior half (Fig. 29); penes with rounded apical lobes (Fig. 99)
... (p. 19) ... Atalophlebioides
— Hind wing usually with visible cross veins in posterior half, these often numerous; penes without rounded apical lobes ... 6

6(5) Hind wing vein Sc approximately four-fifths to nine-tenths length of wing (Fig. 31); males with penis lobes separated to base, and with lateral spines (Fig. 101); females with apex of sternum 9 slightly concave to convex (Fig. 194) ... (p. 21) ... Austroclima
— Hind wing vein Sc at least nine-tenths length of wing (e.g., Fig. 37, 41); males with penis lobes fused to apex, and without lateral spines (Fig. 109); females with apex of sternum 9 cleft (Fig. 197–199) ... (p. 27) ... Deleatidium (Deleatidium)

7(3) Forewing with pigment clouds at cross veins confined to stigmatic area (Fig. 26) ... (p. 18) ... Arachnocolus
— Forewing with pigment clouds at cross veins throughout cells C and Sc ... 8

8(7) Male with narrow, elongate penes at least half length of genital forceps; female with egg guide or ovipositor reaching to at least halfway along sternum 8 ... 9
— Male with broad penes shorter than forceps segment 1; females with egg guide or ovipositor either reaching to less than one-third along sternum 8, or absent ... 10

9(8) Forceps segment 1 of male with an angular bend at midlength; penis openings ventral (Fig. 129); female with egg guide or ovipositor reaching to approximately full length of sternum 8 (Fig. 170) ... (p. 48) ... Isothraulus
— Forceps segment 1 of male with an angular bend at one-third distance from apex (Fig. 136); penis openings dorsolateral (Fig. 137, 138); female with egg guide or ovipositor reaching to approximately three-fifths along sternum 8 (Fig. 174) ... (p. 54) ... Tepakia

10(8) Male with penis lobes divided to base (Fig. 134); female without an egg guide or ovipositor (Fig. 173) ... (p. 52) ... Neozephlebia
— Male with penis lobes fused or separated only at apex; female with an egg guide or ovipositor ... 11

11(10) Forewing vein ICu1 not attached to CuP (Fig. 24); eyes of male separated along midline of head; female with sternum 9 deeply cleft at apex (Fig. 192) ... (p. 17) ... Acanthophlebia
— Forewing vein ICu1 attached to CuP (Fig. 52); eyes of male fused along midline of head; female with sternum 9 shallowly cleft to convex at apex (Fig. 203–205) ... 12

12(11) Male with apex of penes broad and flat (Fig. 105); female with sternum 9 convex (Fig. 195)
... (p. 23) ... Austronella
— Male with apex of penes shallowly cleft (Fig. 141); female usually with sternum 9 concave (Fig. 203) ... (p. 57) ... Zephlebia

Nymph
1 Abdominal gills with lamellae single (Fig. 418)
... (p. 27) ... Deleatidium (sensu lato)
— Abdominal gills with lamellae divided into 2 portions (Fig. 409) ... 2

2(1) Abdominal gills with margin fringed (Fig. 437)
... (p. 48) ... Isothraulus
— Abdominal gills with margin not fringed ... 3

3(2) Abdominal gills on segments 1–5 alike, with membrane oval; gills on segments 6 and 7 reduced to thread-like filaments (Fig. 441, 442) ... (p. 54) ... Tepakia
— Abdominal gills on segments 1–6 or 7 alike ... 4

4(3) Abdominal gills on segments 1–6 alike, but gill 7 dissimilar, reduced to a single lamella or thread, or to 2 very small lamellae or threads ... 5

8
—Abdominal gills on segments 1–7 alike, successively smaller posteriorly, each with double lamellae

S(4) Femora long and thin (Fig. 354); abdominal gills with dorsal and ventral portions dissimilar in shape (Fig. 410); labrum with indistinct crenulations on anterior margin (Fig. 267) ... (p. 18) ... Arachnocolus
—Femora stout (e.g., Fig. 384); abdominal gills with dorsal and ventral portions similar in shape (e.g., Fig. 443); labrum with narrow, pointed denticles on anterior margin (Fig. 289, 291) ... (p. 57) ... Zephlebia

6(4) Labrum, maxillary palps (Fig. 318), and legs (Fig. 351) covered with dense hairs; abdomen with posterolateral projections on segments 7–9 blade-like (Fig. 234) ... (p. 17) ... Acanthophlebia
—Not as above ... 7

7(6) Abdomen with pointed posterolateral projections on at least segments 6–9 ... 8
—Abdomen with posterolateral projections confined to segments 8 and 9 ... 10

8(7) Abdomen strongly convex laterally (Fig. 255); abdominal gills slender, usually without branched tracheae (Fig. 440) ... (p. 52) ... Neozephlebia
—Abdomen tapered to apex; abdominal gills lanceolate, with small branched tracheae ... 9

9(8) Abdomen with posterolateral projections on segments 7–9; clypeus with anterior margin deeply concave; labrum longer than clypeus (Fig. 268) ... (p. 19) ... Atalophlebioides

10(7) Abdomen with pointed posterolateral projections on segments 8 and 9 (Fig. 239); pronotum with lateral margins strongly divergent towards anterior (Fig. 239) ... (p. 23) ... Austronella
—Abdomen with blunt posterolateral projections on segments 8 and 9 (Fig. 251–254); pronotum with lateral margins parallel (Fig. 251) ... 11

11(10) Abdominal gills plate-like, with a slender submedian filament and numerous branched tracheae (Fig. 413, 414) ... (p. 21) ... Austroclima
—Abdominal gills thread-like to lanceolate, with unbranched tracheae or small tracheoles (Fig. 438, 439) ... (p. 49) ... Mutilus

DESCRIPTIONS

Type species Atalophlebia cruentata Hudson, by original designation.

Imago. Eyes of male separated by width of midline. Claws (Fig. 12) paired, alike, apically hooked, with an opposing hook. Forewing (Fig. 24) with vein ICu1 basally attached directly to CuA, without a cross vein to CuP; cross veins in distal third of cell C often anastomosed. Hind wing (Fig. 25) a little more than one-fifth to one-quarter as long as forewing; vein Sc approximately nine-tenths length of hind wing; area posterior to vein R1 with numerous cross veins.

Genitalia. Male (Fig. 94–96): styliger plate wider than long, with apex slightly cleft; penes fused except for distal quarter, with openings recessed ventrally and fringed with hairs. Female: sternum 7 (Fig. 355, 183) with genital extension reaching from slightly more than one-fifth to two-thirds along sternum 8; sternum 9 (Fig. 192) strongly cleft.

Nymph (Fig. 234). Antennae 2.5× as long as head.

Mouthparts. Clypeus broader than labrum, with margins subparallel. Labrum (Fig. 264) densely covered with hairs dorsally; anterior margin (Fig. 265) with a rectangular median concavity bearing 5 denticles, the median denticle smallest. Left mandible (Fig. 292) with outer margin smoothly curved and incisors short, stout, the right outer incisor with prominent denticles. Maxillary palps (Fig. 308) with segment 2 broadened distally, segment 3 subtriangular and with dense hairs over ventral surface. Labium (Fig. 322) with broad palps; segment 3 subtriangular and with short, stout spines on inner margin; glossae bearing numerous long hairs and stout spines; hypopharynx as in Fig. 336.

Thorax. Nota with spines and scattered fine hairs on margins. Femora broad at base, narrower apically; femora and tibiae densely covered with hairs and spines (Fig. 351–353); tarsal claws as in Fig. 397.

Abdomen narrowly oval, broadest at segment 6, with posterolateral projections on segments 2–9 or 3–9, these blade-like on segments 7–9. Gills (Fig. 409) on segments 1–7 alike, successively smaller posteriorly, broad at base and tapered to apex, with densely ramifying tracheal branches.

Remarks. Acanthophlebia shares few characters with other New Zealand Leptophlebiidae, and appears to be more closely related to Pappoura of New Caledonia (Peters & Peters 1981a).
Acanthophlebia cruentata (Hudson)

Fig. 234 (nymph); Map 1


Male imago. Head pale yellowish brown. Eyes with upper portion pale orange-brown to pale brown, lower portion greyish black. Antennae pale yellowish brown.

Thorax. Nota and pleura pale yellowish brown; nota with prominent submedian and lateral marks, and black longitudinal marks on lateral margins. Legs pale yellowish brown; forefemora darker, with a diffuse brownish band near midlength; articulations of tibiae and tarsi washed with brown; tarsal joints pale brown. Forewing (Fig. 24) with cross veins in cells C and Sc surrounded by narrow, dark reddish-brown clouds; membrane hyaline, but tinted with pale yellow in cells C and Sc and at wing base. Hind wing (Fig. 25) hyaline, but proximal half of cell C tinted with pale yellow.

Abdomen (Fig. 64). Terga 1–7 hyaline, pale pinkish brown to pale brown; terga 1–8 or 1–9 with dark greyish submedian longitudinal lines; terga 2–8 with paired greyish anterolateral marks. Genitalia (Fig. 94–96) pale whitish, dark brown on midline. Caudal filaments whitish, with dark brown bands at annulations; segments each with a dark brown distal band.

Female imago as in male, but eyes greyish black, tarsi sometimes paler, and abdominal terga and sterna translucent. Sternae 7–9, Fig. 155, 183, 192.

Subimago with colour pattern as in imago but paler; wings (Fig. 206, 207) with membrane pale yellowish brown, longitudinal veins yellowish brown to hyaline, and cross veins surrounded by narrow, pale greyish clouds.

Mature nymph (Fig. 234). Head and antennae pale yellowish brown to reddish brown, with markings as in imago. Thorax pale brown to brown, with dark brown to black submedian and lateral marks. Legs (Fig. 351–353, 397) as in imago. Abdomen pale orange-brown; terga 7–10 often reddish brown dorsally and with faint markings as in imago. Gills (Fig. 409) hyaline to translucent, with tracheae dark brown to black. Caudal filaments brown.

Type data. Lectotype: female subimago, WN, Karori, Campbell's Stream, January 1900, G.V. Hudson (NMNZ).

Material examined. Lectotype, plus 291 non-type examples (18 5 and 16 2 imagos, 103 5 and 86 2 subimagos, 68 nymphs; AMNZ, BMNH, CMNZ, DRTC, FAMU, NMNZ, NZAC).

ND, AK, CL, WO, BP, TO, WN / —.

Habitat. Nymphs live in streams with low to moderate flow in the North Island and on Great Barrier Island where submerged wood, leaves, frass, gravel, and cobbles occur (Towns 1987). Swarming behaviour of adults has been observed in mid afternoon up to 3 m above quiet pools (McLean 1967).

Remarks. No holotype was designated by Hudson (1904). A lectotype was designated from pinned material collected by Hudson before 1904 (Towns 1983a), and is now in NMNZ.

Genus Arachnocolus Towns & Peters

Arachnocolus Towns & Peters, 1979b: 444–446.

Type species Arachnocolus phillipsi Towns & Peters, by original designation.

Imago. Eyes of male fused on meson of head. Claws paired, alike, apically hooked with an opposing hook, as in Fig. 23. Forewing (Fig. 26) with vein ICu1 attached at base to CuA and CuP by cross veins; costal region with fewer than 10 cross veins. Hind wing (Fig. 27) a little less than one-fifth as long as forewing, with costal margin convex; vein Sc three-quarters length of wing.

Genitalia. Male (Fig. 97, 98): styliger plate wider than long, with apex shallowly cleft; penes fused except for apical tenth, the openings with a row of hairs on ventral surface. Female unknown.

Nymph (Fig. 235). Antennae twice as long as head.

Mouthparts. Clypeus (Fig. 266) with anterior margin concave and lateral margins slightly divergent apically. Labrum (Fig. 266) broader than clypeus, with lateral margins rounded; anteromedian margin (Fig. 267) concave, with indistinct, broad-based, rounded denticles. Left man-
dible (Fig. 293) with proximal half smoothly curved, distal
half straight and with a row of hairs; incisors with apical
teeth unsculptured and pseudoral tuft reduced. Maxillary
palps (Fig. 309) with sparse hairs. Labium (Fig. 323) with
palps slender; palp segment 3 elongate, with a few spines
on inner margin; glossae broad; hypopharynx as in Fig.
339.

Thorax. Pronotum with small spines on anterolateral
margins. Legs (Fig. 354, 355): femora elongate, with
margins subparallel; femora and tibiae with a few scattered
hairs; tarsal claws, Fig. 398.

Abdomen narrowing posteriorly, with posterolateral
projections on segments 6–9 or 7–9. Gills (Fig. 410) on
segments 1–6 alike, successively smaller posteriorly, with
dorsal and ventral portions oval, each terminating in a long,
slender filament; dorsal portion narrower than the ventral,
with filament longer; gill 7 (Fig. 411) reduced to a single
thread-like filament.

Remarks. Arachnocolus appears to be close to Notachalcus
and Ounia from New Caledonia (Peters & Peters 1981a).

Arachnocolus phillipsi Towns & Peters
Fig. 235 (nymph); Map 2

phillipsiTowns & Peters, 1979b: 446–449 (Arachnocolus)
(figures of wings, claws, ♂ and ♀ genitalia, colour
patterns, whole nymph, nymphal mouthparts, gills and
legs).

Dimensions (mm). Male: length of body 6.6–7.2; forewings

Male imago. Head whitish, with blackish-brown marks
near antennae and eyes. Eyes with upper portion pale
brownish orange, lower portion dark grey. Antennae with
scapes brown, flagellum pale brown.

Thorax. Nota and pleurae pale brown; pronotum dark
brown on margins and with paired dark brown submedian
lines. Legs pale yellowish brown, brown at articulations of
forelegs, pale brown at articulations of middle and hind
legs. Wings (Fig. 26, 27) with all veins and membranes
hyaline, washed with pale brown at wing base, but forewing
with longitudinal veins pale brown to brown, and cross
veins in distal third of cells C and Sc brown, surrounded
with narrow brown clouds.

Abdomen (Fig. 65): terga 1–7 hyaline with a narrow,
slight dark brown transverse band on posterior margin; terga
8–10 pale brown, darker on lateral margins. Genitalia (Fig.
97, 98) pale brown, but distal two-thirds of forceps whitish.
[Caudal filaments broken off and missing.]

Female imago unknown.

Subimago as in imago, but prothorax paler; forewing with
longitudinal veins pale brown and cross veins translucent,
but cross veins in cells C and Sc pale brown; hind wing with
longitudinal and cross veins translucent whitish, mem-
brane greyish white. Caudal filaments pale brownish white.

Mature nymph (Fig. 235) with markings as in imago.
Head and antennae pale yellowish brown, thorax pale
yellowish brown to pale brown, and legs pale yellowish
brown, occasionally darker at articulation of femora and
tibiae. Abdomen of male with colour pattern as in imago;
abdomen of female pale yellowish brown, with paired
lateral brown marks on terga 1–9 and paired submedian
brown markings on terga 2–5 or 2–6. Gills (Fig. 410, 411)
with lamellae translucent yellowish brown. Caudal fila-
ments pale yellowish brown.

Type data. Holotype: male imago, AK, Cascade Stream,
reared from nymph, 5 April 1976, D.R. Towns (NZAC).

Paratypes: NZAC – 1 ♂ imago, 1 ♂ subimago, 36
nymphs; CMNZ – 5 nymphs; FAMU – 5 nymphs.

Material examined. Type specimens, plus 73 non-type
examples (CMNZ, DRTC, FAMU, NZAC).

ND, AK, WO, CL / —.

Habitat. Nymphs are most abundant in slow-flowing
reaches of streams, on vegetation trailing into the water. On
Great Barrier Island they were most abundant in first-order
streams on wood and leaves (Towns 1987).

Remarks. Arachnocolus phillipsi is so far known only
from the northern North Island and Great Barrier Island.
However, there has been little sampling effort elsewhere in
small first-order streams. It is likely that with more sam-
pling effort it will be shown to have a wider distribution.

Genus Atalophlebioides Phillips

Deleatidium (Atalophlebioides) Phillips, 1930: 359 (unde-
fined subgenus).

Atalophlebioides: Peters & Edmunds, 1964: 238 (elevated
to genus).

Type species Deleatidium (Atalophlebioides) cromwelli
Phillips, by subsequent designation of Peters & Edmunds
(1964).

Imago. Eyes of male fused on meson of head. Claws (Fig.
13) paired, dissimilar, one apically hooked, the other pad-
like with a small apical hook. Forewing (Fig. 28) with vein ICh1 attached at base to CuA and CuP with cross veins. Hind wing (Fig. 29) a little less than one-quarter as long as forewing; vein Sc three-quarters to nine-tenths length of wing; cross veins few.

Genitalia. Male (Fig. 99, 100): styliger plate wider than long, with apex slightly cleft; penes fused, approximately triangular, with 2 rounded apical lobes and a small midventral appendage. Female: sternum 7 without a genital extension; sternum 9 (Fig. 193) entire or slightly concave apically.

Nymph (Fig. 236). Antennae 1.5× as long as head.

Mouthparts. Clypeus (Fig. 268) with lateral margins divergent apically, anterior margin straight. Labrum (Fig. 268) wider than clypeus, in length one-third to a little less its maximum width, with lateral margins rounded; apical margin (Fig. 269) hooked, with a deep anteromedian emargination. Lef mandible (Fig. 294) with a single small marginal hair tuft, and outer margin curved; incisors (Fig. 295) with serrated apical teeth. Maxillae (Fig. 310) with palp slender, bearing scattered fine hairs and fine hairs. Labium (Fig. 324) with palp slender; palp segment 3 with fine spines on inner margin; glossae large, on same plane as paraglossae; hypopharynx, Fig. 338.

Thorax. Pronotum with small spines on anterolateral margin. Legs (Fig. 356, 357): femora elongate-oval; femora and tibiae with scattered small spines and fine hairs; tarsal claws, Fig. 399.

Abdomen tapered posteriorly, with posterolateral projections on segments 2–9. Gills (Fig. 412) on segments 1–7 alike, successively smaller posteriorly; dorsal and ventral portions of lamellae slender, tapered towards apex; trachea with main trunk along midline of gills.

Remarks. Atalophlebioides was elevated to generic rank by Peters & Edmunds (1964), although differences between it and Deleatidium had first been noted by Ulmer (1938) and later by Traver (1946) (see also p. 28). Following the revision of Atalophlebioides by Towns & Peters (1978), most Australian species previously assigned to Atalophlebioides were placed in Austrophlebioides (Campbell & Suter 1988), and Chilean representatives have been referred to Meridialaris (Pescador & Peters 1987).

Atalophlebioides is most closely related to Deleatidium of New Zealand, from which it can be distinguished in the imago by (1) hind wing vein Sc less than nine-tenths length of wing (Fig. 29), (2) sternum 9 of female entire (Fig. 193), and (3) penes with a mid-ventral appendage and rounded apical lobes (Fig. 99), and in the nymph by (1) labrum rounded on lateral margins (Fig. 268), and (2) abdominal gills with dorsal and ventral lamellae (Fig. 412).

Atalophlebioides cromwelli (Phillips)

Fig. 236 (nymph); Map 3


Male imago. Head brown, darker between antennae. Eyes with upper portion greyish brown, lower portion black. Antennae brown.

Thorax. Nota pale brown to dark brown; pronotum washed with black. Legs pale brown; coxae irregularly washed with dark brown. Wings (Fig. 28, 29): veins and membranes hyaline, with wing bases pale brown, but longitudinal veins of forewings and veins Sc and R of hind wings brown, and distal third of forewing cells C and Sc translucent whitish.

Abdomen (Fig. 66): terga washed with pale brown and black; terga 1–6 with a narrow, transverse, dark brown to black band on posterior margin; terga 2–7 with a dark brown anterior transverse band broken at midline, the area between band and posterior margin pale reddish brown to hyaline; anterior and lateral margins of terga 2–6 and anterior margin of tergum 7 hyaline. Genitalia (Fig. 99, 100) pale brown.

Female imago as in male, but head darker, eyes black, legs pale yellowish brown, with forelegs occasionally dark brown at apex, and abdomen (Fig. 156) darker, with hyaline areas opaque and smaller. Sternum 9, Fig. 193.

Subimago with colour pattern as in male imago, but eyes in male with upper portion orange-brown, wing veins and membranes pale grey, and abdominal terga darker, with anterior margins whitish brown. Caudal filaments pale brown, with darkerannulations at articulations.

Mature nymph (Fig. 236) as in male imago except as follows. Head pale brown to dark brown washed with darker brown or black; eyes in male with upper portion deep reddish brown; antennae pale yellowish brown. Thoracic nota brown; pronotum and mesonotum with dark brown markings on anterolateral margins; metanotum with a narrow, dark brown band near posterior margin. Legs
Abdominal terga with anterior third pale brown. Gills (Fig. 412) with membrane hyaline to pale brown. Caudal filaments pale brown.


**Material examined.** Lectotype, plus 151 non-type examples (11♂ and 25♀ imagos, 18♂, 23♀ and 1 gynandro-morph subimagos, 73 nymphs; BMNH, BPBM, CMNZ, FAMU, NMNZ, NZAC).

Habitat. Nymphs of *Atalophlebioides cromwelli* are found on rocky substrates in a variety of running waters from relatively small streams to large rivers (Towns & Peters 1978, Towns 1987). Around Wellington Phillips (1930) found nymphs to be common only during late summer and autumn.

**Remarks.** No types were designated by Phillips. A lectotype was designated by Towns & Peters (1978).

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**Genus Austroclima** Towns & Peters


Type species *Deleatidium (Atalophlebioides) sepia* Phillips, by original designation.

**Imago.** Eyes of male fused to narrowly separated on meson of head. Claws (Fig. 14) paired, dissimilar, one apically hooked, the other obtuse, pad-like. Forewing (Fig. 30) with vein ICu1 attached at base to CuA and CuP with cross veins; cross veins numerous. Hind wing (Fig. 31) a little less than one-quarter as long as forewing; costal margin concave slightly basal to midlength; vein Sc from a little more than four-fifths length of wing to about equal; cross veins numerous.

Genitalia. Male (Fig. 101-104): styliger plate wider than long, with apex slightly concave; penes divided from apex to styliger plate, the lobes each with a subapical dorsal spine on a small accessory lobe near lateral margin at midlength. Female: sternum 7 without a genital extension; sternum 9 (Fig. 194) entire, slightly concave apically.

**Nymph.** (Fig. 237, 238). Antennae 1.5-2× as long as head.

**Mouthparts.** Clypeus (Fig. 270) with lateral margins subparallel, anterior margin shallowly concave. Labrum (Fig. 270) broader than Clypeus, with lateral margins angularly expanded; anterior margin (Fig. 271) deeply cleft, with 4 shallow slits (denticles). Left mandible (Fig. 296) with outer margin angular, and with a small marginal hair tuft; incisors with apical teeth unserrated. Maxillae (Fig. 311) narrow, with 12-18 subapical spines; palp elongate, with segment 2 not broadened distally. Labium (Fig. 325) with palps broad; palp segment 3 elongate-conical, with scattered fine spines; glossae small, dorsal to paraglossae; hypopharynx, Fig. 339.

**Remarks.** The type species of *Austroclima* was originally placed by Phillips (1930) in *Deleatidium*, subgenus *Atalophlebioides*. However, our analyses have shown that the only characters shared with either *Atalophlebioides* or *Deleatidium* are hyaline forewings and dissimilar claws (Towns & Peters 1979a, 1980). The structure of male and female genitalia and most aspects of nymphal morphology are unlike any species in *Deleatidium* and *Atalophlebioides*.

*Austroclima* is most closely related to *Mauiulus* of New Zealand, but also shares characters with *Dactylophlebia* and *Magellanella* of southern South America. *Austroclima* can be distinguished from *Mauiulus* in the imago by (1) hind wings (Fig. 31) with costal margin concave and vein Sc more than four-fifths length of the wing, (2) sternum 9 of female (Fig. 194) concave, and (3) sexes with colour pattern similar, and in the nymph by (1) abdominal gills (Fig. 413, 414) plate-like, (2) mandibles (Fig. 296) with outer margin angular, and (3) sexes with colour pattern similar.

**KEY TO SPECIES OF AUSTROCLIMA**

**Imago**

Abdominal terga brown, with large, pale brown maculae on terga 3-9 (Fig. 67); male with a flat-topped accessory spine on penes (Fig. 103) (p. 22) .. *sepia*

—Abdominal terga dark brown, without maculae (Fig. 68); male with a pointed accessory spine on penes (Fig. 104) (p. 23) .. *jollyae*

**Nymph**

Abdominal gills oval, with lamellae hyaline (Fig. 413); abdominal terga 3-7 usually with pale maculae (Fig. 237) (p. 22) .. *sepia*
—Abdominal gills angularly expanded apically, with lamellae darkly pigmented except on lateral margins (Fig. 414); abdominal terga dark brown, without maculae (Fig. 238) ... (p. 23) ... jollyae

**Austroclima sepia** (Phillips)

Fig. 237 (nymph); Map 4


**Male imago.** Head brown, darker between antennae. Eyes with upper portion orange-brown to pale brown, lower portion dark grey to black. Antennae brown.

Thorax. Pronotum brown; mesonotum and metanotum dark brown; nota washed with black. Legs yellowish brown, with articulation of femora and tibiae brown; forelegs darker; coxae brown washed with black. Wings (Fig. 30, 31) with veins brown, membranes hyaline to faintly tinted with brown; wing base washed with pale brown. Forewing cells C and Sc translucent whitish in distal third.

Abdomen (Fig. 67) dark brown; terga each with anterolateral quarter pale brown; terga 2–5 or 2–6 with a pale mid-dorsal line edged with dark brown; terga 2–7 with paired, pale anterior submedian maculae; terga 3–9 with large, pale brown, paired lateral maculae. Genitalia (Fig. 101–103) pale brown; penes with lateral accessory lobes bearing a flattened projection terminating in a small spine. Caudal filaments brown, with darker annulations at articulations.

**Female imago** as in male, but with head pale brown, eyes black, and abdomen (Fig. 157) paler. Sternum 9 (Fig. 194) concave apically and grooved along midline.

**Subimago** as in imago, but abdomen darker, wing membranes brownish grey, genitalia whitish, and caudal filaments paler.

**Mature nymph** (Fig. 237). Head yellow-brown to brown; eyes and antennae coloured as in imago.

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Mouthparts. Clypeus, Fig. 270. Labrum (Fig. 270, 271): length 0.50–0.63(0.57)× width. Mandibles, Fig. 296. Maxillae (Fig. 311): galea-lacinia bearing a subapical row of 14–18 spines; palp segment 2 0.94–1.08(1.02)× as long as segment 1, and segment 3 0.55–0.67(0.61)× segment 2. Labium (Fig. 325): palps with segment 2 0.89–1.05(0.98)× as long as segment 1, and segment 3 0.60–0.75(0.67)× segment 2. Hypopharynx, Fig. 339.

Thorax pale yellow-brown to dark brown, with or without dark markings on lateral and posterior margins; pronotum pale yellow-brown to dark brown, with darker lateral markings and scattered small spines on anterolateral margin. Legs (Fig. 358, 359): femora pale yellow-brown, their articulation with tibiae dark brown; tibiae pale brown.

Abdomen as in imago. Gills (Fig. 413) with lamellae oval, translucent whitish to hyaline; tracheae with numerous branches. Caudal filaments as in imago.

**Type data.** Neotype: male imago, AK, Auckland, Cascade Stream, reared from nymph, 7 September 1974, D.R. Towns (NZAC).

**Material examined.** Neotype, plus 534 non-type examples (3 δ and 4 Φ imagos, 11 δ and 13 Φ subimagos, 503 nymphs; BMNH, BPBM, CMNZ, DRTC, FAMU, NMNZ, NZAC).

ND, AK, CL, WO, TO, TK, WN / NN, BR, NC.

**Habitat.** *Austroclima sepia* is widely distributed in New Zealand from sea level to 1000 m altitude (Towns & Peters 1979a). It seems to be most common in small streams, where it dominates a small fauna of mayflies found on aquatic mosses in rapidly flowing water (Towns 1987). In contrast, Phillips (1930) found nymphs on shingle in slower parts of streams in the Wellington area.

**Remarks.** No type material was designated by Phillips (1930) when he first described this species. A specimen that was probably part of Phillips’s original series was located by Towns & Peters (1979a) in the National Museum of New Zealand. This specimen was labelled in handwriting presumed to be that of Phillips as *Atalophlebia sepia*, although the species was included in *Deleatidium* when Phillips’s description was published. Unfortunately this specimen is damaged, and can not be assigned to species with any confidence. A female imago collected in “R. Hutt 30/11/28,” almost certainly a part of Phillips’s original series, was located at the Canterbury Museum (Christchurch) by Mr Terry Hitchings in 1993. This specimen is also damaged beyond recognition, so the neotype designated (Towns & Peters 1979a) remains valid.
**Austroclima jollyae** Towns & Peters  
*Fig. 238 (nymph); Mep 5*

**jollyae** Towns & Peters, 1979a: 220–224 (*Austroclima*).


**Male Imago.** Head dark brown to black, with anterior and lateral margins paler. Eyes with upper portion reddish brown to pale brown, lower portion black. Antennae brown, with flagellum paler.

Thorax. Pronotum brown, irregularly washed with black; mesonotum and scutellum darker. Legs yellowish brown, the forelegs darker; articulations and coxae brown. Wings with veins brown, membrane hyaline faintly tinted with brown, and base brown; forewing cells C and Sc translucent whitish in distal third.

Abdomen (Fig. 68): terga 1–9 dark brown, with terga 2–6 paler in anterior third and terga 3–6 paler along midline; terga 2–5 each with a pale brown posterior transverse band; terga 2–7 with paired, pale submedian maculae. Genitalia pale brown; penes with a pointed spine on dorsolateral surface of each lobe (Fig. 104). Caudal filaments pale brown, darker at articulations.

**Female Imago** as in male, but with head dark brown, eyes black, and abdomen paler; sternum 9 entire, slightly concave apically.

**Subimago** as in imago except as follows. Eyes of male orange-brown; thorax brown to dark brown, with darker marks on mesonotum; femora dark brown on dorsal margin and in distal third; wings with veins pale brownish, membranes brownish grey, and base of forewings washed with pale brown; abdomen darker.

**Mature nymph (Fig. 238).** Head pale brown to dark brown, darker between eyes; antennae pale brown.

Mouthparts. Labrum length 0.50–0.59(0.55)× width. Maxillae: galea-lacinia bearing a subapical row of 12–14 spines; palp segment 2 0.90–1.10(1.00)× as long as segment 1, and segment 3 0.50–0.54(0.52)× segment 2. Labial palps with segment 2 0.90–1.10(1.02)× as long as segment 1, and segment 3 0.44–0.50(0.48)× segment 2.

Thorax with nota pale brown to dark brown with darker markings; pronotum rectangular, the anterolateral margin with few spines or none. Legs pale brown, with articulations darker; forefemora with a paler ventral macula near apex.

Abdomen dark brown; terga darker near posterior margins, paler on lateral margins. Gillis (Fig. 414) angularly expanded apically, darkly pigmented except for outer margins; tracheae black. Caudal filaments as in imago.


Paratypes: NZAC – 5♂ and 15♀ imagos; 20♂ and 7♀ subimagos, 53 nymphs; NMNZ – 1♂ and 1♀ imago, 4♂ and 2♀ subimagos, 23 nymphs; CMNZ – 2♂ and 4♀ imagos, 1♂ and 2♀ subimagos, 21 nymphs; BMNH – 1♂ and 1♀ imago, 2♂ and 2♀ subimagos, 10 nymphs; FAMU – 1♂ imago, 1♂ and 5♀ subimagos, 23 nymphs; BPBM – 2♂ and 4♀ subimagos, 7 nymphs.

**Material examined.** Type specimens, plus 4 non-type nymphs (BMNH, BPBM, CMNZ, DRTC, FAMU, NMNZ, NZAC).

ND, AK, CL, WO / NN, BR, WD, NC, CO, SL, FD.

**Habitat.** *Austroclima jollyae* is found throughout New Zealand from near sea level to 1000 m. Like *A. sepia*, *A. jollyae* is most common in small, forested streams, although in very rapid flow it is often the more abundant of the two.

**Australonella** new genus

Type species *Zephlebia (Zephlebia) planulata* Towns.

**Imago.** Eyes of male fused on meson of head, with lower portion three-fifths as long as upper portion; eyes of female separated on meson of head by 3.5× maximum width of eye.

Legs: [forelegs broken off and missing]; claws paired, alike, apically hooked, with an opposing hook, as in Fig. 23.

Wings (Fig. 32, 33). Forewing a little wider than one-third its own length; vein Rs forked at little less than one-quarter distance from base to margin; vein MA symmetrically forked at a little less than half distance from base to margin; vein MP 2 attached at base to CuA and MP 1 with a cross vein; attachment of MP 2 to MP 1 one-quarter distance from base to margin; MP 3 with base equidistant between MP 1 and CuA; vein ICu 1 attached at base to CuA and CuP by cross veins. Hind wing a little more than half as wide as long and one-fifth (to a little less) as long as forewing, with apex acute; costal margin with a blunt projection at midlength; cross veins mainly confined to
cells C and Sc; vein Sc from a little less to a little more than three-quarters length of wing; vein R1 a little more than nine-tenths length of wing.

Genitalia. Male (Fig. 105, 106): styliger plate a little less than half as long medially as its maximum width, broadly concave at apex. Forecords broad at base; inner margin with a small lobe and forming an angular bend near midlength; segment 2 equal in length to segment 3, and one-fifth as long as segment 1; segment 3 rounded at apex. Penes a little more than two-thirds as long as forecords segment 1, fused to apex; openings each with a row of hairs on ventral surface. Female: sternum 7 with genital extension reaching to a little more than one-tenth along sternum 8 (Fig. 184); sternum 9 entire (Fig. 195).

Nymph (Fig. 239). Head prognathous. Antennae 1.7× as long as head.

Mouthparts. Clypeus (Fig. 272) with short hairs over dorsal surface, anterior margin concave, and lateral margins subparallel. Labrum (Fig. 272) about as wide as clypeus, from a little less to a little more than half as long as wide, with dorsal hairs and submedian, anteromedian, and lateral areas of hair ventrally; anterior margin (Fig. 273) concave, with a median denticle and 1 or 2 broad-based denticles on either side of it. Left mandible (Fig. 297) with scattered hairs from middle of smoothly curved outer margin to base; incisors with unserrated apical teeth; prophalaxal hair tuft large. Maxillae (Fig. 312): galea-lacinia narrow in distal half, with a subapical row of 10-14 spines; palp segment 2 as long as segment 1, and segment 3 nine-tenths as long as segment 2. Hypopharynx (Fig. 340): lingua with well developed lateral processes, and submedian lobes with a crest of small hairs; superlingua as in Fig. 340, with a hair row along anterior margin and with lateral margins rounded. Labium (Fig. 326) with palps slender; palp segment 2 a little longer than segment 1, and segment 3 three-quarters as long as segment 2; glossae elongate, folded as in Fig. 326, dorsal to paraglossae; submentum with scattered spines and hairs on lateral margins.

Thorax: pronotum with anterolateral margins expanded, rounded, bearing small spines. Legs (Fig. 360-362): femora in cross-section oval, expanded apically, with distal half indented so that tibia can be withdrawn into femur, and dorsal surface with numerous large spines; tibiae in cross section suboval, the inner surface flattened and covered with large, bipocinatate spines; claws (Fig. 401) hooked, large, with numerous small denticles becoming successively larger apically.

Abdomen with posteralateral projections on segments 8 and 9. Gills (Fig. 415) on segments 1-7 alike, successively smaller posteriorly; lamellae with dorsal and ventral portions very narrow; tracheae unbranched, pigmented distally. Terminal filament a little longer than body.

Egg (Fig. 458, 459) elongate-oval; chorion with vermiciform sculpturing and with stellate attachment structures over surface.

Remarks. The only species so far known in Austronella was originally described as Zephlebia (Z.) planulata by Towns (1983a). However, Towns pointed out that the generic position of Z. planulata might need revision once nymphs became available, because it was the only species in Zephlebia with (1) sternum 9 with apex consistently entire, (2) genital extension of female imago reaching to one-tenth along sternum 8, and (3) hind wings one-fifth as long as forewings. Imagos reared from nymphs by Mr Phillip Summers have now enabled identification of all life stages of this species. Our data show that the species hitherto referred to as Zephlebia (Z.) planulata is not a member of Zephlebia s.s., although it appears to be within the Zephlebia phylogenetic lineage (Towns & Peters 1980). Accordingly, the new genus Austronella is established to accommodate it.

Austronella can be distinguished from all other known leptophlebiid genera by the following combinations of characters. Imago: (1) claws of a pair similar, as in Fig. 23; (2) hind wings about one-fifth as long as forewings; (3) penes broad, fused to apex, two-thirds as long as forecords segment 1 (Fig. 105); (4) penes with hairs at base of each opening (Fig. 105); (5) sternum 9 of female entire (Fig. 195); and (6) female genital extension reaching to one-tenth along sternum 8 (Fig. 184). Nymph: (1) labrum with lateral margins rounded and anterior margin concave (Fig. 272); (2) labrum, with a single median denticle and two broad lateral denticles on anterolateral margin (Fig. 273); (3) dorsal and ventral portions of abdominal gills on segments 1-7 very narrow (Fig. 415); (4) claws long, narrow, with small denticles (Fig. 401); and (5) abdomen with posteralateral projections on segments 8 and 9.

Despite their narrow gills the nymphs of Austronella in habitus resemble nymphs in the Ephemerellidae, a family not represented in New Zealand. Ephemerellid features are the short, stout legs, long claws, and laterally expanded prothorax. The generic name reflects this affinity. Austronella appears to be most closely related to Tenagophila from New Caledonia (Peters et al. 1996).

Etymology. From australis (Latin), 'southern', plus -ella, a diminutive suffix commonly used in Ephemerellidae; feminine.
**Austronella planulata** (Towns) new combination

Fig. 239 (nymph); Map 6

*planulata* Towns, 1983a: 17–18 (*Zephlebia* (*Zephlebia*)) (figures of wings, ♂ and ♀ genitalia, abdominal coloration of imagos; wings of subimago).

**Dimensions** (mm). Male: length of body 5.7–8.1; forewings 7.8–9.0. Female: length of body 5.8; forewings 7.5–9.1. Mature nymph 6.0–7.5.

**Male Imago.** Head pale brown. Eyes with upper portion reddish brown to orange-brown, lower portion black. Antennae brown to dark brown.

Thorax. Pronotum pale brown, with darker marks on midline, submedially, and on anterior and posterior margins; mesonotum, metanotum, and posterior scutal prothoraces pale brown to brown, with sutures darker, mid dorsum of scutellum whitish, and midline brown. Sterna pale brown to brown, with carinæ and furcasternæ darker. [Legs broken off and missing.] Wings, Fig. 32, 33. Forewing: membranes hyaline except for a distinct dark brown cloud at fork of MA and another at midlength from cell C; cells C and Sc in stigmatic area translucent; longitudinal and cross veins brown; cross veins in cells C and Sc surrounded by narrow, dark brown clouds that are darker towards wing base and apex. Hind wing: longitudinal and cross veins pale brown; membranes hyaline, but darker at wing base.

Abdomen (Fig. 69) pale whitish. Terga 1–7 hyaline, with brown to dark brown lateral marks; terga 2–4 with paired, submedian brown marks; tergum 7 dark brown dorsally; terga 8–10 pale brown to dark brown. Sterna 1–7 hyaline, whitish; sterna 8–10 translucent whitish to pale brown. Genitalia (Fig. 105, 106) and caudal filaments whitish.

**Female Imago.** Head as in male, but dark brown between eyes and occasionally posterior to base of antennæ. Eyes black. Thorax and wings with colour pattern as in male, but mesopleuron irregularly washed with dark brown, clouds around cross veins in forewing cells C and Sc darker and broader, and longitudinal and cross veins darker. Legs pale yellowish brown, brown at articulations of femora and banded with brown at midlength of tibiae and at base of tarsi.

Abdomen pale brown to brown, with markings as in imago, but dark submedian marks more numerous, and pale submedian marks occasionally present. Gills, Fig. 415. Caudal filaments pale yellowish brown, darker at articulations.

**Type data.** Holotype: male imago, WO, Waitomo Caves, Glow-worm Grotto, 27 May 1979, C. Pugsley (NZAC). Allotype ♀ imago: same data as holotype (NZAC). Paratypes: NZAC -2 ♂ and 3 ♀ imagos, 2 ♂ and 5 ♀ subimagos; NMNZ -1 ♂ and 2 ♀ subimagos; CMNZ -1 ♂ imagos; BMNH -1 ♂ and 2 ♀ subimagos; FAMU -2 ♂ and 2 ♀ subimagos; DTNC -1 ♂ and 2 ♀ subimagos.

**Material examined.** Type series, plus 11 non-type examples (1 ♂ and 3 ♀ imagos, 7 nymphs), including non-type vouchers of nymphs (NZAC, FAMU).

ND, WO, BP, TO, WN /—.

**Remarks.** Few nymphs of *Austronella planulata* have ever been collected, so its habitat and habits remain unknown.
**Genus Cryophlebia** Towns & Peters


Type species *Atalophlebioides aucklandensis* Peters, by original designation.

**Imago.** Eyes of male separated by a little less than width of lateral ocellus. Claws (Fig. 15) paired, dissimilar, one hooked with an opposing hook, the other obtuse, pad-like. Forewing (Fig. 34) with vein *ICu* 1 attached at base to *CuA* and *CuP* with cross veins; cross veins numerous. Hind wing (Fig. 35) one-quarter as long as forewing, with costal margin smoothly curved, vein *Sc* nine-tenths length of wing, and cross veins numerous.

Genitalia. Male (Fig. 107, 108): styliger plate wider than long, concave at apex; penis lobes fused except for distal quarter, each with a large, broad-based spine near dorsolateral margin. Female: sternum 7 without a genital extension; sternum 9 (Fig. 196) shallowly cleft apically.

**Nymph** (Fig. 240). Antennae 3× as long as head.

Mouthparts. Clypeus (Fig. 274) with lateral margins divergent distally, anterior margin strongly concave. Labrum (Fig. 274) longer and wider than clypeus; anterior margin (Fig. 275) concave, with blunt denticles. Left mandible (Fig. 298) with outer margin angular, and with scattered hairs extended from middle of outer margin to base; incisors slender, with unserrated apical teeth. Maxillae (Fig. 313) with 21–23 subapical spines; palp segment 3 elongate-conical. Labium (Fig. 327) with glossae dorsal to paraglossae; hypopharynx as in Fig. 341.

Thorax. Pronotum with small spines on anterolateral margin. Legs (Fig. 363, 364) with a submarginal row of hairs on tibiae and tarsi; tarsal claws as in Fig. 402.

Abdomen tapered posteriorly, with postero-lateral projections on segments 7–9. Gills (Fig. 416) on segments 1–7 alike, successively smaller posteriorly; lamellae with dorsal and ventral projections slender.

Remarks. The type species was originally described in *Atalophlebioides* by Peters (1971), from which it was transferred by Towns & Peters (1979a).

Towns & Peters (1979a) suggested that *Cryophlebia* is related to *Atalophlebioides*, but the male genitalia are most similar to those of *Austroclima*. On the other hand some characters of the nympha1 mouthparts (e.g., the short clypeus and long labrum) are not paralleled elsewhere in the *Atalophlebioides* lineage.

**Cryophlebia aucklandensis** (Peters)

Fig. 240 (nymph); Map 7


**Dimensions (mm).** Male: length of body 6.0–9.2; forewings 9.8–11.1. Female: length of body 7.2–7.8; forewings 10.0–11.1. Mature nymph 7.0–7.7.

**Male imago.** Head dark brown. Eyes with upper portion pale brown, lower portion black. Antennae pale.

Thorax dark brown, with sutures paler, carinae darker. Legs: coxae and trochanters brown; remainder of legs paler, but apex of femora darker; claws, Fig. 15. Wings (Fig. 34, 35) with longitudinal and cross veins pale brown, membranes hyaline, but distal third of forewing cells C and Sc translucent brownish white.

Abdomen (Fig. 70) pale brown; terga 2–8 with darker brown lateral markings. Genitalia (Fig. 107, 108) and caudal filaments pale brown.

Female imago as for male, but with head and antennae pale brown, coxae dark brown, trochanters brown, and abdomen (Fig. 159) brown, with terga 2–8 darker and the remainder washed with dark brown.

Subimago as in male imago except as follows. Head of male brown, black at base of ocelli; female paler. Mesonotum and metanotum brown, darker on lateral margins, with pale brown mid-dorsal and submedian longitudinal lines; posterior scutal protuberance and scutellum pale brown; notal furrows dark brown to black. Pleura whitish. Sternum brown, but prosternum whitish. Wings with membranes pale brown, longitudinal veins darker, and cross veins hyaline. Abdomen dark brown, with terga 5 and 6 paler mid-dorsally, and sternum dark brown.

Mature nymph (Fig. 240) as in imago, but head and thorax brown, and abdomen as in subimago; legs, Fig. 363, 364, 402; gills, Fig. 416.

Type data. Holotype: male imago, Auckland Island (N), Mt Eden, rocky stream Bivouac Hill, 540 m, 6–17 January 1963, J.L. Gressitt (NZAC). Allotype female imago: same data as holotype.

Paratypes: NZAC – 12 ∞ and 4 ♀ subimagos, 19 nymphs; BPBM – 5 ∞ and 1 ♀ imagos, 12 ∞ and 4 ♀
subimagos, 19 nymphs; FAMU—10 δ and 2 Φ imagos, 14 δ and 6 Φ subimagos, 38 nymphs; ANIC—3 δ imagos, 7 δ and 3 Φ subimagos, 19 nymphs; LFML—2 δ imagos, 2 δ and 2 Φ subimagos, 7 nymphs.

Material examined. Type series only.

Habitat. Nymphs were found under rocks in small streams, subimagos were found on wet rock surfaces, and imagos were collected swarming above streams (Peters 1971).

Genus Deleatidium Eaton


Type species Deleatidium lillii Eaton, by original monotypy.

Dimensions (mm). Male imago: body length 5.5-15.0; forewings 6.5-15.4. Female: body length 5.6-14.4; forewings 6.7-17.6. Mature nymph: body length 5.0-15.7.

Imago. Eyes of male fused or slightly separated on meson of head, with lower portion three-quarters to nine-tenths as long as upper portion; eyes of female separated on meson of head by 2.0-2.75x maximum width of eye.

Legs: length ratios of foreleg segments in male 0.65-0.89 : 1.00 (2.4-4.4 mm) : 0.03-0.09 : 0.35-0.48 : 0.32-0.46 : 0.25-0.40 : 0.08-0.15; claws of a pair similar, hooked without opposing hook, or dissimilar, one apically hooked, the other pad-like, with or without a small apical hook (Fig. 16-20).

Wings (Fig. 36-43). Forewing: width one-third to a little more than one-third as long as head; veins Rs forked at one-fifth (to a little less) of distance from base to margin; vein MA symmetrically forked at two-fifths (or a little less) to half distance from base to margin; vein MP2 at base closer to CuA than to MP1, attached to both with a cross vein, the attachment to MP1 at one-fifth (or a little less) to one-quarter distance from base to margin; vein ICu attached at base to CuA and CuP with cross veins; remainder of Cu-A area as in Fig. 36, 40, 42; membrane hyaline to pigmented in cells C and Sc. Hind wing (Fig. 37, 41, 43) rounded at apex, with costal margin concave at midlength; width half to two-thirds of length, and length one-fifth to one-third that of forewings; vein Sc nine-tenths length of wings to almost equal; vein R1 equal to wing length.

Genitalia. Male (Fig. 109-128): styliger plate a little less than one-third to a little less than half as long medially as its maximum width, shallowly cleft at apex (Fig. 109, 111, 125, 127); forceps segment 2 from nine-tenths to a little more than one and a quarter times as long as segment 3, and from one-fifth to one-quarter (or a little more) segment 1; segment 3 indented at apex; base of forceps broad, with inner margin forming a smooth to angular bend near midlength (Fig. 109, 115, 121, 125); penes fused, broad at base, with or without paired or fused subapical ventral appendages. Female: sternum 9 (Fig. 197-199) cleft. Terminal filament longer than cerci.

Mature nymph (Fig. 241-249). Head prognathous. Antenna 1.5-2.5x as long as head.

Mouthparts. Clypeus (Fig. 276, 278) with lateral margins divergent apically. Labrum (Fig. 276, 278): length from one-quarter (or a little more) to one-third (or a little more) of width, with dorsal hairs, and with submedian, anterocentral, and anterolateral hair ventrally; anterior margin (Fig. 277, 279) smoothly curved or flat, rolled ventrally; ventral surface with anteromedian cleft bearing 2-5 small, flat-topped to rounded denticles; lateral margins rounded to acute. Left mandible (Fig. 299, 301) with a single small hair tuft on middle of outer margin; prostheca tuft small; incisors (Fig. 300) with serrated apical teeth. Maxillae (Fig. 314, 315): galea-lacinia with distal half expanded medially, bearing a subapical row of 17-26 subapical spines; palp segment 2 three-quarters (or a little more) as long as segment 1, and segment 3 three-fifths to nine-tenths segment 2. Labium (Fig. 328): palp segment 2 from two-thirds to nine-tenths as long as segment 1, and segment 3 three-fifths to three-quarters segment 2; glossa large, in same plane as paraglossae; submentum (Fig. 328-330) with or without spines. Hypopharynx (Fig. 342): lingua with well developed lateral processes; submedian lobes with a sclerotised crest bearing small hairs and spines; anterior margin deeply cleft, the cleavage lined with small spines; superlingua as in Fig. 342, with a hair row along anterior margin and blunt lateral margins.

Pronotum without spines, or with fewer than 5 small spines on anterolateral margins. Legs (Fig. 365-373): femora with large, bipocinate spines on inner margin; tarsi with or without spines on inner margin; claws (Fig. 403) hooked and narrow at apex, with denticles successively larger apically.

Abdomen with posteroventral projections on segments 2-7 up to 2-9. Gillis (Fig. 417-436) on segments 1-7 each
a single broad, undivided lamella, tapered acutely to plate-like with rounded margins; gills on segment 1 with ventral lobe extending up to 1.25× length of lamella; tracheae with main trunk along median line of lamellae and with numerous fine lateral branches. Terminal filament a little longer than cerci; segments each with a distal whorl of small denticles.

**Egg** (Fig. 460–469) cylindrical; chorion ornamented with small nodules and enlarged attachment structures, the latter scattered singly or in irregular rows.

**Remarks.** *Deleatidium* was established by Eaton (1899) to accommodate *D. illii* of New Zealand, with the main diagnostic feature of the genus: “Distinguished from *Leptophlebia* by the δ imago having genitalia conformable in pattern to those of an *Atalophlebia*, and by the nymph having tracheal branchiae in the form of single, ovate, acute, penni-veined, foliaceous lamellae” (p. 288). Phillips (1930) retained the first half of Eaton’s diagnosis but removed the single-gill character to accommodate species with “...adult characters of *Deleatidium* and nymphal characters of *Atalophlebia*” (p. 336). Phillips stated explicitly (p. 336) that *Deleatidium* was divided into two subgenera (*Deleatidium* s.s. and *Atalophlebioides*) as a temporary measure until the relationships of species with gills of double lamellae could be determined. Species from southern South America and Australia were later included in the genus (Ulmer 1938, Traver 1946, 1959, Hacker 1950, 1954). Traver (1946) included wing venation in the diagnosis, and later added “...subanal plate of female entire apically, obtuse” (Traver 1959, p. 3). Apparently these characters were identified from South American material and not from the type species; all New Zealand species of *Deleatidium* have the ninth sternum (= subanal plate) cleft. Hacker (1950, 1954) repeated Phillips’s abbreviated version of Eaton’s diagnosis to include several Australian species in the genus, and retained the two subgenera based on gill lamellae.

The distinctive features of *Atalophlebioides* were recognised by Ulmer (1938), who raised the subgenus to generic level. The validity of these genera was confirmed by Peters & Edmunds (1964) and Towns & Peters (1978). With subsequent revisions both the South American and Australian members of *Deleatidium* have been assigned elsewhere, so the genus is once again endemic to New Zealand.

The separation of *Deleatidium* into two subgenera is reinstated here, but on a different basis from that used by Phillips (1930). The nymphs of species previously assigned to *Penniketellus* have for the first time been identified, and cannot be distinguished from those in *Deleatidium*. However, because of some distinctive characters in the adults, *Penniketellus* is maintained as a subgenus within *Deleatidium* (as *Penniketellum*).

Members of *Deleatidium* are among the most abundant and ubiquitous of New Zealand stream invertebrates. However, identification of described species has proved almost impossible. Phillips (1930) described five new species of *Deleatidium* and redescribed *D. illii*. Unfortunately Phillips was unable to identify the nymphs of some of his new species, descriptions of imagoes were not sufficiently precise to allow identification to species, and he did not designate type material. In 1993 Mr Terry Hitchings of the Canterbury Museum in Christchurch located pinned mayflies with distinctive handwriting and labels identical to those attributed to Phillips by Towns & Peters (1978). Further, a letter written by Phillips in the Canterbury Museum files documented donation of the specimens (T. Hitchings, pers. comm., 1993). Some of these specimens are damaged, but for most species sufficient material is available to designate lectotypes and to permit species identifications that can be checked against reared material from the type localities.

Phillips (1930) noted that four of the species of *Deleatidium* were very similar, but one, *D. myzobranchia*, might be sufficiently distinctive to warrant another genus. We have examined all life stages, including the egg, and believe that the differences are insufficient to support Phillips’s suggestion.

*Deleatidium* was divided by Winterbourn (1978) into two informal species groups, the “illii group” (abdominal gills with pointed apices) and the “myzobranchia group” (abdominal gills with rounded apices). Our analysis of relationships within *Deleatidium* identified rounded gills in the subgenus *Penniketellum* and in two species groups within *Deleatidium* (sensu stricto).

*Deleatidium* can be distinguished from all other known genera of *Leptophlebiidae* by the following combination of characters. In the imago: (1) forewing vein MA symmetrical, and vein MP2 attached to MP1 by a cross vein at one-fifth to one-quarter distance from base to margin (Fig. 36, 40, 42); (2) hind wing with costal margin concave at midlength (Fig. 37, 41, 43); (3) hind wing vein Sc nine-tenths length of wing, and vein R5 attached to MP1 by a cross vein at one-fifth to one-quarter distance from base to margin (Fig. 36, 40, 42); (4) veins MP1 and MP2 divergent apically and in two species groups within *Deleatidium* (sensu stricto).
ble with apex of outer incisor serrated (Fig. 300).

Imagos of *Deleatidium* are most likely to be confused with *Atalophlebioides*, but can be distinguished by the following characters: (1) hind wing vein Sc more than nine-tenths length of wing (Fig. 37, 39, 41, 43); (2) sternum 9 of female with a well-defined apical cleft (Fig. 197); and (3) penes of male fused to apex and without apical lobes (Fig. 109–128). Nymphs of *Deleatidium* can be distinguished from *Atalophlebioides* by their broad, undivided abdominal gills.

**KEY TO SPECIES OF *DELEATIDiUM***

Because species in *Deleatidium* may show geographic variation, much of the following key has been based on the most stable structures – the reproductive system of imagos. For nymphs of some species, confirmation of identity will be possible only if males are reared through to the imago.

**Imago**

1 Tarsal claws similar, hooked (Fig. 20)  
   —Tarsal claws dissimilar, one hooked the other pad-like, with or without a small apical hook (Fig. 16–19)  
   *Deleatidium* (Deleatidium)  
   2

2(1) Forewings with costal and subcostal area pigmented with red or reddish-brown (Fig. 38, 40)  
   — Forewings either without pigmentation or with faint brown colour in costal area (Fig. 36)  
   4

3(2) Forewing pigmentation extended to cell R at midlength (Fig. 38); penes with apex not rolled ventrally, with bifid ventral appendages (Fig. 119, 120)  
   — Forewing pigmentation not extended to cell R at midlength (Fig. 40); penes with apex rolled ventrally, without ventral appendages (Fig. 121, 122)  
   6

4(2) Tarsal pad without an apical hook, as in Fig. 18  
   — Tarsal pad with an apical hook (Fig. 16, 17)  
   5

5(4) Abdominal ganglia lightly pigmented (terminal ganglion darker), connectives hyaline; penes without a ventral appendage, and triangular ventrally in proximal two-thirds (Fig. 113, 114)  
   — Abdominal ganglia and connectives all heavily pigmented; penes with a prominent, blunt ventral appendage, and rectangular ventrally in proximal two-thirds (Fig. 123, 124)  
   6

6(4) Forewing with longitudinal veins in anterior third hyaline; male forceps segment 1 with inner margin strongly angular (Fig. 115)  
   — Forewing with longitudinal veins in anterior third brown; male forceps segment 1 with inner margin smoothly curved (e.g., Fig. 109)  
   7

7(6) Penes elongated, cylindrical in distal third (Fig. 111)  
   — Penes triangular ventrally  
   8

8(7) Penes with a small subapical ventral appendage (Fig. 109, 110); terminal abdominal ganglion usually hyaline  
   — Penes with a large, bifid mid-ventral appendage (Fig. 117, 118); terminal abdominal ganglion pigmented  
   9

**Subimago**

1 Tarsal claws similar, hooked  
   — Tarsal claws dissimilar, one hooked the other pad-like, with or without a small apical hook  
   *Deleatidium* (Penniketellum)  
   2

2(1) Abdomen with large, mid-lateral pale maculae on terga 3–6 or 3–7 (Fig. 168); female head without pointed projections on posterior margin  
   — Abdomen without pale mid-lateral maculae (Fig. 169); female head with paired, pointed projections on posterior margin  
   3

3(1) Wing membranes white  
   — Wing membranes brown, grey, or mottled  
   4

4(3) Wings unicolorous brownish or grey  
   — Wings with clouds of darker pigment at cross veins  
   5

5(4) Abdomen with terminal ganglion pigmented  
   — Abdomen usually with ganglia not pigmented  
   6

6(5) Male genitalia with apex broad, triangular  
   — Male genitalia with apex narrow, pointed  
   7
8(7) Male genitalia with ventral appendages  
--- Male genitalia without ventral appendages

--- Abdomen without a pale mid-dorsal line (Fig. 244), the terga with crescent-shaped marks on posterior margin  
--- Abdomen with a pale mid-dorsal line (Fig. 241), the terga with marks on lateral and posterolateral margins

--- Abdomen with a pale mid-dorsal line (Fig. 241), the terga with marks on lateral and posterolateral margins

--- Abdomen without a pale mid-dorsal line (Fig. 244), the terga with crescent-shaped marks on posterior margin

Subgenus Deleatidium

Imago and subimago. Claws of a pair dissimilar, one apically hooked, the other pad-like, with or without a small apical hook (Fig. 16-19). Forewing width one-third (or a little more) of length, with posterior margin convex basal to vein CuP, as in Fig. 36, 40; hind wing width half to two-thirds of length, and length from one-fifth to a little less than one-third that of forewing.

Remarks. For species in subg. Perniketellum, see p. 46.

Deleatidium lillii Eaton

Fig. 241 (nymph); Map 8


Dimensions (mm). Male: length of body 7.1-8.8 (8.2); forewings 7.5-11.4 (8.9). Female: length of body 6.1-9.3 (7.8). Forewings 7.5-10.6 (9.2). Mature nymph: length of body 7.1-9.3 (8.1).

Male imago. Head brown to dark brown, darker near base of eyes and ocelli. Eyes with upper portion pale brown, lower portion greyish black. Antennal scape brown.

Thorax. Pronotum pale brown to brown, with paired black submedian longitudinal lines, often with small black...
posterior lateral marks; mesothorax and metathorax pale brown to brown, occasionally with paler median anterolateral marks on dorsum of posterior scutal protuberances; scutellum dark brown to blackish. Pleura pale brown to brown, with sutures paler and carinae washed with black. Sterna pale brown to brown, with carinae darker, membranes and sutures paler. Legs pale yellowish brown, with articulation of femur and tibia brown to dark brown, and forelegs darker; length ratios of foreleg segments 0.68-0.77: 1.00 (2.4-3.2 mm) : 0.03-0.07 : 0.35-0.37 : 0.34-0.37. vein Sc 0.91-0.95(0.93)x wing length; cross veins in proximal three-quarters of cells C and Sc hyaline; membranes hyaline, but wing base pale brown. Hind wing width 0.54-0.59(0.56)x length; longitudinal and cross veins pale brown to brown, but cross veins in proximal half of wing and cross veins pale yellowish brown to brown; membrane hyaline, but wing base pale brown.

Abdomen (Fig. 71) pale brown to reddish brown. Tergum 1 greyish or with paired greyish submedian marks; terga 2-6 or 2-7 hyaline, pale brown to reddish brown, and with paired black submedian marks and lateral longitudinal lines; terga 2-7 or 2-8 with a narrow, pale brown median longitudinal line; terga 2-9 with a narrow, greyish-black transverse band on posterior margin; terga 6-10 or 7-10 translucent pale brown to reddish brown; terga 6-8 or 6-9 with paired dorsal and lateral blackish marks; or with dorsum of tergum 7, anterior two-thirds of tergum 8, and anterior one-third of tergum 9 blackish. Tracheae greyish black to hyaline; spiracular area black. Sterna pale whitish to pale brown, with sterna 1 and 2 often darker, and sterna 3-6 often hyaline or with large, greyish-hyaline maculae. Abdominal ganglia hyaline, with terminal ganglion hyaline to greyish. Genitalia (Fig. 109, 110) pale brown to brown, with apex of penes and distal half of forceps often paler; penes with a small subapical ventral appendage; styliger plate apical margin almost entire. Caudal filaments pale brown to brown, with darker annulations at articulations.

Female imago as in male, except as follows. Head pale brown, dark greyish near base of antennae, ocelli, and eyes. Eyes black. Antennae with scape, pedicel, and flagellum yellowish brown to brown. Thorax pale yellowish brown to pale brown. Propleuron with a large, triangular dark greyish mark. Sterna pale yellowish brown to brown; coxae and carinae washed with dark greyish brown. Forelegs paler. Hind wing width 0.34-0.35(0.35)x length. Hind wing width 0.54-0.59(0.56)x length, and length 0.22-0.24(0.23)x that of forewings; vein Sc 0.90-0.95(0.93)x wing length. Abdomen (Fig. 160) pale yellowish brown to pale brown; terga 2-6 or 2-7 not hyaline; terga 2-8 with small paired submedian maculae near anterior margin, and terga 2-9 with or without a darker transverse band on posterior margin. Sternum 9 (Fig. 197) cleft.

Subimago as in male imago, except as follows. Head of male dark greyish to black posterior to ocelli. Eyes of female black; male with upper portion of eyes pale brown, lower portion black.

Prothorax with submedian marks often indistinct. Mesonotum with anterior third brown except for broad whitish to pale brown submedian and longitudinal lines; notal furrows dark brown to black; posterior scutal protuberances whitish to pale brown dorsally, but with narrow, paired greyish submedian longitudinal lines, and lateral margins brown; scutellum whitish dorsally, often washed with greyish towards greyish-brown lateral margins, and with a narrow whitish diagonal line extending towards wing base. Pleura often darker near coxae. Sterna pale whitish, with lateral lobes of mesothoracic furcasternum pale brown to brown, and carinae brown to dark brown. Legs with tarsi occasionally darker. Wing membranes grey (dried) to greyish brown (in ethanol); longitudinal and cross veins pale brown to brown.

Abdomen with markings darker, terga 2-6 or 2-7 of male not hyaline, and sterna whitish to pale brown. Genitalia pale whitish, with forceps occasionally pale brown.

Nymph. Head (Fig. 241) pale yellowish brown to pale brown; clypeus washed with greyish brown, and with greyish submedian marks near base; an irregular dark greyish band between eyes, across lateral ocelli. Eyes of female black; male with upper portion of eyes reddish brown, lower portion black. Antennae 2.5x as long as head.

Mouthparts. Clypeus, Fig. 276. Labrum (Fig. 276) length 0.69-0.87(0.78)x that of clypeus, and width 1.15-1.26 (1.20)x that of clypeus; anterior margin (Fig. 277) smoothly curved and with a narrow, deep anteromedian cleft. Mandibles, Fig. 299, 300. Maxillae (Fig. 315): galea-lacinia with a subapical row of 22-24 spines; palp segment 2 0.92-1.00(0.95)x as long as segment 1, and segment 3 0.64-0.82(0.71)x segment 2. Labium (Fig. 328): submentum occasionally with a few scattered spines near base; palp segment 2 0.77-0.92(0.81)x as long as segment 1, and segment 3 0.43-0.57(0.48)x segment 2. Hypopharynx, Fig. 340.

Thorax pale yellowish brown to brown, with darker submedian and lateral marks; mesonotum with a narrow, dark brown transverse band on anterior margin; metasternum pale yellowish brown, with posterior margin greyish brown. Pleura as in imago. Sterna whitish. Legs (Fig. 365-367,
403) pale whitish brown; femora washed with pale brown on anterior surface near midlength and apex; tarsi pale brown near apex.

Abdomen with colour pattern as in imago, but marks often broader; segments 2–9 or 3–9 with posterolateral spines; terga 2–8 with submedian maculae usually absent, and terga 5 and 6 occasionally pale yellowish brown on mid dorsum. Sterna whitish, with ganglia hyaline and terminal abdominal ganglion hyaline or greyish. Gills (Fig. 417, 418) broad near base, often acutely tapered to apex, those on segment 1 with ventral lobe about one-third length of lamella; lamellae translucent whitish; tracheae and tracheal branches black. Caudal filaments 1.5–1.6x as long as dorsum. Sterna whitish, with ganglia hyaline and terminal abdominal ganglion pigmented and visible externally.

Egg (Fig. 460) cylindrical, with single or paired large attachment structures evenly distributed over chorion.

Type data. Eaton (1899) apparently described *Deleatidium lillii* from material provided by Lillie from Dunedin and by Hudson from Wellington. Only Hudson's material could be traced by Kimmins (1960), who designated as lectotype a male imago from Wellington (BMNH: not seen).


Repositories. NZAC – 8 ♂ and 4 ♀ imagos, 1 ♂ and 1 ♀ subimagos, 49 nymphs; CMNZ – 16 ♂ and 22 ♀ imagos, 7 ♂ and 5 ♀ subimagos, 6 nymphs; NMNZ – 2 ♀ imagos, 79 nymphs; FAMU – 1 ♂ and 1 ♀ imago, 30 nymphs.

ND, AK, CL, WO, WN / NN, WD, DN, SL.

Intraspecific variation. Mature nymphs and adults of *Deleatidium lillii* vary in size, specimens from high altitudes and more southern locations often being larger than those from low-altitude northern areas. Nymphs from near Auckland have more slender gills than those from around Wellington. Pigmentation of abdominal ganglia appears to change with location but remains constant within populations. Nymphs from near Auckland have all abdominal ganglia hyaline, whereas southern North Island and South Island populations commonly have the terminal abdominal ganglion pigmented and visible externally.

Habitat. There is little published information on the ecology of *Deleatidium lillii*, although in some streams it may be among the most abundant invertebrate species (Towns 1981, 1987). Like other species in the genus, *D. lillii* is most abundant on stony substrates. In the Waitakere River it was most common in riffles with moderate to slow flow, and was less common where flow was rapid (Towns 1983b). On Great Barrier Island *D. lillii* was one of two species of *Deleatidium* that predominated in a forest stream modified by a landslip, but was uncommon where streams were unmodified (Towns 1987).

In the Waitakere River *D. lillii* was clearly univoltine with a long winter and spring emergence period (Towns 1983b), whereas the population studied by Hopkins (1976) was bivoltine in streams in the southern North Island. However, it is possible that Hopkins encountered more than one species.

Remarks. *Deleatidium lillii* was first described informally as misidentified *Atalophlebia scita* (Walker) by Lillie (1898). Eaton (1899) recognised that the material represented a new species and genus and named it *Deleatidium lillii*. Lillie (1900) acknowledged his error, but several subsequent authors apparently misunderstood his correction. Phillips (1930) assumed "A. scita" to be a synonym of *D. lillii*, for which he attributed authorship to Walker.

Phillips found nymphs of *D. lillii* to be "practically
identical” (p. 368) to those of D. vernale, and did not provide a description other than figures of abdominal gills 1, 4, and 7. The only existing description of the nymph is Lillie’s (1898) account of “Atelephlebia scita.” This description has many deficiencies, and judging from the figures provided may cover more than one species. For example, Lillie’s illustration of a gill from abdominal segment 1 with a large ventral lobe and round apex is not typical of D. lillii.

Illustrations of adult characteristics of the species have also added to confusion. The wing mount photographed by Phillips (1930) is partly distorted and Lillie’s (1898) figures are incomplete and inaccurate. Even Lillie’s illustration of the head of the male imago is incorrect: males of all Deleatidium species have eyes fused on the meson, and not widely separated as in Lillie’s fig. 3a. The only figures sufficiently accurate to permit determination of any species of Deleatidium are the excellent drawings by Kimmins (1960) of male genitalia of D. lillii mounted from Eaton’s (1898) series.

Deleatidium lillii appears to be most closely related to D. furmosum, but can be distinguished from it by the following characters. In the imago: (1) terga 2-6 or 2-7 with paired black submedian marks and lateral longitudinal lines (Fig. 71); (2) penes without a prominent ventral appendage; and (3) head of male pale brown to dark brown. In the nymph: (1) abdominal gills 1-7 with apex pointed (Fig. 417, 418); and (2) venter of abdomen usually with terminal abdominal ganglion not pigmented.

Deleatidium angustum new species

Fig. 242 (nymph): Map 9


Dimensions (mm). Male: length of body 8.5-9.2(8.7); forewings 8.7-9.4. Female: length of body 6.2-7.6(7.0); forewings 7.8-9.2(8.5). Mature nymph: length of body 7.1-9.7(8.2).

Male imago. Head washed with black, brown near base of lateral ocelli. Eyes with upper portion pale brown to orange-brown, lower portion greenish black to black. Antennae pale brown to brown.

Thorax brown to dark brown, washed on margins and submedially with dark brown to black; mesonotum and metathorax brown, paler between posterior scutal protuberances, with midline darker. Pleura brown washed with dark brown to purplish brown; sutures paler. Sterna brown to dark brown, with sutures whitish and ganglia hyaline. Legs pale yellowish; foreleg pale brown at articulation of femur and tibia and occasionally at articulation of tibia and tarsus; length ratios of foreleg segments 0.66 : 1.00 (3.10 mm): 0.04 : 0.39 : 0.48 : 0.39 : 0.13 ; pretarsal pad with an apical hook, as in Fig. 17. Wings as in Fig. 36. Forewing width 0.35-0.36× length; longitudinal veins and cross veins in cells R to MP pale yellowish-brown; membranes and remainder of cross veins hyaline, but cells C and Sc faintly tinted with brown, and wing bases darker. Hind wing width 0.58× length, and length 0.26-0.29× that of forewing; vein Sc 0.94-0.95× wing length; cross veins few in posterior half of wing.

Abdomen (Fig. 72) brown to dark brown. Tergum I washed with dark brown to black; terga 2-6 hyaline, with submedian, sublateral, and posterior darker marks, and midline whitish; terga 7-10 translucent brown washed submedially with black, and midline whitish. Tracheae hyaline; spiracular area black. Sterna yellowish brown to brown; sterna 2-6 hyaline; sterna 2-8 with darker brown chevron-shaped marks; ganglia hyaline. Genitalia (Fig. 111, 112) pale yellowish brown; styliger plate with a margin cleft; penes with a small, fused subapical ventral appendage. Caudal filaments pale yellowish brown, with narrow dark brown annulations at articulations.

Female imago as in male, except as follows. Head dark brown, washed with black near base of ocelli and antennae; eyes black. Pronotum paler. Legs pale yellowish brown, without darker markings at articulations. Wings with cross veins brown. Forewing width 0.35-0.38(0.37)× length. Hind wing width 0.53-0.63(0.57)× length, and length 0.21-0.24(0.23)× that of forewing; vein Sc 0.94-0.98(0.95)× wing length. Abdomen (Fig. 161) with terga and sterna 2-6 translucent brown, and markings on terga paler; sternum 9 cleft, as in Fig. 197.

Subimago as in male imago, except as follows. Eyes in male with upper portion pale brown, lower portion black. Mesonotum and metanotum pale brown, with broad, whitish mid-dorsal and submedian longitudinal lines; posterior scutal protuberances whitish, midline washed with greyish; scutellum greyish, darker on lateral margins; notal furrows dark brown to black. Pleura in male paler. Sterna of male pale yellowish brown, with sutures whitish. Wing membranes of male pale greyish white to grey; longitudinal veins pale brown to greyish brown; cross veins indisc-

**Nymph** (Fig. 242). Head pale brown, darker near lateral margins of clypeus and on mandibles, with an irregular dark greyish band between eyes across lateral ocelli. Antennae twice as long as head. Eyes of female black; male with upper portion of eyes brown, lower portion black.

**Mouthparts** as in Fig. 276, 277, 299, 314, 328, and 329. Labrum: length 0.61-0.75(0.66)× that of clypeus; width 1.14-1.23(1.19)× that of clypeus; anterior margin straight, with a narrow, deep anteromedian cleft. Maxillae: galea-lacinia with a subapical row of 22-25 spines; palp segment 2 0.84-0.97 (0.89)× as long as segment 1, which has scattered hairs on outer margin, and segment 3 0.66-0.74(0.72)× segment 2. Labium without spines on submentum; palp segment 2 0.74-0.89(0.81)× as long as segment 1, and segment 3 0.61-0.75(0.66)× segment 2.

**Thorax:** notae pale brown, washed submedially and on lateral margins with dark brown. Pleura as in imago. Sternawhite to yellowish white, with ganglia hyaline. Legs pale brown on dorsum, whitish ventrally; femora with a pale whitish macula near base; tarsi darker.

Abdomen with posterolateral projections on segments 7-9; terga pale brown, with markings as in imago. Sterna whitish to yellowish white; ganglia hyaline. Gills (Fig. 440, 420) plate-like, rounded at apex, those on segment 1 with ventral lobe about two-thirds as long as lamella; lamellae translucent, with numerous black tracheal denticles. Caudal filaments 1.2× as long as body, pale brown; segments each with a distal whorl of small brown denticles.

**Egg** (Fig. 461) cylindrical, with enlarged attachment structures arranged in a roughly linear pattern between poles.

**Type data.** Holotype: male imago, AK, Cascade Stream, 14 February 1977, D.R. Towns (NZAC).

**Allotype female imago:** AK, small tributary of Waitakere River, light trap, 14 February 1977, M.G. Black (NZAC).


**Repositories:** NZAC – 6♂ and 4♀ imagos, 93 nymphs; NMNZ – 1♀ imago, 1♂ and 3♀ subimagos, 28 nymphs; CMNZ – 3♀ subimagos, 17 nymphs; FAMU – 1♂ and 2♀ imagos, 3♂ subimagos, 11 nymphs; BMNH – 1♂ subimago, 9 nymphs; DRTC – 2♀ imagos, 13 nymphs.

**Material examined.** Type series only.

**Intraspecific variation.** Male imagos from streams draining Mt Pirongia near Hamilton have darker abdominal sternae than those from the Waitakere Range near Auckland.

Nymphs that appear similar to those described here occupy streams in the southern North Island and in the South Island. However, these have the thoracic ganglia and the terminal two or three abdominal ganglia pigmented, and in the absence of associated nymphs and adults it is unclear whether they are conspecific with *D. angustum*.

**Habitat.** *Deleatidium angustum* appears to be widespread throughout the northern North Island, and in some streams is locally abundant (Towns 1979, 1987). On Great Barrier Island it was part of assemblages found on wet rock faces, runs, and falls, was a dominant species in low to moderate flow on wood, frass, leaves, gravel, and cobbles in first- and second-order streams, and was the predominant species on cobbles covered with algae in third-order streams (Towns 1987). In the Waitakere River catchment it had a poorly synchronised life history and a year-round potential emergence period (Towns 1983b).

**Remarks.** *Deleatidium angustum* and *D. myzobranchia* were considered to be conspecific by Towns (1979), but *D. angustum* can be distinguished by the following characters. In the imago: (1) forewing cells C and Sc faintly tinted with brown; and (2) penes with apex narrow and with a
small subapical ventral appendage (Fig. 111). In the subimago, wings unicolorous greyish white to grey. In the nymph: (1) thoracic and abdominal ganglia unpigmented; (2) sternum 9 with scattered, small hairs; and (3) abdominal gill 1 with ventral lobe extending to two-thirds length of lamella (Fig. 419).

Etymology. angustum (Latin), ‘narrow,’ refers to the narrow apex of the penes.

**Deleatidium autumnale Phillips**

Fig. 243 (nymph); Map 10


Dimensions (mm). Male: length of body 7.4–8.6 (7.9); forewings 8.3–9.0. Female: length of body 7.0–9.3 (8.1); forewings 8.3–9.6. Mature nymph: length of body 6.4–9.9 (8.0).

Male imago. Head pale brown, washed with black at base of eyes and ocelli. Eyes with upper portion pale orange-brown, lower portion greenish black. Antennae with scape, pedicel, and flagellum pale brown.

Thorax. Pronotum pale whitish brown, washed medially and laterally with black. Mesothorax and metathorax pale brown, with posterior scutal protuberances and scutellum often washed medially and submedially with dark blackish brown. Pleura pale brown to whitish brown, lightly washed with black; sutures paler; carinae washed with blackish brown. Sterna pale brown, with lateral margins and carinae washed with black; sutures whitish; ganglia purplish black; connectives hyaline. Legs pale yellowish brown, darker at articulation of forefemur and tibia. Length ratios of foreleg segments 0.74–0.78 : 1.00 (2.4–2.7 mm) : 0.03–0.06 : 0.41–0.48 : 0.41–0.46 : 0.33–0.40 : 0.08–0.13; protarsal pad without an apical hook, as in Fig. 18. Forewing width 0.35–0.37× length; longitudinal veins pale brown to brown, but veins C, Sc, and R, occasionally darker; cross veins in cells C and Sc hyaline; in stigmatic area and elsewhere pale brown; membrane hyaline, but apex of costal brace washed with purplish black. Hind wing width 0.50–0.59× length, and length 0.26–0.29× that of forewing; vein Sc 0.94–0.98× wing length; longitudinal and cross veins in cells C and Sc pale brown; cross veins at wing base washed with purplish, otherwise hyaline; cross veins few in posterior half of wing.

Abdomen (Fig. 73) pale brown. Terga 1–5 hyaline, washed with black except for submedian and lateral pale maculae; terga 6–10 translucent pale yellowish brown; terga 6–8 washed with black. Tracheae hyaline; spiracular areas black. Sterna 1–5 hyaline, washed with greyish brown; sternum 6–10 pale yellowish brown; ganglia purplish black, the terminal ganglion usually darker; connectives hyaline or pale greyish. Genitalia (Fig. 113, 114) pale yellowish brown; penes with ventral appendage in a subapical concavity. Caudal filaments whitish, with dark brown annulations at articulations.

Female imago as in male, except as follows. Forewing width 0.35–0.37× length. Hind wing width 0.52–0.64× length, and length 0.25–0.26× that of forewings; vein Sc 0.90–0.97× wing length. Abdomen (Fig. 162) pale brown; terga 1 and 2 washed with black; terga 3–8 washed with black on anterior and posterior margins, and with submedian and lateral maculae; terga 9 and 10 translucent pale yellowish brown. Sterna translucent pale yellowish brown; ganglia pale grey to purplish black, the terminal ganglion darker; connectives usually hyaline. Sternum 9 cleft, as in Fig. 197.

Subimago as in imago, except as follows. Mesonotum pale brown, paler dorsally along posterior two-thirds of midline, on scutellum, and along lateral parapsidal suture; notauli and lateral furrows dark brown to black; posterolateral mesonotum and margins of scutellum dark brown. Pleura darker. Wings (Fig. 210, 211): membranes pale brown, with darker clouds at cross veins; a few cross veins in a broad arc are from mid anterior margin to near base. Abdomen varying from darker to paler; terga 1–7 pale brown to dark brown, with paler submedian maculae. Sterna as in female imago. Genitalia coloured as in male imago. Caudal filaments pale yellowish brown, with darker annulations at articulations.

Nymph (Fig. 242). Head pale brown, with clypeus, labrum, and mandibles washed with darker brown; an irregular greyish-brown mark between eyes across lateral ocelli. Ocelli black at base, with distal half greyish white. Eyes of female black; male with upper portion of eyes pale greyish olive, lower portion black. Antennae pale brown, 1.6x as long as head.

Mouthparts as in Fig. 276, 277, 299, 314, 328, and 329. Labrum 0.80–1.00(0.92)x as long as clypeus and 1.18–1.21(1.19)x as wide as clypeus. Maxillae: galea-lacinia with a subapical row of 19–23(21) spines; palp segment 2 0.75–0.91(0.83)x as long as segment 1, and segment 3 0.75–0.91(0.81)x segment 2. Labium without spines on submentum; palp segment 2 0.73–0.90(0.84)x as long as segment 1, and segment 3 0.40–0.45(0.43)x segment 2.

Thorax pale yellowish brown, with darker marks on margins. Pleura as in imago. Sterna whitish, with ganglia
greyish brown. Legs pale yellowish brown.

Abdomen with colour pattern as in imago, but terga 1–5 translucent pale brown; posterolateral projections present on segments 3–9 or 4–9, that on segment 9 enlarged. Sterna pale whitish, with ganglia as in imago. Gills (Fig. 421, 422) plate-like, rounded, with lamellae translucent; gills on segment 1 with ventral lobe about equal in length to lamella; tracheae nearest to ventral margin, and branches most numerous dorsally, with all tracheal elements black. Caudal filaments 1.5× as long as body, pale yellowish brown.

Egg (Fig. 452) cylindrical, with single large attachment structures evenly distributed over chorion.

**Type data.** No type specimens were identified by Phillips (1930), who listed the distribution as "R. Waikanae and R. Hutt, Wellington district" (p. 372). Several pinned specimens designated as *Deleatidium autumnale* which we have examined were donated by Phillips to collections in the Canterbury Museum (T. Hitchings, pers comm., 1993). One of them with the label "Deleatidium autumnale ♂ imago R. Hutt 7/4/30" is a male in adequate condition, which we here designate as lectotype.

Three topotypic specimens in the same collection are designated paralectotypes: WN, Hutt River, 1 female imago and 1 female subimago, 8 April 1930, and 1 female imago, 7 April 1930 (J.S. Phillips inferred). The remaining specimens are too damaged to be designated as types.


Repositories: NZAC - 6 ♂ and 6 ♀ imagos, 4 ♂ and 2 ♀ subimagos, 64 nymphs; NMNZ - 4 ♂ and 50 ♀ imagos, 43 nymphs; CMNZ - 1 ♂ and 2 ♀ imagos, 26 nymphs; FAMU - 9 ♂ and 2 ♀ imagos, 1 ♂ subimago, 4 nymphs.

**Intraspecific variation.** In nymphs from the Wellington area, dark pigmentation near the anterior and posterior margins of the terga makes the abdomen appear banded. Elsewhere, these bands may coalesce on the lateral margins to form pale maculate. Mature nymphs have the apex of abdominal gills rounded, but immature nymphs (including those with small, developing wing pads) have the gill apex pointed. Pigmentation of the abdominal and thoracic ganglia appears to be consistent over the known geographic range.

**Habitat.** *Deleatidium autumnale* is extremely abundant in parts of the Hutt River near Wellington, in waters with either rapid or slow flow. Imagos may be particularly common in March and April (Phillips 1930), but have been collected (DRT) in early January.

**Remarks.** Phillips (1930) suggested that the nymphs and imagos of *Deleatidium autumnale* could easily be confused with those of *D. vernale* and *D. lillii*. We have found that winged stages of *D. autumnale* are most likely to be confused with imagos and subimagos of *D. vernale* and subimagos of *D. myzobranchia*. In the imagos, *D. autumnale* can be distinguished from *D. vernale* by differences in the structure of the male genitalia and differences in the pigmentation of connectives in the abdominal ganglia. However, abdominal colour patterns of the two species appear to be too variable to be consistently useful.

Colour patterns of the subimago forewings are similar in *D. autumnale* and *D. myzobranchia*, but they can be distinguished by the purplish-brown colour of longitudinal veins C, Sc, and R in the latter species (see p. 42).

In the Wellington area nymphs of *D. autumnale* are most likely to be confused with *D. vernale*, but can be distinguished by their round abdominal gill margins, differences in pigmentation of the abdominal ganglia, and differences in dorsal abdominal colour pattern (Fig. 73, 78).

**Deleatidium cerinum** Phillips

Fig. 244 (nymph); Map 11


**Dimensions (mm).** Male: length of body 5.5–6.6(6.1); forewings 6.5–7.0. Female: length of body 5.6–6.2(5.9);
forewings 6.7–7.4. Mature nymph: length of body 5.0–6.4(5.7).

Male imago. Head pale brown, washed on lateral and anterior margins and between antennae with black. Eyes with upper portion pale orange, lower portion black. Antennae pale yellowish; pedicel washed with purplish brown.

Thorax. Pronotum brown, washed with purplish brown on margins. Mesonotum, metanotum, and posterior scutal protuberances pale brown; posterior scutal protuberances washed with purplish brown submedially; scutellum washed with purplish brown. Pleura pale brown irregularly washed with purplish brown, with a broad purplish-black diagonal band from base of forecoxae to anterior wing processes; carinae darker. Sterna pale brown washed with darker brown laterally and on midline; ganglia hyaline. Legs: [forelegs broken off and missing]; middle and hind legs pale yellowish; pretarsal pad with a small apical hook, as in Fig. 17. Wings as in Fig. 36. Forewing width 0.38–0.55× length; veins C, Sc, and R, pale yellowish brown; longitudinal veins otherwise yellowish to hyaline; membranes pale yellowish brown. Hind wing width 0.49–0.55× length, and length 0.25–0.28× that of forewings; vein Sc 0.90–0.91× wing length; cross veins few.

Abdomen (Fig. 74): tergum 1 washed with black; terga 2-6 hyaline, with narrow black band on posterior margin; terga 7-10 pale brown, washed dorsally with dark brown to black. Tracheae grey to black; spiracular area black. Sterna pale yellowish brown. Legs as in imago, but femora washed medially and towards apex with darker brown. Abdomen with posterolateral projections on segments 5–9. Terga pale yellowish brown; terga 1–8 with narrow, blackish posterior marks forming an irregular band. Sterna pale yellowish brown, with ganglia hyaline. Genitalia (Fig. 115, 116) pale brown; forceps segment 1 with inner margin angular. Caudal filaments white, in proximal third with dark brown arulations at articulations.

Female imago as in male, except as follows. Eyes black. Thorax occasionally darker on dorsum, and notal furrow washed with black. Pleura and sterna often darker, and sterna brown. Forewing width 0.36–0.37× length. Hind wing width 0.52–0.56× length, and length 0.21–0.25× that of forewings; vein Sc 0.90–0.92× wing length. Abdomen (Fig. 163) brown; terga 3–7 with a pale mid-dorsal longitudinal line edged with black and with small, paired, submedian pale brown maculae. Sterna 1–7 or 1–8 brown to dark brown, often pale brown on midline and successively paler posteriorly. Sternum 9 (Fig. 198) shallowly cleft.

Subimago as in imago, except as follows. Pronotum brown; mesonotum pale brown, with broad whitish mid-dorsal and submedian longitudinal lines. Sterna pale brown washed with purplish brown. Legs darker at articulation of femora and tibiae, and occasionally on tarsi. Wing membranes unicolorous whitish; forewing with longitudinal veins pale brown to hyaline. Abdomen of male with terga 2–6 and 10 yellowish brown, terga 7–9 pale brown; female with terga 1–8 dark brown. Sterna and genitalia of male whitish, of female as in imago.

Nymph (Fig. 244). Head pale yellowish brown, darker on clypeus, mandibles, and labrum. Antennae twice as long as head. Eyes of female black; male with upper portion of eyes yellowish brown, lower portion black.

Mouthparts as in Fig. 276, 299, 314, 328, and 329. Labrum 0.83–0.87× as long as clypeus and 1.20–1.24× as wide as clypeus; anterior margin smoothly curved, with a wide, deep anteromedian cleft. Maxillae: galea-lacinia with a subapical row of 17 or 18 spines; palp segment 2 0.83–0.87× as long as segment 1, and segment 3 0.69–0.72× segment 2. Labium without hairs or spines on submentum; palp segment 2 0.66–0.71× as long as segment 1, and segment 3 0.56–0.6× segment 2.

Thorax pale yellowish brown, with small darker marks on posterolateral pronotum and anterolateral mesonotum. Pleura pale yellowish brown washed with purplish brown. Sterna pale yellowish brown. Legs as in imago, but femora washed medially and towards apex with darker brown.

Abdomen with posterolateral projections on segments 5–9. Terga pale yellowish brown; terga 1–8 with narrow, blackish posterior marks forming an irregular band. Sterna pale yellowish brown, with ganglia hyaline. Gills (Fig. 423, 424) broad near base, tapered acutely towards apex; gills on segment 1 with ventral lobe small; lamellae translucent, with numerous tracheal branches; tracheal elements greyish black. Caudal filaments about as long as body, pale yellowish brown; segments each with a distal whorl of small brown denticles.

Egg (Fig. 463) cylindrical, with single large attachment structures evenly distributed over chorion.

Type data. No type specimens were designated by Phillips (1930), who listed the distribution as "R. Hutt, Wellington district" (ibid., p. 383). Two pinned specimens identified as Deleatidium cerinum which we have examined were donated by Phillips to collections in the Canterbury Museum (T. Hitchings, pers. comm., 1993). One of them with the label "Deleatidium cerinum R. Hutt 7/4/30" is here designated as lectotype. A second specimen with the label "Deleatidium cerinum Ρ subimago R. Hutt 7/4/30" is here designated as allolectotype. The collector is inferred to be J.S. Phillips.

Material examined. Type specimens, plus the following
Male genitalia with inner margin of forceps segment 1.

**Deleatidium fumosum**, D. fumosum, ganglion unpigmented, (4) body length <7 mm, and (5) confirm these observations.

confirm those of


**Repositories**: **NZAC**: 4 ♂ and 1 ♀ imagos, 4 ♂ and 2 ♀ subimagos, 3 nymphs; **NMNZ**: 4 ♂ and 2 ♀ imagos, 1 ♂ subimago, 1 nymph; **CMNZ**: 1 ♂ and 1 ♀ imagos 4 ♂ and 1 ♂ subimagos, 1 nymph; **PAMU**: 11 ♂ and 19 ♀ imagos, 1 ♂ and 1 ♀ subimago, 2 nymphs.

**Habitat.** Most nymphs were collected in slow to moderate flow in moderately large streams and rivers. A few nymphs have been found in streams and rivers with rapid flow (I.D. McLellan, pers. comm.). The narrow abdominal gills indicate that this species probably inhabits areas with a relatively low flow rate, as compared with other members of the genus, which use enlarged gills to assist with adhesion to substrates in rapid flow. Phillips (1930) found *D. cerinum* emerging at the end of summer and through autumn. However, we have examined winged stages collected as early as October, indicating an extended emergence period.

**Remarks.** Phillips (1930) was able to identify only the imago and subimago of *Deleatidium cerinum*, but suggested from examination of exuviae that nymphs are smaller than *D. lillii*, with narrower abdominal gills. We can confirm these observations.

*Deleatidium cerinum* imagos are most similar to those of *D. fumosum*, but can be distinguished by (1) forewing longitudinal veins pale yellowish brown to hyaline, (2) wings with cross veins hyaline, (3) terminal abdominal ganglion unpigmented, (4) body length <7 mm, and (5) male genitalia with inner margin shorter than 5.9. Nymphs of *D. cerinum* are most similar to those of *D. lillii*, but can be distinguished by (1) abdominal terga 1–8 with narrow, irregular, black posterior bands (Fig. 244), (2) 1st abdominal gills with ventral lobe small (Fig. 423), and (3) body length of mature nymphs <7 mm.

**Deleatidium fumosum** Phillips

**Fig. 245 (nymph); Map 12**


**Dimensions (mm). Male**: length of body 6.9–8.2(7.8); forewings 8.2–8.8(8.4). **Female**: length of body 5.8–7.5; forewings 8.0–9.1. Mature nymph: length of body 6.8–8.6(7.7).

**Male Imago.** Head black, but pale brown near anterior margins. Eyes with upper portion pale orange, lower portion black. Antennae pale brown; scape and pedicel washed with dark brown.

**Thorax.** Pronotum pale brown, washed on midline and laterally with purplish grey; mesonotum and metanotum brown, darker dorsally and on scutellum. Pleura from pale brown to brown, occasionally washed with purple at articulation with thorax. Hind wing width 0.53–0.67(0.58) x length, wing base washed with pale brown, occasionally washed with purple at articulation with thorax. Hind wing length 0.53–0.67(0.58) x length, and length 0.25–0.28(0.27) x of forewing: vein Sc 0.88–0.94(0.92) x wing length; cross veins few in posterior half of wing.

**Abdomen** (Fig. 75) pale brown. Tergum 1 washed with dark brown to blackish brown; terga 2–6 hyaline, washed on posterior margin and laterally with dark brown to blackish brown; terga 2–7 with midline pale brown; terga 7–9 washed on dorsum with dark brown. Tracheae and tracheal area hyaline to pale greyish. Sternum 1 brown; sternum 2–8 hyaline, washed with pale brown to whitish, paler posteriorly; abdominal ganglia hyaline to pale greyish, the terminal ganglion greyish to dark grey. Genitalia
(Fig. 117, 118) pale brown; ventral appendage prominent, bifid. Caudal filaments pale whitish brown, with dark brown annulations at articulations.

**Female imago** as in male, except as follows. Head pale brown, washed with black between eyes. Eyes black. Thorax paler. Forewing width 0.38x length. Hind wing width 0.52–0.54x length, and length 0.23–0.24x that of forewings; vein Sc 0.86–0.96x wing length. Abdomen (Fig. 164): terga pale brown with translucent markings as in male, but darker, and terga 2–9 with midline pale brown; sterna translucent pale brown, washed with brown. Sternum 9 shallowly cleft, as in Fig. 198. [Caudal filaments broken off and missing.]

**Subimago** as in imago, except as follows. Head with colour pattern as in female imago. Male with upper portion of eyes pale brown, lower portion black. Prothorax as in male imago. Metanotum pale brown to brown, with broad, whitish, mid-dorsal and submedian longitudinal lines; posterior scutal protuberances pale whitish; scutellum greyish, washed with dark brown; dorsally and on lateral margins. Wing membranes unicellular pale grey; longitudinal veins darker, cross veins hyaline. Terga of male translucent. Sterna translucent pale yellowish brown in male. Genitalia pale yellowish brown. Caudal filaments 1.3–1.6x as long as body, pale yellowish brown; segments each with a distal whorl of small brown denticles.

**Nymph** (Fig. 245). Head brown, with labrum paler brown, and darker brown across lateral ocelli; in male paler, with a subapical row of 21 or 22 spines; palp segment 2 0.89–1.05(0.99)x as long as segment 1, and segment 3 0.68–0.83(0.75)x segment 2. Labium without spines on submentum; palp segment 2 0.76–0.90(0.83)x as long as segment 1, and segment 3 0.42–0.49(0.45)x segment 2.

Thorax brown, with small, dark submedian marks on prothorax and lateral marks on prothorax and mesothorax. Pleura as in imago. Sterna whitish; thoracic ganglia hyaline. Legs pale brown, with large yellowish-brown maculae near base and apex.

Abdomen with posterolateral projections on segments 3, 4, or 5 to 9; terga translucent pale brown, with markings as in imago, but terga 2–8 with blackish submedian, posterolateral, and posterior marks. Sterna translucent whitish, successively more yellowish brown posteriorly; ganglia hyaline, but terminal ganglion dark greyish. Gills (Fig. 425, 426) broad near base, varying from tapered towards apex and with a small apical point on segments 2–7 or 3–7 to apically rounded except for apical point on segment 5; gills on segment 1 with ventral lobe extending to about half length of lamella; lamellae translucent whitish; tracheal elements black. Caudal filaments 1.3–1.6x as long as body, pale yellowish brown; segments each with a distal whorl of small brown denticles.

**Egg** (Fig. 464) cylindrical, with single large attachment structures evenly distributed over chorion.

**Type data.** Phillips (1930, p. 373) gave the distribution of *Deleatidium fumosum* as "streams round Wellington." We have been unable to locate any specimens of this species from the original series, and assume that they are either lost or were never submitted (see Remarks). We therefore designate the following specimen as neotype: male imago, WN, Hutt River at Kaitoke, reared from nymph, 26 January 1981. DRT (NZAC).


Repositories: NZAC – 11 δ and 21 Ψ imagos, 13 δ and...
Intraspecific variation. The number of posterolateral projections on the abdomen can be difficult to determine because of the small size of the first projections. Most specimens that we examined had projections on segments 5–9. The number of abdominal gills with an apical point also varied. Abdominal gills of young nymphs tapered to an acute point, but the gill lamellae become more plate-like with maturity. Gills of nymphs with well developed wing pads had apical points on gills 2–7 or 3–7, one specimen had a point on gill 3 on one side but not on the other, and some nymphs had a point only on gills on segment 5. Most nymphs had only the terminal abdominal ganglion pigmented, but a few also had pigmentation of the thoracic ganglia.

Habitat. Deleatidium fumosum inhabits riffle areas in streams and rivers where it can be one of the more abundant species of Deleatidium. It is less common in areas where flow is rapid such as on cascades (Towns 1983b). Phillips (1930) found winged stages in autumn and late summer, but Towns (1983b) demonstrated that D. fumosum produces numerous cohorts with almost continuous emergence from late winter until autumn.

Remarks. Phillips (1930) appeared uncertain whether Deleatidium fumosum was distinct from D. lillii, stating (p. 372): "... I have come to the conclusion, lately, that the smaller fly is a distinct species [from D. lillii]: since arriving at this opinion, I, unfortunately, have had no opportunity of breeding these flies separately: it would be desirable to do this so as to confirm the belief that these are two separate flies." Under present rules of nomenclature the lack of reference material and the diffidence of the author would be sufficient to invalidate the species description. However, since the species was described before 1961, fumosum is an available name. We have confirmed the identity of this widespread species by rearing.

A neotype has been designated here for Deleatidium fumosum under the following criteria in Article 75 of the International Code of Zoological Nomenclature (1985): (1) the neotype is designated as part of a major "revisory work" in which it is essential for solving confused identities of closely similar nominal species-group taxa; (2) the neotype is based as nearly as practicable on the original type locality (which was not directly identified).

Deleatidium fumosum appears to be most closely related to D. lillii, from which it can be distinguished in the imago by (1) males with head black, (2) penes with a prominent bifid ventral appendage (Fig. 117, 118), and (3) abdominal terga with narrow posterior and posterolateral dark marks (Fig. 75); and in the nymph by (1) gills broad, with small apical point sometimes present (Fig. 426), (2) ventral abdomen with terminal ganglion pigmented dark grey, and (3) abdomen with narrow posterior and posterolateral dark marks (Fig. 245).

Deleatidium magnum new species

Fig. 246 (nymph); Map 13


Male imago. Head black, with anterior margin in dark brown. Eyes separated on meson of head by three-quarters width of anterior ocellus; upper portion orange-brown, lower portion greenish. Antennae dark brown.

Thorax. Pronotum dark brown, washed near midline and on posterolateral margins with black; mesonotum dark brown; metanotum black dorsally. Pleura brown to dark brown, with membranes whitish to greyish. Sternum brown to dark brown; furcasternum darker. Legs: forelegs dark brown; middle and hind legs pale brown, darker at articulation of femora and tibiae and on tarsi; length ratios of foreleg segments: 0.86–0.89 : 1.00 (4.0–4.4 mm) : 0.07–0.09 : 0.32–0.36 : 0.32–0.36 : 0.24–0.26 : 0.14; pretarsal pad with a small accessory hook, as in Fig. 19. Wings (Fig. 38, 39) washed with pale brown and dark brown basally. Forewing: length 0.35× length; longitudinal and cross veins blackish-brown; membrane hyaline, but cells C and Sc washed with reddish brown, extending to cell R at midlength. Hind wing width 0.61× length, and length 0.30× that of forewing; vein Sc 0.96× length of wing; longitudinal and cross veins blackish brown; cross veins numerous.

Abdomen (Fig. 76) brown. Terga 1–4 black, but brown on lateral margins; tergum 1 dark brown at midlength; terga 2–4 with midline and anterior margin brown and with large lateral maculae; terga 5 and 6 pale brown, washed laterally with black; terga 7 and 8 black, with brown lateral and submedian maculae; terga 9 and 10 brown, with tergum 9 washed submedially and on anterior and lateral margins with black. Tracheae hyaline; spiracular areas black. Sterna pale brown to brown, with ganglia darker. Genitalia (Fig. 119, 120): forceps pale brown; penes dark brown, with paired subapical ventral appendages. Caudal filaments dark brown, blackish at articulations.
**Female imago** as in male, except as follows. Head pale brown, washed with black on meson posterior to ocelli, dark brown on anterior margin. Eyes greenish black. Thoracic nota pale brown, and ganglia purplish grey. Forewing width 0.35×length; membrane darker, with area of coloration extending to cell R larger. Hind wing width 0.61×length, and length 0.25×that of forewing; vein Sc 0.98×length of wing. Abdomen (Fig. 166) with maculae, lateral margins of terga, and sterna paler, and ganglia darker. Sternum 9 with a U-shaped cleft, as in Fig. 199.

**Subimago** as in imago, except as follows. Head pale brown, but dark brown to black near base of eyes. Pronotum pale brown, with narrow dark brown submedian marks; mesonotum dark brown on dorsum; metanotum pale brown except for dark brown longitudinal submedian marks; notal furrows dark brown to black; posterior scutal protuberances pale brown, with greyish marks on either side of midline, and lateral margins dark brown; scutellum pale brown washed with dark greyish, and lateral margins dark brown. Pleura pale brown washed with greyish and dark brown. Sterna and legs paler. Wings: membrane pale brown with dark greyish clouds at cross veins, and in pale brown washed with dark greyish, and lateral margins protuberances pale brown, with greyish marks on either side of midline, and lateral margins dark brown; scutellum with a U-shaped cleft, as in Fig. 199.

**Nymph** (Fig. 246). Head dark greyish brown, paler on male translucent pale brown. Male genitalia paler. Brown with dark greyish clouds at cross veins, and in pale brown washed with dark greyish, and lateral margins protuberances pale brown, with greyish marks on either side of midline, and lateral margins dark brown; scutellum with a U-shaped cleft, as in Fig. 199.

**Material examined.** Type series, plus 19 non-type nymphs, TO, Chateau Tongariro, 22 Nov 1966, JAM Colin (NZAC). Allotype female imago: same data as holotype (NZAC).

**Remarks.** _Deleatidium magnum_ is most similar to _D. myzobranchia_, from which it can be distinguished in the imago by (1) forewings with reddish-brown area in cells C and Sc extending to R at midlength (Fig. 38), and (2) penes with paired ventral subapical appendages and with apex not rolled ventrally (Fig. 119, 120); and in the nymph by (1) abdominal gills on segment 1 with ventral lobe extending to two-thirds length of lamella (Fig. 427), (2) abdominal gills on segment 7 flat, held dorsally (Fig. 246, 429), and (3) abdomen with pointed posterolateral projections on seg-
ments 6–9 or 7–9, those on segment 9 large.

*Etymology. magnum* (Latin), 'large', in reference to the extremely large size of mature nymphs and imagos.

**Deleatidium myzobranchia** Phillips

Fig. 247 (nymph); Map 14


**Dimensions** (mm). Male: length of body 8.0–11.0(9.6); forewings 9.5–11.8(10.8). Female: length of body 7.8–10.8(9.8); forewings 9.7–12.2(11.1). Mature nymph: length of body 8.6–11.6(9.4).

**Male Imago.** Head washed with black, but pale brown on anterior margin. Eyes with upper portion orange-brown to pale brown, lower portion greenish black to black. Antennae pale brown; pedicel washed with dark brown.

**Thorax.** Pronotum pale brown, washed submedially with diffuse black; mesonotum and metanotum pale brown to brown, darker dorsally; scutellum pale brown; to brown; a pale median line between posterior scutal protuberances, with or without: darker submedian marks. Pleura pale brown, washed with black near coxae; sutures paler. Sterna pale brown, occasionally darker medially; ganglia outlined with pale grey to pigmented dark grey. Legs pale brown; ganglia pale grey, the terminal ganglion darker. Genitalia (Fig. 121, 122) whitish to pale brown, with apex rolled ventrally; penes occasionally darker at apex. Caudal filaments pale yellowish brown to pale brown, with darker markings at articulations.

**Female Imago as in male, except as follows.** Head pale brown, washed with black near eyes, antennae, and ocelli. Eyes black. Femora with markings paler or absent. Wing colour as in male, but membrane of cells C and Sc reddish. Forewing width 0.34–0.37(0.36)× length. Hind wing width 0.57–0.60(0.58)× length, and length 0.24–0.26(0.25)× that of forewing; vein Sc 0.91–0.95(0.94)× length of wing. Abdomen (Fig. 166) with terga translucent, occasionally pinkish, and sterna pale pinkish brown to pale brown. Sternum 9 with a U-shaped cleft, as in Fig. 199.

**Subimago as in imago, except as follows.** Mesonotum and metanotum brown with broad, pale brown mid-dorsal and submedian longitudinal lines; posterior scutal protuberances pale brown; scutellum greyish brown; notal furrows and lateral margins dark brown. Pleura pale whitish brown washed with dark brown to black. Wings (Fig. 212, 213): membrane pale brown, with diffuse greyish clouds at cross veins; longitudinal and cross veins dark brown. Abdomen in male with terga and sterna translucent pale brown. Caudal filaments pale brown, with darker markings and a dense covering of dark brown hairs.

**Nymph (Fig. 247).** Head dark brown, paler on all margins and near base of ocelli. Antennae twice as long as head, pale yellowish brown. Eyes of female black; male with upper portion of eyes brown to reddish brown, lower portion black.

**Mouthparts.** Clypeus, Fig. 278. Labrum (Fig. 278) 0.77–0.85× as long as clypeus and 1.21–1.24× as wide as clypeus; anterior margin (Fig. 279) flat, with a narrow anterior cleft. Mandibles, Fig. 301. Maxillae (Fig. 315): galea-lacinia with a subapical row of 22–26 spines; palp segment 2 0.83–0.98(0.90)× as long as segment 1, which has dense hairs on outer margin, and segment 3 0.60–0.65× segment 2. Labium as in Fig. 328; submentum (Fig. 329) without spines; palp segment 2 0.71–0.77(0.75)× as long as segment 1, and segment 3 0.40–0.46(0.44)× segment 2.

**Thorax:** not brown to dark brown, with darker submedian marks, and with paired rows of prominent fine hairs submedially. Pleura brown to dark brown, washed with darker brown to black. Sterna pale whitish; ganglia grey to purplish. Legs (Fig. 368–370): pale brown to brown; femora washed with darker brown at base and apex; femora, tibiae, and tarsi with a dense fringe of long hairs dorsum.
Abdomen: with small, blunt posterolateral projections on segments 7–9. Colour pattern as in imago, but markings often broader, and terga of male translucent pale brown. Sternum pale whitish; ganglia pale greyish to hyaline, the terminal ganglion dark greyish. Sternum 9 with a dense covering of short hairs. Gill 1 with lobe extending to 1.5× length of lamella; gill 7 folded ventrally; lamellae translucent whitish, heavily invested with numerous dark grey transverse branches. Caudal filaments 1.2–1.4× as long as body; annulations with small, dark brown denticles.

Egg (Fig. 466, 467) cylindrical, with single large attachment structures evenly distributed over chorion; chorion ornamented with closely packed small nodules.

Type data. Phillips (1930) listed the distribution of Delaeatidium myzobranchia as "Hawkes Bay, Wellington, Nelson and Canterbury provincial districts" (p. 382), but did not designate a type locality. Three specimens of *D. myzobranchia* attributable to Phillips are in the collections of the Canterbury Museum. One of these with the label "♀ imago hatched 1/11/28 in Ngaio" is here designated as lectotype. A second specimen, with the label data "♂ subimago, depressed gills hatched aquarium Nov 10th 1928 Khandallah," is here designated as paralectotype. The third specimen lacks locality data, and is not given a type designation.


Repositories: NZAC – 6 ♂ and 7 ♀ imagos, 1 ♂ and 4 ♀ subimagos, 91 nymphs; NMNZ – 2 ♂ and 1 ♀ imagos, 1 ♂ and 2 ♀ subimagos, 61 nymphs; CMNZ – 2 ♀ imagos, 2 ♂ and 3 ♀ subimagos, 27 nymphs; FAMU – 4 ♀ and 7 ♂ imagos, 2 ♂ and 4 ♀ subimagos, 16 nymphs.

AK, CL, WO, BP, TO, TK, WN/NN, BR, WD, NC, DN, CO.

Intraspecific variation. Eggs from northern and central North Island populations of *D. myzobranchia* showed some differences in the density of ornamentation on the chorion. This difference was consistent with variations in tarsal claw structure in imagos and subimagos. All material examined by us from the Wellington area (including the type series) has an accessorial claw on the tarsal pad, whereas in other populations it is absent. The structure of tarsal claws is usually stable, and can be used to define genera or even generic lineages. In this instance we were unable to find any consistent external character to distinguish populations with an accessorial claw from those without. We therefore consider the two populations to be conspecific. The regions in which they occur are as follows: without an accessorial claw – AK, BR, NC, DN, CO; with an accessorial claw – WO, TO, WN, NN.

The intensity and colour of pigment in the forewings varied from pale brown to reddish – the "rose-madder pink" of Phillips (1930). The brown coloration probably resulted from fading in preservative. Body colour also varied, with some southern South Island populations darker than those further north in colour of thorax, abdomen, and legs and intensity of clouds in the wings of subimagos.

Habitat. Delaeatidium myzobranchia occupies hard substrates in cool streams, usually where flow is rapid (see, e.g., Towns 1979). In the northern North Island, *D. myzobranchia* is strongly univoltine, with a restricted emergence period completed in November (Towns...
However, in more southern areas (e.g., Nelson Lakes) adults can be caught as late as January, raising the possibility of additional growth cohorts, slower growth rates, or less well synchronised life history patterns.

Remarks. Imagos of *Deleatidium myzobranchia* are most similar to those of *D. magnum*, from which they can be distinguished by (1) forewings with reddish-brown area confined to cells C and Sc (Fig. 40), and (2) penes without subapical ventral appendages and with apex rolled ventrally (Fig. 121, 122). Nymphs of *D. myzobranchia* are most similar to those of *D. (Penniketellum) cornutum*, from which they can be distinguished by (1) abdominal terga 2-8 with pale maculae (Fig. 247), (2) abdomen with post-erolateral projections on terga 7-9, and (3) abdomen with dense hairs confined to sternum 9.

*Deleatidium vernale* Phillips

Fig. 248 (nymph); Map 15

*vernale* Phillips, 1930: 360-368 (Deleatidium) (nymphal mouthparts, legs and caudal setae).

*autumnale*: Phillips, 1930: pl. 63 fig. 8 (Deleatidium) (mislabelled figure of subimago forewing).

Dimensions (mm). Male: length of body 7.7-9.3(8.5); forewings 8.5-9.6(9.1). Female: length of body 7.0-8.2(7.7); forewings 8.2-9.3(8.8). Mature nymph: length of body 7.2-8.3(7.9).

**Male imago.** Head washed with black, but pale whitish near base of antennae and hyaline along anterior margin. Eyes with upper portion orange-brown, lower portion greenish black. Antennae pale yellowish brown; pedicel occasionally washed with darker brown.

Thorax. Pronotum pale whitish, with or without submedian brownish marks, and lateral margins with small blackish marks; mesonotum and metathorax whitish brown, darker dorsally and on margins of posterior scutal protuberances; scutellum brown. Pleura whitish washed with diffuse black; a broad blackish band near base of forecoxae. Sterna brown; sutures whitish; ganglia purplish grey. Legs pale whitish brown to pale brown; articulation of femora and tibiae pale brown; length ratios of foreleg segments 0.65-0.67 : 1.00 (3.0-3.1 mm); 0.04 : 0.39-0.42 : 0.43-0.45 : 0.33-0.37 : 0.12-0.13; tarsal pad without an apical hook, as in Fig. 18. Wings as in Fig. 36, 37. Forewing width 0.35-0.36(0.36)× length; longitudinal and cross veins pale brown, but cross veins in proximal two-thirds of cells C and Sc hyaline, and costal brace purplish brown; membranes hyaline, but base of wing faintly washed with pale brown. Hind wing width 0.57-0.62(0.59)× length, and length 0.26-0.28(0.27)× that of forewing; vein Sc 0.93-0.97(0.95)× wing length; cross veins few in posterior half of wing.

Abdomen (Fig. 78) pale yellowish brown. Terga 1 and 2 washed with dark brown; terga 2-6 hyaline; terga 2-8 with a broad, pale median line; terga 3-8 washed with dark brown, and with median and submedian maculae; terga 7-10 translucent pale yellowish brown. Tracheae hyaline; spiracular areas black. Sterna pale whitish; sterna 1-7 hyaline; sterna 8-10 translucent; ganglia and connectives purplish grey. Genitalia (Fig. 123, 124) pale yellowish brown; styliger plate with margin shallowly cleft; penes occasionally with a dark spot at apex of ventral lobe. Caudal filaments pale yellowish, with dark brown annulations at articulations.

Female imago as in male, except as follows. Head pale brown, washed with black. Eyes black. Nota and pleura paler. Thoracic ganglia darker, and connectives greyish. Forewing width 0.35-0.36(0.36)× length. Hind wing width 0.57-0.58(0.57)× length, and length 0.23-0.25(0.24)× that of forewings; vein Sc 0.95-0.96(0.96)× length of wing. Abdomen (Fig. 167) with terga 2-6 translucent pale whitish brown to yellowish brown; sternum 9 with a shallow apical cleft, as in Fig. 198.

Subimago as in imago, except as follows. Head paler; male with upper portion of eyes pale brown. Pronotum paler; mesonotum and metanotum pale brown with broad, whitish mid-dorsal and submedian longitudinal lines; posterior scutal protuberances and dorsal scutellum whitish; posteralateral scutellum and lateral margins of scutellum pale brown; notal furrows dark brown. Wings (Fig. 214, 215) pale brown (in ethanol) to greyish (dried), with diffuse narrow clouds of darker pigment at cross veins. Abdomen with colour pattern as in female imago. Genitalia of male whitish.

Nymph (Fig. 248). Head brown, washed with darker brown near midline towards inner margins of mandibles; an irregular dark greyish band between eyes across lateral ocelli. Eyes of female black; male with upper portion of eyes reddish brown, lower portion black. Antennae 2.25× as long as head.

Mouthparts as in Fig. 276, 299, 314, and 328. Labrum 0.78-0.89(0.84)× as long as clypeus, 1.12-1.17(1.14)× as wide as clypeus; anterior margin smoothly curved and with a wide, deep anteromedian cleft. Maxillae: galea-lacinia with a subapical row of 21 or 22 spines; palp segment 2 0.97-1.09(1.05)× as long as segment 1, and segment 3 0.61-0.73(0.68)× segment 2. Labium with spines on outer
margin in proximal half of submentum (Fig. 330); palp segment 2 0.78-0.86(0.82)x as long as segment 1, and segment 3 0.40-0.47(0.45)x segment 2.

Thorax. Nota whitish to pale brown; pronotum with darker marks. Pleura as in imago. Sterna whitish; ganglia and connectives dark greyish purple. Legs yellowish, with paler maculae near base and apex, pale brown near articulation of femora and tibiae.

Abdomen with prominent posterolateral projections on segments 2-9 or 3-9. Terga with colour pattern as in female imago. Stera whitish, with ganglia and connectives greyish purple. Gills (Fig. 433, 434) broad near base, oval, acutely tapered to apex; gills on segment 1 with a small ventral lobe about one-third as long as lamella; lamellae translucent whitish; tracheae numerous, black. Caudal filaments 1.4-1.7x as long as body, pale yellowish brown; segments each with a whorl of small, brown denticles.

Egg (Fig. 468) cylindrical, with single or paired large attachment structures evenly distributed over chorion.

Type data. Phillips (1930) listed the distribution of Deleatidium vernale as “Tributary of the Kaiwarra [sic] Stream at Ngāio and Khandallah, near Wellington” (p. 368). One of us (DRT) has confirmed the presence of D. vernale in tributaries of the Kaiwharawhara Stream in both Ngāio and Khandallah. Three specimens of D. vernale attributable to Phillips are in the collections of the Canterbury Museum. One of these with the label “♂ imago Ngāio 2/12/28” is here designated as lectotype. A second specimen with the label data “♀ imago Khandallah aqu [aquarium] 4/11/28,” is here designated a paralectotype. The third specimen (a female subimago) lacks locality data, and is not designated as a type. However, it can be attributed to the Kaiwharawhara Stream, apparently the only locality from which Phillips collected this species.


Repositories: NZAC – 11 ♂ and 6 ♀ imagos, 1 ♂ and 1 ♀ subimago, 26 nymphs; NMNZ – 1 ♂ and 3 ♀ imagos, 23 ♀ and 29 ♀ subimagos, 47 nymphs; CMNZ – 1 ♂ and 3 ♀ imagos, 2 ♀ subimagos, 114 nymphs; FAMU – 1 ♂ and 1 ♀ imago, 15 nymphs.

Intraspecific variation. Imago and nymphs of several species of Deleatidium can be distinguished by the pigmentation of the thoracic and abdominal ganglia. Dark pigmentation consistently separates D. vernale from other species in the genus from the Wellington area. However, few specimens of D. vernale have been obtained elsewhere, so stability of pigmentation of the ganglia cannot be confirmed.

Habitat. Deleatidium vernale is at times very abundant in some small streams in the Wellington area. Nymphs occupy stones in a range of flow regimes, often with small nymphs in rapid flow and more mature nymphs near the stream margins, where the flow rate is reduced. Phillips (1930, p. 358) noted that D. vernale was “secured” in spring and early summer, but did not specify which life stage. We assume that he was referring to winged stages, which one of us (DRT) collected in the Wellington area in January (summer). However, material from other areas indicates that winged stages of this species can be obtained from October to February.

Remarks. Nymphs of Deleatidium vernale were found by Phillips (1930) to be distinguishable with difficulty from those of D. lillii. He also predicted that nymphs and imagos of D. autumnale would be easily confused with those of D. vernale and D. lillii.

Deleatidium vernale appears to be most closely related to D. autumnale, but can be distinguished in the image by (1) proximal two-thirds of penes rectangular (Fig. 123), (2) penes with a prominent subapical lobe (Fig. 123), and (3) thoracic and abdominal ganglia and their connectives strongly pigmented; and in the nymph by (1) abdominal gills acutely tapered to apex (Fig. 433, 434), (2) large posterolateral projections present on segments 2-9 or 3-9, and (3) thoracic and abdominal ganglia and their connectives strongly pigmented.

Nymphs of Deleatidium vernale can be distinguished from those of D. lillii by (1) abdominal terga with submedian and lateral marks (Fig. 248), and (2) thoracic and abdominal ganglia and their connectives strongly pigmented.

Phillips (1930) provided photographs of the forewings from subimagos of D. autumnale and D. vernale (plate 63 figs. 8 and 9). Our analysis of material obtained from the same locations as those collected by Phillips indicates that the captions on these figures have been reversed.
Subgenus Penniketellum Towns & Peters
new status


Type species Penniketellus insolitus Towns & Peters, by original designation.

Imago and subimago. Claws of a pair alike, hooked, without an opposing hook (Fig. 20). Wings as in Fig. 42, 43. Forewing width two-thirds to a little less than one-third of length, with posterior margin concave proximal to vein CuP. Hind wing width two-thirds (to a little less) of length, and length one-third (to a little less) that of forewing.

Remarks. In their diagnosis of Penniketellus, Towns & Peters (1979b) noted large ventral fleshy appendages on the penes. Such appendages do not occur in all species now included in the subgenus.

When Penniketellus was established the nymph was unknown. The new status developed above results from nymphs observed transforming to the subimago by one of us (DRT). Imagos and subimagos of Deleatidium (Penniketellum) have two particularly unusual characters: the tarsal claws are unlike those of any other New Zealand genus, and the hind wing is the largest known for the family in this country. We also have a small number of specimens of additional species in the subgenus, all of which have originated at high altitudes (several above 1000 m) in the South Island. These are either imagos in poor condition or unassociated nymphs. To avoid possible confusion with Deleatidium s.s. and Deleatidium sensu stricto, these species will not be described until further material is available. No members of subgenus Penniketellum are known from the North Island.

Species in D. (Penniketellum) can be distinguished from Deleatidium s.s. in the imago and subimago by (1) wings with posterior margin basal to vein CuP concave, and (2) claws of a pair similar, hooked. All species that we have identified in the subgenus have subimagos with the forewings unicolorous grey.

One species, D. (Penniketellum) insolitus, is known only from the imago and subimago and another (described below) only from the subimago and nymph. A key to species of Penniketellum cannot be provided here because the subimagos are the only life stages so far identified in common. Characters distinguishing these subimagos are given below.

Deleatidium (Penniketellum) insolitus
(Towns & Peters)

Map 16

insolitus Towns & Peters, 1979b: 451 (Penniketellus)
(figures of wings, genitalia, claws, and abdominal colour patterns).

Dimensions (mm). Male: length of body 8.2–9.0; forewings 10.0–11.4. Female: length of body 7.8–8.8; forewings 9.4–10.3.

Male imago. Head brownish black, darker medially, paler on anterocentral margin. Eyes with upper portion orange-brown, lower portion black. Antennae with pedicel dark brown, black apically, and flagellum brown.

Thorax. Pronotum greyish brown washed with black; mesonotum and metanotum blackish brown; carinae black; sutures greyish white. Sterna dark brown. Legs brown, darker at margins of femora and at articulation of femora and tibiae; coxae dark brown washed with black; claws, Fig. 20. Wings (Fig. 42, 43) with longitudinal and cross veins brown; membrane of forewing hyaline, but base washed with pale brown; and distal third of cells C and Sc translucent; whitish; membrane of hind wing tinted with brown, darker near base.

Abdomen (Fig. 79) dark greyish brown. Terga 2–7 with mid-dorsum hyaline edged with black; terga 2–8 with anterolateral margins washed with black; terga 2–7 with a narrow, transverse hyaline band, and tergum 7 with a narrow pale brown band; terga 3–7 with small, paired, submedian hyaline maculae and large, paired, hyaline lateral maculae; terga 8 and 9 with mid dorsum pale brown; posterior fifth of tergum 8 and posterior half of terga 9 and 10 pale brown. Sterna 1–7 hyaline, and the remainder whitish to pale brown; ganglia dark greyish brown. Genitalia (Fig. 125, 126) pale brown to dark brown, with large ventral appendages. Caudal filaments pale brown, with darker annulations at articulations.

Female imago as in male, except as follows. Eyes black, with margins brown. Pronotum dark brown; sterna paler, and ganglia dark grey. Abdomen (Fig. 168) with maculae and posterior bands pale brown, and sterna pale brown; sternum 9 with a U-shaped cleft (Fig. 199).

Subimago [male unknown] as in imago, except as follows. Head with ocellar area and posterior margin greyish white. Anterior and mid-lateral mesonotum, posterior scutal prothorax, and scutellum pale brown; lateral mesonotum and lateral and posterior scutellum brown; nota with black submedial lines; ganglia dark grey. Wing mem-
branes translucent whitish brown; longitudinal and cross veins pale brown; the cross veins surrounded by greyish clouds. Caudal filaments pale brown.

**Nymph** unknown.


Paratypes: NZAC - 1 ♂ and 2 ♀ imagos, 2 ♀ subimagos; FAMU - 1 ♂ and 1 ♀ imago.

Material examined. Type series only.

—/NC.

**Deleatidium (Penniketellum) cornutum new species**

Fig. 249 (nymph); Map 17

**Dimensions (mm):** Male subimago: length of body 12.3; forewings 14.4. Female subimago: length of body 10.6–11.0(10.8); forewings 11.4–12.7. Nymph: 9.0–13.0(11.0).

**Imago** unknown.

Male subimago. Head washed with dark brown to black, but whitish near base of antennae. Eyes with upper portion pale orange-brown, lower portion black. Antennae dark brown.

Thorax. Pronotum dark brown with paler brown midlateral patches. Mesonotum dark brown in anterior third; medioparapsidal sutures dark brown submedially; dorsal and sublateral mesonotum, dorsal surface of posterior scutal protuberances, and scutellum pale greyish white; notal furrows and lateral mesonotum washed with dark brown and black. Pleura washed with purplish black, but carinae blackish brown and sutures whitish. Sterna whitish, but prosternum and lateral lobes of furcasternum brown; thoracic ganglia greyish. Legs: femora with dorsal surface purplish brown, ventral surface pale orange-brown to whitish; tibiae and tarsi whitish, but tibiae washed with dark brown near articulation with femora; tarsi basally with inner margin forming a prominent spine. Wings: longitudinal veins pale brown; cross veins hyaline; membranes unicolorous pale greyish brown. Forewing width 0.32x length. Hind wing width 0.61x length, and length 0.29x that of forewings; vein Sc 0.94x length of wing.

Abdomen (Fig. 80) unicolorous dark brown. Terga 1–9 with a pale brown band on posterior margin, widest and extending to postero loral margins on terga 8 and 9; tergum 10 with anterior third dark brown, posterior two-thirds pale yellowish brown. Tracheae and spiracular areas hyaline. Sterna yellowish white; ganglia greyish brown. Genitalia (Fig. 127, 128) whitish, but penes with a purplish spot apically on a small, subapical ventral appendage. Caudal filaments whitish.

Female subimago as in male except as follows. Head pale whitish, washed with dark brown on anterior margin and between eyes; posterior margin with paired, submedian horn-like projections. Eyes greenish black. Pronotum pale brown to brown, washed irregularly with dark brown. Forewing width 0.33–0.38x length; cross veins hyaline to pale brown. Hind wing width 0.60–0.63x length, and length 0.30–0.31x that of forewing; vein Sc 0.92–0.96x length of wing. Abdomen (Fig. 169) with terga 5 and 6 with paler submedian maculae, and terga 3–9 with pale brown posterolateral maculae; sternum 9 with a U-shaped apical cleft, as in Fig. 199.

**Nymph** (Fig. 249). Head pale brown washed with dark brown on labrum, clypeus, near antennae, and between eyes. Eyes of female black; male with upper portion of eyes brown, lower portion black. Antennae 2.0–2.25x as long as head.

Mouthparts. Clypeus as in Fig. 278. Labrum: length 0.70x that of clypeus, width 1.13–1.14x that of clypeus; anterior margin flat. Mandibles as in Fig. 301. Maxillae as in Fig. 315; galea-lacinia with a subapical row of 21 or 22 spines; palp segment 2 0.80–0.89x as long as segment 1, which has dense hairs on outer margin, and segment 3 0.76–0.78x segment 2. Labium as in Fig. 328, but submentum without spines, as in Fig. 329; palp segment 2 0.73–0.77x as long as segment 1, and segment 3 0.44–0.45x segment 2.

Thorax: pronotum bearing long, fine submedian hairs, pale brown, washed submedially and on lateral margins with dark brown; mesonotum brown washed with darker brown. Pleura as in subimago. Sterna whitish; sterna 6–9 with short, fine hairs, those on sternum 9 most dense; ganglia greyish purplish; connectives hyaline. Legs (Fig. 371–373) as in subimago, but paler.

Abdomen with posterolateral projections on segments 8 and 9; terga with colour pattern as in subimago. Sterna whitish; sterna 6–9 with short, fine hairs, those on sternum 9 most dense; ganglia greyish purplish; connectives hyaline. Gills (Fig. 435, 436) broad, plate-like, with margins rounded; gill 1 with ventral lobe extending to 1.25–1.5x length of lamella; gill 7 folded ventrally, as in Fig. 432; lamellae translucent whitish, invested with numerous dark grey tracheal branches. Caudal filaments 1.1–1.2x as long as body, pale yellowish brown to brown; segments each with a distal whorl of small, dark brown denticles.
Egg (Fig. 469) cylindrical, with enlarged attachment structures arranged in roughly linear pattern between poles.


Repositories: NZAC - 5 ♀ subimagos, 22 nymphs; CMNZ - 1 ♂ subimago, 7 nymphs; FAMU - 7 nymphs.

Association of subimagos and nymphs was by observation of emergence.

Material examined. Type series only.

— / MK, WD.

Habitat. D. (Penniketellum) cornutum is known only from streams in or near the Southern Alps. Nymphs were observed by one of us (DRT) transforming to subimagos at midday in warm weather during summer.

Remarks. Female subimagos of D. (P). cornutum can be distinguished from those of D. (P). insolitum by the absence of mid-lateral maculae on the abdomen and the presence of horn-like projections on the posterior margin of the head. Male subimagos of D. (P). insolitum are unknown.

Etymology. cornutum (Latin), 'horned,' in reference to projections on the head of female subimagos.

Genus Isothraulus Towns & Peters


Type species Isothraulus abditus Towns & Peters, by original designation.

Imago. Eyes of male fused on meson of head. Claws paired, alike, apically hooked, with an opposing hook as in Fig. 23. Forewing (Fig. 44) with vein ICu1 attached at base to CuA and CuP by cross veins; costal region with >10 cross veins, and with clouds of pigment around cross veins in cells C and Sc. Hind wing (Fig. 45) one-fifth as long as forewing, with costal margin convex; vein Sc two-thirds length of wing; cross veins few.

Genitalia. Male (Fig. 129, 130): styliger plate narrow, a little wider than long, with apex shallowly cleft; forceps segment 1 forming an angular bend near midlength; penes fused, tubular, elongated to approximately length of forewings, opening on ventral, with a row of long hairs on ventral surface. Female: genital extension or egg guide extending entire length of sternum 8 (Fig. 170); sternum 9 (Fig. 200) entire.

Nymph (Fig. 250). Antennae 2.5× as long as head.

Mouthparts. Clypeus (Fig. 280) with anterior margin concave, lateral margins subparallel. Labrum (Fig. 280) broader and shorter than clypeus, with lateral margins rounded; anteromedian margin (Fig. 281) concave, with small denticles ventrally. Left mandible (Fig. 302): outer margin smoothly curved, with a single small tuft of hair on midline; incisors with apical teeth un serrated and prosthecal tuft reduced. Maxillae (Fig. 316) with sparse hairs on palps. Labium (Fig. 331): palps slender, with segment 3 elongate and bearing a few spines on inner margin; glossae broad. Hypopharynx, Fig. 343.

Thorax. Pronotum with small spines on anterolateral margin. Legs (Fig. 374, 375): femora short, ovoid, with a few spines; femora and tibiae with a few scattered hairs; tarsal claws, Fig. 404.

Abdomen narrowing posteriorly, with posterolateral projections on segments 7–9. Gills (Fig. 437) on segments 1–7 alike, successively smaller posteriorly, with dorsal and ventral portions plate-like and margin fringed.

Remarks. Imagos of Isothraulus superficially resemble Tepakia n.gen. (p. 54), and nymphs have similarities with the Thraulus group of genera from the Ethiopian, Palaearctic, Oriental, and Australian regions (Grant & Peters 1993). It is still unclear whether these similarities represent convergence or an ancient phylogenetic link.

Isothraulus can be distinguished from Tepakia in the imago by (1) forceps segment 1 curved near midlength (Fig. 129), (2) penis openings oriented ventrally (Fig. 129), and (3) female genital extension or egg guide extending entire length of sternum 8 (Fig. 170); and in the nymph by (1) clypeus without spines on lateral margins (Fig. 280), (2) abdominal gills with margins fringed (Fig. 437), and (3) labial palp segment 3 elongate (Fig. 331).

Isothraulus abditus Towns & Peters

Fig. 250 (nymph); Map 18

abditus Towns & Peters, 1979b: 442–444 (Isothraulus) (figures of wings, claw, genitalia, colour patterns, mouthparts, leg, gill, full nymph, egg).

Dimensions (mm). Male: length of body 6.7–7.9; forewings...
Paratypes: NZAC - 5 ♂ and 1 ♀ imagos, 1 ♂ subimago, 8 nymphs; FAMU - 2 ♂ imagos, 2 nymphs.

Material examined. Type series, plus 56 non-type nymphs. AK, CL / —.

Habitat. Nymphs were recorded originally by Towns & Peters (1979b) from slow-flowing waters in the Waitakere catchment near Auckland. The species has been recorded subsequently on Great Barrier Island from upper reaches of streams, in isolated pools connected by subterranean flow (Towns 1987).

Remarks. Confirmed records of Isothraulus abditus have been obtained only from the Auckland area and on Great Barrier Island. Nymphs of this species probably are also found in intermittent streams on Little Barrier Island (K.A.J. Wise, pers comm., 1985). This appears to be one of New Zealand's rarest mayflies.

Genus Mauiulus Towns & Peters


Type species Mauiulus luma Towns & Peters, by original designation.


Imago. Eyes of male fused on meson of head.

Legs: length ratios of foreleg segments in male 0.49–0.58 : 1.00 (1.8–2.8 mm) : 0.04–0.06 : 0.35–0.40 : 0.31–0.37 : 0.25–0.29 : 0.09–0.12. Claws (Fig. 21) paired, dissimilar, one apically hooked, the other obtuse, pad-like. Forewing (Fig. 46) with few cross veins; vein ICu1 attached at base to CuA and CuP by cross veins. Hind wing (Fig. 47) a little less than one-fifth as long as forewing, with costal margin convex; vein Sc two-thirds to about four-fifths length of hind wings; cross veins few.

Abdomen with colour pattern sexually dimorphic; male with terga 2–6 colourless, hyaline. Genitalia. Male (Fig. 131–133): styliger plate wider than long, with apex concave; penes divided almost to styliger plate, the lobes each with a large spine on a lateral accessory lobe. Female: sternum 7 without a genital extension; sternum 9 (Fig. 201) entire, convex apically.

Nymph (Fig. 251). Antennae 1.5–2.0x as long as head.

Mouthparts. Clypeus (Fig. 282) with anterior margin slightly concave, lateral margins subparallel. Labrum (Fig. 284)
Mauiulus luma Towns & Peters

Fig. 251 (nymph); Map 19


Male imago. Head pale brown, irregularly washed with black. Eyes with upper portion pale brownish orange, lower portion black. Antennae pale yellowish brown.

Thorax pale brown to brown. Pronotum paler brown to greyish white, with darker marks on lateral margins and near midline. Pleura pale brown, washed with dark brown in an irregular diagonal band. Sterna pale brown. Legs pale yellowish brown; coxae pale brown washed with dark brown. Wings (Fig. 46, 47): longitudinal and cross veins hyaline to pale brown; membrane hyaline, but base of forewings washed with pale brown, and distal third of cells C and Sc translucent whitish.

Abdomen as in Fig. 82. Tergum 1 pale brown to dark brown, with paired dorsal hyaline maculae; terga 2–6 hyaline, with a narrow, transverse posterior black band and small, darker posterolateral diagonal marks; terga 7–10 yellowish brown to dark brown, darker on anterior third to two-thirds, with paired hyaline anterosubmedian maculae. Sterna 2–6 hyaline; sterna 7–9 pale brown, washed with dark brown to black; terminal ganglion brown. Genitalia (Fig. 131, 132): styliger plate pale brown to dark brown; forceps and penes whitish; penes with a spine on a large accessory lobe. Caudal filaments white, occasionally with darker annulations.

Female imago as in male, except as follows. Head with an irregular dark brown band between eyes and dark brown marks on anterior and lateral margins. Eyes black. Tho- racic nota paler. Legs occasionally darker at articulation of femora and tibiae. Abdomen (Fig. 171) with terga 1–10 pale brown laterally, with a dark brown transverse band on posterior margin, and midline pale edged with dark brown; terga 2–8 with paired pale brown submedian maculae; terga 9 and 10 pale brown.

Subimago as in imago, except as follows. Upper portion of eyes pale brown, lower portion black. Mesonotum and metanotum pale brown, but dark brown to black on meso- notum submedially and near wing bases; sterna pale whitish. Wings with membrane greyish white; longitudinal and cross veins translucent whitish, but longitudinal veins and
base of forewing tinged with pale brown. Abdome of male with terga 2–6 yellowish; sterna whitish irregularly washed with brown. Male genitalia pale whitish.

Nymph (Fig. 251). Head pale brown to dark brown, darker between eyes submedially, otherwise as in imago; male with upper portion of eyes pale brown to reddish brown.

Mouthparts: clypeus and labrum, Fig. 282, 283; mandibles, Fig. 303; maxillae, Fig. 317; labium, Fig. 332; hypopharynx, Fig. 344.

Thoracic nota pale brown, with darker markings on lateral margins and near midline. Legs (Fig. 376, 377, 405): femora pale brown, with irregular darker markings near apex; tibiae and tarsi whitish to pale brown.

Abdomen (female, Fig. 252) as in subimagos. Gills (Fig. 438) narrow; membrane hyaline to whitish. Caudal filaments pale brown, unbandcd or banded with whitish brown.


Paratypes: NZAC – 5 ♂ and 3 ♀ imagoes; 8 ♂ and 4 ♀ subimagos, 41 nymphs; NMNZ – 2 ♂ and 2 ♀ imagoes, 1 ♂ and 2 ♀ subimagos, 15 nymphs; CMNZ – 1 ♂ and 8 ♀ imagoes, 2 ♂ and 3 ♀ subimagos, 3 nymphs; BMNH – 1 ♂ imago, 1 ♂ and 1 ♀ subimago, 5 nymphs; FAMU – 3 ♂ and 2 ♀ imagoes, 3 ♂ and 1 ♀ subimagos, 19 nymphs; BPBM – 1 ♀ imago, 5 nymphs.

Material examined. Type series only.

AK, CL,WO, BP/NN, BR, WD.

Habitat. Nymphs can be found in a range of stream habitats from near sea level to 600 m. Mauiulus luma is most abundant on moss and macroscopic algae in small forested streams with flow regimes ranging from slow (Towns 1979) to rapid (Towns 1987).

**Mauiulus aquilus** new species

Map 20

Dimensions (mm). Male: length of body 4.6–5.7; forewings 6.9. Female: length of body 5.0–6.0; forewings 7.3. Mature nymph: length of body 5.0–6.4 (6.0).

**Male imago.** Head black, but pale brown near base of antennae and ocelli. Eyes with upper portion pale orangecrown, lower portion black. Antennae pale whitish brown.

Thorax. Pronotum pale brown, heavily washed with black; mesonotum and metanotum brown, with dorsal mesonotum paler, lateral margins darker, and medial sutures washed with black. Pleura pale whitish brown washed with purplish black, and with dark purplish-black markings near base of coxae. Sterna pale brown, with a broad, blackish transverse band across basisternum; sutures whitish. Legs white to pale yellowish brown, with darker marks near articulation of femora and tibiae; length ratios of foreleg segments 0.56–0.58 : 1.00 (1.8–2.2 mm) : 0.04–0.05 : 0.36–0.38 : 0.35 : 0.27–0.29 : 0.09–0.10. Wings as in Fig. 46, 47. Forewing width 0.35× length; longitudinal veins pale brown; cross veins hyaline; membrane hyaline, but base of wing brown. Hind wing width 0.56× length, and length 0.21× that of forewing; vein Sc 0.81× wing length; vein R1 0.97× wing length; longitudinal and cross veins hyaline, but vein Sc pale brown; membrane hyaline, but wing base washed with brown.

Abdomen, Fig. 83. Tergum 1 washed with black; terga 2–6 hyaline, but posterior and posterolateral margins washed with blackish; terga 2, 3, and 6 washed with blackish on midlateral margins; terga 7–10 washed with blackish brown; tergum 10 paler. Tracheae edged with blackish; spiracular areas black. Sterna 1–6 hyaline; sterna 7–10 translucent yellowish to pale brown; abdominal ganglia hyaline. Genitalia (Fig. 133) yellowish to pale brown; penes with a spine on small accessory lobe. Caudal filaments white.

**Female imago** as in male, except as follows. Head pale brown on anterior margin and submedially between eyes. Eyes black. Legs pale yellowish brown. Forewing width 0.35× length. Hind wing width 0.53× length, and length 0.20× that of forewing; vein Sc 0.76× length of wing, R1 0.95× length of wing. Abdomen, Fig. 172; terga 1–7 dark brown; terga 2–9 with small, paired submedian maculae and with midline pale brown; terga 4–6 occasionally with pale brown longitudinal mid-lateral marks; terga 8–10 pale brown, but terga 8 and 9 washed on lateral and/or anterior margins with dark brown. Sterna pale whitish brown. Caudal filaments pale whitish brown, darker at articulations.

Subimagos as in imago, except as follows. Head pale brown, washed with black between eyes anterior to ocelli; female with paired submedian black marks between eyes; cervical membrane black. Mesonotum and metanotum brown, but pale whitish brown along midline, medial to notal furrow, and on scutellum; posterior scutal protuberances washed submedially with brown; lateral margins of scutellum washed with dark brown; notal furrows dark brown; lateral margins of mesonotum near wing base washed with blackish. Sterna pale whitish to yellowish; prosternum with dark brown submedian marks near base of coxae. Wings pale greyish brown, but longitudinal veins of
forewings pale brown. Abdomen with terga 2–6 of male translucent whitish brown, and sternae pale whitish brown. Genitalia of male whitish.

Nymph. Head dark brown, washed with black near ocelli; female with submedial marks as in imago. Eyes of female black; male with upper portion of eyes reddish brown, lower portion black. Antennae 1.75× as long as head, pale brown.

Mouthparts as in Fig. 282, 283, 303, 317, 332, and 344. Labrum 1.5–2.4(1.9)× as long as clypeus and 1.2–1.4(1.3)× as wide as clypeus. Maxillae: galea-lacinia with a subapical row of 11 or 12 spines; palp segment 2 0.94–1.08(1.04)× as long as segment 1, and segment 3 0.54–0.67(0.60)× segment 2. Labium: palp segment 2 0.86–1.07(0.93)× as long as segment 1, and segment 3 0.68–0.81(0.76)× segment 2.

Thorax. Pronotum as in imago; mesonotum pale brown to brown, irregularly washed with dark brown to black. Pleura and sternae as in subimago. Legs: ventral surface pale whitish brown; dorsal surface of fore and middle femora pale brown, with paler marks near base and apex; hind femora darker, with a pale macula near apex; tibiae brown, paler near base and apex; tarsi brown, paler near base.

Abdomen (Fig. 253, 254) with colour pattern as in subimago, but male often with dark brown lateral marks on terga 2–5, and female often with terga 1–7 dark brown whereas nymphs from the Rangitukia Stream often have pale brown and dark brown patches.

Habitat. Mauiulus aquilus is known only from forested streams in the Waikato and Bay of Plenty regions. Nymphs have been collected on rocks, wood, moss, and algae in moderate to rapid flow. In two samples from the Ngamuwahine River 17.5% of the nymphs were hosts for chironomid larvae in June 1979, and 37% in December–January 1980–81. In the Ngamuwahine River M. aquilus is sympatric with M. luma (D.R. Towns, unpublished data).

Etymology. aquilus (Latin), "dark-coloured", refers to the dark coloration of the nymph.

Genus Neozephlebia Penniket

Neozephlebia Penniket, 1961: 8 (subgenus of Zephlebia).

Towns, 1983a: 23 (elevated to genus).

Type species Baetis scita Walker, by original designation.

Imago. Eyes of male fused on meson of head. Claws (Fig. 22) paired, alike, apically hooked, with an opposing hook.

Forewing (Fig. 48) with vein ICu1 attached at base to CuA and CuP by cross veins; vein MP2 with base closer to MP1 than to CuA. Hind wing (Fig. 49) a little more than one-tenth to a little less than one-fifteenth as long as forewing; costal margin with a blunt projection at two-fifths to half of wing length; vein Sc seven-tenths to four-fifths length of hind wing; cross veins few.

Genitalia. Male (Fig. 134, 135): styliger plate wider than long, with apex concave; penes fused basally, divided in distal two-thirds, with a small area of spines near opening. Female sternum 7 without a genital extension; sternum 9 (Fig. 202) deeply cleft.

Nymph (Fig. 255). Antennae about twice as long as head.

Mouthparts. Clypeus (Fig. 284) with anterior margin straight and with lateral margins subparallel. Labrum (Fig. 284) about as long as clypeus; lateral margins smoothly rounded; anteromedian margin (Fig. 285) with a rectangular median concavity bearing 5 denticles, the median one largest. Left mandible (Fig. 304): outer margin smoothly curved, with scattered hair at middle; incisors stout, with apical teeth unserrated. Maxillae (Fig. 318): galea-lacinia
with a subapical row of 13–16 spines; palp segment 3 triangular, with dense hair. Labium (Fig. 333); segment 3 a little shorter than segment 2, subtriangular, with short, stout spines on inner margin; glossae elongate, with short, blunt dorsal spines. Hypopharynx, Fig. 345.

Thorax. Pronotum with small spines on anterolateral margin; mesonotum and metanotum with scattered hairs on margins. Legs (Fig. 378–380): femora narrowly oval, with large spines; femora and tibiae with a few scattered hairs; tarsal claws, Fig. 405.

Abdomen narrowly oval, broadest at segments 4–6, with posterior lateral projections on segments 5–9 or 6–9, those on segment 9 enlarged, blade-like. Gills (Fig. 440) on segments 1–7 alike, successively smaller posteriorly, with dorsal and ventral portions slender, smoothly tapered to apex; tracheae with main trunk occasionally finely branched.

Remarks. Neozephlebia was established as a subgenus of Zephlebia by Penniket (1961). More recent assessments of Zephlebia indicated that it belongs to a lineage distinct from Neozephlebia (Towns & Peters 1980). Neozephlebia does not appear to be closely related to any other genera in New Zealand.

Neozephlebia scita (Walker)

Fig. 255 (nymph); Map 21


Male imago. Head dark brown, but whitish to pale brown distally, medially, and between eyes and base of antennae. Eyes with upper portion pale brown to brown, lower portion black. Antennae pale brown to whitish; scape washed with black at apex.

Thorax pale brown to brown, darker submedially between posterior scutal protuberances and on scutellum. Pronotum blackish brown submedially and on margins; scutellum darker. Pleura pale brown to dark brown, irregularly washed with darker brown; propleuron with an irregular diagonal dark brown band. Sterna pale yellowish brown to dark brown. Legs whitish to yellowish; femora with a diffuse, darker brown band at midlength; tibiae and tarsi often darker at base and apex. Wings (Fig. 48, 49): veins pale brown to brown; membranes hyaline, but wing bases washed with pale brown to brown; forewing with distal third of cell C and Sc translucent whitish, and cross veins of cells C, Sc, and R1 surrounded by brown to dark brown clouds, sometimes extending from cell C to R1 at wing midlength.

Abdomen (Fig. 84): terga brown to dark brown; terga 2–8 often with darker anterolateral marks; anterior margin and paired anterior, submedian, and lateral maculae hyaline. Sterna brown; sterna 2–7 with paired, hyaline anterior submedian maculae; sternum 8 with paired, pale brown anterior submedian maculae. Genitalia (Fig. 134, 135) pale brown to brown. Caudal filaments whitish to yellowish, with dark brown bands at articulations.

Female imago as in male, except as follows. Head paler brown, with dark brown markings on posterior margin, on midline between eyes, and between antennae. Eyes black. Pronotum with midline blackish. Abdomen (Fig. 173) with lateral maculae and anterior margins of terga pale brown, and terga 2–9 with pale brown anterior submedian maculae.

Subimago as in imago, except as follows. Mesonotum pale yellowish brown to brown, paler along inner margin of sutures; anterior half of outer sutures brown, paler posteriorly; posterior scutal protuberances yellowish brown to brown submedially, with midline dark brown; scutellum pale, washed with greyish brown. Forefemora washed with brown near apex. Wings (Fig. 216, 217): membrane brownish; longitudinal and cross veins brown, paler in hind wings; forewing cross veins with greyish clouds, fused near fork of Rs and near intercalaries. Abdominal terga 2–8 with maculae and anterior margins translucent whitish brown, and sternum pale to dark brown, with translucent whitish-brown maculae on segments 2–7.

Nymph (Fig. 255). Head brown, with darker marks as in male imago; mandibles, labrum, and clypeus tinted with orange-brown. Eyes of male with upper portion dark reddish brown, lower portion black. Antennae pale yellowish.
Mouthparts: clypeus and labrum, Fig. 284, 285; mandibles, Fig. 304; maxillae, Fig. 318; labium, Fig. 333; hypopharynx, Fig. 345.

Thorax pale brown to brown, irregularly washed with darker brown submedially, occasionally with lateral dark brown marks. Pleura and sternum as in imago. Legs (Fig. 378–380, 406) pale whitish to yellowish brown; femora with a dark brown band near midlength, less distinct on middle and hind legs; apex of femora and foretarsi occasionally with a dark brown band.

Abdomen as in imago, but terga with lateral margins whitish to yellowish, mid dorsum with a yellowish longitudinal line, and base of gills with dark brown to black marks. Gills (Fig. 440) with lamellae hyaline; tracheae dark brown to black, occasionally with short, fine branches. Caudal filaments pale brown; segments each with a distal whorl of brown denticles and small hairs.

**Typedata.** Lectotype: male imago, "N. Zeal.", designated by Kimmins (1960) (BMNH).

**Material examined.** Lectotype, plus 269 non-type examples (29♂ and 64 ♀ imagos, 5♂ and 112 subimagos, 160 nymphs; AMNZ, BMNH, BPBM, CMNZ, DRTC, FAMU, NZAC, NMNZ).

ND, AK, CL, TK, WN/SD, NN, BR, WD, NC, SC, DN, FD, SL.

**Habitat.** Neozephlebia scita is one of the most widely distributed New Zealand mayflies, in both range and habitat. It has been recorded from small streams to large springs, from soft mud to weed, and from low to rapid flow on wood, leaves, frass, and gravel (Towns 1983a, 1987). In northern New Zealand nymphal growth is poorly synchronised, and adults are present from spring (October) to autumn (April) (Towns 1981, 1983a). Swarming was observed by McLean (1967) in mid afternoon at 5–10 m, mostly over pools.

**Remarks.** The colour of adults and nymphs of Neozephlebia scita varies from pale brown to dark brown at any one locality, but no morphological differences support the earlier description of two separate species (Towns 1983a).

**Tepakia new genus**

**Imago.** Eyes of male fused on meson of head, with lower portion three-quarters as long as upper portion; eyes of female separated on meson of head by a little less than twice maximum width of an eye.

Legs: length ratios in foreleg of male 0.75 : 1.00 (2.1 mm) : 0.05 : 0.36 : 0.38 : 0.35 : 0.15; claws of a pair alike, apically hooked, with an opposing hook, as in Fig. 23.

Wings, Fig. 50, 51. Forewing one-third as wide as long; vein Rs forked at one-fifth of distance from base to margin; vein MA symmetrically forked at a little less than half distance from base to margin; vein MP2 attached at base to MP1 and CuA with a cross vein; attachment of MP2 to MP1 one-fifth distance from base to margin; base of MP2 equidistant between MP1 and CuA; vein IC1 attached at base to CuA and CuP with cross veins; remainder of Cu-A area as in Fig. 50. Hind wing a little less than two-thirds as wide as long, and one-fifth as long as forewing; vein Sc four-fifths length of wing; vein R1 a little less than length of wing; cross veins few in posterior half of wing; costal margin with a blunt projection near midlength; wing apex acute and rounded.

Genitalia. Male (Fig. 136–138): styliger plate ninth-sixteenths as long medially as its maximum width; apex convex dorsally. Forceps segment 1 forming a smooth bend near distal quarter; segment 2 slightly shorter than segment 3, and a little more than one-tenth as long as segment 1; apex of segment 3 rounded. Penes with lobes fused, elongate, a little shorter than forceps segment 1, with small hairs inside openings. Female (Fig. 174): ovipositor or egg guide reaching to a little more than three-fifths along sternum 8. Sternum 9 entire, as in Fig. 205. Caudal filaments broken off and missing in both sexes.

Mature nymph (Fig. 256). Head prognathous. Antennae a little less than 3.0x as long as head.

Mouthparts. Clypeus (Fig. 286) with lateral margins subparallel. Labrum (Fig. 286) as wide as clypeus, a little shorter than clypeus, and a little more than two-fifths as long as wide, with dense dorsal hair and submedian, antero-submedian, and anterolateral areas of hair ventrally; anterior margin (Fig. 287) with a rectangular median concavity bearing 5 denticles, the median one smallest. Left mandible (Fig. 305) with outer margin smoothly curved and bearing scattered hairs near midlength and towards base; incisors large and stout, with apical teeth unequally. Maxillae (Fig. 319): galea-lacinia narrow in distal half, with a subapical row of 15 spines; palp segment 1 with small spines on outer margin; segment 2 a little shorter than segment 1; segment 3 stout, three-quarters as long as segment 2. Labium (Fig. 334): palps broad, with segment 2 four-fifths as long as segment 1, and segment 3 three-quarters as long as segment 2, subtriangular, bearing short, stout spines on inner margin; glossae ventral to paraglossae, bearing numerous short spines, with apex expanded and turned basally; submentum with numerous long spines. Hypopharynx (Fig. 346): lingua with lateral processes well developed, anterior margin deeply cleft,
and apex of submedian lobes rounded; superlingua as in Fig. 346.

Pronotum with long spines on anterolateral margins. Legs (Fig. 381–383): femora elongate, dorsoventrally compressed, with distal third indented to accommodate tibiae and dorsal surface bearing stout spines; tibiae with long, bipicate spines on inner margin; claws (Fig. 407) hooked, narrow, elongate, with denticles small, numerous, successively larger distally.

Abdomen narrowly oval, broadest at segments 4–6, with posterolateral projections on segments 7–9. Gills (Fig. 441, 442) on segments 1–7 with double lamellae, those on segments 1–5 with lamellae oval; tracheal trunks towards ventral margin of lamellae, extended into a filament; gills on segments 6 and 7 narrow, thread-like. Caudal filaments 1.5× as long as body, the terminal filament a little longer than the cerci; segments each with a distal whorl of small denticles and fine hairs.

Egg (Fig. 471) cylindrical, rounded at poles.

Remarks. *Tepakia* can be distinguished from all other leptopheid genera by the following combinations of characters. In the imago: (1) hind wing less than one-fifth as long as forewing, with a blunt costal projection (Fig. 51); (2) forewing vein MP2 joined to MP1 by a cross vein, its base equidistant between veins MP1 and CuA (Fig. 50); (3) penes fused, elongate, with small hairs at opening; (4) genital forceps with a bend near apical quarter of 1st segment (Fig. 136); (5) claws of a pair alike, apically hooked with an opposing hook, as in Fig. 23; (6) female with ovipositor or egg guide reaching to a little more than three-fifths along sternum 8 (Fig. 174); and (7) female with ovipositor or egg guide reaching to a little more than three-fifths along sternum 8 (Fig. 174).

*Tepakia* is most similar to *Isothraulus*, from which it can be distinguished in the imago by (1) forceps segment 1 curved near distal quarter (Fig. 136) (2) penis openings oriented dorsally (Fig. 138), and (3) female with genital extension or egg guide reaching to a little more than three-fifths along sternum 8 (Fig. 174); and in the nymph by (1) clypeus with spines on lateral margins (Fig. 286), (2) abdominal gills with margins not fringed (Fig. 441), and (3) tabial palp segment 3 triangular, with inner margin bearing stout spines (Fig. 334).

Etymology. Derived from Te Paki (Northland), one of the few localities in which the type species has been found; gender feminine.

*Tepakia caligata* new species

Fig. 256 (nymph); Map 22

*Isothraulus* sp.: Towns & Peters 1979b: 444 ("second species of *Isothraulus*").


Male Imago. Head dark brown, washed with black near base of antennae and ocelli. Eyes with upper portion orange-brown to brown, lower portion black. Antennae pale brown; scape washed with darker brown.

Thorax. Pronotum brown to dark brown, washed with black on margins, midline, and submedially; mesoscutum dark brown. Pleura pale brown, extensively washed with blackish. Serrate brown to dark brown; carinae washed with dark brown to black. Legs: forefemora brown; foretibiae and tarsi pale brown; middle and hind legs pale yellowish white, but articulation of femora and tibiae washed with dark brown, and tarsi dark brown. Wings (Fig. 50, 51) with longitudinal and cross veins dark brown; membrane hyaline, but base of wing washed with dark brown. Forewing with cross veins in cells C and Sc with narrow, dark brown.
clouds of pigment.

Abdomen (Fig. 85) brown to dark brown. Terga 1 or 2 to 7 or 8 hyaline; terga 2–7 with midline edged with dark brown; terga 3–7 with chevron-shaped dark brown submedian marks; terga 8–10 brown to dark brown, darker dorsally. Tracheae hyaline, edged with greyish black; spiracular areas black. Sterna brown to dark brown; sterna 2–7 hyaline, with paired submedian maculae. Genitalia dark brown. (Caudal filaments broken off and missing.)

Female imago as in male, except as follows. Eyes greenish black. Thorax paler. [Fore and middle legs broken off and missing.] Wings with narrow brown clouds of pigment around cross veins extending to cell R and scattered through cross veins in distal third; hind wing with veins and cross veins darker. Abdomen (Fig. 174) darker. (Sterna 8–10 damaged. Caudal filaments broken off and missing.)

Subimago. Head pale brown, washed with black near base of antennae and ocelli. Eyes black. Antennae as in male imago.

Thorax. Pronotum pale whitish brown, washed submedially and laterally with black; mesonotum, metanotum, and posterior scutal pronumbers brown but midline, area medial to notal furrows, and scutellum pale whitish brown; lateral margins of scutellum washed with dark brown. Pleura as in male imago. Sterna blackish brown, but furcasternum with lateral lobes paler. Legs yellowish brown; articulation of femora and tibiae dark brown; tarsi dark brown; claws yellowish brown. Wings: membrane pale brown; longitudinal and cross veins dark brown; cross veins surrounded by narrow, dark brown clouds, in female with the clouds broader in cell C, and forming a narrow patch at midlength.

Abdomen as in Fig. 85. Terga dark brown, translucent, with darker chevron-shaped markings as in male imago; terga 2–8 with small, pale brown anterosubmedian maculae. Sterna dark brown; sterna 2–7 with small anterosubmedian maculae. Male with penis dark brown, forceps pale brown. Female with genital extension reaching to one-third along sternum 8; sternum 9 entire. Caudal filaments pale yellowish brown, with dark brown annulations at articulations.

Nymph (Fig. 256). Head pale yellowish brown, darker brown on clypeus and labrum. Eyes of female black; male with upper portion of eyes pale brown, lower portion black.

Thorax. Nota pale yellowish brown, with darker marks on anterolateral and lateral margins of pronotum, near wing bases, and submedially on mesonotum. Pleura pale yellowish brown, washed with brown on and near coxae. Sterna pale yellowish brown. Legs (Fig. 381–383, 407) pale yellowish brown, with broad, darker brown bands paired on fore femora and at midlength of tibiae and tarsi.

Abdomen with posterolateral projections on segments 7–9. Terga pale yellowish brown; terga 3–7 with brown, submedian chevron-shaped marks, broadest on tergum 6; terga 8 and 9 washed with dark brown. Sterna pale yellowish brown; ganglia hyaline. Gills (Fig. 441, 442) on segments 1–5 with lamellae broad, oval, hyaline, on segments 6 and 7 narrow, thread-like. Caudal filaments pale yellowish; segments each with a whorl of small, pale brown denticles.

Egg (Fig. 471) cylindrical, rounded at poles; chorion with attachment structures scattered in pairs and triples.


Repositories: NZAC – 2 ♂ imagos, 1 ♂ and 1 ♀ subimago, 7 nymphs.

Material examined. Type series only.

ND, AK, CL, WO, WN / —.

Intraspecific variation. Nymphs apparently retain their pale yellowish-brown colour until they reach the final instar. However, when they are about to transform the darker colour of the subimagos becomes visible in the tarsi and on the ventral abdomen.

Habitat. The few specimens known are from widely scattered North Island localities and Kapiti Island. All nymphs were collected from very small streams; those in the Waikoha Stream were from vegetation in moderate to slow flow (P. Summerhays, pers. comm.).

Remarks. In their description of Isothraulus abditus Towns & Peters (1979b) noted that a second species, apparently in that genus, was represented by a single specimen from the Kaueranga River valley. Association of nymphs and imagos through rearing by Mr P. Summerhays has enabled us to determine that this species is T. caligata.

Etymology. caligata (Latin), 'booted', in reference to the distinctively coloured tarsi of the subimagos and imagos.
Genus Zephlebia Penniket


Type species Atalophlebia versicolor Eaton, by original designation.

Dimensions (mm). Male imago: body length 7.1-12.2; forewings 7.4-13.3. Female: body length 6.5-11.7; forewings 8.0-14.0. Mature nymph: body length 5.8-12.7.

Imago. Eyes of male fused on meson of head.

Legs: length ratios of foreleg segments in male 0.60-0.82 : 1.00 (2.3-4.4 mm) : 0.03-0.07 : 0.38-0.50 : 0.33-0.49 : 0.26-0.41 : 0.08-0.16. Claws (Fig. 23) paired, alike, apically hooked, with an opposing hook. Wings as in Fig. 52-63. Forewing vein MP₂ attached at base to CuA and MP₁ with a cross vein, or attached at base to CuA but not MP₁; vein 1Cu₁ attached at base to CuA and CuP by cross veins; vein MP₂ with base equidistant between MP₁ and CuA or closer to CuA. Hind wing a little less than one-fifth to a little less than one-quarter as long as forewing; costal margin convex; vein Sc a little more than three-quarters to a little less than nine-tenths length of wing; cross veins few.

Genitalia. Male (Fig. 139-154): styliger plate wider than long, concave apically; penes fused except at apex, with a row of hairs on ventral surface of each opening. Female: sternum 7 with genital extension reaching a little more than one-tenth to two-fifths along sternum 8 (Fig. 185-191); sternum 9 shallowly cleft to entire, as in Fig. 203-205.

Nymph (Fig. 257-263). Antennae 2.0-3.5x as long as head.

Mouthparts. Clypeus (Fig. 288, 290) with anterior margin straight and lateral margins subparallel. Labrum (Fig. 288, 290) longer and a little wider than clypeus; anterior margin concave, with broad-based flat-topped denticles ventrally, the median one pointed (Fig. 289), or with 5 prominent, pointed denticles (Fig. 291). Left mandible (Fig. 306, 307) with a large hair tuft on smoothly curved to angular outer margin; prostheca hair tuft large; incisors slender to stout, with apical teeth unscerotized. Maxillae (Fig. 320, 321): galea-lacinia with a subapical row of 15-24 spines; palp segment 3 slender, elongate. Labium (Fig. 335): palp segment 3 slender; glossae elongate, thickened subapically; hypopharynx as in Fig. 347.

Thorax (Fig. 348-350): pronotum with prominent spines on anterolateral margins; mesonotum and metanotum with or without dorsal submedian spines or projections. Legs (Fig. 384-396) with femora slender, elongate to ovoid; tarsal claws, Fig. 408.

Abdomen weakly oval to strongly tapered posteriorly, with postero-lateral projections on segments 2-9 to 7-9. Gills (Fig. 443-457) on segments 1-6 alike, successively smaller posteriorly, with dorsal and ventral portions plate-like to narrowly oval, terminating in a slender submedian filament; gills on segment 7 reduced to small, narrow lamellae, a single lanceolate lamella, or a single filament; tracheae with numerous fine branches. Caudal filaments 1.5-3.0x as long as body.

Egg (Fig. 472-474) cylindrical to elongate oval or fusiform, with rounded, stellate, or scale-like attachment structures over chorion or with carinae formed into folded ridges.

Remarks. In his revision of Zephlebia, Towns (1983a) found a much wider range of variation than is encountered elsewhere in New Zealand leptophlebiid genera, many characters changing along a species gradient. However, a break in the gradient was represented by Zephlebia borealis (Phillips), for which the subgenus Terama was established (Towns 1983a). The hitherto unknown species of Zephlebia described below have characters bridging the two subgenera defined by Towns (1983a), so Terama is here synonymised with Zephlebia. Although no subgenera are now recognised in Zephlebia, the phylogenetic relationships postulated by Towns (1983a) remain little changed.

KEY TO SPECIES OF ZEPHLEBIA

Imago

1 Femora of forelegs either darker brown than middle and hind legs or with a dark band at midlength ... 2
—Femora and tibiae of forelegs pale yellowish brown, the femora without a band at midlength ... 6

2(1) Femora of all legs with a darker brown band at midlength (Fig. 2) ... (p. 67) ... spectabilis
—Femora with bands either absent or restricted to forelegs ... 3

3(2) Femora of forelegs with a band at midlength; terga 1-6 of male without dark brown submedian marks ... (p. 59) ... borealis
—Femora of forelegs unicolorous; terga 1-6 of male with dark brown submedian marks (Fig. 90, 91, 93) ... 4

4(3) Forewing vein MP₂ attached at base only to CuA (Fig. 59) ... (p. 63) ... nebulosa
—Forewing vein MP₂ attached at base to CuA and MP₁ with a cross vein ... 5
5(4) Forewing with membrane of cells C and Sc yellowish, and with reddish-brown clouds in stigmatic area (Fig. 60); wing colour patterns not sexually dimorphic 

—Forewing with membrane of cells C and Sc hyaline except for clouds at cross veins; wing colour patterns sexually dimorphic (Fig. 62, 63) 

6(1) Forewings with reddish-brown cloud confined to cells C and Sc (Fig. 56) 

—Forewings with reddish-brown cloud extended from Sc to beyond R2 

7(6) Body length >8 mm; forewings with membrane of cells C and Sc pale yellow (Fig. 52); terga 4 and 5 with median subdorsal marks (Fig. 86) 

—Body length <8 mm; forewings with membrane of cells C and Sc very pale yellow to hyaline (Fig. 57); terga 4 and 5 without median subdorsal marks (Fig. 89) 

Nymph 

1 Prothorax and mesothorax without submedian projections or spines; abdomen with postero-lateral projections on segments 2–9 

—Prothorax and mesothorax with submedian projections or tufts of spines (Fig. 348–350); abdomen with postero-lateral projections on segments 5, 6, or 7 to 9 

2(1) Labrum with large, pointed denticles (Fig. 291); middle abdominal gills with an apical projection less than one-sixth length of gill (Fig. 445) 

—Labrum with small, flat-topped anteromedian denticles, the central one pointed (Fig. 289); middle abdominal gills with an apical projection at least one-quarter length of gill 

3(2) Abdomen of male with submedian marks indistinct (Fig. 258), paler than in female 

—Abdomen of males and females with submedian marks dark, as in Fig. 91 

4(2) Abdomen with broad, blackish, paired postero-lateral marks (Fig. 261); gills dark greyish black 

—Abdomen without dark, broad postero-lateral marks (Fig. 259); gills pale greyish 

5(1) Prothorax and mesothorax with submedian tufts of spines (Fig. 350); posterior abdominal terga with lateral margins fringed with hairs (Fig. 262) 

—Prothorax and mesothorax with paired submedian projections, as in Fig. 348; posterior abdominal terga with lateral margins hairless 

6(5) Femora broadly expanded (e.g., Fig. 394); femora dark brown with pale maculae; abdomen with postero-lateral projections on segments 6–9 or 7–9 

—Femora slender (Fig. 384); femora pale brown, with darker brown marks or bands; abdomen with postero-lateral projections on segments 5–9 or 6–9 

7(6) Prothorax and mesothorax with small submedian projections (Fig. 348); body length of mature nymph >8 mm; abdominal gills with apical projections shorter than blade of lamellae (Fig. 443) 

—Prothorax and mesothorax with prominent submedian projections (Fig. 349); body length <8 mm; abdominal gills with apical projections about equal in length to blade of lamellae (Fig. 450) 

Zephlebia versicolor (Eaton) 

Fig. 257 (nymph); Map 23 


Male imago. Head pale brown, occasionally dark brown on antero-lateral margins and at base of antennae. Eyes with upper portion reddish brown, lower portion greyish black. Antennae with scape dark brown, pedicel pale brown to dark brown, flagellum pale brown. Thorax pale brown, darker on margins of pronotum and on dorsum of posterior scutal protuberances, brown on lateral margins of scutellum. Pleura dark greyish brown to brown. Sterna dark brown to brown. Legs pale brownish yellow, darker at articulation of fore femur and tibia. Wings (Fig. 52, 53) with membrane hyaline and some longitudinal and cross veins dark brown. Forewing cells C and Sc
pale yellow, with distal third translucent, and cross veins surrounded by narrow, dark brown clouds; cells C, Sc, and R with a small, dark reddish-brown cloud at midlength.

Abdomen (Fig. 86) pale brown. Terga 1–9 with a narrow, transverse, posterior dark brown band; tergum 1 dark brown, with paired, pale brown submedian maculae; terga 2–6 hyaline, with paired, dorsal dark brown marks; terga 6–10 washed dorsally and/or laterally with dark brown. Sterna pale brown to dark brown; sterna 1–8 or 2–8 with paired hyaline submedian maculae; sterna 2–5 hyaline on lateral margins. Genitalia (Fig. 139, 140) pale brown, darker on midline. Caudal filaments white, with dark brown bands at articulations, the bands wider distally.

Female imago as in male, except as follows. Head paler, with a broad brown transverse band between eyes, and dark brown posterior marks. Forewing cells C and Sc occasionally pale brown. Abdomen (Fig. 175, 185) with terga 2–6 opaque, and submedian dorsal marks on terga 4 and 5 larger; sternum 7 with genital extension reaching one-fifth to one-quarter along sternum 8; sternum 9 (Fig. 203) with a shallow apical cleft.

Subimago as in imago, except as follows. Male with upper portion of eyes orange-brown, and antennae with scape pale brown to dark brown. Thorax pale brown, but mesonotum whitish on dorsum and with a whitish midlateral band, and sutures dark brown to black; posterior scutal protuberances pale brown, darker medially; midline and anterior margins whitish; scutellum whitish. Pleura and sternae irregularly washed with dark grey or greyish brown. Wings (Fig. 218, 219) with membranes greyish (dried) to opaque, and submedian dorsal marks on terga 4 and 5 larger; sternum 7 with genital extension reaching one-fifth to one-quarter along sternum 8; sternum 9 (Fig. 203) with a shallow apical cleft.

Material examined. Lectotype, plus 235 non-type examples (35 ♂ , 1 indet., and 20 ♀ imagos, 17 ♂ and 17 ♀ subimagos, 145 nymphs; BMNH, BPBM, DRTC, FAMU, NZAC).

Habitat. Nymphs are most commonly found on the bed of small, heavily forested streams in areas of low flow or on trailing vegetation (Towns 1983a), amongst debris (Phillips 1930) and on submerged wood (Penniket 1961).

Remarks. Zephlebia versicolor appears to be most closely related to Z. inconspicua, but can be distinguished by the following characters. In the imago: (1) body length > 8 mm; (2) forewing membrane in cells C and Sc pale yellow; and (3) penes broad, about half as long as forceps segment 1 (Fig. 139). In the nymph: (1) pronotum and mesonotum with small, blunt projections; (2) body length of mature nymphs > 8 mm; (3) abdominal gills with basal portion broad (Fig. 443); and (4) caudal filaments 2.5× as long as body.

Zephlebia borealis (Phillips)

Fig. 258 (nymph); Map 24

borealis Phillips, 1930: 356–357 (Atalophlebia) (also as Atalophlebia ? n. sp.). Penniket 1961: 9 (Zephlebia (Zephlebia)). Towns 1983a: 19–21 (Zephlebia (Terana)) (definition of new subgenus, designation of
lectotype, redescription, figures of wings, ♂ and ♀ genitalia, and abdominal coloration of imagoes; wings and thorax of subimago, full nymph, and maxillary palp, abdominal gills, and legs).


Male imago. Head pale brown, blackish brown on anterior margins and in a narrow band between eyes. Eyes with upper portion orange-brown, lower portion black. Antennae with base blackish brown, flagellum pale brown.

Thorax. Pronotum whitish brown, with margins black, and with paired black submedian longitudinal lines extending to between posterior scutal protuberances. Mesonotum and metanotum pale yellowish brown; posterior metathorax with a broad dark transverse band; scutellum whitish on dorsum, with lateral margins pale brown. Pleura pale brown irregularly washed with dark brown and black; a broad, dark brown diagonal line extending from dorso-posterior propedia to anteroventral margin of forecoxae. Sterna dark brown, with proxesternum paler. Legs pale yellowish brown, but dark brown at apex of femora, at apex of middle and hind tibiae, and at articulations of tarsi; forefemora with a broad, diffuse reddish band at midlength; tibiae with a dark brown to black band at apex. Wings (Fig. 54, 55): membrane of cells C and Sc tinted with pale yellow; cross veins surrounded by broad, dark reddish-brown clouds fused at wing midlength; stigmatic area with membrane brownish red; membrane otherwise hyaline, but wing base washed with pale brown, and costal area washed with purplish brown; longitudinal and cross veins dark brown. Hind wing with longitudinal and cross veins pale brown.

Abdomen (Fig. 87) pale whitish brown; terga 1–6 hyaline; tergum 7 translucent; terga 8 and 9 dark brown, paler on dorsum and anterior margin, and tergum 10 pale brown; terga 1–9 with a dark brown posterior transverse band; terga 4–7 with faint darker submedian marks. Sternum 1 dark brown; sternum 2–6 hyaline; sternum 2–9 washed with dark brown posteriorly, the darker areas larger on sternum 7–9. Genitalia (Fig. 141, 142) pale brown. Caudal filaments whitish to yellowish, with darker brown bands at articulations.

Female imago as in male, except as follows. Head darker, the posterior margin with brown submedian and lateral marks. Thorax darker; pigmented area of wings darker, and cross veins in cells C joined by reddish-brown cloud. Abdomen (Fig. 176, 186) darker, with terga and sternum opaque; terga 1–9 with a broad, pale brown mid-dorsal longitudinal line bordered with darker brown submedian marks; sternum 7 with genital extension reaching one-fifth to one-third along sternum 8; sternum 9 (Fig. 204) with a shallow apical cleft.

Subimago. as in imago, except as follows. Male with upper portion of eyes pale brown to orange-brown. Mesonotum with anterior third and area between medioparapsidal and lateral parapsidal sutures dark brown to black; remainder of mesonotum and scutellum whitish brown on dorsum, with lateral margins greyish brown to brown. Wings (Fig. 220, 221): membrane translucent brownish, tinted with yellowish in cells C and Sc (dried); longitudinal and cross veins dark brown, paler in hind wings; clouds greyish, but at cross veins in cells C and Sc brown to dark brown, and membrane in stigmatic area reddish brown. Abdominal terga 1–6 translucent in male, and coloration paler in female.

Nymph (Fig. 258). Head brown washed with darker brown, and with whitish maculae dorsally. Antennae 2.20–3.05(2.65)× as long as head.

Mouthparts. Labrum (Fig. 290, 291): length 0.49–0.60 (0.55)× width; anterior margin with 5 prominent pointed denticles. Mandibles (Fig. 307) with outer margin smoothly curved, incisors short, stout. Maxillae: galea-lacinia with a subapical row of 15–18 spines; palps with hair and sparse denticles. Mandibles (Fig. 307) with outer margin smoothly curved, incisors short, stout. Maxillae: galea-lacinia with a subapical row of 15–18 spines; palps with hair and sparse denticles.

Abdomen. Labial palps with segment 2 0.92–1.15(0.98)× as long as head.


Material examined. Lectotype, plus 177 non-type examples (4 ♂ and 7 ♂ imagoes, 4 ♂ and 4 ♀ subimagos, 158 nymphs) (AMNZ, BMNH, BPBM, CMNZ, FAMU, NMNZ, NZAC, DRTC).
Habitat. *Zephlebia borealis* is probably widespread throughout the North Island, and is common in small streams around Wellington. However, it has not been found south of Cook Strait, despite searches in habitats equivalent to those it occupies in the North Island.

Nymphs are often abundant in slow-flowing reaches of heavily forested streams, particularly on aggregations of wood, twigs and leaves (Towns 1983a). On Great Barrier Island *Z. borealis* was the dominant species in a small assemblage of mayflies on wood and leaves in pools in first-order streams (Towns 1987).

Remarks. *Zephlebia borealis* can be distinguished from *Z. dentata* in the imago by (1) forefemora with a broad, diffuse, reddish-brown band; (2) body length usually >9 mm, and (3) female with a sclerotised, prominent genital extension (Fig. 186); and in the nymph by (1) labrum with prominent, pointed denticles on an anteromedian extension (Fig. 291), and (2) abdomen with enlarged posterolateral projections on segments 6–9 (Fig. 258). *Z. borealis* appears to be most closely related to *Z. pirongia* n.sp., from which it can be distinguished in the imago by (1) forefemora with a broad, diffuse reddish band at midlength, (2) female with genital extension reaching one-fifth to one-third along sternum 8 (Fig. 186), and (3) abdominal colour pattern sexually dimorphic, the males with terga 1–6 hyaline (Fig. 87). In the nymph too the abdominal colour pattern is sexually dimorphic, males having terga 1–6 opaque.

**Zephlebia dentata** (Eaton)

Fig. 259 (nymph); Map 25


Dimensions (mm). Male: length of body 8.0–9.0; forewings 8.6–11.1. Female: length of body 8.0–8.9; forewings 9.5–10.5. Mature nymph: 5.8–9.4.

**Male Imago.** Head pale brown, darker on anterolateral margins and between eyes. Eyes with upper portion orange-brown, lower portion greyish black. Antennae pale brown, with pedicel darker.

Thorax pale brown to yellowish brown, with dorsum of scutellum whitish. Pronotum black on margins, and with black submedian longitudinal lines; metathorax with dark brown submedian and lateral marks. Pleura pale brown, irregularly washed with darker brown; propleural with a broad, blackish diagonal line from posterior margin to anterocentral margin of forecoxae. Sterna pale brown. Legs pale yellowish, but dark brown at apex of femora, at articulations of fore tibia, and at articulations of all tarsal segments. Forewing (Fig. 56) with membrane of cells C and Sc tinted yellow, the distal third translucent; cross veins surrounded by broad reddish-brown clouds that are fused at midlength in cells C and Sc, and with diffuse clouds in stigmatic area; longitudinal and cross veins otherwise brown to dark brown, and membrane hyaline, but veins paler in hind wings.

Abdomen (Fig. 88) pale reddish brown. Terga 1–9 with a narrow dark brown posterior transverse band; terga 2–8 with paired anterior submedian maculae; terga 2–7 with narrow dark brown paired median lines, dark brown lateral marks, and paired submedian marks; terga 8 and 9 brown, darker laterally; sternum 10 pale brown, darker on dorsum. Sterna pale reddish brown; sterna 2–8 with paired anterior submedian maculae, and with anterior margin hyaline. Genitalia (Fig. 143, 144) pale brown, washed with darker brown on stylii plate and forceps. Caudal filaments white, with narrow, dark brown bands at articulations.

**Female Imago** as in male, except as follows. Head darker posterior to ocelli and on posterior margin. Eyes greyish black. Abdomen dark reddish brown, with anterior margin of maculae of terga 2–8 pale reddish brown, and dorsal and lateral markings on terga 2–7 indistinct; sternum 7 with genital extension small, reaching one-quarter to one-fifth along sternum 8 (Fig. 177, 187); sternum 9 with a shallow apical cleft.

Subimago as in imago, except as follows. Mesosternum and metanotum pale brown; scutellum whitish brown, but posterior scutal protuberances with paired submedian greyish-brown marks and brown dorsolateral margins. Mesosternum whitish to pale brown. Wings (Fig. 222, 223) with membrane translucent (dried) or brownish (in ethanol); forewing other than membrane of cells C and Sc with pale greyish clouds around cross veins, and base washed with pale brown; base of hind wing greyish. Abdomen in female pale brown, and terga 2–8 with anterior margin and maculae pale brown.

**Nymph** (Fig. 259). Head pale brown to brown, washed
with darker brown near antennae and ocelli, and with pale whitish macula lateral to ocelli. Male with upper portion of eyes reddish brown. Antennae 2.1–2.5(2.4)× as long as head.

Mouthparts. Labrum length 0.53–0.57(0.56)× width. Maxillae: galea-lacinia with a subapical row of 21–24 spines; palp segment 2 0.93–1.07(0.99)× as long as segment 1, and segment 3 0.56–0.71(0.64)× segment 2. Labial palps with segment 2 0.88–1.00(0.97)× as long as segment 1, and segment 3 0.50–0.64(0.57)× segment 2.

Thorax pale brown, with lateral margins darker and midline whitish. Pronotum and mesonotum irregularly washed with dark brown submedially and medially, without submedian spines or projections. Legs (Fig. 390) brownish white; femora mottled or banded with greyish brown; tibiae and tarsi greyish brown near midlength and base; tarsi darker near base.

Abdomen with posterolateral projections on segments 2–9. Terga pale brown to brown, with markings as in imago, but maculae pale brown or absent, paired submedian lines broader, and midline without submedian lines. Sterna pale whitish, washed with dark brown. Gills (Fig. 448, 449) on segments 1–6 similar; gills on segment 7 with dorsal and ventral portions reduced, often thread-like; lamellae grey; tracheae and branchios dark brownish grey. Caudal filaments pale brown, with darker annulations at articulations.

**Type data.** Lectotype male imago and allolectotype female imago: Wellington, designated by Kimmins (1960) (BMNH).

**Material examined.** Lectotype, plus 321 non-type examples (11 ♂ and 6 ♀ imagos, 6 ♂, 3 ♀, and 3 indet. subimagos, 292 nymphs; BMNH, BPBM, CMNZ, DRTC, FAMU, NZAC).

**Habitat.** Zephlebia dentata is widely distributed through the North Island, where it appears to be most abundant in heavily forested streams less than 2 m wide (Towns 1983a). On Great Barrier Island it was found in a wide range of habitats, from cobbles covered in algae in third-order streams to wet rock faces, runs, and falls (Towns 1987).

**Remarks.** Zephlebia dentata appears to have been confused with Z. versicolor and Z. borealis previous to the revision by Towns (1983a), who gave details of characters separating these species. Briefly, Z. dentata can be distinguished from Z. versicolor in the imago by reddish-brown clouds in forewings cells C and Sc, and the penes more than half as long as forceps segment 1; and in the nymph by absence of submedian projections on the thorax, posterolateral projections on abdominal terga 2–9, and legs with femora dorsoventrally expanded. Characters distinguishing Z. dentata from Z. borealis in the imago are body length less than 10 mm, forelegs without a broad, reddish mid-femoral band, and male with abdominal terga and sternta pigmented; and in the nymph mandibles with outer margins angular, labrum without prominent pointed denticles on the anteromedian margin, and lamellae of abdominal gills greyish. A new species, Z. nebulosa (described below), also appears to be closely related to Z. dentata. Characters separating them are given on p. 65.
Caudal filaments white, with dark brown bands at articulations.

**Female imago** as in male, except as follows. Head washed with dark brown between eyes. Eyes dark grey. Pleura paler. Forewing with cloud at midlength extended to IRs, and a small faint cloud at fork of vein MA. Abdomen with submedian marks broader; terga 1–6 opaque, terga 1–7 with a pale brown mid-dorsal line, and terga 2–6 with dark brown longitudinal lines on lateral margin; sternum 7 with genital extension reaching to one-fifth along sternum 8 (Fig. 178, 188); sternum 9 with a shallow apical cleft.

**Subimago** as in imago, except as follows. Eyes of female black; male with upper portion of eyes orange-brown. Thorax paler; anterior third of mesonotum and posterior scutal protuberances pale brown, whitish along posterior two-thirds of median longitudinal suture and medial to lateral parapsidal sutures; anterior third of lateral parapsidal sutures dark brown; posterior scutal protuberances with submedian black marks, scutellum whitish. Pleura and sterna paler. Wings (Fig. 224, 225) with membrane translucent greyish (dried) or brownish (in ethanol); wing bases washed with brown to dark brown. Forewing with longitudinal and cross veins brown to dark brown; cross veins in cells C, Sc, and R with narrow, dark brown clouds, otherwise surrounded with faint pale brown clouds. Hind wing with longitudinal and cross veins pale greyish brown. Abdominal terga 1–6 of male pale brown, and sterna 7–9 washed with dark brown midventrally.

**Nymph** (Fig. 260). Head brown, paler on midline and in a broad, transverse band anterior to eyes, washed with darker brown near eyes. Male with upper portion of eyes reddish brown, lower portion black.

**Mouthparts.** Labrum length 0.53–0.56(0.55)× width. Maxillae: galea-lacinia with a subapical row of 15–18 spines; palp segment 2 0.88–1.00(0.93)× as long as segment 1, and segment 3 0.59–0.64(0.63)× segment 2. Labial palp segment 2 0.91–1.00(0.96)× as long as segment 1, and segment 3 0.52–0.65(0.60)× segment 2.

Thorax brown, with metastomum paler. Pronotum and mesostomum brown, with prominent dorsal submedian projections (Fig. 349); mesostomum with paired, submedian dark brown posterior marks. Legs: femora pale brown, darker ventrally and near apex; tibiae pale brown, darker at midlength: tarsi pale brown, darker dorsally.

Abdomen with postceralateral projections on segments 5–9 or 6–9; colour pattern as in imago, but mid-dorsum of terga 4 and 5 pale brown for entire length. Gills (Fig. 450, 451) on segments 1–6 similar, with basal portion narrowly oval, and lamellae translucent pale yellowish brown; gills on segment 7 reduced to a single thread-like filament. Caudal filaments about twice as long as body, pale brown to brown, with darker annulations at articulations.

**Type data.** Holotype: male imago, AK, Cascade Stream, reared from nymph, 3 March 1976. D.R. Towns (NZAC).

**Allotype** female imago: same data as holotype except 25 February 1976.

**Paratypes:** NZAC—4♂ imagos, 1♂ and 1♀ subimago, 20 nymphs; NMNZ—5 nymphs; CMNZ—1♂ imago, 5 nymphs; BMNH—4 nymphs; BPBM—5 nymphs; FAMU—16 nymphs; DRTC—3 nymphs.

**Material examined.** Type series only.

**Habitat.** Nymphs of *Zephlebia inconspicua* are most abundant in slow-flowing reaches of heavily forested streams, on emergent and trailing vegetation (Towns 1983a).

**Remarks.** *Zephlebia inconspicua* appears to be most closely related to *Z. versicolor*. Characters distinguishing them are given by Towns (1983a). Briefly, imagos of *Z. inconspicua* are smaller (<8 mm), forewing cells C and Sc are hyaline, and the penes are more than half as long as forceps segment 1; nymphs of *Z. inconspicua* have prominent projections on the thorax, basal portions of the abdominal gills are narrowly oval, and caudal filaments are about twice as long as the body.

**Zephlebia nebulosa** new species

Fig. 261 (nymph); Map 27

**Dimensions (mm).** Male: length of body 10.5–11.1; forewings 11.6–11.8. Female: length of body 11.0–11.6; forewings 13.0–13.7. Mature nymph: 8.1–12.1.

**Male Imago.** Head dark brown. Eyes with upper portion orange-brown, lower portion greyish black. Antennae blackish, pedicel dark brown, palp at base, and flagellum pale brown.

Thorax. Pronotum brown, with broad, paired, black submedian longitudinal lines and black margins. Mesothorax brown, with anterior third, lateral margins, and suture of mesonotum darker; scutellum brown, with paler brown anterodorsal maculae and dark brown dorsal submedian marks. Pleura dark brown, irregularly washed with darker brown to black; propleura with a broad black diagonal line from dorsoposterior margin to anteroventral margin of...
forecoxa. Sterna dark brown; carinae black. Legs pale yellowish, but articulation of tarsal joints and all foreleg segments washed with dark brown, and forefemur dark blackish brown; length ratios of foreleg segments 0.60-0.69:1.00 (3.4-3.5 mm); 0.05-0.08:0.38-0.42:0.36-0.37:0.29-0.30:0.14-0.16. Forewing (Fig. 58): width 0.38× length; membrane in cells C and Sc yellowish; cross veins of stigmatic area in cells C and Sc surrounded by diffuse reddish-brown clouds; diffuse dark brown cloud at wing midlength near vein R2 and towards wing apex; remainder of membrane hyaline, but wing base washed with pale brown, and costal area dark brown; longitudinal and cross veins dark brown; vein MP2 attached at base only to CuA, as in Fig. 59. Hind wing width 0.62× length, and length 0.20× that of forewings; vein Sc 0.83× wing length; vein R1 0.97× wing length; longitudinal and cross veins in distal third of wing dark brown, otherwise pale brown; membrane hyaline, but wing base washed with black.

Abdomen, Fig. 90. Terga dark reddish brown; terga 1–7 hyaline, each with a narrow dark brown transverse band; terga 1–8 with blackish median, paired submedian, and posterolateral marks; terga 1–9 with pale triangular maculae on mid dorsum, and tergum 9 otherwise blackish brown; tergum 10 dark brown; medially and laterally, otherwise pale brown. Terga and sternum 9 with a shallow apical cleft, as in Fig. 203. Mature nymph (Fig. 261). Head with colour pattern as in imago, with pale brown maculae lateral to ocelli and distal to median ocellus. Antennae 1.5× as long as head. Eyes of female black; male with upper portion of eyes reddish brown, lower portion black.

Mouthparts as in Fig. 288, 289, 306, and 320. Labrum length 0.45–0.48× width and 1.32–1.52× length of clypeus, width 1.14–1.20× that of clypeus; anteromedian margin with small, subequal denticles. Maxillae: galea-lacinia with a subapical row of 16 or 17 spines; palp segment 2 0.95–1.06× as long as segment 1, and segment 3 0.50–0.53× segment 2. Labial palp segment 2 0.86–0.90× as long as segment 1, and segment 3 0.56–0.69× segment 2.

Thorax: prothorax and mesothorax brown; nota with dark brown submedian and lateral marks; pronotum and mesonotum without dorsal spines or projections. Legs (Fig. 391–393): femora pale brown to brown, whitish at base and apex, the forefemur with whitish maculae and a large greyish-brown mark on basal surface, the middle and hind femora with pale marks and maculae; tibiae and tarsi pale whitish brown, with a broad pale brown band at midlength; femora and tibiae short, stout.

Abdomen with posterolateral projections present on segments 2–9; colour pattern as in imago. Gills (Fig. 452, 453) on segments 1–7 similar, plate-like, oval, with apex recessed, successively smaller posteriorly; lamellae dark greyish black; tracheal elements numerous, black. Caudal filaments a little longer than body, pale brown; segments each with a distal whorl of small denticles.

Egg (Fig. 472) elongate oval; chorion covered with small, closely packed tubular attachment structures.

Subadult as in imago, except as follows. Head of male paler. Eyes of female greyish black; male with upper portion of eyes pale brown, lower portion black. Pronotum paler. Mesonotum dorsally with anterior third and area between medioparapsidal and lateral parapsidal sutures pale brown, with a broad whitish band medial to outer parapsidal suture, whitish on anterior margin, and pale brown between lateral parapsidal sutures and notal wing processes; anterior half of lateral parapsidal sutures dark brown to black; posterior scutal protuberances whitish mid-dorsally, except for greyish-brown submedian marks, otherwise pale brown, and darker brown laterally; scutellum pale brown. Pleuraple pale brown, washed with greyish brown; sutures pale; carinae darker. Sterna brown, but prosternum and lateral lobes of furcasternum pale brown; carinae darker. Legs pale. Wings (Fig. 226, 227) with membranes translucent greyish and cross veins surrounded by faint, narrow greyish clouds. Male genitalia pale whitish, but styli plate pale brown, and penis with a brown mark between lobes.


Repositories: NZAC - 1 ♂ and 1 ♀ imago, 1 ♂ and 2 ♀ subimagos, 18 nymphs; NMNZ - 1 ♀ imago, 1 ♂ and 1 ♀ subimago, 5 nymphs; CMNZ - 6 nymphs; FAMU - 1 ♂ and 2 ♀ subimagos, 7 nymphs; BMNH - 12 nymphs.

Material examined. Type series only.

AK, CL, WO / —.

Habitat. Zephlebia nebulosa is known only from the northern North Island, including Great Barrier Island. Nymphs were found in streams less than 50 cm wide in heavily forested areas, where water flows rapidly over roots, wood, and rock faces. On Great Barrier this species dominated a small fauna of mayflies inhabiting wet rock faces, runs, and falls (Towns 1987).

Remarks. Most imagos and subimagos of Zephlebia nebulosa have the base of forewing vein M2 attached to vein CuA. One specimen has one wing with this condition and the other with the condition found in Z. borealis, i.e., vein M2 attached to CuA and M1 with a cross vein, but with the attachment closer to CuA than to M1. Mature nymphs of Z. nebulosa from the Waitakere Ranges and on Great Barrier Island are smaller than those from Mt Pirongia, but closely resemble them in all other characters. Immature nymphs differ from mature specimens in having the sterna but closely resemble them in all other characters. Immature nymphs are characterised by the subgeneric division useless.

Zephlebia nebulosa appears to be most closely related to Z. dentata. It can be distinguished in the imago by (1) vein M2 attached at base only to CuA (Fig. 59), (2) forefemora dark brown, (3) forewing membrane with dark brown clouds which are larger and more numerous in females (Fig. 59), (4) body length >10 mm, and (5) female with genital extension reaching one-tenth to one-fifth along sternum 8 (Fig. 189); and in the nymph by (1) abdominal gills dark, plate-like, with apical filament recessed, and gills on segment 7 not greatly reduced (Fig. 453), (2) legs short, stout (Fig. 391), (3) forefemora with a large greyish-brown spot near base on anterior surface (Fig. 391), and (4) abdomen with broad, blackish, paired submedian and posttergal marks (Fig. 261).

Imagos of Z. nebulosa can be distinguished from those of Z. tuberculata by (1) vein M2 attached at base only to CuA (Fig. 59), (2) middle and hind femora without dark brown apical marks, (3) forewing membrane in cells C and Sc yellowish, and with reddish-brown clouds in stigmatic area (Fig. 58), and (4) body length >10 mm. Z. nebulosa subimagos have the forefemora dark brown.

Etymology. nebulosa (Latin), 'cloudy', in reference to the forewings of the imagos.

Zephlebia pirongia new species

Map 28

Dimensions (mm). Male: length of body 10.2–12.2 (11.3); forewings 12.7–13.3 (12.9). Female: length of body 10.6–11.7; forewings 12.7–14.0. Mature nymph: 10.9–12.4.

Male imago. Head pale brown, blackish brown posterior to antennae and on anterior and lateral margins. Eyes with upper portion orange-brown, lower portion greyish black. Antennae with scape and pedicel brown to dark brown, flagellum pale brown to brown.

Thorax. Pronotum pale whitish brown, black on lateral margins, and with paired, black submedian longitudinal marks. Mesonotum pale brown to brown; anterior third of mesonotum and sutures darker; lateral margins of mesonotum paler; scutellum brown, paler dorsally, with paler brown anterodorsal maculae and dark greyish-brown dorsal submedian marks. Pleura dark brown, irregularly washed with darker brown; propodeum with a broad, black diagonal line from dorsoposterior margin to anteromedial margin of forecoxae; sutures whitish; carinae black. Sterna dark brown to blackish brown. Legs pale yellowish, with forefemur dark reddish brown; articulation of femora and tibiae and tarsal joints washed with dark brown, darker on forelegs; length ratios of foreleg segments 0.70–0.82: 1.00 (3.7–4.4 mm) : 0.04 : 0.38–0.45 : 0.37–0.45 : 0.28–0.39 ;
0.11–0.12. Forewing (Fig. 60): width 0.34–0.38(0.37)× length; membrane of cells C and Sc tinted with pale yellow; crossveins surrounded by broad, dark reddish-brown clouds, these fused at midlength and occasionally extending to vein R2; stigmatic area with membrane pigmented reddish brown, the pigmentation more diffuse towards wing apex; membrane otherwise hyaline, but wing base washed with pale brown, and costal area washed with purplish brown; longitudinal and cross veins dark brown. Hind wing width 0.58–0.63× length, and length 0.18–0.19× that of forewing; vein Sc 0.77–0.82× wing length; vein R1 0.95–0.98× wing length; longitudinal and cross veins brown; membrane hyaline, but wing base washed with pale greyish brown.

Abdomen (Fig. 91) pale brown to brown. Terga 1–7 hyaline, and terga 8–10 translucent; tergum 1 with pale brown median and paired dorsal maculae; tergum 2–9 with broad dark brown submedian longitudinal marks, narrower on terga 4–7; terga 2–7 with small, paired, submedian pale brown maculae; tergum 8–10 with midline dark brown; tergum 10 pale brown, darker on posterior margin and occasionally on lateral margins. Tracheae hyaline; spiracular areas black. Sterna dark brown, paler medially; sterna 2–7 hyaline; sterna 2–8 with paired, submedian maculae near anterior margin and middle; ganglia hyaline. Genitalia (Fig. 149, 150) pale brown, but styliger plate dark brown; forceps segment 2 with a brown basal band, and penes with a brown longitudinal mark between lobes. Caudal filaments pale yellowish, with broad dark brown bands at articulations and narrow bands at midlength, the bands broader posteriorly.

Female imago as in male, except as follows. Head with dark brown marks near posterior margin, between eyes. Eyes greyish black. Antennae paler. Mesonotum paler; thoracic sterna occasionally paler, and lateral lobes of furcasternum pale brown. Forewing width 0.36–0.39× length. Hind wing width 0.60–0.69× length, and length 0.17–0.18× that of forewing; vein Sc 0.75–0.85× wing length; vein R1 0.98× wing length. Abdomen translucent pale brown to dark brown, with markings less distinct when abdomen dark brown; sternum 7 (Fig. 180) with genital extension reaching to one-tenth along sternum 8.

Subimago as in image, except as follows. Male with upper portion of eyes pale orange-brown. Thorax with anterior third of mesonotum, area between medioparapsidal and lateral parapsidal sutures, and lateral margins brown; remainder of mesonotum pale whitish to pale brown, but anterior half of lateral parapsidal sutures dark brown to black; scutellum whitish on dorsum, except for irregular greyish submedian marks on posterior cutal protuberances; lateral margins brown. Pleura paler whitish brown. Sterna greyish brown, with lateral lobes of furcasternum pale brown. Legs occasionally darker. Wings (Fig. 228, 229) with longitudinal and cross veins dark brown; forewing with membrane translucent pale brown, but tinted with yellowish in cells C and Sc, and cross veins otherwise surrounded by greyish clouds; hind wing with membrane greyish, paler in proximal third. Abdominal terga of male translucent. Male genitalia pale whitish.

Mature nymph. Head brown, darker at base of antennae, and on dorsal surface of mandibles; female with dark brown submedian marks between eyes, whitish maculate lateral to ocelli and anterior to median ocellus, and occasionally a dark brown transverse line from median ocellus towards lateral ocelli. Eyes of female black; male with upper portion of eyes dark reddish brown, lower portion greyish black. Antennae 2.75–3.0x as long as head.

Mouthparts as in Fig. 290, 291, 307, and 321. Labrum length 0.55–0.61× width and 1.47–1.59× that of clypeus, width 1.01–1.05× that of clypeus. Maxillae: galea-lacinia with a subapical row of 15 spines; palp segment 2 0.83–0.93× as long as segment 1, and segment 3 0.52–0.65× segment 2. Labial palp segment 2 0.92–0.97× as long as segment 1, and segment 3 0.44–0.45× segment 2.

Thorax brown to dark brown; pronotum with lateral margins darker brown to black; pronotum and mesonotum with darker dorsal marks, and without submedian spines or projections; metanotum pale brown, dark brown on posterior margin; scutellum with paired dark brown submedian marks. Legs as in Fig. 387–389: femora pale brown, dark brown at apex, the fore and middle femora with paler maculae, the hind femur paler subapically; tibiae pale whitish brown, darker at midlength; tarsi pale brown.

Abdomen with posterolateral projections on segments 2–9, those on segments 6–9 enlarged, as in Fig. 258; colour pattern as in image. Gills on segments 1–6 similar; gills on segment 7 reduced to small, single lamellae, as in Fig. 447; lamellae with tracheae and tracheal branches blackish, as in Fig. 445. Caudal filaments 1.5–1.75× as long as body, pale brown; segments each with a distal whorl of dark brown dendrites and small hairs.

Egg (Fig. 473) cylindrical, rounded at poles; chorion covered with small nodules, and with scattered single and paired stellate attachment structures.


Paratypes. WO. Type locality: 2♂ and 1♀ imagos, 3♂ and 3♀ subimagos, Mar–Aug 1981, PS; 7 nymphs, Aug.
1981, PS. Rangitukia/Te Miro stms: 1 ♂ and 1 ♀ imago, undated, PS.
Repositories: NZAC - 3 ♂ and 2 ♀, imagos, 1 ♂ and 1 ♀ subimago, 5 nymphs; NMNZ - 2 ♂ and 2 ♀ subimagos, 2 nymphs.

Material examined. Type series only.

Habitat. *Zephlebia pirongia* is known only from streams in the vicinity of Mt Pirongia, near Hamilton, where it commonly occurs in the same drainage system as the closely related *Z. borealis*. The two species rarely overlap in range; *Z. pirongia* is usually confined to minor tributaries, whereas *Z. borealis* inhabits the larger streams (P. Summerhays, pers. comm.).

Remarks. Adults of *Z. pirongia* show affinities with *Z. borealis* and *Z. nebulosa*, but the egg and nymph are most similar to those of *Z. borealis*. *Zephlebia pirongia* can be distinguished from *Z. borealis* in the imago by (1) forefemora unicolorous, dark reddish-brown, (2) female with genital extension reaching to about one-tenth along sternum 8 (Fig. 180), and (3) abdominal colour patterns not sexually dimorphic; in the subimago by (1) forefemora unicolorous dark reddish-brown, and (2) forewing membrane pale brown, with broad greyish clouds at cross veins, as in Fig. 228; and in the nymph by (1) abdomen with broad submedian marks distinctive for males and females, and (2) femora with a narrow dark brown mark at apex.

The number of subapical spines on the galea-lacinia in *Z. pirongia* is given here as 15, but this may be an approximation because they become interspersed with the apical hairs and spines.

Etymology. Named after the type locality, Mt Pirongia.

**Zephlebia spectabilis** Towns

Fig. 1, 262 (nymph), 2 (imago); Map 29

*spectabilis* Towns, 1983a: 14–17 *Zephlebia (Zephlebia)*) (figures of wings, ♂ and ♀ genitalia, and abdominal coloration of imagos; wings of subimago, full nymph, abdominal gills, and legs).

Dimensions (mm). Male: length of body 8.3–10.2 (9.2); forewings 9.6–11.3 (10.3). Female: length of body 6.5–11.1 (8.1); forewings 8.7–13.3 (10.6). Mature nymph: 7.8–9.7 (8.7).

**Male imago** (Fig. 2). Head pale brown, darker on lateral and anteromedian margins and posterior to antennae. Eyes with upper portion orange-brown to pale brown, lower portion greenish black. Antennae pale brown; scape and pedicel washed with darker brown.

Thorax brown to dark brown. Pronotum and scutellum pale brown with darker submedian marks and lateral margins; mesonotum and metanotum darker dorsally, laterally, on posterior scutal protuberances, and between notal wing processes and outer parapsidal sutures; posterior scutal protuberances with paired, dark brown submedian longitudinal marks; pleura brown, irregularly washed with dark brown to black; propodea with a broad, dark brown diagonal line from dorsoposterior margin to anteroventral margin of forecoxae; sutures whitish. Sterna brown, irregularly washed with darker brown; carinae dark brown to black. Legs pale yellowish brown, darker at articulation of trochanter and tarsus and at articulation of all femora and tibiae; femora with a broad, diffuse dark brown band at midlength. Forewing (Fig. 62) 0.34–0.36 (0.35)× as wide as long; vein MP2 attached at base only to vein CuA; membrane of cells C and Sc tinted with pale brown, darker at cross veins, near midlength, and in stigmatic area; costal area purplish brown. Longitudinal and cross veins brown to dark brown in forewing, paler in hind wing; remainder of membranes hyaline; wing bases washed with pale brown.

Abdomen. Fig. 92. Terga 1–8 pale brown, and terga 9 and 10 dark brown, darker on posterior and lateral margins; tergum 1 and terga 8–10 translucent, terga 2–7 hyaline; terga 1–7 or 2–7 with paired submedian dark brown marks; terga 1–5 or 2–5 and 8 with paired lateral marks; terga 1–7 with a narrow, transverse dark brown band on posterior margin. Sterna pale brown, but sternum 8 darker; sternum 2–7 or 2–8 hyaline, remainder translucent; sternum 1–8 each with a darker posterior transverse band and longitudinal median line. Genitalia (Fig. 151, 152) pale brown washed with darker brown. Caudal filaments pale yellowish brown, with broad dark brown bands at articulations becoming narrower distally.

**Female imago** as in male, except as follows. Head darker between eyes and on midline near ocelli. Eyes black. Thorax paler. Articulation of foretibia and tarsus pale yellowish brown. Forewing with a faint pale brown cloud at midlength, occasionally extending to vein R2. Abdominal terga and sterna translucent, with submedian marks on terga broader, and sterna darker; sternum 7 with genital extension reaching one-quarter to two-fifths along sternum 8 (Fig. 181, 190); sternum 9 (Fig. 205) entire, or with a very shallow apical cleft.

**Subimago** as in imago, except as follows. Head paler; male with upper portion of eyes pale brown. Thorax paler;
mesonotum and posterior scutal protuberances pale brown; anterior half of lateral parapsidal sutures dark brown to black; posterior scutal protuberances with dark submedian marks and whitish musculature; scutellum whitish, with lateral margins occasionally pale brown. Pleura and pro sternum paler. Wings (Fig. 230, 231) with membrane translucent brownish; longitudinal and cross veins brown to dark brown; cross veins with diffuse, pale brown clouds darkest in cells C, Sc, and R and fused at wing midlength; clouds fused at fork of MA. Hind wing with a diffuse, pale brownish cloud in distal third. Abdomen paler; sterna washed with brown to dark brown.

**Nymph (Fig. 262).** Head with colour pattern as in imago. Eyes of male with upper portion reddish brown, lower portion black. Antennae 2.5× as long as head. Mouthparts. Clypeus with numerous short hairs on margin. Labrum length 0.50–0.53(0.51)× width. Left mandible with hairs extending to base of outer margin. Maxillae: galea-lacinia with a subapical row of 19–21 spines; palp segment 2 0.89–0.95(0.92)× as long as segment 1, and segment 3 0.69–0.99(0.79)× segment 2. Labial palp segment 2 0.81–0.93(0.86)× as long as segment 1, and segment 3 0.64–0.75(0.70)× segment 2.

Thorax (Fig. 350) pale brown, washed with dark brown to black on pronotum and mesonotum submedially and laterally, and on mesonotum irregularly; pronotum with anterolateral margins expanded, and with paired dorsal submedian tufts of small spines; mesonotum with paired dorsal submedian tufts of small spines and with small spines scattered over dorsolateral surface. Legs (Fig. 394–396) pale brown, mottled and banded with darker brown; femora broadly expanded anteriorly, and with prominent spatulate spines over surface; tibiae pale brown, banded with darker brown; tarsi pale brown with a broad, darker brown band.

Abdomen with colour pattern as in female imago, but submedian and lateral marks often joined near anterior margin of terga; segments 7–9 with prominent posterolateral projections bearing fine hairs on margins. Gills (Fig. 454, 455) on segments 1–6 similar, plate-like, successively smaller posteriorly; gills on segment 7 reduced to a single small, thread-like filament; lamellae translucent pale grey to brownish; tracheal elements pale grey to dark grey. Caudal filaments twice as long as body, pale brown; segments each with a distal whorl of dark brown denticles and prominent fine hairs.

**Type data.** Holotype: male imago, AK, Waitakere River, light trap, 8 February 1977, M.G. Black (NZAC). Allotype female imago: same data as holotype (NZAC).

Paratypes: NZAC – 38♂ and 16♀ imagos, 4♂ and 6♀ subimagos, 17 nymphs; AMNZ – 6♂ and 1♀ imagos, 1♂ and 1♀ subimago, 2 nymphs; CMNZ – 1♂ and 6♀ imagos, 1♀ subimago; NMNZ – 1♂ and 1♀ imagos, 3♂ subimagos, 11 nymphs; BMNH – 1♂ and 1♀ imagos, 2♂ and 1♀ subimagos, 7 nymphs; BPRM – 2♂ imagos, 2♂ subimagos, 3 nymphs; FAMU – 4♂ and 2♀ imagos, 4♂ and 2♀ subimagos, 19 nymphs; DRTC – 3♂ and 1♀ imagos, 1♂ subimago, 5 nymphs.

**Material examined.** Type series only.

ND, AK, CL, WO, BP, WN / NN, BR, DN, SL.

**Habitat.** Nymphs of *Zephlebia spectabilis* appear to be most common on stony substrates in forested streams where flow rates are less than 0.2 metres per second (Towns 1983a).

**Remarks.** Like *Zephlebia nebulosa*, *Z. spectabilis* lacks a cross vein connection between the base of vein MP₂ and MP₁, although a few specimens may be found with the connection present on either one wing or both (Towns 1983a). *Zephlebia spectabilis* appears to be most closely related to *Z. tuberculata*, but can be distinguished by the following characters. In the imago: (1) forewings without large clouds at midlength (Fig. 61); (2) all legs with mid-femoral bands; (3) vein MP₂ not connected at base to MP₁ (Fig. 61); and (4) genital extension of female reaching one-quarter to two-fifths along sternum 8 (Fig. 190). In the nymph: (1) pronotum and mesonotum with submedian tufts of small spines (Fig. 350); (2) abdominal gills on segment 7 reduced to a single, thread-like filament (Fig. 455); and (3) caudal filaments with prominent fine hairs (Fig. 262).

**Zephlebia tuberculata new species**

Fig. 263 (nymph); Map 30

**Dimensions (mm).** Male: length of body 7.1–8.3(7.8); forewings 8.0–8.9(8.4). Female: length of body 7.3–8.4(7.9); forewings 9.5–10.2(9.7). Mature nymph: 5.7–9.2(8.0).

**Male imago.** Head pale brown, but dark brown at base of antennae, on dorsum along midline, and along suture between ocelli. Eyes with upper portion reddish brown, lower portion greyish black. Antennae with scape dark brown, pedicel dark brown at base, paler distally, and flagellum pale brown.

Thorax. Pronotum pale brown, with black paired dorsal submedian longitudinal lines and lateral margins; mesothorax pale yellowish brown to pale brown, darker on
anterior third of notum and washed with darker brown along parapsidal sutures and submedially on posterior scutal protuberances; scutellum with lateral margins pale brown. Pleura dark brown, irregularly washed with black, and whitish near base of forewings; propodeum pale brown, with a broad black diagonal line from dorso-posterior margin to anteroventral margin of forecoxae. Sterna brown to dark brown, with carinae darker and lateral lobes of furcasternum occasionally paler. Legs pale yellowish, but forefemur dark brown, and middle and hind femora faintly washed with dark brown on anterior surface; femora with a narrow, dark brown to black apical band; length ratios of foreleg segments 0.67-0.69 : 1.00 (2.4-2.9 mm) : 0.03-0.06 : 0.37-0.42 : 0.33-0.46 : 0.30-0.36 : 0.10-0.12. Forewing, Fig. 62; width 0.35-0.36(0.35)x length; cross veins in cells C and Sc with narrow dark brown clouds; membrane hyaline, but with a diffuse brown cloud at wing midlength in cells C and Sc, occasionally extending beyond vein R2, and with faint clouds in stigmatic area and often at fork of vein MA; wing base washed with pale brown, and costal area purplish brown; longitudinal and cross veins pale brown to brown. Hind wing width 0.55-0.60(0.57)x length, and length 0.20-0.25(0.22)x that of forewing; vein Sc 0.73-0.83(0.79)x wing length; vein R1 0.89-0.98(0.95)x wing length; longitudinal and cross veins pale brown to yellowish; membrane hyaline, but wing base tinted with yellowish brown.

Abdomen, Fig. 93. Tergum 1 dark brown, paler medially and on anterior margin, terga 2-7 or 2-8 pale brown, hyaline, and terga 7-10 or 8-10 pale brown; terga 1-10 with a narrow, dark brown to black transverse band on posterior margin; terga 2-7 with paired dorsal submedian and lateral dark brown marks; terga 8 and 9 whitish middorsally, and with darker brown lateral marks; tergum 10 black along midline, and with darker brown lateral marks. Tracheae hyaline; spiracular areas black. Sterna brown, with sternum 9 occasionally paler; sternum 3-6 or 3-7 hyaline; sternum 2-7 with small, paired submedian maculae near anterior margin and near midline; abdominal ganglia hyaline. Genitalia (Fig. 153, 154): styliger plate and proximal half of furcasternum segment 1 washed with brown; forceps otherwise pale whitish; penes whitish to pale brown, darker basally, and with a dark brown mark near apex, between lobes. Caudal filaments pale, with broad, dark brown bands at articulations, these broader posteriorly; segments in distal half each with narrow brown annulations at midlength.

Female imago as in male, except as follows. Head paler, washed with dark brown on posterior margins and posterior and lateral to ocelli. Antennae paler. Eyes greyish black. Mesonotum paler. Legs darker, but forefemur paler, and tarsi brown. Forewing, Fig. 63; width 0.37-0.38(0.38)x length; clouds at cross veins darker, broader, and extending to cell R1 and near fork of MA; membrane in proximal half of cells C and Sc tinted with pale yellowish brown; large, diffuse, pale brown to dark brown clouds at wing midlength in cells C, Sc, and R1, in stigmatic area, at forks of veins Rs and MA, and at base of veins Rs and MA. Hind wing width 0.54-0.60(0.57)x length, and length 0.21-0.25(0.22)x that of forewing; longitudinal and cross veins darker; vein Sc 0.78-0.83(0.81)x wing length; vein R1 0.96-0.98(0.97)x wing length. Abdomen with lateral marks less distinct, and terga 2-8 opaque; tergum 10 pale brown to dark brown; sterna pale brown to dark brown; sternum 7 with genital extension reaching one-twelfth to one-fifth along sternum 8 (Fig. 182, 191); sternum 9 with a shallow apical cleft, as in Fig. 203.

Subimago as in imago, except as follows. Eyes of female greyish black; male with upper portion of eyes brown, lower portion greyish black.

Pronotum paler; anterior third of mesonotum and area between lateral parapsidal sutures and median notal suture pale brown, but with a broad whitish band along posterior two-thirds of median longitudinal suture and medial to lateral parapsidal sutures; medioparapsidal sutures dark brown; mesonotum between lateral parapsidal sutures and notal wing processes pale brown, with anterior half of lateral parapsidal sutures dark brown to black; posterior scutal protuberances whitish submedially, with lateral margins pale brown, midline bordered laterally by paired dark brown marks; scutellum whitish lateral margins washed with greyish brown. Pleura pale brown washed with greyish brown. Sterna with lateral lobes of furcasternum pale brown. Femora pale yellowish brown, washed subapically with a diffuse reddish-brown band. Wings (Fig. 232, 233) with membrane translucent greyish; male with longitudinal and cross veins pale brownish, cross veins in cells C, Sc, and R1 reddish brown, and all cross veins with pale reddish-brown clouds; female with longitudinal veins, cross veins, and clouds darker, and hind wing with a diffuse greyish-brown cloud in distal third.

Abdomen paler; male with terga 2-8 opaque and middorsum of terga 1-9 pale brown; sterna as in female, but paler. Male genitalia whitish, but dark brown between lobes of penes. Caudal filaments with bands at articulations narrower.

Nymph (Fig. 263). Head brown to dark brown, darker near base of antennae and eyes, laterally to ocelli, and near posterior margin on either side of midline, with small, whitish maculae lateral to ocelli and distal to anterior ocellus. Eyes of female greyish black; male with upper portion of eyes deep reddish brown, lower portion greyish
black. Antennae 2.25–2.5× as long as head.

Mouthparts as in Fig. 288, 289, 306, and 320. Labrum length 0.45–0.50(0.49)x width and 1.27–1.37(1.32)x length of clypeus, width 1.18–1.23(1.21)x that of clypeus. Maxillae: galea-lacinia with a subapical row of 20–26 spines; palp segment 2 0.91–1.11(1.02)× as long as segment 1, and segment 3 0.67–0.76(0.73)x segment 2. Labial palp segment 2 0.96–1.03(1.00)× as long as segment 1, and segment 3 0.57–0.62(0.59)x segment 2.

Thorax as in Fig. 349. Pronotum and mesonotum pale brown to dark brown, with prominent, paired dorsal submedian projections; pronotum with darker brown lateral margins and dark mid-dorsal and submedian marks; mesonotum with darker marks; metanotum pale brown, with dark brown to black posterior and lateral margins. Legs: forefemur broadly expanded anteriorly and with prominent spines over surface, as in Fig. 394; femora pale brown to dark brown, with whitish bands and maculae; tibiae brown to dark brown, with base and apex whitish; tarsi brown to dark brown, whitish near base and apex.

Abdomen with posterolateral projections present on segments 6–9 or 7–9; colour pattern as in imago. Gills (Fig. 456, 457) on segments 1–6 similar, plate-like, successively smaller posteriorly; gills on segment 7 with dorsal and ventral portions reduced to a single thread-like filament or double filaments with reduced lamellae; lamellae translucent greyish; tracheal elements numerous, dark grey. Caudal filaments 2.2–2.7× as long as body, brown, with or without darker annulations at articulations; segments each with a distal whorl of small denticles.

Egg (Fig. 474) cylindrical, rounded at poles; chorion with closely packed scale-like surface structures.


Material examined. Type series only.

Habitat. Zephlebia tuberculata is known only from the northern half of the North Island. The few nymphs collected by DRT were in slow flow near stream margins. This species is locally common in streams draining Mt Pirongia, where it inhabits woody substrates in open areas (P. Summerhays, pers. comm.).

Remarks. Most nymphs have posterolateral projections on abdominal segments 7–9, but those from Mt Pirongia have projections on segments 6–9. The nymphs also show some variation in colour, specimens from the Kaimai Ranges being paler than those from Mt Pirongia. Zephlebia tuberculata appears to be most closely related to Z. spectabilis, from which it can be distinguished in the imago by (1) forewing membrane of females with distinctive clouds (Fig. 62, 63), (2) forewing vein ΜP2 connected at base to ΜP1 by a cross vein (Fig. 63), (3) middle and hind legs without mid-femoral bands, (4) fore-femur dark brown, and (5) female with genital extension usually reaching to less than one-fifth along sternum 8 (Fig. 191); and in the nymph by (1) pronotum and mesonotum with large dorsal submedian projections, as in Fig. 349, (2) gills on abdominal segment 7 not much shorter than gill 6, and (3) caudal filaments without prominent hairs.

Imagos and subimagos of Z. tuberculata also resemble Z. nebulosa. Characters distinguishing them are provided on p. 65.

Etymology. tuberculata (Latin), in reference to the tuberculate projections of the nymphal thorax.
REFERENCES


Hudson, G.V. 1904: New Zealand Neuruphila; a popular introduction to the life histories and habits of mayflies, dragon flies and allied insects inhabiting New Zealand, including notes on their relation to angling. London, West Newman & Co. 102 p.


APPENDIX 1: Character states used in proposed phylogeny of New Zealand Leptophlebiidae (Text-fig. 1): D, derived; A, ancestral; N, nymph; I, imago.

1. D: Sternum 9 of ♂ with apex moderately cleft to entire (I) (Fig. 193–201).
   A: Sternum 9 of ♂ deeply cleft (Fig. 192, 202).

2. D: Mandibles with base of prosthecal tuft spine-like (N) (Fig. 304).
   A: Mandibles with base of prosthecal tuft broad, fleshy (Fig. 292).

3. D: Genital extension absent (I).
   A: Genital extension present to very well developed (Fig. 183).

4. D: Forewing without clouds of pigment around cross veins in costal area (I).
   A: Forewings with clouds of pigment around cross veins in costal area (Fig. 24).

5. D: Tarsal claws dissimilar or, if similar, with no opposing hook (I) (Fig. 18, 20).
   A: Tarsal claws of imago similar, with an opposing hook (Fig. 12).

6. D: Glossae broad, on about same plane as paraglossae (N) (Fig. 328).
   A: Glossae narrow, not on same plane as paraglossae (Fig. 335).

7. D: Galea-lacinia broad, usually with >20 subapical spines (N) (Fig. 314).
   A: Galea-lacinia narrow, usually with <20 subapical spines (Fig. 311).

8. D: Clypeus with lateral margins strongly divergent apically (N) (Fig. 276).
   A: Clypeus with lateral margins weakly divergent to subparallel (Fig. 264).

9. D: Penes not divided to styliger plate (I) (Fig. 94).
   A: Penes divided to styliger plate (Fig. 101).

10. D: Labrum hooded on anterior margin (N) (Fig. 276).
     A: Labrum with anterior margin flat.

11. D: Labrum shorter than clypeus (N) (Fig. 276).
     A: Labrum longer than clypeus.

12. D: Mandibles with prosthecal tuft reduced to a few hairs (N) (Fig. 294).
     A: Mandibles with prosthecal tuft well developed, brush-like (Fig. 297).

13. D: Mandibles with apex of incisors serrated (N) (Fig. 300).
     A: Mandibles with apex of incisors smooth.

14. D: Penis openings subapical, lined on ventral margin with an external row of hairs (I) (Fig. 139).
     A: Penis openings without hairs at margin or, if present, then hair recessed (Fig. 96).

15. D: Labrum with anterior margin rounded, deeply emarginate (N) (Fig. 270).
     A: Labrum with anterior margin slightly curved to flat.

16. D: Penes with mid-dorsal spines (I) (Fig. 108).
     A: Penes without dorsal spines.

17. D: Penes elongate, tubular (I) (Fig. 136). A: Penes short, rectangular.

18. D: Penes fused to apex (I) (Fig. 105). A: Penes divided at apex (Fig. 139).

19. D: Abdominal gills 1–6 similar, but gill 7 often a single filament (N) (Fig. 411).
     A: Abdominal gills 1–7 similar, but gill 7 slightly smaller than gill 6.

20. D: Right mandible with denticles on outer incisor (N).
     A: Right mandible with outer incisor smooth or spinose.

APPENDIX 2: Abbreviations used in illustrations

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Fig. 1 Habit, dorsal, nymph of *Zephlebia spectabilis* (caudal filaments truncated).

Fig. 2 Habit, lateral, male imago of *Z. spectabilis*, with (inset) detail of head.
Fig. 3-6 Morphology of imago and subimago (not to same scale): (3) male imago, lateral (forelegs and caudal filaments truncated); (4) foreleg, showing segmentation; (5, 6) forewing and hind wing, showing venation; (7) hind abdomen of male, lateral, showing genitalia; (8) hind abdomen of female, lateral, showing egg guide.
Fig. 9 Thoracic nota of subimago.

Fig. 10 (right) Morphology of nymph, dorsal (caudal filaments truncated).

Fig. 11 Mouthparts of nymph, in ‘exploded’ view; principal elements labelled in full.
Fig. 12–23 Fore claws of male imagos: (12) Acanthophlebia cruentata; (13) Atalophlebioides cromwelli; (14) Austroclima sepia; (15) Cryophlebia aucklandensis; (16) Deleatidium lili; (17) D. fumosum; (18, 19) D. myzobranchia (Cascade Stm, AK; Kaiwharawhara Stm, WN); (20) Deleatidium (Penniketellum) insolitum; (21) Mauiulus flora; (22) Neozephlebia scita; (23) Zephlebia versicolor.
Fig. 24–33 Wings of male imagos (where hind wing enlarged; scale line indicates actual length relative to forewing): (24, 25) Acanthophlebia cruentata; (26, 27) Arachnocolus philipsi; (28, 29) Atalophlebioides cromwelli; (30, 31) Austroclima sepia; (32, 33) Austronella planulata.
Fig. 34-45  Wings of male imagos (where hindwing enlarged, scale line indicates actual length relative to forewing): (34, 35) Cryophiebia aucklandensis; (36, 37) Deleatidium lilli; (38, 39) D. magnum (part forewing); (40, 41) D. myzobranchia; (42, 43) D. (PennikelleILLISELLUM) insolitum (hind wing to scale); (44, 45) Isothraulus abditus.
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Kua whakatūria tēnei rārangi pukapuka hei whakahauhau ki nga tohunga whai mātavranga kia whakātū i nga mea e pā ana ki nga kararehe o Niu Tireni. He āhua tohunga tēnei rārangi pukapuka, engari, ko te hiahia kia mārama ai te tuhituhi, kia mōhio ai te maria ki nga tohu o ia ngārara, o ia ngārara, a, kia whakāri i te mātavranga e pā ana ki a rātou.

Ko ēnei pukapuka 'Fauna of New Zealand' kāore e pā ana ki nga kararehe moana, arā, ki nga ika, ki nga mātaitai rānei. E tino mōhio tāna nga kararehe. Kei roto i nga pukapuka e kia ana 'Marine Fauna of New Zealand' nga tuhituhi e pā ana ki nga kararehe moana nga ika me nga mātaitai, hoki.

Tuhituhinga. Ko te tono ki nga tohunga kia tukua mai ā koutou pukapuka. E wātea ana te kokohinga kararehe e kia ana ko te New Zealand Arthropod Collection hei mātakitaki māu. Me whāki ō koutou whakāro ki te mema o te kāhui tohutohu o 'Fauna' e tika ana, ki te Etiti rānei, i mua i te timatanga tuhituhi.

Nga kai-hoko pukapuka. Me tuhi ki te 'Fauna of N.Z.', Manaaki Whenua Press, Landcare Research, P.O. Box 40, Lincoln 8152, New Zealand.

E rua nga tūmomo kai-hoko: 'A' — Kai-hoko tūmau; ka tukua ia pukapuka, ia pukapuka, me te kaute, i muri tonu i te tāngā o taua pukapuka. 'B' — ka tukua nga pānui anake, a tōna wā, a tōna wā. Te utu (tirohia te whāragangi 142) Ko te kōpakilanga me te pane kuini kei roto i te utu. Me utu koutou e noho ana i Niu Tireni me Āitereira ki nga tāra o Niu Tireni. Ko ētahi atu me utu te whakarihang a nga tāra Marikena.

E toe ana nga pukapuka o mua. Mehe mea e hiahia ana koe ki te katoa o nga pukapuka, tonoa mai kia heka iho te utu. E tekau pai hēneti te heke iho o te utu ki nga toa hoko pukapuka.
Area codes and boundaries used to categorise specimen locality data (after Crosby et al. 1978)

Base-map for plotting collection localities; this may be photocopied without copyright release.
THE NEW ZEALAND SUBREGION
(excludes Lord Howe, Norfolk, and Macquarie islands except in the context of extralimital zoogeography)
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