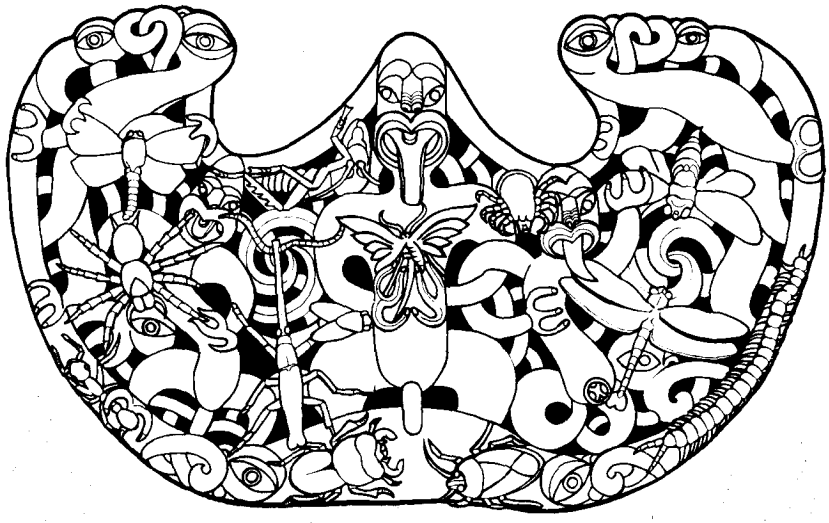

Fauna of New Zealand

Ko te Aitanga Pepeke o Aotearoa

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Fauna of New Zealand
Ko te Aitanga Pēpeke o Aotearoa

Number / Nama 36

Leptophlebiidae

(Insecta: Ephemeroptera)

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Front cover: The insect depicted is *Zephlebia spectabilis* (Illustrator: D.R. Towns, from a photo by Bill Crawford). Aro mua: Ko te pēpeke nei ko *Zephlebia spectabilis* (Kai-whakāhua: D.R. Towns)

Class **Insecta**
Order **Ephemeroptera**
Family **Leptophlebiidae**

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. The imago too usually lives for 24 hours, during which time it mates, often in swarms that gather over water or landmarks such as small trees. Eggs are then deposited in streams.

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)

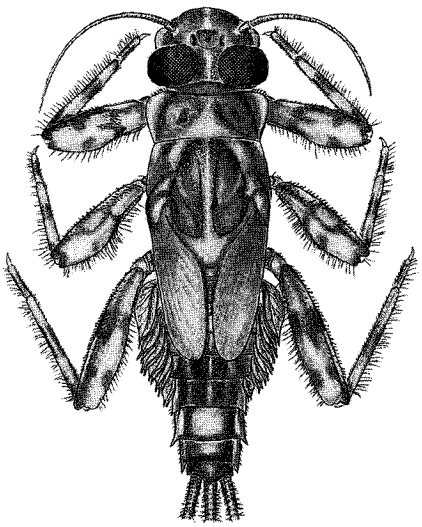

Illustration / Whakaāhua: *Zephlebia spectabilis*, nymph / tūngoungou (Illustrator / Kaiwhakaāhua: David Towns)

Ko Leptophlebiidae te rōpū tino nui iNiu Tīreni nei ka huihuitia e toru tekau momo i roto i nga tātai tekau mā rua, tuturu ake no Niu Tīreni 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 nohonoho ki nga wāhi wairere, wai maanu, kīhai e paru ana. Ko nga momo i Niu Tīreni ka kitea noatia ki te wairere anahe. Ko ētahi momo na noho ki nga wai maanu, nga roto, ā, ki nga wai hōhonu o nga awa āta rere. Ko te nuinga o nga kaikai he detritus me te algae. I a puruma mai e rātou i nga tokatoka, wahie, me nga raurau i nga paraihe huruhuru i ō rātou māngai.

Ko nga kōhungahunga ka tupu, ka tuku kiri tae atu ki te tau kotahi, ka whiti atu ki te rua wāhanga parirau ai: he subimago kāhore anō kia oti tika te tupu o nga whēkau tuku hēki o roto, ka noho tēnei āhua mo te rua tekau mā whā hāora, ā, a muri atu he imago kua whakatinana katoa nga whekau whānautanga. Kāhore ia subimago me imago he whēkau e mahi ana mo te āhua kai he wehewehenga māngai rānei. Ko te imago ka ora heoi anō mo te rua tekau mā whā hāora anahe, ā ka mahimahi hoki, kamirara katoa ka huihui i runga i te wai i nga tohu whenua rānei, pēnei i te wāhi rākau. Ka whanautia nga hēki 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 kaituhi a **William L. Peters** he Ahorangi no Entomology he Tumūāki hoki no te Center for Studies i Entomology i te Wharewānanga o A and M Florida, i Tallahassee, Āmerika ko ia anō te mema whakahaere i nga taumata i reira, mai anō i te mutunga 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 tāhia koni atu i te kotahi rau i roto i āna nei hīkoi haere he kohikohi, he whakatupu mayflies. I roto i ēnei hīkoinga kua tae ia ki New Caledonia, Ahitereiria, Āhia South East, Uropa, ā ki te Raki ki Waenga o nga whenua o Āmerika.

Ko nga kōhunga ka noho i te wairere kaha ētahi wā ka pararahi, ka tupu te āhua o nga ū taetae ngotengote i nga hawa kia ū ai te puriti.

Ko ētahi atu momo ka whai hawa he muka haere ana, e pararahi ana rānei. Ko nga kōhungahunga e kaikai mea ana i nga rākau e tere haere ana i te wai, kia rātou nga matimati nunui, wae rerekē rānei hei āwhina i a rātou kia ū tika ai. Taki tahi noa iho he karakara māpurapura ana engari ko nga imagos ka putaputa te kōwhai me te whero i nga parirau. Ko nga imagos i a momo rerekē ka rima miramita ki tekau mā rima miramita te roa.

Ko nga mayflies o te whānau Leptophlebiidae no rātou anō te nuinga o nga iroiro ko noho i te wai rere mā i nga awawa o Niu Tīreni nei. He tino kai nui anō tēnei ki te ika nei te kōkopu e mōhiotia ana e nga kaihī i tenei ika (he kai) anō hoki na te nuinga o nga ngārara, manu, ika o konei anō. Na te mahamaha i te wai mā me te nui hoki o te hau pūmau me te hanga ohooho noa iho ki te paru ka meatia nga mayflies hei orotake i te āhua o te pai te mā o te wai i Niu Tīreni i nga wai o nga awaawa hoki.

Ko nga mea takitahi o nga mayflies i Nui Tīreni nei ko Leptophlebiidae mā ā kei runga atu i te kotahi torunga momo ka mōhiota i nga wāhi e tapu tapu ana. Ko ētahi anō o nga momo takitahi te kitea na te mea kīhai anō kia āta tohutohutia mai he aha pū nga momo tae atu ki nga mea e kaha ana te kitea. Ko te mātou mahi ka whakarato mai i nga tohutohu tuatahi ki a āta mōhiotia ai nga poutama oranga o nga Leptophlebiidae i Niu Tīreni nei.

He iti noa ka taeā te mohio me titiro noa iho i te kanohi, ko te nuinga anō o nga momo kia mohiotia ai me titiri anō ki nga karaehe pūtaiao pēnei i te compound microscope mō te āhua whakatinana i nga honohono māngai o nga kōhungahunga.

Ko te kaituhi ko **David Towns** he pūtaiao he rangatira whakahaere i te Auckland Regional Whare Pūtaiao o Te Papa Atawhai i Ākarana nei. Ka uru atu David ki te tirotiro i nga mayflies i a ia e tauira ana i nga invertebrates e nohonoho an ki nga awaawa ngahere kauri e pātata ana ki Ākarana mo tana tuhinga roa tohungatanga (PhD). Ka huri taua mahi nei ki tētahi kete rangahau me te Ahorangi nei a William L. Peters i Florida (Āmerika) i te Wharewānanga o A and M mai i te tau 1977 ki 1979. Na rātou i whakamārama mai e hia noa atu momo hōu me nga tātai ka kitea i te wā e rangahau ana i nga mahi i nga rākau kauri o te ngahere. I te pūtea moni ka riro mai i ai a i te taumata ako i te Wharewānanga o Adelaide i te tau 1979 ki 1982. Ka kohikohia anō etahi i Niu Tīreni, i taeā ai e David ki te tīmata i nga whānuitanga wēwehe o te kāwai o Leptophlebiidae mā. Ko tēnei mahi ko te nuinga ano ka oti i a ia e mahitahi ana me Bill Peters i Tallahassee i te tau 1993 i te wā i a David e wātea mārika mai ana mo ana 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

Genus ***Acanthophlebia*** Towns, 1983a 17
cruentata (Hudson, 1904) 18

Genus ***Arachnocolus*** Towns & Peters, 1979b 18
phillipsi Towns & Peters, 1979b 19

Genus ***Atalophlebioides*** Phillips, 1930 19
cromwelli (Phillips, 1930) 20

Genus ***Austroclima*** Towns & Peters, 1979a 21
sepia (Phillips, 1930) 22
jollyae Towns & Peters, 1979a 23

Austronella new genus 23
planulata (Towns, 1983a) new combination 25

Genus ***Cryophlebia*** Towns & Peters, 1979a 26
aucklandensis (Peters, 1971) 26

Genus ***Deleatidium*** Eaton, 1899 27
Subgenus ***Deleatidium*** 30
lillii Eaton, 1899 30
angustum new species 33
autumnale Phillips, 1930 35
cerinum Phillips, 1930 36
fumosum Phillips, 1930 38
magnum new species 40
myzobranchia Phillips, 1930 42
vernale Phillips, 1930 44
Subg. ***Penniketellum*** Towns & Peters, 1979b n.st. 46
insolitum (Towns & Peters, 1979b) 46
cornutum new species 47

Genus ***Isothraulus*** Towns & Peters, 1979b 48
abditus Towns & Peters, 1979b 48

Genus ***Mauiulus*** Towns & Peters, 1979a 49
luma Towns & Peters, 1979a 50
aquilus new species 51

Genus ***Neozephlebia*** Penniket, 1961 52
scita (Walker, 1853) 53

Tepakia new genus 54
caligata new species 55

Genus ***Zephlebia*** Penniket, 1961 57
versicolor (Eaton, 1899) 58
borealis (Phillips, 1930) 59
dentata (Eaton, 1871) 61
inconspicua Towns, 1983a 62
nebulosa new species 63
pirongia new species 65
spectabilis Towns, 1983a 67
tuberculata new species 68

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INTRODUCTION

Mayflies (Ephemeroptera) are regarded as one of the most primitive orders of winged insect 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 phyletic 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 leptophlebiine and atalophlebiine mayflies are preserved in Baltic amber, and therefore diverged more than 50 my BP (Hubbard & Savage 1981). However, since the more derived lineages of Atalophlebiinae are well represented in New Zealand, the divergence between Atalophlebiinae and Leptophlebiinae apparently pre-dated the fragmentation of Gondwanaland *c.* 80 my BP (Stevens *et al.* 1988).

All mayfly species have aquatic nymphs 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 to an imago after 24 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 *Baetis 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 *Atalophlebia 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 *Atalophlebia cruentata* (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: *Atalophlebioides* and *Deleatidium* appear to be part of a lineage with representatives in South America (*Meridialaris* and *Massartellopsis*), Australia (*Austrophlebioides*), Celebes (*Sulawesia*), Sri Lanka and southern India (*Petersula*), and Madagascar (*Petersophlebia*) (Pescador & Peters 1980a, Campbell & Suter 1988, Peters & Edmunds 1990). *Cryophlebia* of the Auckland Islands may have affinities with this group.

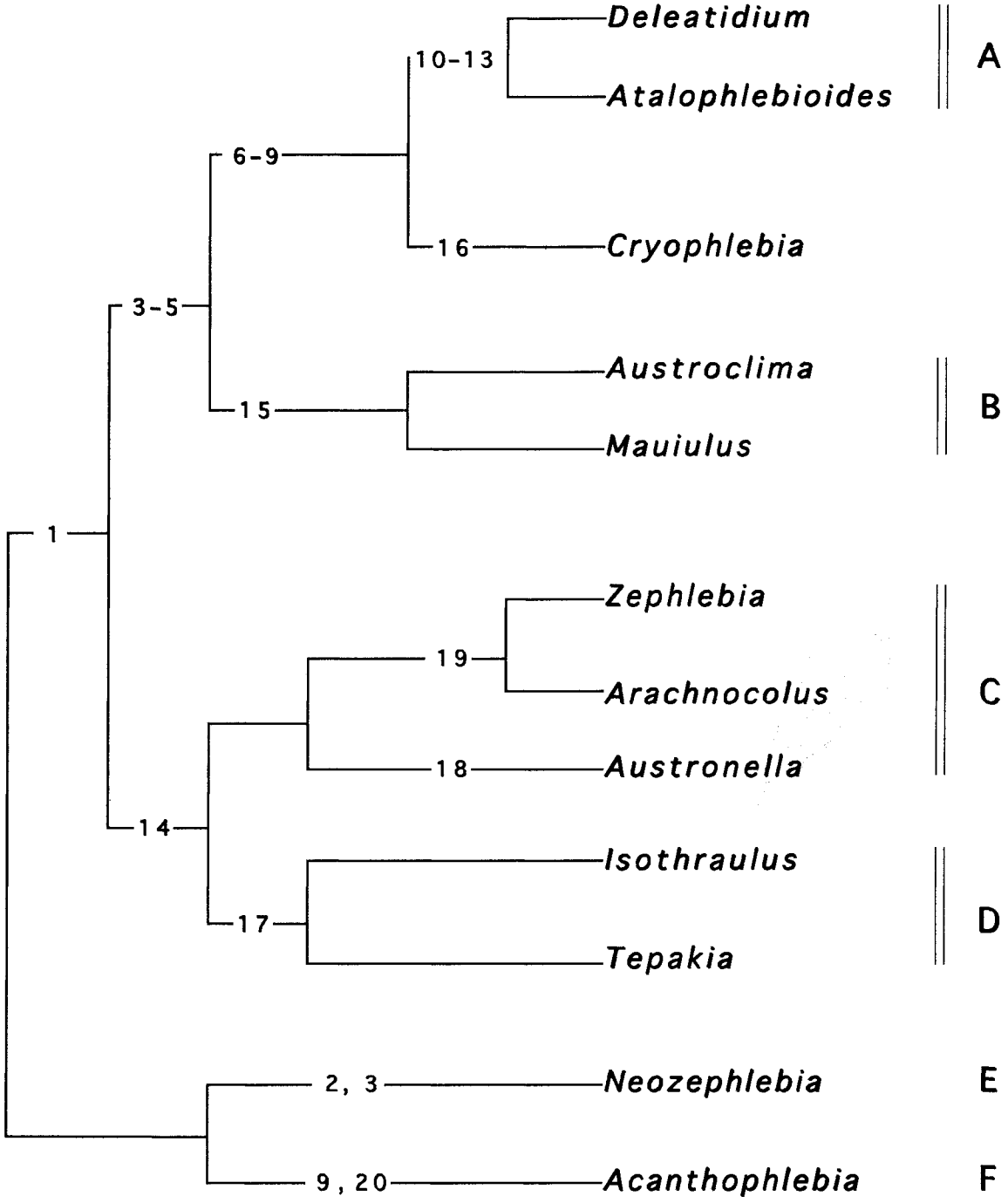
B: *Austroclima* and *Mauiulus* are apparently part of a lineage with representatives in South America (*Dactylophlebia* and *Magallanella*) (Pescador & Peters 1980a, b).

C: *Arachnocolus, Zephlebia*, and *Austronella* n.gen. appear to be part of a lineage with representatives in South America (*Demoulinellus*) and in New Caledonia (*Lepeorus, Celiphlebia, Poya, Tindea, Peloracantha, Coula, Ounia, Notachalcus,* and *Tenagophila*) (Pescador & Peters 1982, Peters & Peters 1981a, b, 1979–80, Peters *et al.* 1978, 1990, and in press).

D: *Isothraulus* and *Tepakia* n.gen. appear to have affinities with group C. *Isothraulus* may be related to undescribed genera in New Caledonia (W.L. and J.G. Peters, unpublished data), but also has many morphological similarities with the tropical genus *Thraulus*, which is represented in Australia (Peters & Campbell 1991). *Tepakia* has morphological similarities with a lineage previously known only from Madagascar and the Seychelles (*Nesophlebia, Maheathraulus*) (Peters & Edmunds 1984).

E: *Neozephlebia* appears to be part of a lineage with representatives in New Caledonia (*Simulacala* and *Fasciamirus*) (Peters *et al.* 1990). Suggested affinities with southern South America and Australia (*Nousia*) 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 (*Atalophlebia, Atalomicra, Jappa*, and *Ulmerophlebia*), 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 MA_2 attached at base to MA_1; 1 intercalary vein between MA_1 and MA_2; vein MP_2 free at base, or attached at base to MP_1, or attached at base to CuA; 1 intercalary vein between MP_1 and MP_2, none between MP_2 and CuA; vein ICu_1 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, with or without an anterolateral tooth-like projection; cardo with or without a row of marginal setae; palpi 3-segmented. Hypopharynx well developed; lingua with to without lateral processes. Labial palps 3-segmented; glossae and paraglossae distinct, well developed; glossae straight to strongly curved ventrally; submentum with or without setae on lateral margins. Pronotum with to without spine-like 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, Arachnocolus, 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).

Habitat	Species
Runs, falls and wet rock faces	*Zephlebia nebulosa* (42%), *Z. dentata* (19%), *Deleatidium angustum* (16%), *Austroclima sepia* (15%)
Wood and leaves in first order pools	*Zephlebia borealis* (45%), *Isothraulus abditus* (29%), *Arachnocolus phillipsi* (21%)
Wood, leaves, and gravel in low-moderate flow in second-order streams	*Zephlebia borealis* (16%), *Z. dentata* (14%), *Deleatidium angustum* (13%), *D. lillii* (10%), *Arachnocolus phillipsi* (9%), *Acanthophlebia cruentata* (7%), *Neozephlebia scita* (7%)
Hard substrata with algae in moderate flow	*Deleatidium angustum* (56%), *Zephlebia dentata* (16%)
Hard substrata with moss in rapid flow	*Austroclima sepia* (72%), *A. jollyae* (9%), *Mauiulus luma* (13%)

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 *Zephlebia*, 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

one Ecological Region – *Zephlebia pirongia*; known from only two contiguous Ecological Regions – *Isothraulus abditus* and *Mauiulus aquilus*; known from only three Ecological Regions – *Arachnocolus phillipsi*, *Deleatidium (D.) magnum*, *Deleatidium (P.) cornutum*, and *Zephlebia nebulosa*. *Austronella planulata*, listed by Collier (1993) as known from only two contiguous Ecological Regions, is now known from six regions, and *Tepakia caligata*, listed by Collier (1993) as *Isothraulus* sp., is now known from four regions.

Some species deserve attention both because they are rare and because they are unique New Zealand representatives of generic lineages distributed throughout the Southern Hemisphere. Examples include *Austronella planulata* and *Isothraulus abditus*, with their nearest relatives in New Caledonia, and *Tepakia caligata*, with its nearest relatives in Madagascar and the Seychelles.

Two river catchments have significance because of their importance as a source of reference mayflies. The Waitakere River catchment is the type locality for six species described either here or in previous revisions by us (plus the locality for one neotype), and the Hutt River is type locality for five species described by Phillips (1930). Parts of both localities are managed as water catchment areas by regional authorities, and should be secure from serious disturbance.

METHODS AND CONVENTIONS

Collecting

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 subimago 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 to 100% 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 *Mauiulus*, *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 here 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 Rallidentidae, 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. McLellan
AJQ, A.J. Quinn
BAH, B.A. Holloway
BWH, B.W. Hayward
GCH, G.C. Hayward
ELT, E.L. Towns
GK, G. Kuschel
IDM, I.D. 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. Summerhays
RGO, R.G. Ordish
WJC, W.J. Crawford
AMF (?A.G. McFarlane)
AKW, A.K. Walker
BHP, B.H. Patrick
CMC, C.M. McCullough
DRT, D.R. Towns
GFE, G.F. Edmunds, Jr
GWR, G.W. Ramsay
IMH, I.M. Henderson
JCW, J.C. Watt
JGP, J.G. Penniket
JRJ (?J.R. Jackson)
KAJW, K.A.J. Wise
MJW, M.J. Winterbourn
NMcK (initials only)
PP, P. Parr
RN, R. Neill
SEN, S.E. Nichols

- *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
BPBM 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
NMNZ 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.

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 ... 2

—Hind wings large, exceeding one-third length of forewings ... 3

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

4(3) Tarsal claws similar, each with a hook ... **Nesameletidae** (*Nesameletus*)

—Tarsal claws dissimilar, with a hook and a club ... 5

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

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

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

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

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

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

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

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

7(6) Gills without accessory fibrillar tufts ... **Nesameletidae** (*Nesameletus*)

—Gills with accessory fibrillar tufts ... **Rallidentidae** (*Rallidens*)

(B) KEY TO GENERA OF LEPTOPHLEBIIDAE KNOWN FROM NEW ZEALAND

Imago

1 Forewing vein MP_2 not attached at base to CuA (Fig. 34); restricted to Auckland Is... (p. 26) .. ***Cryophlebia***
—Forewing vein MP_2 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) .. ***Mauiulus***
—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 ICu_1 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 ICu_1 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

—Abdominal gills on segments 1–7 alike, successively smaller posteriorly, each with double lamellae ... 6

5(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. 274) ... (p. 26) .. ***Cryophlebia***
—Abdomen with posterolateral projections on segments 2–9; clypeus with anterior margin not concave; labrum less than half as long as 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) .. ***Mauiulus***

DESCRIPTIONS

Genus *Acanthophlebia* Towns

Towns, 1983a: 28–31 (*Acanthophlebia*).

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 ICu_1 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 R_1 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. 155, 183) with genital extension reaching from slightly more than one-fifth to two-fifths 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 *Papposa* of New Caledonia (Peters & Peters 1981a).

Acanthophlebia cruentata (Hudson)

Fig. 234 (nymph); Map 1

cruentata Hudson, 1904: 33 (*Atalophlebia*). Phillips 1930: 347–352 (description of imago, subimago, and nymph; figures of ♂ genitalia, wings, and nymphal mouthparts, gills, and abdomen). Penniket 1961: 9 *(Zephlebia (Zephlebia))* (notes several characters that differ from *Zephlebia* but retains it in the subgenus). Towns 1983a: 28–31 *(Acanthophlebia)* (full redescription, figures of wings, claws, ♂ and ♀ genitalia, colour patterns, SEM of genitalia and egg, wings of subimago, whole nymph, mouthparts, and legs).

Dimensions (mm). Male: length of body 9.1–10.1; forewings 9.3–10.5. Female: length of body 8.0–9.2; forewings 9.5–10.2. Mature nymph: 7.9–10.9.

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. Sterna 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 submedial 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 ♂ and 16 ♀ imagos, 103 ♂ and 86 ♀ 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 ICu_1 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 unserrated and prosthecal 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

phillipsi Towns & 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 6.9–7.5. Female: unknown. Mature nymph: 6.6–7.2.

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 scape brown, flagellum pale brown.

Thorax. Nota and pleura pale brown; pronotum dark brown on margins and with paired dark brown submedian lines. Legs pale yellowish white, 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, faint 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, membrane 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 filaments 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 sampling effort it will be shown to have a wider distribution.

Genus *Atalophlebioides* Phillips

Deleatidium (Atalophlebioides) Phillips, 1930: 359 (undefined 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 ICu_1 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 mid-ventral 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) hooded, with a deep anteromedian emargination. Left 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 palps slender, bearing scattered fine hairs and spines. Labium (Fig. 324) with palps 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; tracheae 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

cromwelli Phillips, 1930: 385–389 *(Deleatidium (Atalophlebioides))* (figures of nymphal mouthparts, legs and gills). Peters & Edmunds 1964: 238–239 *(Atalophlebioides)*. Towns & Peters 1978: 607–614 (full redescription, figures of wings, claws, ♂ and ♀ genitalia, colour patterns, whole nymph, nymphal mouthparts, gills and legs, SEM of egg).

Dimensions (mm). Male: length of body 6.8–8.2; forewings 7.7–8.9. Female: length of body 6.8–7.8; forewings 7.7–8.9. Mature nymph 6.1–7.6.

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 darker annulations 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,

Fig. 356, 357, 399. Abdominal terga with anterior third pale brown. Gills (Fig. 412) with membrane hyaline to pale brown. Caudal filaments pale brown.

Type data. Lectotype: female imago, WN, Hutt River, 25 March 1930, J.S. Phillips [collector inferred] (NMNZ).

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

ND, AK, CL, WN / NN, BR.

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).

Genus *Austroclima* Towns & Peters

Austroclima Towns & Peters, 1979a: 213–216.

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 ICu_1 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; palps 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.

Thorax. Pronotum with or without spines on anterolateral margin. Legs (Fig. 358, 359): femora short, oval, with scattered stout spines; tarsal claws, Fig. 400.

Abdomen narrowly oval to tapered posteriorly, with blunt posterolateral projections on segments 8 and 9. Gills (Fig. 413, 414) on segments 1–7 alike, successively smaller posteriorly; lamellae with dorsal and ventral portions plate-like, each terminating in a long, slender submedian filament; tracheae greatly branched.

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

sepia Phillips, 1930: 383-384 *(Deleatidium (Atalophlebioides))* (figures of egg and gills). Peters & Edmunds 1964: 238 *(Atalophlebioides)*. Towns & Peters 1979a: 213–220 *(Austroclima)* (full redescription, figures of wings, claws, ♂ and ♀ genitalia, colour patterns, whole nymph, nymphal mouthparts, gills, and legs, SEM of egg).

Dimensions (mm). Male: length of body 7.2–9.1; forewings 7.9–9.9. Female: length of body 9.2–9.4; forewings 11.2. Mature nymph: 5.5–10.4.

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 middorsal 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.

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 darker 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 ♂ and 4 ♀ imagos, 11 ♂ and 13 ♀ 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 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); Map 5

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

Dimensions (mm). Male: length of body 8.5–10.5; forewings 10.3–10.7. Female: length of body 7.2–10.0; forewings 10.3–11.1. Mature nymph: 7.1–10.6.

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. Gills (Fig. 414) angularly expanded apically, darkly pigmented except for outer margins; tracheae black. Caudal filaments as in imago.

Type data. Holotype: male imago, AK, Cascade Stream, reared from nymph, 31 August 1974, D.R. Towns (NZAC). **Allotype**: female imago, same data as holotype except 28 March 1975.

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.

Austronella 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 a 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_2 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 R_1 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. Forceps 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 forceps 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, anterosubmedian, 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; prosthecal 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, bipectinate spines; claws (Fig. 401) hooked, large, with numerous small denticles becoming successively larger apically.

Abdomen with posterolateral 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 vermiform 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 Summerhays 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 forceps 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 posterolateral 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 protuberances pale brown to brown, with sutures darker, mid dorsum of scutellum whitish, and midline dark brown. Sterna pale brown to brown, with carinae and furcasterna 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 to vein R_2; 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 antennae. 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 at articulations of femora and tibiae and at basal joints of tarsi. Abdomen as in Fig. 158. Terga 1–3 dark brown, with lateral margins pale brown; terga 2–5 with midline pale brown; terga 4–6 with pale brown submedian maculae; terga 4–7 pale brown with dark brown, curved submedian marks; tergum 7 or terga 8–10 dark brown. Sterna pale brown washed on lateral margins with darker brown; sternum 9, Fig. 195. Caudal filaments whitish to pale brownish, with darker annulations at articulations.

Subimago as in imago, but head in female paler, and in male with upper portion of eyes dark brown. Mesonotum brown, whitish medially, brown submedially, dark brown to black along anterior half of lateral parapsidal sutures; scutellum whitish, but lateral half of posterior scutal protuberances and lateral margins of scutellum brown. Pleura whitish; mesopleuron irregularly washed with dark brown. Sterna whitish. Legs as in female imago. Wings (Fig. 208, 209): membranes whitish (in ethanol) or pale greyish (dried); longitudinal veins paler, and cross veins surrounded by faint greyish clouds. Abdomen in male pale yellowish, with darker markings. Genitalia and caudal filaments whitish.

Nymph (Fig. 239). Head pale brown to brown, paler on midline and between lateral ocelli. Eyes of female black; male with upper portion of eyes brown to reddish brown, lower portion black. Antennae pale yellowish.

Thorax: pronotum pale brown to brown, with darker submedian marks; mesonotum and metanotum pale brown to brown, occasionally washed submedially with darker brown. Legs pale yellowish brown, mottled with darker brown on 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** female imago: same data as holotype (NZAC).

Paratypes: NZAC – 2 ♂ and 3 ♀ imagos, 2 ♂ and 5 ♀ subimagos; NMNZ – 1 ♂ and 2 ♀ subimagos; CMNZ – 1 ♂ imago; BMNH – 1 ♂ and 2 ♀ subimagos; FAMU – 2 ♂ and 2 ♀ subimagos; DRTC – 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

Cryophlebia Towns & Peters, 1979a: 230–234.

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 posterolateral projections on segments 7–9. Gills (Fig. 416) on segments 1–7 alike, successively smaller posteriorly; lamellae with dorsal and ventral portions 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 nymphal 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

aucklandensis Peters, 1971: 47–51 *(Atalophlebioides)* (figures of ♂ and ♀ genitalia, wings, claws, abdominal colour patterns, nymphal mouthparts, legs, claws, and gills). Towns & Peters, 1979a: 230–234 *(Cryophlebia)* (re-publication of original figures, illustration of whole nymph).

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. Sterna 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 sterna 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 ♂ and 2 ♀ imagos, 14 ♂ and 6 ♀ subimagos, 38 nymphs; ANIC – 3 ♂ imagos, 7 ♂ and 3 ♀ subimagos, 19 nymphs; LFML – 2 ♂ imagos, 2 ♂ and 2 ♀ subimagos, 7 nymphs.

Material examined. Type series only.
— / Auckland Is / —.

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

Deleatidium Eaton, 1899: 288. Phillips, 1930: 357 (expanded description of nymph). Ulmer, 1938: 105 (revision of subgenera). Traver, 1946: 422–423 (revised diagnosis); —1959: 3 (key characters). Harker, 1950: 19 (repeat of Eaton's diagnosis); —1954: 253 (re-establishment of subgenera). Peters & Edmunds, 1972: 1408 (Chilean representatives to separate genus). Tsui & Peters, 1975: 556, 587 (external morphology and phylogeny). Landa *et al.* 1980: 175, 177, 178, 180, 181, 184, 188–190 (internal morphology).

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 2.0–2.75× 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 an 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 of length; vein 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 MP_2 at base closer to CuA than to MP_1, attached to both with a cross vein, the attachment to MP_1 at one-fifth (or a little less) to one-quarter distance from base to margin; vein ICu_1 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 R_1 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. Antennae 1.5–2.5× 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, anterosubmedian, 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; prosthecal 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 two-fifths to three-fifths segment 2; glossae 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, bipectinate 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 posterolateral projections on segments 2–7 up to 2–9. Gills (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. lillii* of New Zealand, with the main diagnostic feature of the genus: "Distinguished from *Leptophlebia* by the ♂ 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, Harker 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. Harker (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 subgenera 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. lillii*. Unfortunately Phillips was unable to identify the nymphs of some of his new species, descriptions of imagos 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 "*lillii* 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 MP_2 attached to MP_1 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 R_1 reaching wing apex (Fig. 37, 41, 43); (4) penes of male fused to apex, usually with subapical ventral appendages (Fig. 109–128); (5) claws of a pair as in Fig. 16–20; and (6) sternum 9 of female cleft apically (Fig. 197–199). In the nymph: (1) abdominal gills present on segments 1–7, each with a single broad, undivided lamella and with margins rounded to tapered apically, and gills on segment 1 extended ventrally (Fig. 417–436); (2) labrum hooded, with anteromedian cleft bearing 2–5 small denticles (Fig. 276–279); (3) clypeus with lateral margins divergent apically (Fig. 276, 278); and (4) mandi-

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)
... (p. 46) .. ***Deleatidium (Penniketellum)***
—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) ... 3
—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)
... (p. 40) .. ***magnum***
—Forewing pigmentation not extended to cell R at midlength (Fig. 40); penes with apex rolled ventrally, without ventral appendages (Fig. 121, 122)
... (p. 42) .. ***myzobranchia***

4(2) Tarsal pad without an apical hook, as in Fig. 18 ... 5
—Tarsal pad with an apical hook (Fig. 16, 17) ... 6

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) ... (p. 35) .. ***autumnale***
—Abdominal ganglia and connectives all heavily pigmented; penes with a prominent, blunt ventral appendage, and rectangular ventrally in proximal two-thirds (Fig. 123, 124) ... (p. 44) .. ***vernale***

6(4) Forewing with longitudinal veins in anterior third hyaline; male forceps segment 1 with inner margin strongly angular (Fig. 115) ... (p. 36) .. ***cerinum***
—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)
... (p. 33) .. ***angustum***
—Penes triangular ventrally ... 8

8(7) Penes with a small subapical ventral appendage (Fig. 109, 110); terminal abdominal ganglion usually hyaline
... (p. 30) .. ***lillii***
—Penes with a large, bifid mid-ventral appendage (Fig. 117, 118); terminal abdominal ganglion pigmented
... (p. 38) .. ***fumosum***

Subimago

1 Tarsal claws similar, hooked
Deleatidium (Penniketellum) .. 2
—Tarsal claws dissimilar, one hooked the other pad-like, with or without a small apical hook
Deleatidium (Deleatidium) .. 3

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 ... (p. 46) .. ***insolitum***
—Abdomen without pale mid-lateral maculae (Fig. 169); female head with paired, pointed projections on posterior margin ... (p. 47) .. ***cornutum***

3(1) Wing membranes white ... (p. 36) .. ***cerinum***
— Wing membranes brown, grey, or mottled ... 4

4(3) Wings unicolorous brownish or grey ... 5
—Wings with clouds of darker pigment at cross veins ... 7

5(4) Abdomen with terminal ganglion pigmented
... (p. 38) .. ***fumosum***
—Abdomen usually with ganglia not pigmented ... 6

6(5) Male genitalia with apex broad, triangular
... (p. 30) .. ***lillii***
—Male genitalia with apex narrow, pointed
... (p. 33) .. ***angustum***

7(4) Forewings with reddish pigmentation in costal and subcostal area ... 8
—Forewings without reddish pigmentation in costal and subcostal area ... 9

8(7) Male genitalia with ventral appendages ... (p. 40) .. ***magnum***
—Male genitalia without ventral appendages ... (p. 42) .. ***myzobranchia***

9(7) Forewings with pigmentation forming large hyaline patches (Fig. 210); terminal abdominal ganglion more darkly pigmented than others ... (p. 35) .. ***autumnale***
—Forewings without large unpigmented patches (Fig. 214); all ganglia and connectives strongly pigmented ... (p. 44) .. ***vernale***

Mature nymph

1 Abdominal gills with apex smoothly rounded on all lamellae (Fig. 419–422, 425–432, 435, 436) ... 2
—Abdominal gills with apex pointed on some or all lamellae (Fig. 417, 418, 423, 424, 433, 434) ... 6

2(1) Abdominal gills strongly developed as an adhesion disc; 7th gill folded and turned beneath abdomen ... 3
—Abdominal gills variable, but 7th gill not folded beneath abdomen ... 4

3(2) Abdomen with dense, fine hair over ventral surface of sterna 6–9 ... (p. 47) .. ***D. (P.) cornutum***
—Abdomen with scattered fine hair confined to sternum 9 ... (p. 42) .. ***myzobranchia***

4(2) Abdomen with posterolateral projections on segments 7–9, and ganglia unpigmented ... (p. 33) .. ***angustum***
—Abdomen with posterolateral projections on segments 3–9 to 6–9, and ganglia pigmented ... 5

5(4) Abdomen with small posterolateral projections on segments 3–9 or 4–9 ... (p. 35) .. ***autumnale***
—Abdomen with posterolateral projections on segments 6–9, those on 9 large ... (p. 40) .. ***magnum***

6(1) Abdominal gill 1 wider than long, with apex rounded (Fig. 425); gill 5 with apex pointed; remaining gills with apex rounded or pointed ... (p. 38) .. ***fumosum***
—All abdominal gills with apex acutely pointed; gill 1 longer than wide (Fig. 417) ... 7

7(6) Abdomen with posterolateral projections on segments 2–9 large; thoracic and abdominal ganglia and connectives strongly pigmented ... (p. 44) .. ***vernale***
—Abdomen with posterolateral projections on segments 2–9 or 5–9 small; thoracic and abdominal ganglia either entirely unpigmented or only terminal ganglion pigmented ... 8

8(7) Abdomen with a pale mid-dorsal line (Fig. 241), the terga with marks on lateral and posterolateral margins ... (p. 30) .. ***lillii***
—Abdomen without a pale mid-dorsal line (Fig. 244), the terga with crescent-shaped marks on posterior margin ... (p. 36) .. ***cerinum***

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). Wings (Fig. 36–41): 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. *Penniketellum*, see p. 46.

Deleatidium lillii Eaton

Fig. 241 (nymph); Map 8

scita: Lillie, 1898: 167–168 *(Atalophlebia)* (misidentification) (figures of wings and appendages of ♂ imagos, ♀ subimago, and nymph, legs, appendages, and mouthparts).

lillii Eaton, 1899: 289 *(Deleatidium)*. Lillie 1900: 149–150 (copy of Eaton's description). Hudson 1904: 35. Phillips 1930: 368–371 (incorrectly attributed to Walker) (redescription, figures of imago wing, nymphal gills 1, 4, and 7). Mosely 1932: 10 (as *lilii* [sic]; incorrectly attributed to Walker). Ulmer 1938: 105. Harker 1950: 19. Kimmins 1960: 298–299 (figure of ♂ genitalia). Tsui & Peters 1975: 556. Hopkins, 1976: 631. Towns 1978: 410; —1979: 255 (distribution in Waitakere R.); —1981: 197 (contribution to benthos); —1983b: 40, 42, 43, 47; —1985: 233 (life history patterns); —1987: 353, 354 (micro-distribution and abundance on Great Barrier I.).

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

posterolateral 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 : 0.25–0.32 : 0.08–0.12; pretarsal pad (Fig. 16) with an apical hook. Wings, Fig. 36, 37. Forewing width 0.33–0.37(0.35)× length; longitudinal and cross veins pale brown to brown, but cross veins in proximal three-quarters of cells C and Sc hyaline; membranes hyaline, but wing base pale brown. Hind wing width 0.56–0.64(0.59)× length, and length 0.22–0.26(0.25)× that of forewing; vein Sc 0.91–0.95(0.93)× wing length; cross veins few in posterior half of wing; longitudinal and cross veins pale 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 brown to brown, with sterna 1 and 2 often darker, and sterna 3–6 often hyaline or with large, paired 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. Wing veins darker. Forewing width 0.34–0.35(0.35)× length. Hind wing width 0.54–0.59(0.56)× length, and length 0.22–0.24(0.23)× that of forewings; vein Sc 0.90–0.95(0.93)× 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 2.5× as long as head.

Mouthparts. Clypeus, Fig. 276. Labrum (Fig. 276) length 0.69–0.87(0.78)× that of clypeus, and width 1.15–1.26 (1.20)× 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)× as long as segment 1, and segment 3 0.64–0.82(0.71)× segment 2. Labium (Fig. 328): submentum occasionally with a few scattered spines near base; palp segment 2 0.77–0.92(0.81)× as long as segment 1, and segment 3 0.43–0.57(0.48)× 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; metanotum 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 1.5–1.6× as long as body, pale yellowish brown to pale brown; segments each with a distal whorl of small dark brown denticles.

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).

Material examined. The following non-type examples. **ND.** Waipoua State Forest: 6 ♂ imagos, 8–14 Jun 1966, JCW. **AK.** Cascade Stm: 1 ♂ subimago, 31 Oct 1966, JAM; 1 ♂ imago, 9 Feb 1977, MGB; 1 ♂ imago, undated, DRT. Waitakere R.: 1 ♂ imago, 8 Feb 1977, MGB. Karamatura Stm: 6 nymphs, 7 Jul 1964, JAM. Oponaku Stm: 27 nymphs, 13 May 1964; 3 nymphs 13 Jun 1964, JAM. Kitekite–Glen Esk Stm: 1 nymph, 27 Dec 1976, DRT. Swanson Stm: 1 nymph, 21 Jun 1964, JAM Colln. Orere Stm: 1 ♂ imago, 1 ♀ subimago, 25 Jun 1964, JAM Colln; 1 ♀ imago, 21 Jun 1964, JAM. **CL.** Sml trib. of Kauaeranga R.: 5 nymphs, 4 Jan 1977, DRT. Tarawaere Stm: 9 nymphs, 3 Jan 1977, DRT. Waterfalls Ck: 4 nymphs, 3 Jan 1977, DRT. Atuatumoe Stm: 17 nymphs, 3 Jan 1977, DRT. **WO.** Putaruru: 9 nymphs, 8 May 1964; 1 nymph, 16 May 1964, JAM Colln. **WN.** Orongorongo Field Station: 1 ♂ imago, 16 Sep 1969, JCW. Catchpool Stm: 26 nymphs, 8 Jul 1979, DRT, BWH. Hutt R., Silverstream: 5 nymphs, 12 Jul 1979, DRT, ELT, BWH, GCH. Hutt central: 1 nymph, 9 Jul 1979, DRT, BWH. Hayward's Reserve: 10 nymphs, 13 Jul 1979, DRT. Korokoro Stm: 8 nymphs, 9 Jul 1979, DRT, BWH. Tyer's Stm: 1 ♂ and 3 ♀ imagos, 14 nymphs, 24 Jan 1981, DRT. Khandallah: 1 nymph, 14 Apr 1963, JAM Colln. Sml trib. Kaiwharawhara Stm: 3 ♀ imagos, 15 nymphs, 26 Jan 1981, DRT. **NN.** Sml ck near Anatori R.: 12 nymphs, 24 Oct 1969, IDM. Sml stm nr Utopia: 1 nymph, 24 Aug 1968, IDM. **DN.** Leith Vly: 1 ♂ and 4 ♀ subimagos, 27 Oct 1992, BHP. Fraser's Gully: 3 ♂ and 4 ♀ imagos, 1 ♂ and 1 ♀ subimago, 25 May 1993; 1 ♂ imago, 4 ♂ subimagos, 1 Jun 1993, BHP. Bethune's Gully: 6 ♂ and 11 ♀ imagos, 1 ♂ subimago, 31 Oct 1992, BHP. Bradford: 3 ♂ and 3 ♀ imagos, 25 May 1993, BHP. **SL.** Kuriwao R.: 1 ♂ imago, 5 Nov 1992, BHP. **WD.** Simonin Pass: 1 ♂ imago, 31 Jan 1975, GWR.

Repositories. NZAC – 8 ♂ and 4 ♀ imagos, 1 ♂ and 1 ♀ subimago, 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 "*Atalophlebia 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. fumosum*, 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

myzobranchia: Towns, 1979: 255–256 *(Deleatidium)* (misidentification; distribution in Waitakere R.).

'[sp.] nr *myzobranchia*': Towns 1981: 193–194, 197 *(Deleatidium)* (contributions to benthos and life history).

'sp. A': Towns 1983b: 41–47 *(Deleatidium)*; —1985: 232 (life history patterns); — 1987: 353–356 (distribution and microhabitat on Great Barrier I.).

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 (3.0 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 1 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 0.94-0.96(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 indis-

tinct to hyaline. Terga in male translucent pale yellowish brown. Sterna of male whitish, successively more yellowish towards sternum 9, to dark brown. Genitalia whitish. Caudal filaments paler.

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, and 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(0.70)× 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: nota pale brown, washed submedially and on lateral margins with dark brown. Pleura as in imago. Sterna whitish 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. 419, 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 branches. 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, reared, 29 February – 1 March 1974, D.R. Towns (NZAC). **Allotype** female imago: AK, small tributary of Waitakere River, light trap, 14 February 1977, M.G. Black (NZAC).

Paratypes. ND. Waipoua State Forest: 2 ♂ imagos, 1 ♂ subimago, 8–14 Jun 1966, JCW. Okawawa Stm: 3 nymphs, 5 Feb 1975, JCW, SEN. **AK.** Cascade Stm (DRT unless otherwise indicated): 1 ♂ subimago, 5 Jun 1974; 5 nymphs, 8 Jan 1981; 1 ♂ and 2 ♀ subimagos, 20 Nov 1975; 1 ♂ imago, 4 Nov 1975; 1 ♂ and 2 ♀ subimagos, 29 Oct 1975; 1 ♀ imago, 30 Oct 1975; 1 ♂ imago, 29 Apr 1974; 1 ♀ imago, 13 Mar 1974; 1 ♀ imago, 19 Mar 1974; 2 ♂ subimagos, 9 Feb 1977, MGB; 1 ♂ and 1 ♀ subimago, 8 Nov 1966, JAM; 1 ♂ and 1 ♀ subimago, 31 Oct 1966, JAM. Sml trib. Waitakere R.: 3 ♀ imagos, 14 Feb 1977, MGB. Waitakere R.: 2 nymphs, 23 Apr 1974, DRT. Kitekite–Glen Esk Stm: 13 nymphs, 22 Dec 1976, DRT. Opanaku Stm: 19 nymphs, 13 May 1964, JAM Colln. Karamatura Stm.: 2 ♂ and 1 ♀ subimagos, undated, JAM Colln; 14 nymphs, 8 Jul 1964, JAM. Orere Point: 51 nymphs, 29 Dec 1976, DRT, ELT, MNC. Orere Stm: 3 nymphs, 29 Dec 1976, DRT. **CL.** Thames: 4 nymphs, MJW. Kauaeranga R.: 3 nymphs, 4 Jan 1977, DRT. Tairua R.: 28 nymphs, 15 Jan 1977, DRT. **WO.** Mangaokahu Stm: 3 ♀ imagos, undated, PS. Te Miro Stm: 3 ♀ subimagos, 6 nymphs, Jan–Feb 1980, PS; 3 ♂ imagos, undated, PS. Rangitukia Stm: 9 nymphs, 17 Jan 1981, DRT; 4 nymphs, 17 Jan 1981, DRT, PS; 1 nymph, Jan–Feb 1980, PS; 4 nymphs, undated, PS.

Repositories: NZAC – 6 ♂ and 4 ♀ imagos, 6 ♂ and 5 ♀ subimagos, 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 sterna 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

autumnale Phillips, 1930: 371–372 *(Deleatidium)*.
vernale Phillips, 1930: pl. 63 fig. 9 *(Deleatidium)* (mislabelled figure of subimago forewing).

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; pretarsal 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_1 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; sterna 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; notal 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 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. 243). 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)× as long as clypeus and 1.18–1.21(1.19)× 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)× as long as segment 1, and segment 3 0.75–0.91(0.81)× segment 2. Labium without spines on submentum; palp segment 2 0.73–0.90(0.84)× as long as segment 1, and segment 3 0.40–0.45(0.43)× 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. 462) 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.

Material examined. Type specimens, plus the following non-type examples. **AK.** Cashmore Bridge near Orere Pt: 14 nymphs, 29 Dec 1976, DRT. Orere Stm: 61 nymphs, 29 Dec 1976, DRT. **WO.** Mangaokahu Stm: 5 ♂ and 3 ♀ imagos, 3 ♂ and 2 ♀ subimagos, undated, PS; 6 nymphs, Jan–Feb 1980, PS. **TO.** Waihi Stm, Taupo: 1 ♂ imago, 8 Mar 1966, JGP. Taringamotu R.: 1 ♂ imago, 9 Mar 1966, GFE. Mohaka R. (upper): 2 ♂ and 1 ♀ imagos, 20 May 1995, WJC. **WN.** Locality not specified: 2 ♂ imagos, Jan 1961, PP. 2 Allen St, Lower Hutt: 1 ♂ imago, 1 ♀ subimago, 9 Mar 1983, DRT. Hutt R., Lower Hutt: 34 nymphs, 9 July 1979, DRT, BWH. Hutt R., Silverstream: 3 ♂ and 49 ♀ imagos, 1 ♂ and 1 ♀ subimago, 22 Jan 1981, DRT; 1 ♂ subimago, 24 Jan 1981, DRT; 1 ♀ imago, 25 Jan 1981, DRT; 43 nymphs, 12 Jul 1979, DRT, ELT, BWH, GCH. Rimutaka Forest Park, Catchpool Stream: 24 nymphs, 8 Jul 1979, DRT, BWH. Waikanae R.: 2 ♂ imagos, 1 ♂ subimago, 7 Mar 1966, JGP. **BR.** L. Rotoroa: 1 ♂ and 2 ♀ imagos, 2 Jan 1988, DRT. Kokiri: 2 ♂ imagos, Apr 1960, JGP. **NC.** Arthur's Pass: 1 ♂ imago, undated, JGP. **SC.** Hanging Rock, Opihi R. (?): 1 ♂ and 2 ♀ imagos, 27 Mar 1964, AMF.

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 maculae. 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

cerinum Phillips, 1930: 382–383 *(Deleatidium).* Towns 1987: 353.

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× length; veins C, Sc, and R_1 pale yellowish brown; longitudinal veins otherwise yellowish to hyaline; membrane and cross veins hyaline. Hind wing width 0.54–0.55× 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. Sternum 1 blackish; sterna 2–6 hyaline; sterna 7–9 pale brown washed posteriorly with darker brown; ganglia hyaline. Genitalia (Fig. 115, 116) pale brown; forceps segment 1 with inner margin angular. Caudal filaments white, in proximal third with dark brown annulations 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 0.78–0.80× 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× 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 ♂ imago R. Hutt 7/4/30" is a male in adequate condition, which we here designate as **lectotype.** A second specimen with the label "Deleatidium cerinum ♀ 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

non-type examples. **ND.** Mangamuka Bridge: 1 ♀ subimago, 7–10 Oct 1974, JSD. Waipoua State Forest Camp: 3 ♂ imagos, 15 Oct 1967, JSD; 1 ♀ imago, 4 Feb 1975, ?collector. **AK.** Cascade Stm: 2 ♂ subimagos, 12 Nov 1975, DRT; 1 ♀ imago, 20 Nov 1975, DRT. Waitakere R.: 1 nymph, 17 Jan 1974, DRT. Piha Stm: 1 ♂ imago, 6 Feb 1975, DRT. **CL.** Tairua R.: 4 nymphs, 15 Jan 1977, DRT. **TO.** Taringamotu R.: 5 ♂ and 17 ♀ imagos, 9 Mar 1966, GFE. Mahuia: 1 ♂ imago, Dec 1961, JGP. **WN.** Awapuni, 15 Wincanton Pl.: 1 ♂ and 1 ♀ imago, 23 Jan 1966, MJW; 1 ♀ imago, 1 ♂ subimago, 1 Feb 1966, MJW; 1 ♂ and 3 ♀ imagos, 19 ♂ and 17 ♀ subimagos, 12 Feb 1966, MJW. Waikanae R.: 2 ♂ and 2 ♀ imagos, 1 ♂ and 1 ♀ subimago, 7 Mar 1966, JGP. Stokes Vly: 2 ♂ imagos, 30 Dec 1958, BAH. Hutt R., Upper Hutt: 3 ♂ imagos, JE. Hutt R., Silverstream: 8 ♀ imagos, 22 Jan 1981, DRT; 1 ♂ subimago, 3 nymphs, 23 Jan 1981, DRT; 1 ♂ subimago, 24 Jan 1981, DRT. Pomare: 2 ♂ and 2 ♀ subimagos, 23 Dec 1958, BAH. **NN.** Karamea Bluff, Sandel Ck: 2 nymphs, 24 Jan 1973, ACM. **BR.** D'Urville R.: 1 nymph, 2 Jan 1988, DRT. Ohikanui R.: 1 ♀ subimago, 9 Oct 1981, IDM.

Repositories: NZAC – 4 ♂ and 1 ♀ imagos, 22 ♂ and 23 ♀ subimagos, 3 nymphs; NMNZ – 2 ♂ imagos, 1 ♀ subimago, 1 nymph; CMNZ – 1 ♂ and 1 ♀ imagos 4 ♂ and 1 ♀ subimagos, 1 nymph; FAMU – 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 of forceps segment 1 angular (Fig. 115). 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

fumosum Phillips, 1930: 372–373 *(Deleatidium)*. Mosely 1932: 10.

'sp. C': Towns, 1979: 257 *(Deleatidium)* (distribution in Waitakere R.); —1981: 194 (contribution to Waitakere R. benthos); —1983b: 41–42, 47; —1985: 233 (life history patterns); —1987: 353 (distribution on Great Barrier I.).

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 washed with purplish brown to fully purplish brown. Sterna pale brown to brown, with membranes and sutures paler. Legs: forelegs pale brown, darker at articulations of femora and tarsi; middle and hind legs pale yellowish brown; length ratios of foreleg segments 0.65–0.66 : 1.00 (3.0 mm) : 0.03–0.04 : 0.37–0.39 : 0.36–0.40 : 0.33 : 0.10; pretarsal pad with an apical hook, as in Fig. 17. Wings (Fig. 36, 37) with longitudinal veins pale brown, cross veins pale brown to hyaline, and membrane hyaline. Forewing width 0.35–0.38(0.37)× length; wing base washed with pale brown, occasionally washed with purple at articulation with thorax. Hind wing width 0.53–0.67(0.58)× length, and length 0.25–0.28(0.27)× that of forewing; vein Sc 0.88–0.94(0.92)× 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; sterna 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 0.36× length. Hind wing width 0.52–0.54× length, and length 0.23–0.24× that of forewings; vein Sc 0.86–0.96× 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. Mesonotum 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 unicolorous 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 pale brown, darker at annulations.

Nymph (Fig. 245). Head brown, with labrum paler brown, and darker brown across lateral ocelli; in male pale, with a pale mark between antennae and along posterior margin. Antennae 1.75–2.0× 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 0.72–0.82× as long as clypeus and 1.14–1.20 (1.18)× as wide; anterior margin smoothly curved, with a wide, deep anteromedian cleft. Maxillae: galea-lacinia with a subapical row of 21 or 22 spines; palp segment 2 0.89–1.05(0.99)× as long as segment 1, and segment 3 0.68–0.83(0.75)× segment 2. Labium without spines on submentum; palp segment 2 0.76–0.90(0.83)× as long as segment 1, and segment 3 0.42–0.49(0.45)× 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 1.3–1.6× 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).

Material examined. Neotype, plus the following non-type examples. **ND.** Waipoua: 2 ♂ imagos, undated, JGP. **AK.** Cascade Stm: 12 ♂ and 24 ♀ subimagos, 31 Oct 1966, JAM; 6 ♂ and 4 ♀ imagos, 1 ♂ and 1 ♀ subimago, 30–31 Oct 1975, DRT; 3 ♂ and 2 ♀ subimagos, 20 Nov 1975, DRT; 1 nymph, 8 Jan 1981, DRT. **CL.** Wainora Stm: 22 nymphs, 2 Jan 1977, DRT, ELT, BWH, GCH. Orere Point: 10 nymphs, 29 Dec 1976, DRT. Kauaeranga R.: 36 nymphs, 4 Jan 1977, DRT, ELT, BWH, GCH. **WO.** Rangitukia Stm: 14 nymphs, 17 Jan 1981, DRT, PS; 2 ♂ imagos, undated, PS. **WN.** Korokoro Stm.: 2 ♂ imagos, 3 nymphs, 23 Jan 1981, DRT; 10 nymphs, 9 Jul 1979, DRT, BWH. Hutt R., Kaitoke: 1 ♀ imago, 1 ♂ and 1 ♀ subimago, 1 nymph, 25 Jan 1981, DRT, BWH, GCH. Trib. of Hutt R., Kaitoke: 69 nymphs, 25 Jan 1981, DRT, BWH, GCH. Hutt R., Silverstream: 1 nymph, 23 Jan 1981, DRT. Tyer's Stm, Khandallah: 1 nymph, 24 Jan 1981, DRT. Rimutaka Forest Park, Catchpool Stm: 48 nymphs, 8 Jul 1979, DRT, BWH. **NN.** Richmond: 1 ♂ subimago, 5 Dec 1972, GK. Waikoropupu R., Fish Spring: 13 nymphs, 30 Dec 1987, DRT. **BR.** Stm nr D'Urville R.: 1 nymph, 2 Jan 1988, DRT. Tawhai: 1 ♂ and 1 ♀ imago, Jan 1972, JSD. Gowan R.: 37 ♂ and 5 ♀ imagos, 6 Mar 1966, GFE. Fuchsia Ck: 1 ♂ subimago, 12 Jan 1975, IDM. Rahu Saddle: 1 ♂ and 3 ♀ imagos, 26 Jan 1972, JSD. Kokiri: 6 ♂ and 15 ♀ imagos, 22 Oct 1966, NM^{C}K; 12 ♂ imagos, 15 Oct 1960; 1 ♂ and 2 ♀ imagos, 2 nymphs, 4 Jan 1961, JGP. **WD.** Otira Gorge: 3 nymphs, 5 Nov 1966, JIT.

Repositories: NZAC – 11 ♂ and 21 ♀ imagos, 13 ♂ and

24 ♀ subimagos, 40 nymphs; NMNZ – 2 ♂ and 1 ♀ imagos, 4 ♂ and 2 ♀ subimagos, 35 nymphs; CMNZ – 2 ♂ imagos, 3 ♂ subimagos, 74 nymphs; FAMU – 53 ♂ and 7 ♀ imagos, 1 ♀ subimago, 2 nymphs.

ND, AK, CL, WO, WN / NN, BR, WD.

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

Dimensions (mm). Male: Length of body 13.6–15.0(14.3); forewings 15.4. Female: Length of body 14.0–14.4; forewings 17.6. Mature nymph: length of body 13.4–15.2(14.4).

Male imago. Head black, with anterior margin 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 width 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 forewing cells C and Sc tinted with brownish; longitudinal and cross veins dark brown to black. Terga and sterna of male translucent pale brown. Male genitalia paler.

Nymph (Fig. 246). Head dark greyish brown, paler on posterior margin and on lateral labrum. Eyes of female black; male with upper portion of eyes dark reddish, lower portion black.

Mouthparts as in Fig. 276, 277, 299, 314, 328, and 329. Labrum 0.67–0.87× as long as clypeus and 1.05–1.13× as wide as clypeus; anterior margin curved, with a narrow anteromedian cleft. Maxillae: galea-lacinia with a subapical row of 22 or 23 spines; palp segment 2 0.90–0.92× as long as segment 1, and segment 3 0.67–0.73× segment 2. Labium without hairs or spines on submentum; palp segment 2 0.68–0.71× as long as segment 1, and segment 3 0.49–0.56× segment 2.

Thorax. Pronotum dark grey, with darker marks as in male imago; mesonotum greyish to blackish on lateral margins, brown on meson. Pleura washed with greyish. Sterna pale whitish; ganglia greyish. Legs pale whitish; femora washed with greyish near midlength and at articulation with tibiae.

Abdomen with pointed posterolateral projections on segments 6–9 or 7–9, those on segment 9 large; colour pattern as in imago, but sterna whitish. Gills (Fig. 427–429) broad, plate-like, those on segment 1 with ventral lobe extending to two-thirds length of lamella, those on segment 7 flat, held dorsally; lamellae densely invested with tracheal branches. Caudal filaments pale brown, with small darker brown denticles at articulations.

Egg (Fig. 465) cylindrical, with single large attachment structures evenly distributed over chorion; chorion ornamented with evenly spaced pentagonal and quadrilateral impressions formed by rows of small nodules.

Type data. Holotype: male imago, TO, Whakapapaiti Stream, 17 September 1993, W.J. Crawford (NZAC). **Allotype** female imago: same data as holotype (NZAC).

Paratypes. TO. Whakapapaiti Stm: 3 ♂ and 1 ♀ imagos, 4 nymphs, same data as holotype; 6 ♂ and 1 ♀ imagos, 7 Nov 1993, WJC; 4 ♂ and 1 ♀ subimagos, 4 nymphs, 22 Oct 1993, WJC; 7 nymphs, 23 Oct 1993, WJC; 2 ♀ subimagos, 23 Oct 1966, ?collector. Whakapapanui Stm: 1 ♂ and 1 ♀ imago, 3 nymphs, same data as holotype. Waimarino R.: 2 ♀ imagos, 20 Nov 1994, WJC. **RI.** Rangiwahia, 1000 m: 1 ♂ subimago, 18 Dec 1994, IMH.

Repositories: NZAC – 3 ♂ and 1 ♀ imagos, 4 ♂ and 3 ♀ subimagos, 3 nymphs; NMNZ – 3 ♂ imagos, 3 nymphs; CMNZ – 3 ♂ imagos, 1 ♂ subimago, 3 nymphs; FAMU – 1 ♂ and 2 ♀ imagos, 4 nymphs; BMNH – 4 nymphs; DRTC – 1 ♂ and 1 / imago, 2 nymphs.

Material examined. Type series, plus 19 non-type nymphs, **TO**, Chateau Tongariro, 22 Nov 1966, JAM Colln (NZAC).

TO, RI / —.

Intraspecific variation. Nymphs from the vicinity of Chateau Tongariro, although immature, were considerably paler than those described above. We have also examined subimagos from the central South Island which closely resemble *D. magnum*. However, definitive identification is not possible in the absence of male imagos.

Habitat. So far known only from streams that drain Mt Ruapehu and the adjacent Kaimanawa Ranges (where it is sympatric with *D. myzobranchia*), the Ruahine Ranges, and the Akitio River catchment in southern Hawkes Bay (W.J. Crawford, pers. comm.).

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

myzobranchia Phillips, 1930: 373–382 *(Deleatidium)* (figures of ♂ genitalia and legs, subimago wings, nymphal mouthparts, legs, and abdominal gills). Towns 1983b: 41–42, 44–46; —1985: 233 (life history patterns); —1987: 353 (distribution on Great Barrier I.).

'sp. E': Towns 1979: 257 *(Deleatidium)*.

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 midventrally; ganglia outlined with pale grey to pigmented dark grey. Legs pale yellowish brown, darker near articulation of femora and tibiae; femora often washed with brown near base; length ratios of foreleg segments 0.61 : 1.00 (3.4 mm) : 0.06 : 0.37 : 0.33 : 0.28 : 0.10; pretarsal pad with or without a small apical hook (Fig. 18, 19). Wings as in Fig. 40, 41. Forewing width 0.34–0.37(0.36)× length; longitudinal and cross veins purplish brown to brown; membranes hyaline, but cells C and Sc faintly tinted with purplish red to pale brown, and wing bases darker. Hind wing width 0.58–0.62(0.61)× length, and length 0.25–0.26(0.26)× that of forewing; vein Sc 0.92–0.97(0.95)× wing length; longitudinal and cross veins purplish brown to brown; cross veins few in posterior third of wing.

Abdomen (Fig. 77) pale brown. Tergum 1 washed with dark brown to black; terga 2–6 hyaline, with lateral and submedian dark brown to blackish marks delimiting pale brown to pale reddish-brown patches and maculae; terga 7–10 pale brown, washed dorsally with darker brown. Tracheae hyaline; tracheal areas washed with black. Sterna 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 annulations 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 annulations 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 anteromedian 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 0.40–0.48(0.44)× segment 2.

Thorax: nota 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 on 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. Sterna pale whitish; ganglia pale greyish to hyaline, the terminal ganglion dark greyish. Sternum 9 with a dense covering of short hairs. Gills (Fig. 430–432) rounded, with margin entire; gill 1 with lobe extending to 1.5× length of lamella; gill 7 folded ventrally; lamellae translucent whitish, heavily invested with numerous dark grey tracheal branches. Caudal filaments 1.2–1.4× as long as body, pale brown to brown; 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 *Deleatidium 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.

Material examined. Type specimens, plus the following non-type examples. **AK.** Cascade Stm (all DRT): 1 nymph, 24 Sep 1974; 1 ♀ subimago, 30 Sep 1975; 1 ♀ subimago, 1 Oct 1975; 1 ♂ imago, 1 ♂ subimago, 3 Oct 1975; 1 ♀ imago, 13 Oct 1975; 2 ♂ imagos, 14 Oct 1975; 2 ♀ imagos, 17 Oct 1975; 1 ♂ and 1 ♀ imago 18 Oct 1975; 4 nymphs, 22 Oct 1975; 2 ♀ subimagos, 26 Oct 1975. **CL.** Kauaeranga R.: 2 nymphs, 4 Jan 1977, DRT. Wainora Stm: 1 nymph, 2 Jan 1977, DRT. Waterfalls Ck: 5 nymphs, 3 Jan 1977, DRT. Tarawaere Stm: 51 nymphs, 3 Jan 1977, DRT, ELT, BWH, GCH. **WO.** Mangaokahu Stm: 4 nymphs, Jan–Feb 1980, PS. Rangitukia Stm: 5 nymphs, 17 Jan 1981, DRT, PS. Te Kuiti, Reeve's Farm: 1 ♂ imago, 14 Feb 1959, KAJW. **BP.** Mohau Stm: 18 nymphs, 26 Nov 1966, JAM. **TO.** Manganuiateao R.: 1 ♂ and 1 ♀ imago, 1 ♂ and 1 ♀ subimago, 16 Oct 1993, WJC. Waimarino R.: 1 ♀ imago, 20 Nov 1994, WJC. **TK.** Pouakai Range, Tatangi: 33 nymphs, 30 Nov 1975, AKW. **WN.** Hutt R. at Kaitoke: 2 nymphs, 25 Jan 1981, DRT, ELT, GCH, BWH. Korokoro Stm: 6 nymphs, 24 Jan 1981, DRT. Tyer's Stm: 11 nymphs, 24 Jan 1981, DRT. Sml trib. Kaiwharawhara Stm: 1 ♂ and 3 ♀ imagos, 25 Jan 1981; 25 nymphs, 26 Jan 1981, DRT. Hutt R., Silverstream: 4 nymphs, 12 Jul 1979, DRT, ELT, BWH, GCH. **NN.** Mt Glasgow, St Andrew Stm: 5 ♀ imagos, 8 Nov 1969, IDM. **NN/BR.** Fuchsia Ck: 2 ♂ and 3 ♀ subimagos, 12 Jan 1975, IDM. Fairdown Ck: 12 nymphs, 22 Jan 1973, IDM. **BR.** L. Rotoroa: 1 ♂ imago, 26 Nov 1972, ACM. D'Urville Flat: 3 ♂ imagos, 3 Jan 1988, DRT; 1 ♀ imago, 2 Jan 1988, DRT. **WD.** Otira Gorge: 8 nymphs, 8 Nov 1966, JIT. **NC.** Sudden Stm: 3 ♂ and 1 ♀ imagos, 10 Nov 1962, JRJ. Whitcombe R., Price's Flat: 2 nymphs, 24 Aug 1981, RN. **DN.** Leith Vly: 1 ♂ subimago, 24 Nov 1990, BHP; 2 ♀ subimagos, 27 Oct 1992, BHP; 1 ♀ imago, 4 ♂ and 1 ♀ subimagos, 6 Oct 1992, BHP. Wood Haugh: 1 ♂ and 1 ♀ subimago, 18 Sept 1992, BHP. **CO.** Leaning Rock Ck: 1 ♂ and 1 ♀ subimago, 16 Oct 1992, BHP.

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 accessory 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 accessory claw from those without. We therefore consider the two populations to be conspecific. The regions in which they occur are as follows: without an accessory claw – AK, BR, NC, DN, CO; with an accessory 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. *Deleatidium myzobranchia* occupies hard substrates in cool streams, usually where flow is rapid (see, e.g., Towns 1979). In the northern North Island *D. myzobranchia* apparently is strongly univoltine, with a restricted emergence period completed in November (Towns

1983b). 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 posterolateral 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; posterolateral 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)× as long as segment 1, and segment 3 0.40–0.47(0.45)× 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. Sterna 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 1.4–1.7× 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 Ngaio 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 Ngaio 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 Ngaio 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 **paralectotye**. 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.

Material examined. Type specimens, plus the following non-type examples. **WN.** Korokoro Stm, Petone: 7 ♂ and 11 ♀ imagos, 23 ♂ and 29 ♀ subimagos, 23 Jan 1981, DRT; 1 ♂ and 1 ♀ subimago, 25 Jan 1981, DRT; 114 nymphs, 9 Jul 1979; 62 nymphs, 23 Jan 1981, DRT, BWH. Trib. Kaiwharawhara Stm, Wilton's Bush: 1 ♂ and 2 ♀ imagos, 25 Jan 1981, DRT. Tyer's Stm, Khandallah: 1 ♀ imago, 24 Jan 1981, DRT. Rimutaka Forest Park, Catchpool Stm: 45 nymphs, 8 Jul 1979, DRT, BWH. **BR.** L. Rotoroa: 1 ♂ and 1 ♀ imago, 3 Jan 1988, DRT; 5 ♀ imagos, 12 Jan 1966, MJW. L. Rotoiti: 8 ♂ and 1 ♀ imagos, 11 Jan 1966, MJW. **DN.** Fortification Stm: 1 ♂ subimago, 31 Oct 1992, BHP. Awamoko R.: 1 ♀ imago, 11 Oct 1992, BHP. **CO.** Conroy's Rd: 1 ♂ imago, 14 Feb 1992, BHP.

WN / BR, DN, CO.

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. Imagos 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 imago 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 fig. 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

Penniketellus Towns & Peters, 1979b: 449–450 (subgenus of *Deleatidium*).

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* 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) insolitum*, 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) insolitum (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 anteroventral 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 protuberances, and scutellum pale brown; lateral mesonotum and lateral and posterolateral 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.

Type data. Holotype: male imago, NC, Edwards Valley, near Arthur's Pass, above bush line, 23–29 April 1962, J.R. Jackson (NZAC). **Allotype** female imago: same data as holotype (NZAC).

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 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 0.32× length. Hind wing width 0.61× length, and length 0.29× that of forewings; vein Sc 0.94× length of wing.

Abdomen (Fig. 80) unicolorous dark brown. Terga 1–9 with a pale brown band on posterior margin, widest and extending to posterolateral 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 0.33–0.38× length; cross veins hyaline to pale brown. Hind wing width 0.60–0.63× length, and length 0.30–0.31x that of forewing; vein Sc 0.92–0.96× 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 2.0–2.25× as long as head.

Mouthparts. Clypeus as in Fig. 278. Labrum: length 0.70x that of clypeus, width 1.13–1.14× 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 0.80–0.89× as long as segment 1, which has dense hairs on outer margin, and segment 3 0.76–0.78× segment 2. Labium as in Fig. 328, but submentum without spines, as in Fig. 329; palp segment 2 0.73–0.77× as long as segment 1, and segment 3 0.44–0.45× segment 2.

Thorax: pronotum bearing long, fine submedial hairs, pale brown, washed submedially and on lateral margins with dark brown; mesonotum brown washed with darker brown. Pleura as in subimago. Sterna whitish; ganglia dark 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 1.25–1.5× length of lamella; gill 7 folded ventrally, as in Fig. 432; lamellae translucent whitish, invested with numerous dark grey tracheal branches. Caudal filaments 1.1–1.2× 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.

Type data. Holotype: male subimago, MK, stream at base of Tasman Glacier, 10 January 1988, D.R. Towns, E.L. Towns (NZAC). **Allotype** female subimago: same data as holotype (NZAC).

Paratypes. MK. Same data as holotype: 5 ♀ subimagos, 20 nymphs. Sml trib. Hooker R.: 9 nymphs, 10 Jan 1988, DRT, ELT. Sml stm nr L. Benmore: 7 nymphs, 2 Dec 1986, DRT. **WD.** Waitaha R., Moonbeam Torrent, 460 m: 1 ♂ subimago, 17 Nov 1994, IMH.

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

Isothraulus Towns & Peters, 1979b: 439–442.

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 ICu_1 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 forceps, opening on venter, 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 middle; incisors with apical teeth unserrated 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, Palearctic, 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

7.8–8.2. Female: length of body 6.9–7.9; forewings 7.5–8.8. Mature nymph: [final-instar nymphs unknown].

Male imago. Head pale yellowish brown, with small black marks on dorsum near antennae and on venter. Eyes with upper portion pale brownish orange, lower portion black. Antennae yellowish brown, with flagellum paler.

Thorax. Pronotum pale yellowish brown, irregularly washed with black; mesonotum pale brown, with margins, carinae, and scutellum dark brown. Sterna and pleura whitish, with an irregular blackish-brown transverse band at articulations with coxae. Legs pale, with a narrow dark brown band on femora at articulation with tibiae [forelegs broken off and missing]. Wings (Fig. 44, 45): longitudinal and cross veins brown to pale brown; forewing with cross veins in cells C and Sc, veins Sc and R_1 at bulla, and fork of MA surrounded with purplish-brown clouds; membrane hyaline, but base of forewings washed with pale brown, and distal third of cells C and Sc translucent whitish.

Abdomen (Fig. 81). Terga 1–7 hyaline, with a narrow transverse band on posterior margin; tergum 7 with paired, faint anterolateral markings; terga 8 and 9 dark brown, paler on midline and at margins; tergum 10 pale brown, paler on midline. Sterna 1–7 hyaline; sterna 8 and 9 translucent whitish; sterna 1, 8, and 9 washed with brown. Genitalia whitish. Caudal filaments white.

Female imago as in male, except as follows. Head with midline dark brown, and with large, dark brown maculae on posterior margin between eyes. Eyes black. Abdomen (Fig. 170) with terga 1–7 pale brownish; colour pattern of terga and sterna darker; sternum 9, Fig. 201. Caudal filaments with pale brown annulations at articulations.

Subimago unknown.

Nymph (Fig. 250). Head as in imago, but with dark brown markings posterior and lateral to eyes. Male with upper portion of eyes reddish brown, lower portion black. Antennae whitish.

Thorax: nota pale brown, with dark brown medial and posterior markings; colour pattern otherwise as in imago. Legs (Fig. 374, 375, 404) pale brown, with femora darker near apex.

Abdomen as in imago. Gills (Fig. 437) with lamellae greyish purple, tracheae and tracheal branches darker. Caudal filaments pale brown.

Type data. Holotype: male imago, AK, tributary of Waitakere River near Anderson's Track, 16 February 1977, M. Black (NZAC). **Allotype** female imago: same data as holotype (NZAC).

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

Mauiulus Towns & Peters, 1979a: 224–226.

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

Dimensions (mm). Male imago: body length 4.6–5.9; forewings 6.1–7.1. Female: body length 3.9–6.1; forewings 6.0–7.4. Mature nymph: body length 4.2–6.4.

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 ICu_1 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 1.5–2.0× as long as head.

Mouthparts. Clypeus (Fig. 282) with anterior margin slightly concave, lateral margins subparallel. Labrum (Fig.

282) longer than clypeus, with lateral margins smoothly rounded; anteromedian margin (Fig. 283) deeply cleft, with broad-based denticles formed by slits. Left mandible (Fig. 303) with outer margin smoothly curved, bearing a small tuft of hair at middle; incisors with apical teeth unserrated, and prosthecal tuft large. Maxillae (Fig. 317): galea-lacinia with a subapical row of 10–13 spines; palps with sparse hairs. Labium (Fig. 332): palp segment 3 a little shorter than segment 2, with few spines on inner margin; glossae small, dorsal to paraglossae. Hypopharynx, Fig. 344.

Thorax. Pronotum with small spines on anterolateral margins. Legs (Fig. 376, 377): femora short, ovoid, with large, flat-topped spines near apex; femora and tibiae with a few scattered hairs; tarsal claws, Fig. 405.

Abdomen narrowing posteriorly, with blunt posterolateral projections on segments 8 and 9. Gills (Fig. 438, 439) on segments 1–7 alike, successively smaller posteriorly; dorsal and ventral portions slender, narrow to lanceolate, smoothly tapered to apex, with or without tracheal branches.

Egg (Fig. 470) fusiform, with vertical or horizontal tubercles in ridges between poles and a cluster of vertical tubercles at poles.

Remarks. *Mauiulus* appears to be most closely related to *Austroclima*, but can be distinguished in the imago by (1) hind wing with costal margin convex, and with vein Sc two-thirds to four-fifths length of wing (Fig. 47), (2) colour pattern sexually dimorphic, and (3) sternum 9 of female convex apically (Fig. 201); and in the nymph by (1) mandibles with outer margin smoothly curved (Fig. 303), (2) abdominal gills slender, narrow to lanceolate (Fig. 438, 439), and (3) colour pattern sexually dimorphic.

KEY TO SPECIES OF *MAUIULUS*

Imago

Abdominal terga 9 and 10 not paler than tergum 8 (Fig. 82); penes with spine on a large accessory lobe (Fig. 131) ... (p. 50) .. ***luma***

—Abdominal terga 9 and 10 paler than tergum 8 (Fig. 83); penes with lateral spine on a small accessory lobe (Fig. 133) ... (p. 51) .. ***aquilus***

Nymph

Abdominal gills narrow, with tracheae unbranched (Fig. 438) ... (p. 50) .. ***luma***

— Abdominal gills lanceolate, with lamellae invested by short tracheoles (Fig. 439) ... (p. 51) .. ***aquilus***

Mauiulus luma Towns & Peters

Fig. 251 (nymph); Map 19

luma Towns & Peters, 1979a: 226–230 *(Mauiulus)* (figures of wings, claw, genitalia, colour patterns, mouthparts, leg, gill, full nymph, egg).

Dimensions (mm). Male: length of body 5.4–5.9; forewings 6.1–7.1. Female: length of body 3.9–6.1; forewings 6.0–7.4. Mature nymph: length of body 4.2–5.5.

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. Thoracic 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 mesonotum 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. Abdomen 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 subimago. Gills (Fig. 438) narrow; membrane hyaline to whitish. Caudal filaments pale brown, unbanded or banded with whitish brown.

Type data. Holotype: male imago, AK, Cascade Stream, reared from nymph, 1 March 1976, D.R. Towns (NZAC). **Allotype** female imago: same data as holotype except 19 March 1974.

Paratypes: NZAC – 5 ♂ and 3 ♀ imagos, 8 ♂ and 4 ♀ subimagos, 41 nymphs; NMNZ – 2 ♂ and 2 ♀ imagos, 1 ♂ and 2 ♀ subimagos, 15 nymphs; CMNZ – 1 ♂ and 8 ♀ imagos, 2 ♂ and 3 ♀ subimagos, 3 nymphs; BMNH – 1 ♂ imago, 1 ♂ and 1 ♀ subimago, 5 nymphs; FAMU – 3 ♂ and 2 ♂ imagos, 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 orange-brown, 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 R_1 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, R_1 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.

Subimago 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 sterna 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 sterna 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 blackish brown. Sterna as in subimago, but female occasionally with sternum 1 washed with dark brown, and with dark brown anterolateral marks on sterna 2–7. Gills (Fig. 439) narrow lanceolate; membranes translucent whitish, invested with numerous fine tracheal branches. Caudal filaments as long as body, pale brown, with small darker brown denticles at articulations.

Egg (Fig. 470) fusiform, with 4 ridges of vertical tubercles extending between poles; poles with a cluster of vertical tubercles; chorion ornamented with fine, reticulate raised ridges.

Type data. Holotype: male imago, WO, Rangitukia Stream, June 1981, P. Summerhays (NZAC). **Allotype** female imago: same data as holotype except November 1981 (NZAC).

Paratypes. BP. Ngamuwahine R.: 47 nymphs, 30 Jun 1979, DRT, ELT, AJQ; 20 nymphs, 29 Dec 1980, DRT; 40 nymphs, 31 Dec 1980, DRT. **WO.** Rangitukia Stm (all PS): 3 ♀ imagos, 2 ♂ and 3 ♀ subimagos, undated; 1 ♀ imago, Nov 1981; 2 ♀ imagos, 1 ♂ subimago, May–Jun 1981; 9 nymphs, May–Aug 1981.

Repositories: NZAC – 3 ♂ and 3 ♀ imagos, 2 ♂ subimagos, 25 nymphs; NMNZ – 1 ♂ and 2 ♀ subimagos, 4 nymphs; CMNZ – 46 nymphs; FAMU – 47 nymphs.

Material examined. Type series only.
BP, WO / —.

Intraspecific variation. Abdominal colour pattern of nymphs varies, those from the Ngamuwahine River frequently having 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 ICu_1 attached at base to CuA and CuP by cross veins; vein MP_2 with base closer to MP_1 than to CuA. Hind wing (Fig. 49) a little more than one-tenth to a little less than one-fifth 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. 406.

Abdomen narrowly oval, broadest at segments 4–6, with posterolateral 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

scita Walker, 1853: 570 *(Baetis)*. Eaton 1871: 81 *(Leptophlebia)*; —1884: 90 *(Atalophlebia)*. Kimmins 1960: 295 (designation of lectotype). Penniket 1961: 9 *(Zephlebia (Neozephlebia))* (figures of wings and ♂ genitalia). Towns 1983a: 23–27 *(Neozephlebia)* (redescription, figures of wings, ♂ and ♀ genitalia, claws, and abdominal coloration of imago; wings and thorax of subimago, full nymph and nymphal mouthparts, gills, and legs). Winterbourn & Towns 1989: 19–20 (figure of nymphal gills; correction to *nodularis*).

nodularis Eaton, 1871: 81 *(Leptophlebia)*. Lillie 1898: 168 (see figures referred to by Phillips). Phillips 1930: 352, 354–356 *(Atalophlebia)* (photographs of wings of imago and subimago, and of whole nymph). Winterbourn & Towns 1981: 17 *(Zephlebia (Neozephlebia))* (figure of nymphal gills). Synonymised by Towns (1983a: 25).

Dimensions (mm). Male: length of body 7.3–8.9; forewings 7.3–9.2. Female: length of body 6.2–8.1; forewings 8.2–10.1. Mature nymph: length of body 6.0–8.8.

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 R_1 surrounded by brown to dark brown clouds, sometimes extending from cell C to R_1 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 sterna 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 sterna as in imago. Legs (Fig. 378–380, 406) pale whitish to yellowish brown; femora with a dark 6rown 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.

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

Material examined. Lectotype, plus 269 non-type examples (29 ♂ and 64 ♀ imagos, 5 ♂ and 11 ♀ 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 MP_2 attached at base to MP_1 and CuA with a cross vein; attachment of MP_2 to MP_1 one-fifth distance from base to margin; base of MP_2 equidistant between MP_1 and CuA; vein ICu_1 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 R_1 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 nine-tenths 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 3.0× 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, anterosubmedian, 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 unserrated. 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, bipectinate 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 leptophlebiid 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 MP_2 joined to MP_1 by a cross vein, its base equidistant between veins MP_1 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 sternum 9 entire, as in Fig. 205. In the nymph: (1) clypeus as wide as labrum, with lateral margins subparallel (Fig. 286); (2) labrum with 5 denticles in a rectangular recess, the central one smallest (Fig. 286); (3) maxilla with galea-lacinia bearing 15 subapical spines; (4) labial palps with segment 3 subtriangular, bearing short spines on inner margin and long spines on lateral margin (Fig. 334); (5) labium with glossae expanded apically and turned towards base (Fig. 334); (6) claws elongate and narrow apically, with numerous small denticles (Fig. 407); (7) gills on abdominal segments 1–7 with double lamellae, those on segments 1–5 with lamella hyaline, those on segments 6 and 7 narrow, thread-like; and (8) abdomen with posterolateral projections on segments 7–9.

Tepakia appears to be related to *Nesophlebia* from Madagascar and *Maheathraulus* from the Seychelles. Peters & Edmunds (1984) were unable to definitively determine the relationships between *Nesophlebia, Maheathraulus,* and other Southern Hemisphere genera. *Tepakia* can be distinguished from these two genera in the imago by (1) forceps segment 1 of male without long spines on inner margin, (2) male with upper portion of eyes not reniform, and lower portion equal in height to upper portion, and (3) hind wings with numerous longitudinal veins; and in the nymph by (1) maxilla with galea-lacinia bearing 15 subapical spines, (2) claws with numerous small denticles, apically elongate and narrow (Fig. 407), and (3) gills on abdominal segments 1–7 with double lamellae, those on segments 1–5 with lamellae hyaline, and those on segments 6 and 7 narrow, thread-like.

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) labial 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*").

Dimensions (mm). Male: length of body 6.6–7.4; forewings 7.1. Female: length of body 7.9; forewings 7.8. Mature nymph: length of body 5.9–6.8.

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; mesonotum dark brown. Pleura pale brown, extensively washed with blackish. Sterna 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 protuberances 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 penes 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 forefemora 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.

Type data. Holotype: male imago, WO, Waikoha Stream, undated, P. Summerhays (NZAC). **Allotype** female imago: WN, Kapiti Island, Waiorua Stream, 4 February 1995, I.M. Henderson (CMNZ).

Paratypes. ND. Te Paki, S. Pandora: 1 nymph, 7 Feb 1975, AKW. **AK.** Trib. of Waitakere R.: 1 nymph, Jan 1995, CMC. **CL.** Sml trib. of Kauaeranga R.: 1 ♂ imago, 2 nymphs, 2 Jan 1975, DRT. **WO.** Waikoha Stm: 1 ♂ and 1 ♀ subimago, 3 nymphs, undated, PS. **WN.** Kapiti I., Waiorua Stm: 1 ♂ and 1 ♀ imago, 4 Feb 1995, IMH.

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 Kauaeranga 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

Zephlebia Penniket, 1961: 8.

Terama Towns, 1983a: 18 (subgenus of *Zephlebia*). **New synonymy.**

Type species *Atalophlebia versicolor* Eaton, by original designation.

Dimensions (mm). Male imago: body length 7.1–12.2; forewings7.4–13.3. 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 MP_2 attached at base to CuA and MP_1 with a cross vein, or attached at base to CuA but not MP_1; vein ICu_1 attached at base to CuA and CuP by cross veins; vein MP_2 with base equidistant between MP_1 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 2.0–3.5× 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; prosthecal hair tuft large; incisors slender to stout, with apical teeth unserrated. 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 posterolateral 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 1.5–3.0× 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 MP_2 attached at base only to CuA (Fig. 59) ... (p. 63) .. ***nebulosa***

—Forewing vein MP_2 attached at base to CuA and MP_1 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 ... (p. 65) .. ***pirongia***

—Forewing with membrane of cells C and Sc hyaline except for clouds at cross veins; wing colour patterns sexually dimorphic (Fig. 62, 63) ... (p. 68) .. ***tuberculata***

6(1) Forewings with reddish-brown cloud confined to cells C and Sc (Fig. 56) ... (p. 61) .. ***dentata***

—Forewings with reddish-brown cloud extended from Sc to beyond R_2 ... 7

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) ... (p. 58) .. ***versicolor***

—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) ... (p. 62) .. ***inconspicua***

Nymph

1 Prothorax and mesothorax without submedian projections or spines; abdomen with posterolateral projections on segments 2–9 ... 2

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

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) ... 3

—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 ... 4

3(2) Abdomen of male with submedian marks indistinct (Fig. 258), paler than in female ... (p. 59) .. ***borealis***

—Abdomen of males and females with submedian marks dark, as in Fig. 91 ... (p. 65) .. ***pirongia***

4(2) Abdomen with broad, blackish, paired posterolateral marks (Fig. 261); gills dark greyish black ... (p. 63) .. ***nebulosa***

—Abdomen without dark, broad posterolateral marks (Fig. 259); gills pale greyish ... (p. 61) .. ***dentata***

5(1) Prothorax and mesothorax with submedian tufts of spines (Fig. 350); posterior abdominal terga with lateral margins fringed with hairs (Fig. 262) ... (p. 67) .. ***spectabilis***

—Prothorax and mesothorax with paired submedian projections, as in Fig. 348; posterior abdominal terga with lateral margins hairless ... 6

6(5) Femora broadly expanded (e.g., Fig. 394); femora dark brown with pale maculae; abdomen with posterolateral projections on segments 6–9 or 7–9 ... (p. 68) .. ***tuberculata***

—Femora slender (Fig. 384); femora pale brown, with darker brown marks or bands; abdomen with posterolateral projections on segments 5–9 or 6–9 ... 7

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) ... (p. 58) .. ***versicolor***

—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) ... (p. 62) .. ***inconspicua***

Zephlebia versicolor (Eaton)

Fig. 257 (nymph); Map 23

versicolor Eaton, 1899: 286–287 *(Atalophlebia)*. Phillips 1930: 339–344 (figures of egg, nymphal gills, mouthparts, and abdomen, and wings of subimago). Kimmins 1960: 296 (designation of lectotype, figure of ♂ genitalia). Penniket 1961: 8 *(Zephlebia (Zephlebia))* (figures of wings and genitalia). Towns 1983a: 6–8 (redescription, figures of wings, ♂ and ♀ genitalia, claws, and abdominal coloration of imagos; wings and thorax of subimago, full nymph and nymphal mouthparts, abdominal gills and legs).

Dimensions (mm). Male: length of body 8.5–10.5; forewings 10.1–10.5. Female: length of body 9.0–10.6; forewings 11.2–12.6. Nymph: 8.8–10.3.

Male imago. Head pale brown, occasionally dark brown on anterolateral 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 forefemur 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 sterna irregularly washed with dark grey or greyish brown. Wings (Fig. 218, 219) with membranes greyish (dried) to brownish (in ethanol), occasionally pale yellowish in forewing cells C and Sc; longitudinal and cross veins dark brown, darker in forewing cells C and Sc, paler in posterior half of hind wing; cross veins with pale lateral dark brown clouds, these greyish in hind wing; forewing with a diffuse cloud from vein Sc to base of IMP, and a cloud in distal third from R_2 to R_3; base of forewing pale brown, base of hind wing dark brown. Abdominal terga 8–10 of male pale brown dorsally, occasionally washed with darker brown.

Nymph (Fig. 257). Head pale brown to dark brown; darker marks between eyes and on posterior margin, and pale brownish-white marks between antennae and on midline posterior to ocelli. Antennae 2.8–3.5(3.2)× as long as head.

Mouthparts. Clypeus, Fig. 288. Labrum (Fig. 288): length 0.48–0.53(0.51)× width; anteromedian denticles, Fig. 289. Maxillae (Fig. 320): galea-lacinia with a subapical row of 18–20 spines; segment 2 0.77–1.00(0.93)× as long as segment 1, and segment 3 0.57–0.86(0.71)× segment 2. Labial palps (Fig. 335) with segment 2 1.00–1.05(1.02)× as long as segment 1, and segment 3 0.55-0.61(0.59)× segment 2.

Thorax (Fig. 348) pale brown to dark brown, paler on midline. Pronotum with lateral margins pale brown; pronotum and mesonotum with small, paired, dorsal submedian projections. Legs (Fig. 384–386): femora pale brown, mottled or banded with darker brown; tibiae pale brown, darker at midlength and near apex.

Abdomen with posterolateral projections on segments 6–9. Colour pattern as in imago, but lateral margins of terga 1–9 and midline of terga 3–8 pale brown, and terga 8–10 pale brown or washed with dark brown. Gills (Fig. 443, 444) on segments 1–6 similar; gills on segment 7 with dorsal and ventral portions reduced to thread-like filaments, a single lanceolate lamella, or a single filament; lamellae pale yellowish brown to translucent; tracheae dark grey. Caudal filaments 2.5× as long as body, pale brown to brown, darker at articulations.

Type data. Lectotype: male imago (see Kimmins 1960) (BMNH).

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).

ND, AK, WO, CL, BP, TO, GB, WA, WN/NN, BR, NC.

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 (Fig. 348); (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 (Terama))* (definition of new subgenus, designation of

lectotype, redescription, figures of wings, ♂ and ♀ genitalia, and abdominal coloration of imagos; wings and thorax of subimago, full nymph, and maxillary palp, abdominal gills, and legs).

Dimensions (mm). Male: length of body 10.5–11.9; forewings 11.9–12.2. Female: length of body 8.4–11.0; forewings 13.1–13.4. Mature nymph: 8.5–12.7.

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 dorsoposterior propleura to anteroventral margin of forecoxae. Sterna dark brown, with prosternum 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; sterna 2–6 hyaline; sterna 2–9 washed with dark brown posteriorly, the darker areas larger on sterna 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 sterna 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 pale brown, anterior half of 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 spines, as in Fig. 321, segment 2 0.88–1.19(1.02)× as long as segment 1, and segment 3 0.42–0.65(0.53)× segment 2. Labial palps with segment 2 0.92–1.15(0.98)× as long as segment 1, and segment 3 0.40–0.56(0.51)× segment 2.

Thorax brown washed with darker brown medially and on lateral margins, but pronotum pale brown laterally; pronotum and mesonotum without submedian spines or projections. Legs (Fig. 387–389) pale brown, darker near apex of femora; fore and middle femora with paler maculae.

Abdomen with posterolateral projections on segments 2–9, those on segments 6–9 enlarged; colour pattern as in imago. Gills (Fig. 445–447) on segments 1–6 similar; gills on segment 7 reduced to a single lamella; lamellae greyish black; tracheae and branches darker. Caudal filaments brown, with darker annulations at articulations.

Type data. Lectotype nymphal gills and legs, no locality data, but with Phillips's handwritten labels, designated by Towns 1983a) (BMNH).

Material examined. Lectotype, plus 177 non-type examples (4 ♂ and 7 ♀ imagos, 4 ♂ and 4 ♀ subimagos, 158 nymphs) (AMNZ, BMNH, BPBM, CMNZ, FAMU, NMNZ, NZAC, DRTC).

ND, AK, CL, BP, WO, GB, TK, WN / —.

Habitat. *Zephlebia borealis* is probably widespread through 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 emargination (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

dentata Eaton, 1871: 80 *(Leptophlebia)*;—1884: 88 *(Atalophlebia)*; 1899: 287–288 (redescription of imago, figure of forewing). Phillips 1930: 344, 346–347 (figures of wings of subimago, comparison with *Z. versicolor*). Mosely 1932: 7 (photographs of imagos and subimagos). Kimmins 1960: 295, 297 (figures of ♂ genitalia). Penniket 1961: 9 *(Zephlebia (Zephlebia))*. Towns 1983a: 19–21 (redescription, 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 8.0–9.0; 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; propleura with a broad, blackish diagonal line from posterior margin to anteroventral 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; tergum 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 styliger 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. Mesonotum 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 maculae 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 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 branches 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).

ND, AK, CL, WO, BP, TO, GB, TK, WA, WN / —.

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 forewing 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 sterna 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.

Zephlebia inconspicua Towns

Fig. 260 (nymph); Map 26

inconspicua Towns, 1983a: 12–14 *(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 7.1–7.6; forewings 7.4–8.6. Female: length of body 6.6; forewings 8.0. Mature nymph: 5.8–7.8.

Male imago. Head pale brown, washed with darker brown on lateral margins and posterior to antennae. Eyes with upper portion reddish brown, lower portion greenish black. Antennae pale brown, with scape darker.

Thorax. Pronotum brown; mesonotum, metanotum, and scutellum pale brown; darker brown marks submedially and on lateral margins of pronotum, submedially on metanotum, in dorsal and submedian areas on posterior scutal protuberances, and on lateral margins of scutellum. Pleura brown, irregularly washed with dark brown to black. Sterna brown. Legs: femora pale brownish yellow; tibiae and tarsi paler. Wings with membrane hyaline, but bases tinted with pale brown. Forewing (Fig. 57) with a diffuse, dark brown cloud at midlength between veins C and R_2, and distal third of cells C and Sc translucent; veins pale brown to dark brown, often paler in Cu-A area; cross veins in cells C and Sc surrounded by narrow, dark brown clouds. Hind wing with cross veins hyaline to pale brown.

Abdomen (Fig. 89) pale brown, with paired submedian dark brown marks on terga 1–3, 6, and 7. Tergum 1 dark brown on margins; terga 2–8 with paired anterolateral and posterolateral marks; terga 1–7 or 1–8 with a broad, dark brown transverse band on posterior margin; terga 1–6 hyaline; terga 7–10 pale brown to dark brown, with or without dark brown lateral marks. Sterna 2–6 pale brown; sterna 1 and 8 or 9 to 10 dark brown. Genitalia (Fig. 145, 146) pale whitish brown; styliger plate and penes darker.

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 metanotum paler. Pronotum and mesonotum brown, with prominent dorsal submedian projections (Fig. 349); mesonotum 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 posterolateral 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.
ND, AK, CL, WO, TO / —.

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

Zephlebia sp. A: Towns 1987: 353–354.

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 with scape blackish, pedicel dark brown, paler 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 sutures 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 R_2 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 MP_2 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 R_1 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. Tracheae hyaline; spiracular areas black. Sterna brown to dark brown; sterna 2–7 hyaline; sterna 2–8 with paired submedian maculae near anterior margin and middle; sterna 8 and 9 brown; ganglia hyaline. Genitalia (Fig. 147, 148) pale brown; styliger plate and proximal half of forceps segment 1 brown; penes with dark brown submedian and apical marks. Caudal filaments whitish, with broad, dark brown bands at articulations and narrow bands at midlength of annuli, the bands broader posteriorly.

Female imago as in male, except as follows. Head pale brown, blackish near base of antennae and between eyes and lateral ocelli, with a transverse greyish-brown mark posterior to lateral ocelli. Eyes greyish black. Antennal flagellum paler. Thorax paler, with mesonotum pale yellowish brown. Forefemora paler. Forewing (Fig. 59): width 0.38–0.39× length; cross veins in cell R surrounded by dark brown clouds, fused at wing midlength and extending to vein R_{4+5}; large clouds at base of intercalaries near wing apex and on IMP. Hind wing width 0.58–0.61× length, and length 0.19–0.20× that of forewing; veins in distal half to two-thirds dark brown; vein Sc 0.80–0.82× wing length; vein R_1 0.97× wing length. Abdomen pale brown to brown; sternum 7 with genital extension reaching one-tenth to a little less than one-fifth along sternum 8 (Fig. 179, 189); sternum 9 with a shallow apical cleft, as in Fig. 203.

Subimago 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. Pleura pale brown, washed with greyish brown; sutures paler; carinae darker. Sterna brown, but prosternum and lateral lobes of furcasternum pale brown; carinae darker. Legs paler. Wings (Fig. 226, 227) with membranes translucent greyish and cross veins surrounded by faint, narrow greyish clouds. Male genitalia pale whitish, but styliger plate pale brown, and penes with a brown mark between lobes.

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.

Type data. Holotype: male imago, WO, headwaters of Rangitukia Stream, reared, February 1981, P. Summerhays (NZAC). **Allotype** female imago: same data as holotype (NZAC).

Paratypes. AK. Sml trib. of Waitakere R.: 1 ♀ subimago, 30 Mar 1977, MGB. Cascade Stm: 1 ♂ subimago, 9 Feb 1977; 1 ♀ subimago, 9 Mar 1977, MGB. Sml stream nr Waitakere R.–Cascade Stm: 5 nymphs, 8 Jan 1981, DRT; 6 nymphs, 13 Jan 1981, DRT, ELT. **CL.** Great Barrier I., stm nr Cape Barrier Rd: 27 nymphs, 30 Aug 1985, DRT. **WO.** Headwaters of Rangitukia Stm: 1 ♂ and 2 ♀ imagos, 2 ♂ and 3 ♀ subimagos, Feb 1981, PS; 2 nymphs, on wood, 17 Jan 1981, DRT, PS.

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 streamlets 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 MP_2 connected to vein CuA. One specimen has one wing with this condition and the other with the condition found in *Z. borealis*, i.e., vein MP_2 attached to CuA and MP_1 with a cross vein, but with the attachment closer to CuA than to MP_1. 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 pale whitish.

The relationship between *Zephlebia nebulosa* and other members of the genus is unclear. The unusual structure of forewing vein CuA is found also – but less consistently – in *Z. borealis* (Towns 1983a), but the unusual sexual dimorphism in forewing colour pattern is similar to that of *Z. tuberculata*. On the other hand, nymphs have abdominal colour patterns, body shape and absence of thoracic projections that indicate a relationship with *Z. dentata*. The above range of relationships fills the character gap hitherto used to separate two subgenera in *Zephlebia*, forming a character gradient that renders 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 MP_2 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 posterolateral marks (Fig. 261).

Imagos of *Z. nebulosa* can be distinguished from those of *Z. tuberculata* by (1) vein MP_2 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. Mesothorax 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; propleura with a broad, black diagonal line from dorsoposterior margin to anteroventral 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; cross veins surrounded by broad, dark reddish-brown clouds, these fused at midlength and occasionally extending to vein R_2; 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 R_1 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; terga 2–9 with broad dark brown submedian longitudinal marks, narrower on terga 4–7; terga 2–7 with small, paired, submedian pale brown maculae; terga 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 midventrally; 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 brown. Forewing width 0.36–0.39× length. Hind wing width 0.60–0.99× length, and length 0.17–0.18× that of forewing; vein Sc 0.75–0.85× wing length; vein R_1 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 imago, 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 scutal 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 maculae 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 2.75–3.0× 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 imago. 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 denticles and small hairs.

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

Type data. Holotype: male imago, WO, headwaters of Rangitukia Stream, March–June 1981, P. Summerhays (NZAC). **Allotype** female imago: same data as holotype (NZAC).

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.

WO / —.

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; propleura 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 foretibia 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 MP_2 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; sterna 2–7or 2–8 hyaline, remainder translucent; sterna 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 R_2. 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 maculae; scutellum whitish, with lateral margins occasionally pale brown. Pleura and prosternum 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 0.69–0.88(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 metanotum 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 ♀ imago, 3 ♂ subimagos, 11 nymphs; BMNH – 1 ♂ and 1 ♀ imago, 2 ♂ and 1 ♀ subimagos, 7 nymphs; BPBM – 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 MP_2 and MP_1, 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 MP_2 not connected at base to MP_1 (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: 6.7–9.2(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; propleura pale brown, with a broad black diagonal line from dorsoposterior 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)× 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 R_2, 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)× length, and length 0.20–0.23(0.22)× that of forewing; vein Sc 0.73–0.83(0.79)× wing length; vein R_1 0.89–0.98(0.95)× 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; sterna 3–6 or 3–7 hyaline; sterna 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 forceps 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)× length; clouds at cross veins darker, broader, and extending to cell R_1 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 R_1, in stigmatic area, at forks of veins Rs and MA, and at base of veins R_3 and IMP. Hind wing width 0.54–0.60(0.57)× length, and length 0.21–0.23(0.22)× that of forewing; longitudinal and cross veins darker; vein Sc 0.78-0.83(0.81)× wing length; vein R_1 0.96–0.98(0.97)× 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-tenth 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 R_1 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)× width and 1.27–1.37(1.32)× length of clypeus, width 1.18–1.23(1.21)× 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)× 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)× 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.

Type data. Holotype: male imago, WO, Rangitukia Stream, August 1981, P. Summerhays (NZAC). **Allotype** female imago: same data as holotype (NZAC).

Paratypes. ND. Mangamuka Br.: 1 ♀ imago, 7–10 Oct, 1974, JSD. Waipoua State Forest: 2 ♀ imagos, 15 Oct 1967, JSD. Whangarei Falls 1 ♀ imago, 12 Oct 1967, KAJW; 4 ♂ and 6 ♀ subimagos, 16 Mar 1968, KAJW. **AK.** Big Omaha Vly: 1 ♂ subimago, 1 nymph, 20–21 Dec 1980, DRT, PGT. Pohuehue Stm: 3 nymphs, 21 Dec 1980, DRT, PGT. Cascade Stm: 4 ♀ imagos, 5 ♂ and 5 ♀ subimagos, 4 Nov 1966, JAM. Waitakere R.: 4 ♂ and 2 ♀ subimagos, 31 Oct 1966, JAM; 1 ♂ subimago, 3 Apr 1977, MGB; 1 nymph, 13 Dec 1974, DRT. **BP.** Ngamuwahine R.: 2 nymphs, 30 Jun 1979, DRT, AJQ. **WO.** Kaniwhaniwha Stm: 1 nymph, Mar 1981, PS. Type locality, same data as holotype: 2 ♂ and 5 ♀ imagos, 7 ♀ subimagos, 7 nymphs. Otorohanga: 1 ♀ imago, 2 Mar 1969, RGO.

Repositories: NZAC – 2 ♂ and 7 ♀ imagos, 4 ♂ and 2 ♀ subimagos, 7 nymphs; NMNZ – 1 ♀ imago, 2 ♂ and 1 ♀ subimagos; AMNZ – 1 ♀ imago, 4 ♂ and 6 ♀ subimagos; FAMU – 2 ♀ subimagos, 2 nymphs; BMNH – 2 ♀ subimagos, 2 nymphs.

Material examined. Type series only.

ND, AK, BP, WO / —.

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 MP_2 connected at base to MP_1 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 meso-notum 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.

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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

ag	abdominal gill
am	anteromedian margin
an	antenna
ce	cercus
cf	caudal filaments
cl	clypeus
cp	costal projection
cx	coxa
eg	egg guide
fe	femur
fl	flagellum
fo	genital forceps
fw	forewing
gl	galea-lacinia
go	glossa
hw	hind wing
in	incisors
la	labrum
le	lower eye
li	lingua
lp	labial palp
lps	lateroparapsidal suture
lss	lateral scutal suture
mls	median longitudinal suture
mn	mesonotum
mp	maxillary palp
mps	medioparapsidal suture
nf	notal furrows
no	thoracic notum
oc l/m	ocelli, lateral/median
pa	paraglossa
pd	pedicel
pe	penes
pn	pronotum
pp	posterolateral projection
psp	posterior scutal protuberance
pt	prosthecal tuft
sa	stigmatic area
sc	scape
sl	superlingua
sm	scutellum
sp	styliger plate
st	abdominal sternum
su	submentum
ta	tarsus
tc	tarsal claw(s)
te	abdominal tergum
tf	terminal filament
ti	tibia
tr	trochanter
ue	upper eye
wp	wing pad

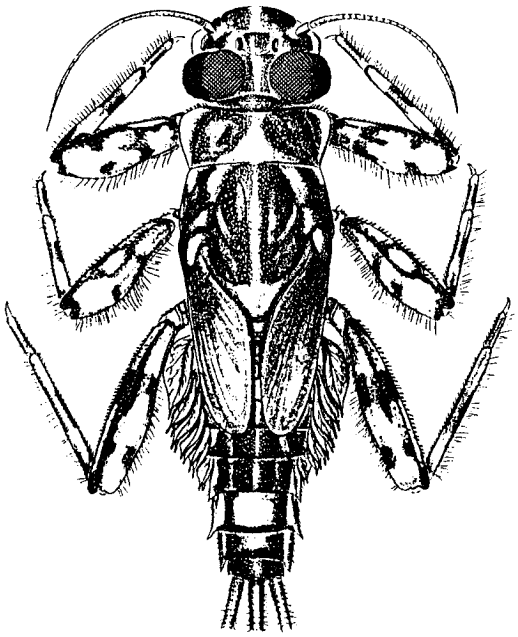
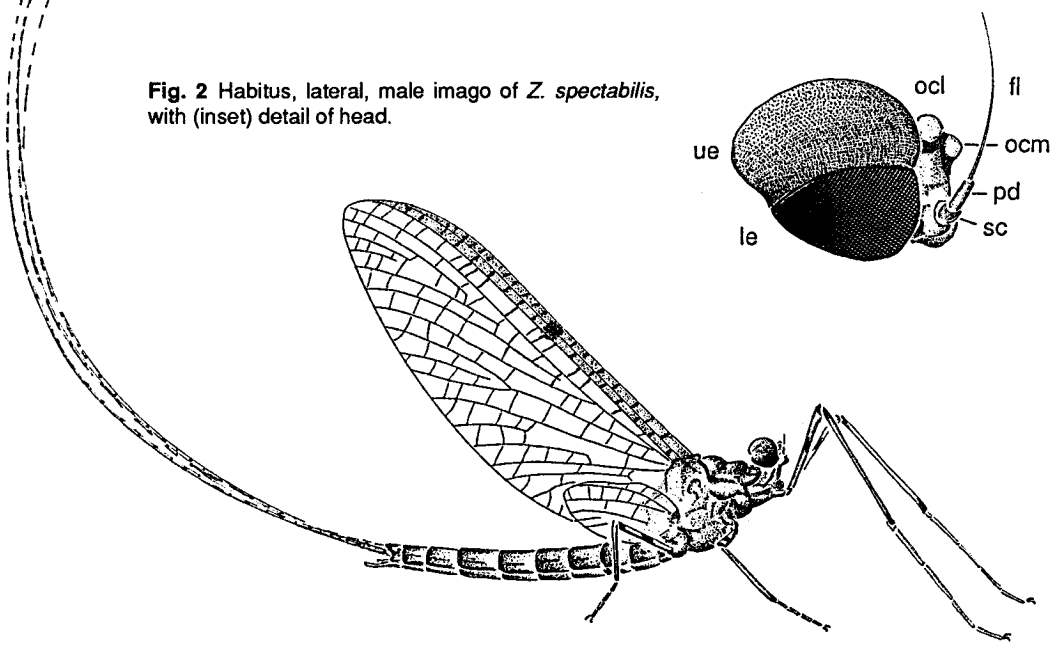


Fig. 1 Habitus, dorsal, nymph of *Zephlebia spectabilis* (caudal filaments truncated).

Fig. 2 Habitus, lateral, male imago of *Z. spectabilis,* with (inset) detail of head.



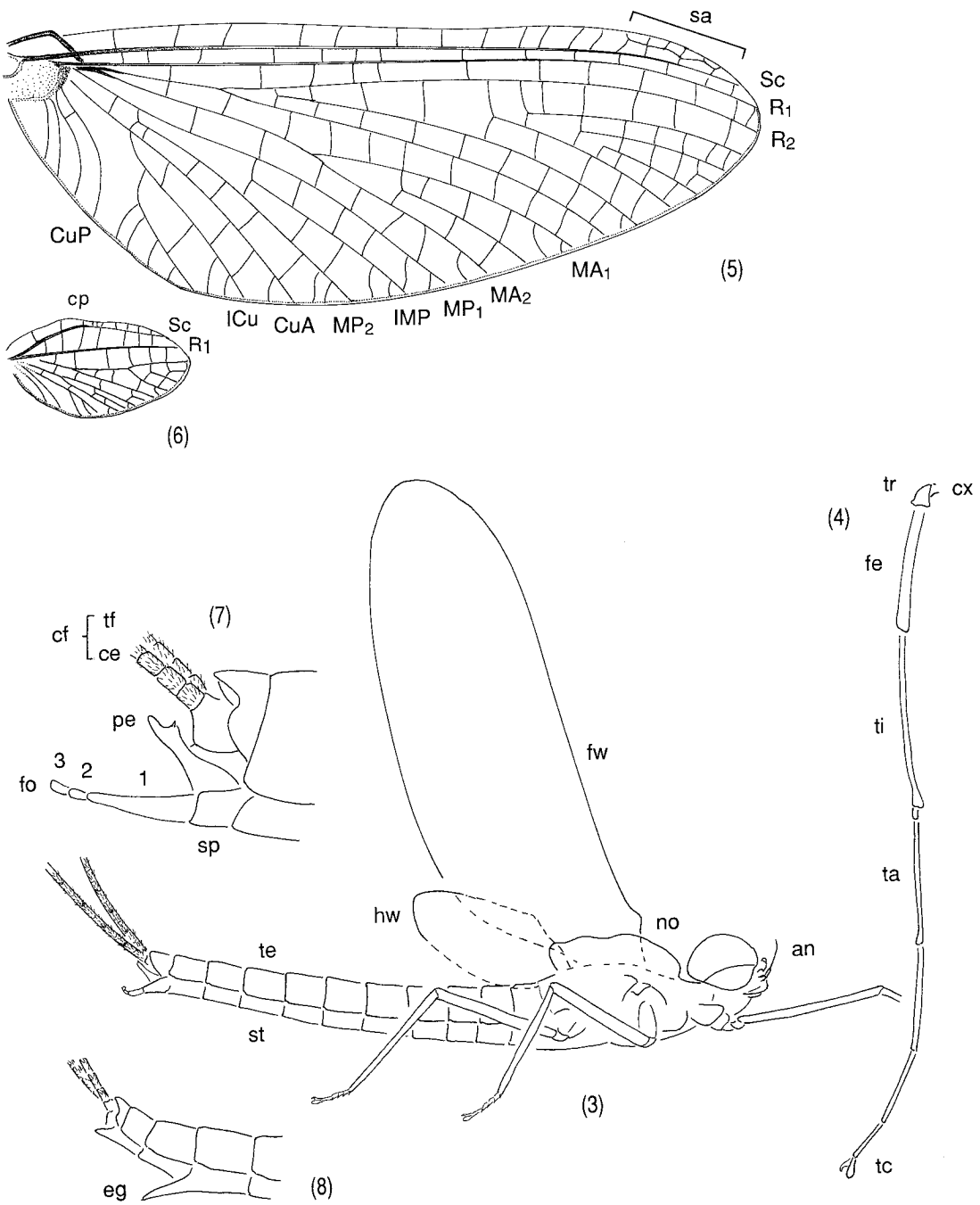


Fig. 3–8 Morphology of imago and subimago (not to same scale): (3) male imago, lateral (forelegs and caudal filaments truncated); (4) foreleg, showing segmentation; (5, 6) forewing and hind wing, showing venation: (7) hind abdomen of male, lateral, showing genitalia; (8) hind abdomen of female, lateral, showing egg guide.

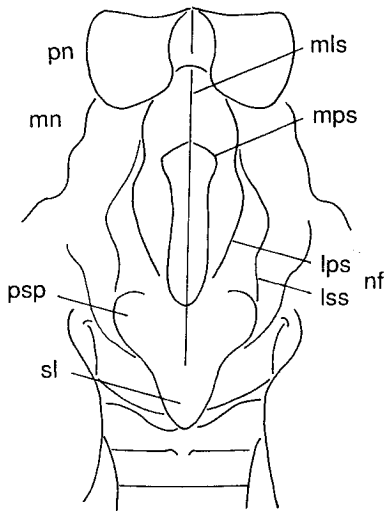


Fig. 9 Thoracic nota of subimago.

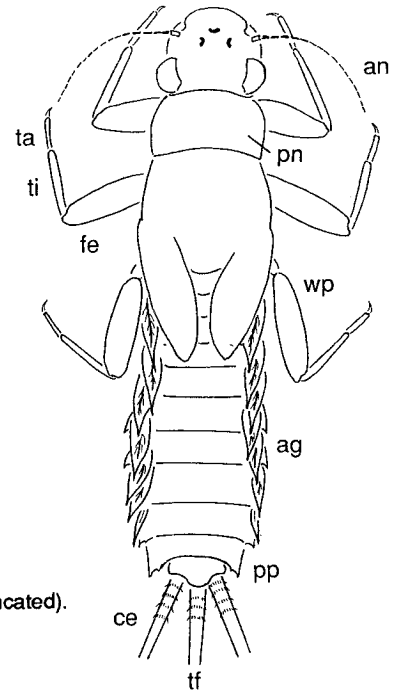


Fig. 10 (right) Morphology of nymph, dorsal (caudal filaments truncated).

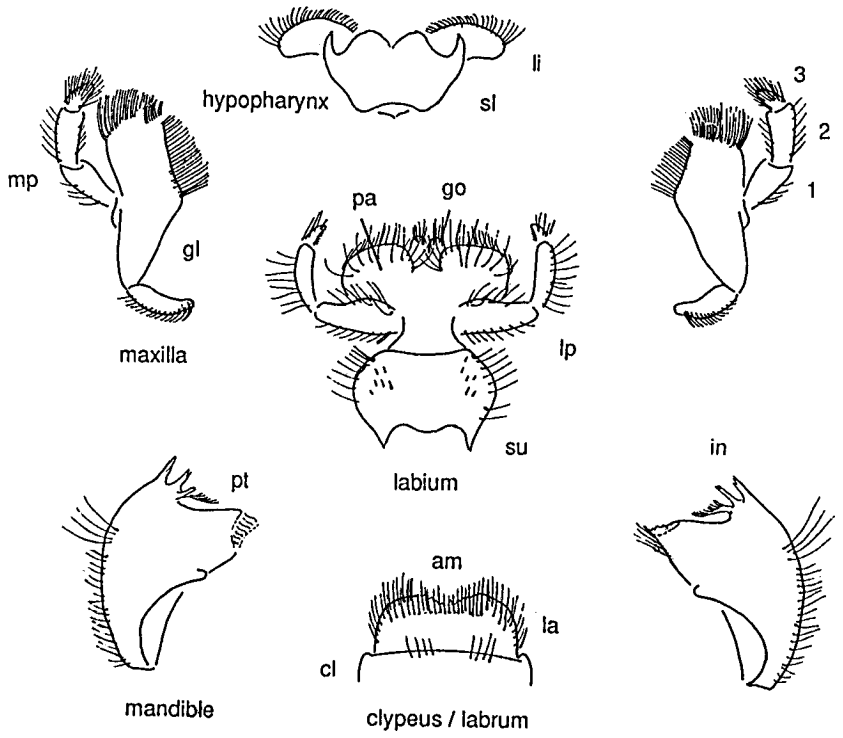
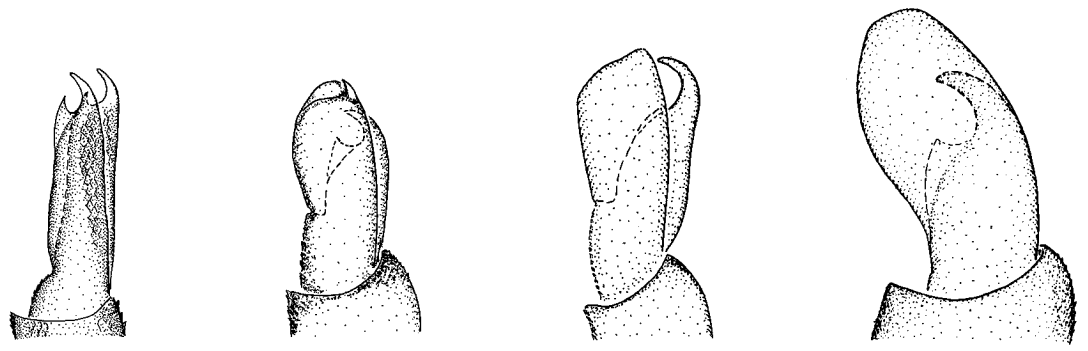
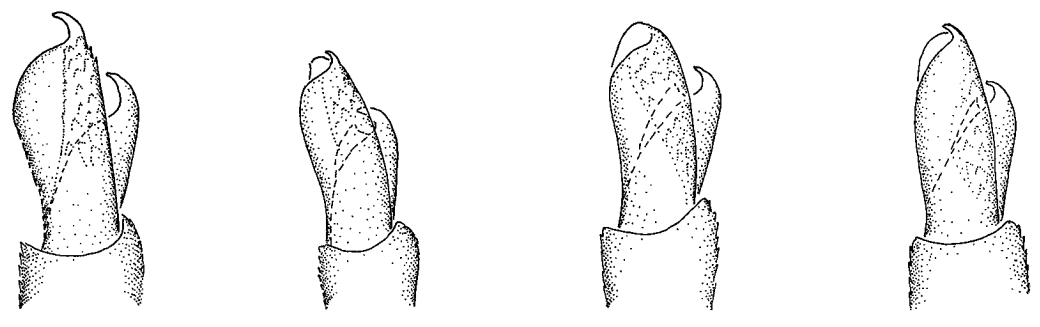


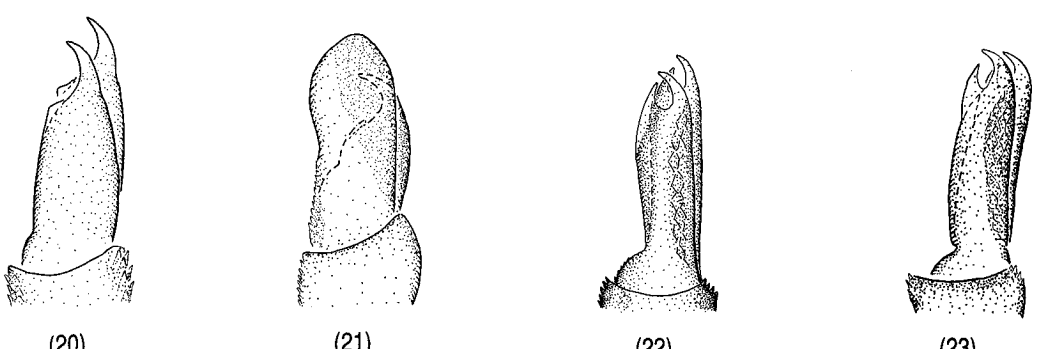
Fig. 11 Mouthparts of nymph, in 'exploded' view; principal elements labelled in full.



(12) (13) (14) (15)



(16) (17) (18) (19)



(20) (21) (22) (23)

Fig. 12–23 Fore claws of male imagos: (12) *Acanthophlebia cruentata*; (13) *Atalophlebioides cromwelli*; (14) *Austroclima sepia*; (15) *Cryophlebia aucklandensis*; (16) *Deleatidium lillii*; (17) *D. fumosum*; (18, 19) *D. myzobranchia* (Cascade Stm, AK; Kaiwharawhara Stm, WN); (20) *Deleatidium (Penniketellum) insolitum*; (21) *Mauiulus luma*; (22) *Neozephlebia scita*; (23) *Zephlebia versicolor*.

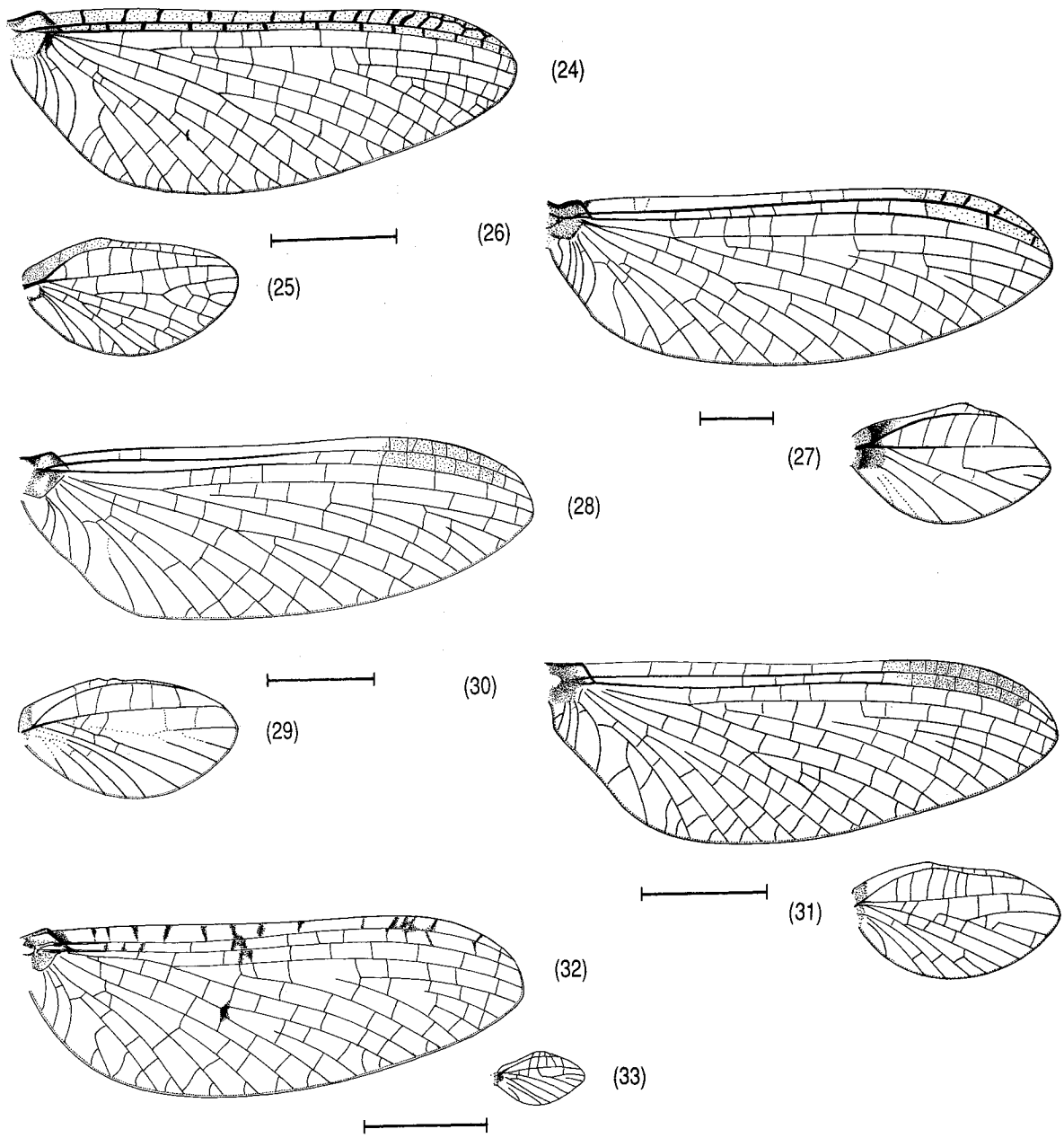


Fig. 24–33 Wings of male imagos (where hind wing enlarged, scale line indicates actual length relative to forewing): (24, 25) *Acanthophlebia cruentata*; (26, 27) *Arachnocolus phillipsi*; (28, 29) *Atalophlebioides cromwelli*; (30, 31) *Austroclima sepia*; (32, 33) *Austronella planulata*.

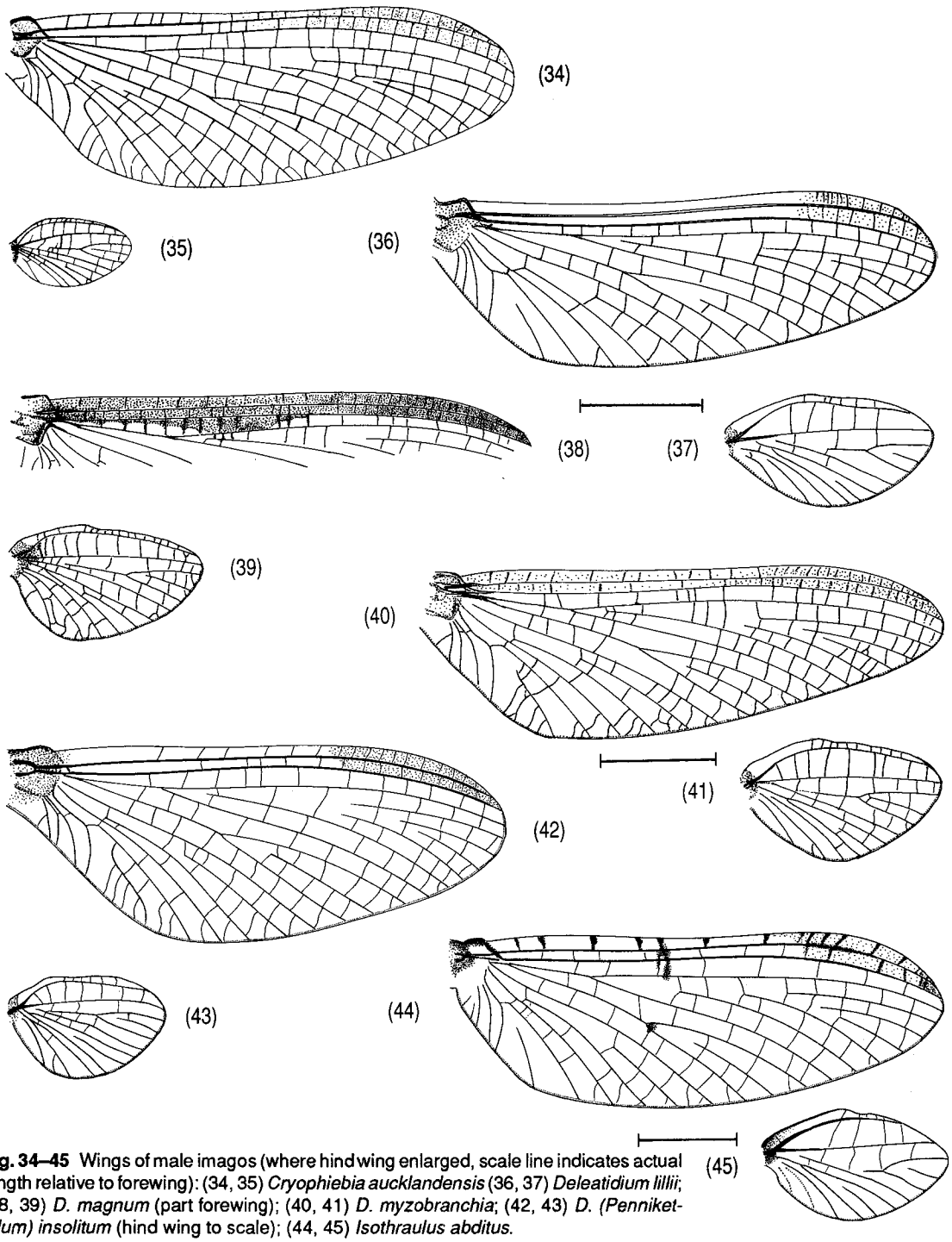


Fig. 34–45 Wings of male imagos (where hind wing enlarged, scale line indicates actual length relative to forewing): (34, 35) *Cryophiebia aucklandensis* (36, 37) *Deleatidium lillii*; (38, 39) *D. magnum* (part forewing); (40, 41) *D. myzobranchia*; (42, 43) *D. (Penniketellum) insolitum* (hind wing to scale); (44, 45) *Isothraulus abditus*.

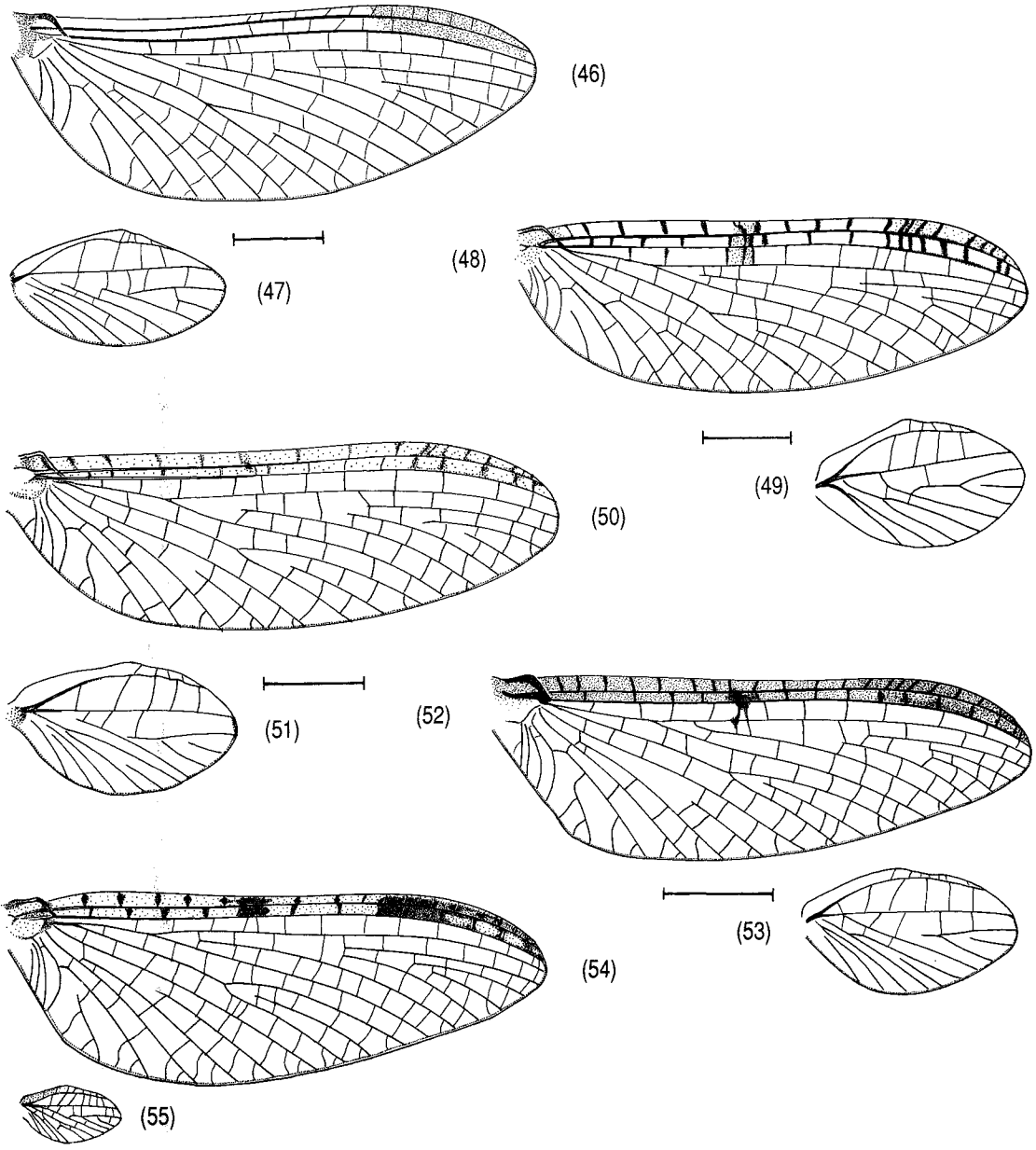


Fig. 46–55 Wings of male imagos (where hind wing enlarged, scale line indicates actual length relative to forewing): (46, 47) *Maululus luma* (48, 49) *Neozephlebia scita*; (50, 51) *Tepakia caligata*; (52, 53) *Zephlebia versicolor*; (54, 55) *Z. borealis*.

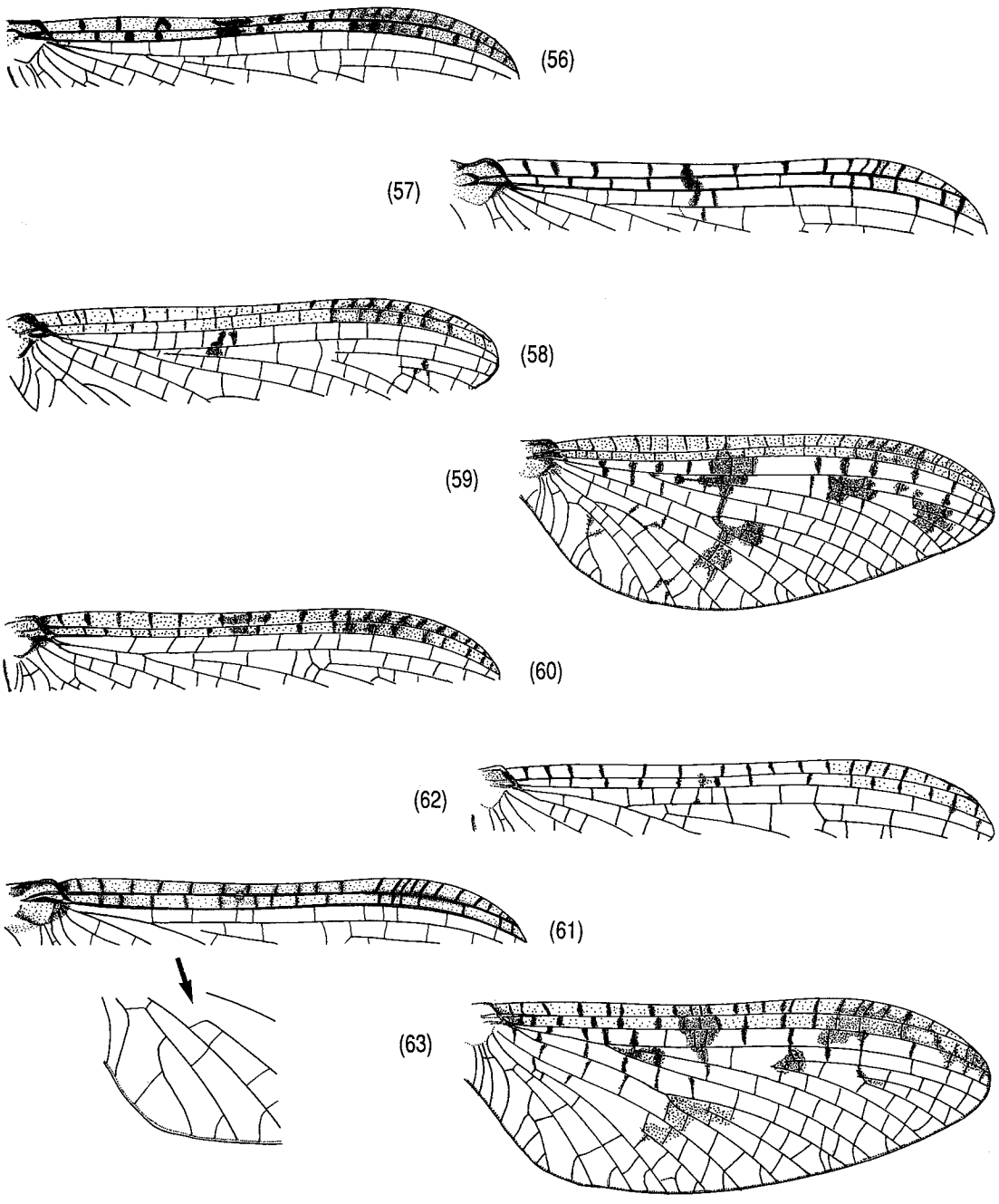


Fig. 56–63 Wings of male imagos: (56) *Z. dentata*, part forewing; (57) *Z. inconspicua*; (58, 59) *Z. nebulosa*, part forewing of male, forewing of female; (60) *Z. pirongia*, part forewing of male; (61) *Z. spectabilis*, part forewing of male, and CuA area (enlarged; arrowed – base of vein MP_2); (62, 63) *Z. tuberculata*, part forewing of male, forewing of female.

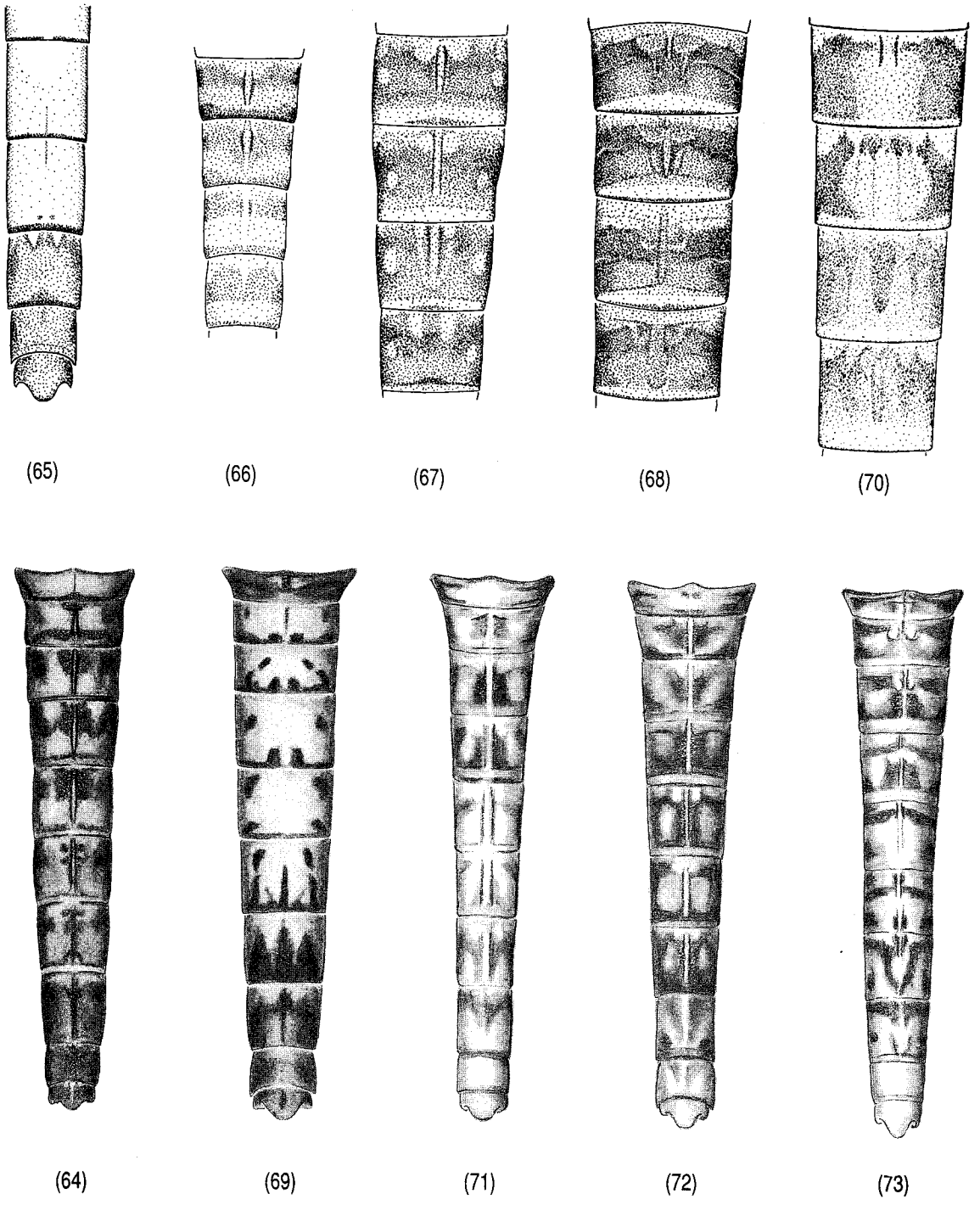


Fig. 64–73 Abdominal terga (T) of male imagos, showing colour pattern: (64) *Acanthophlebia cruentata*; (65) *Arachnocolus phillipsi*, T6–T10; (66) *Atalophlebioides cromwelli*, T4–T7; (67) *Austroclima sepia*, T3–T6; (68) *A. jollyae*, T3–T6; (69) *Austronella planulata*; (70) *Cryophlebia aucklandensis*,T4–T7; (71) *Deleatidium lillii*; (72) *D. angustum*; (73) *D. autumnale*.

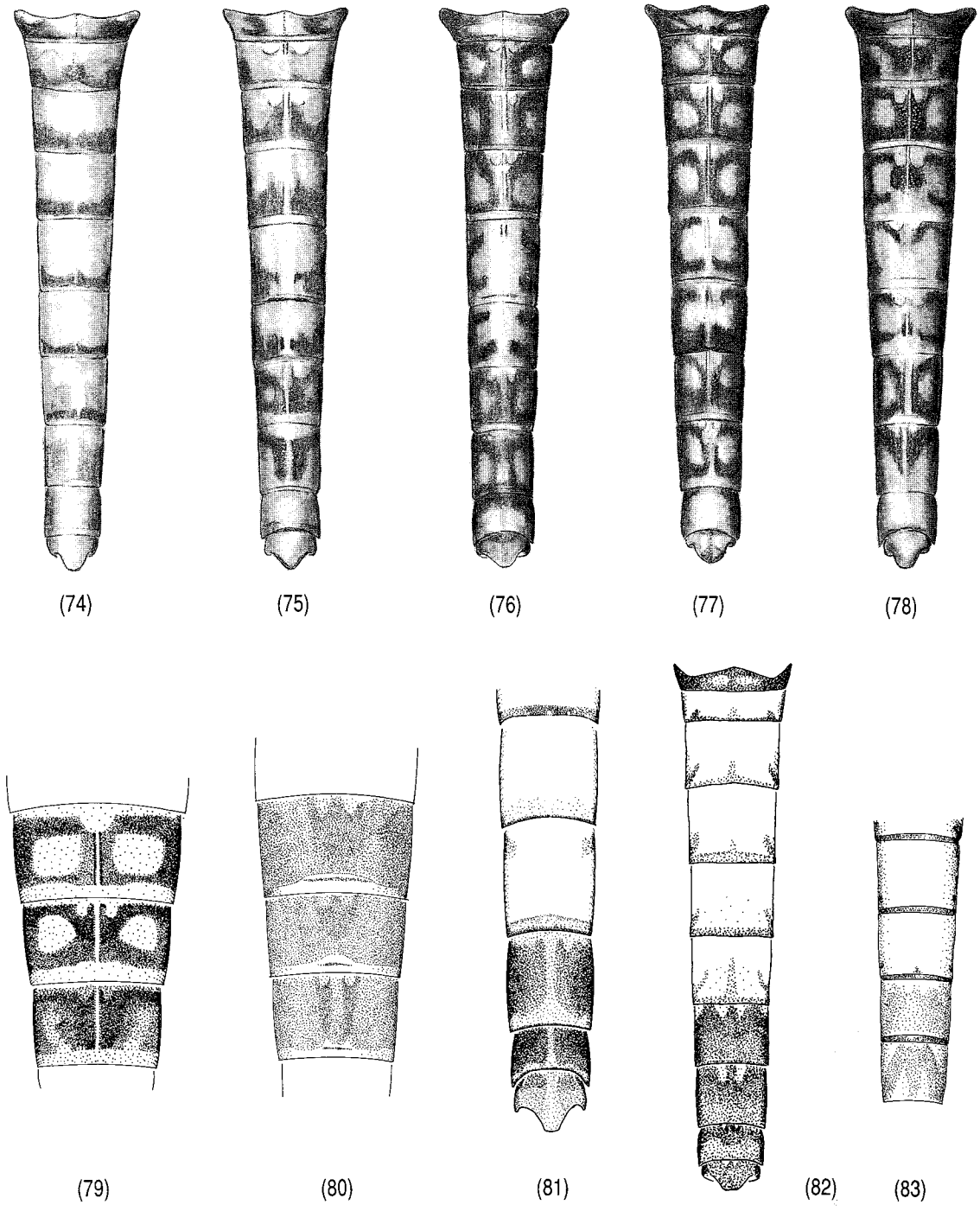


Fig. 74–83 Abdominal terga (T) of male imagos, showing colour pattern: (74) *Deleatidium cerinum*; (75) *D. fumosum*; (76) *D. magnum*; (77) *D. myzobranchia*; (78) *D. vernale*; (79) *D. (Penniketellum) insolitum*, T5–T7; (80) *D. (P.) cornutum*, T5–T7; (81) *Isothraulus abditus*, T6–T10; (82) *Mauiulus luma*; (83) *M. aquilus*, T5–T9.

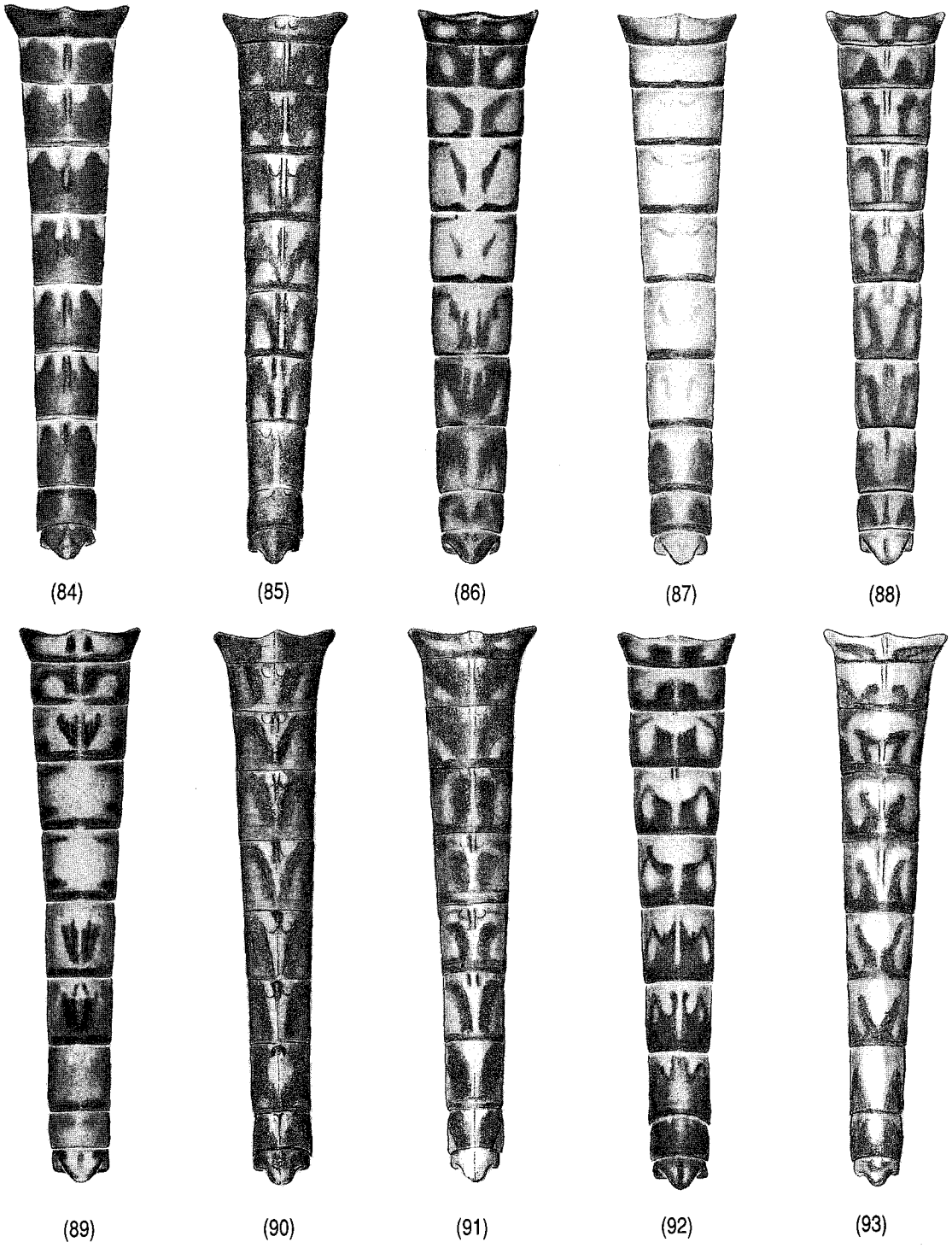


Fig. 84–93 Abdominal terga of male imagos, showing colour pattern: (84) *Neozephlebia scita*; (85) *Tepakia caligata*; (86) *Zephlebia versicolor*; (87) *Z. borealis*; (88) *Z. dentata*; (89) *Z. inconspicua*; (90) *Z. nebulosa*; (91) *Z. pirongia*; (92) *Z. spectabilis*; (93) *Z. tuberculata*.

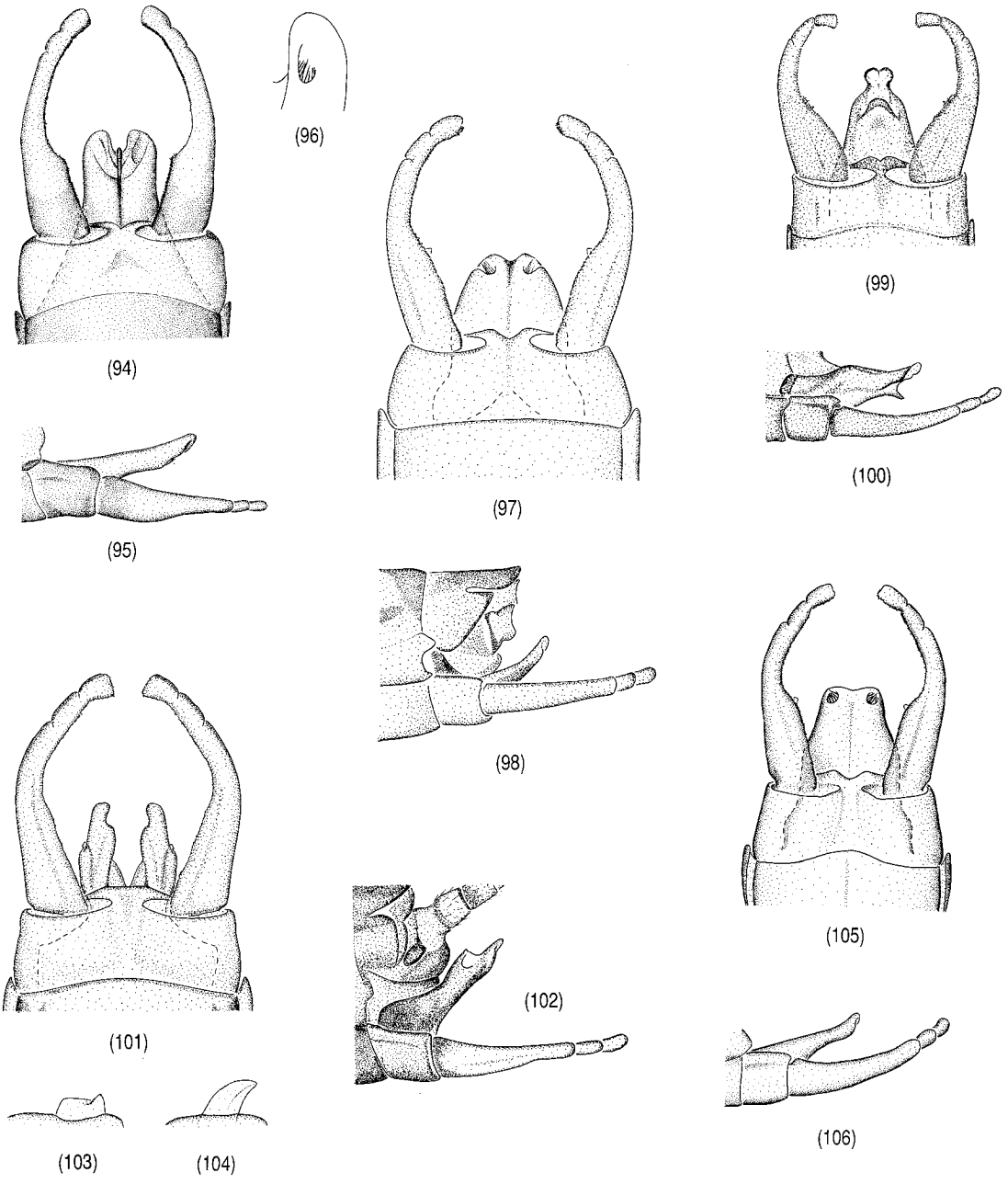
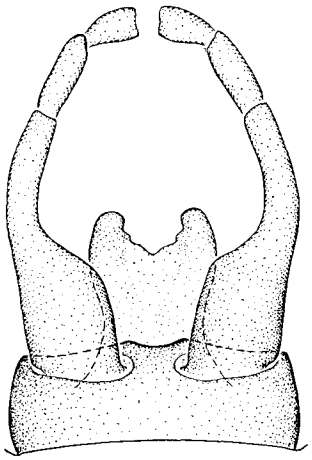


Fig. 94–106 Genitalia of male imagos, ventral and lateral views: (94, 95) *Acanthophlebia cruentata*, with (96) penis opening, enlarged; (97, 98) *Arachnocolus phillipsi*; (99, 100) *Atalophlebioides cromwelli*; (101, 102) *Austroclima sepia*, with (103) enlargement of spine on dorsolateral surface of penis and (104) same, *A. jollyae*; (105, 106) *Austronella planulata*.



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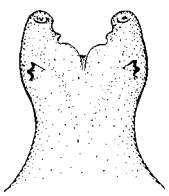

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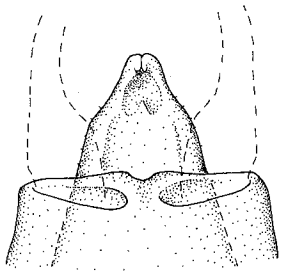

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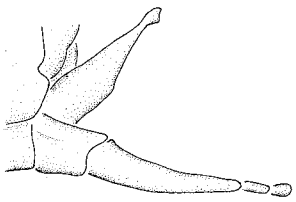

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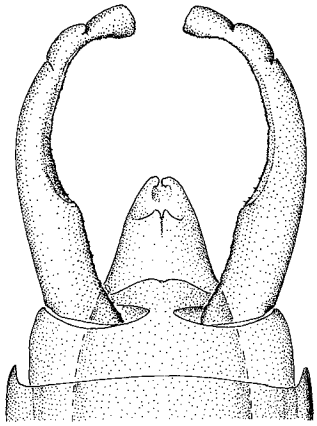

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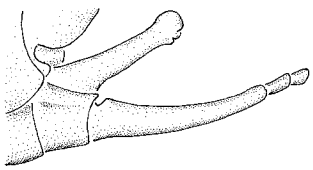

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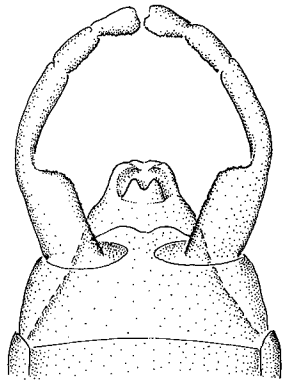

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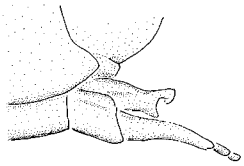

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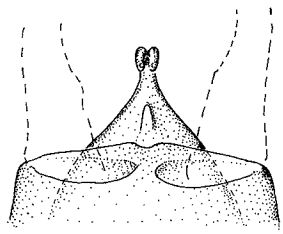

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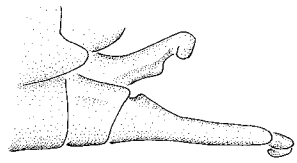

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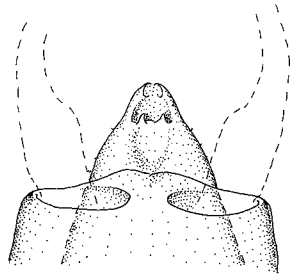

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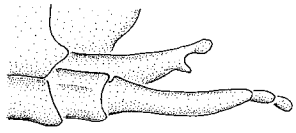

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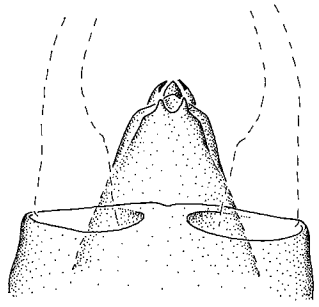

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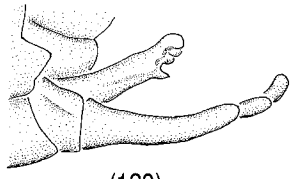


(120)

Fig. 107–120 Genitalia of male imagos, ventral and lateral views: (107) *Cryophlebia aucklandensis*, ventral, with (108) dorsal view of penes; (109, 110) *Deleatidium lillii*; (111, 112) *D. angustum*; (113, 114) *D. autumnale*; (115, 116) *D. cerinum*; (117, 118) *D. fumosum*; (119, 120) *D. magnum*.

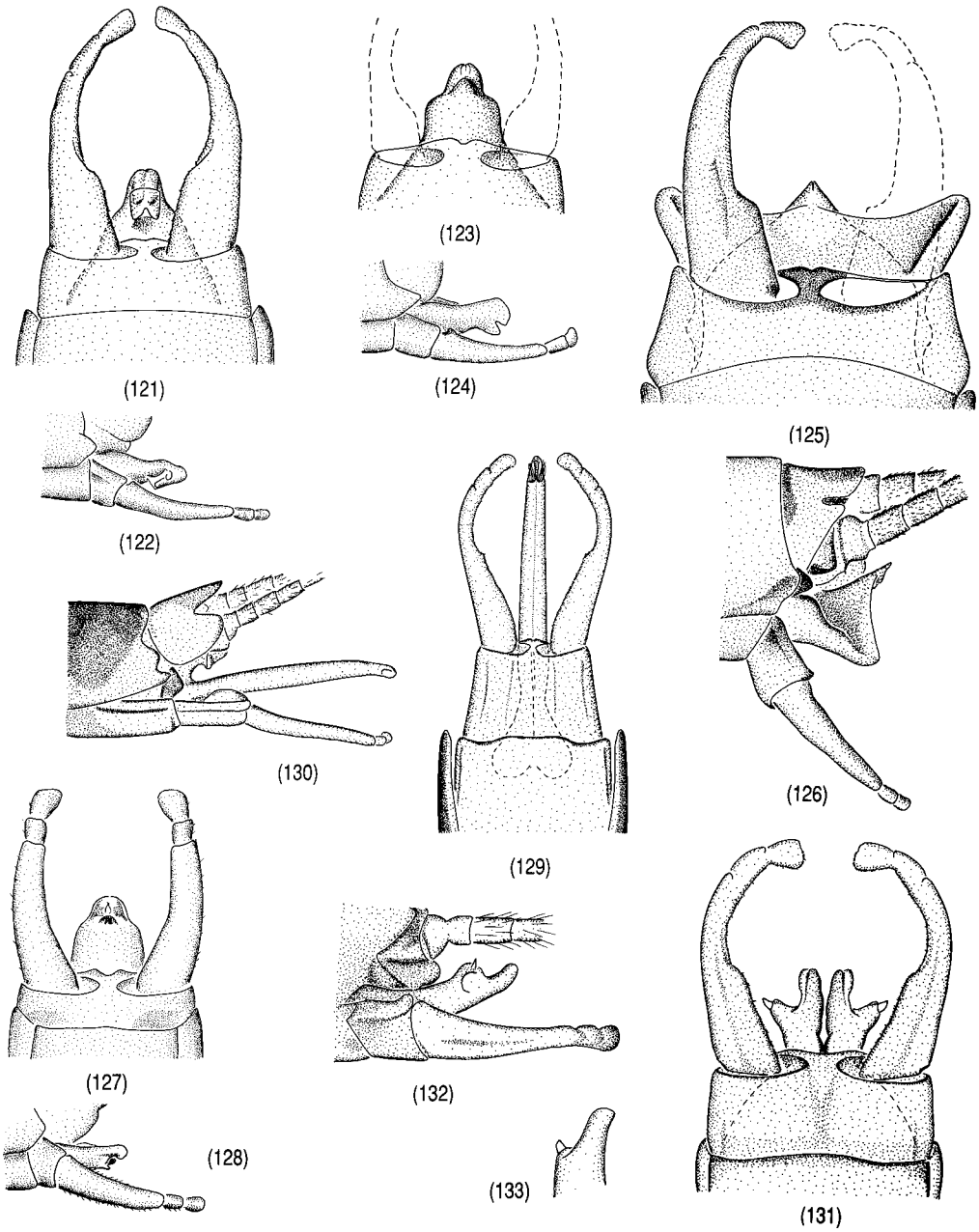
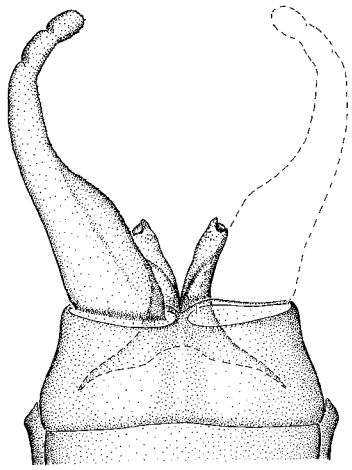


Fig. 121–133 Genitalia of male imagos, ventral and lateral views: (121, 122) *Deleatidium myzobranchia*; (123, 124) *D. vernale*; (125, 126) *D. (Penniketellum) insolitum*; (127, 128) *D. (P.) cornutum*, subimago; (129, 130) *Isothraulus abditus*; (131, 132) *Mauiulus luma*; (133) *M. aquilus*, enlargement of spine on dorsolateral surface of penis.



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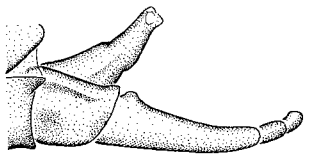

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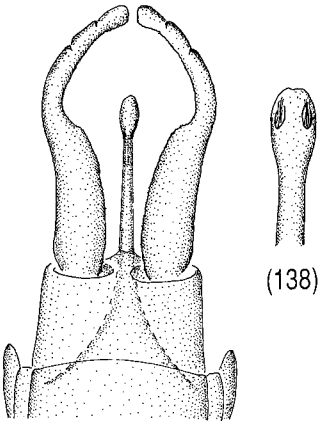

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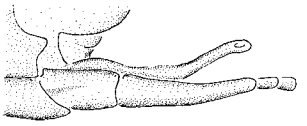

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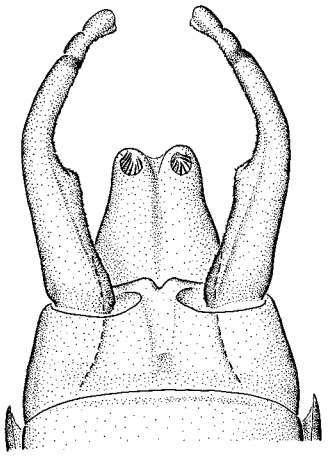

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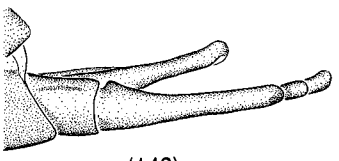

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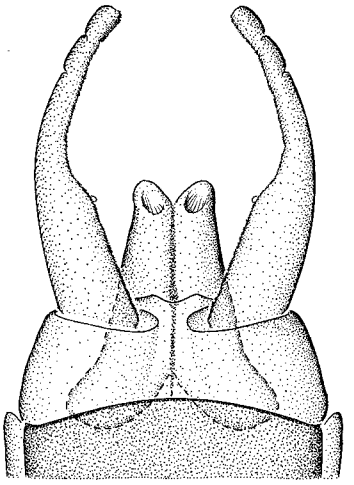

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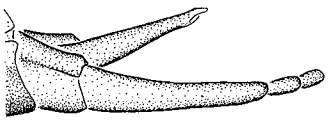

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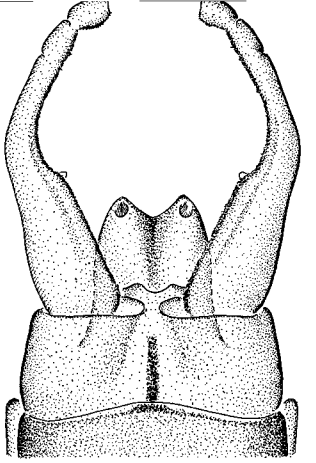

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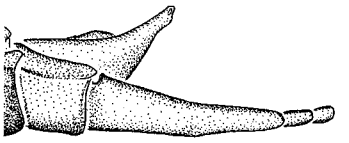

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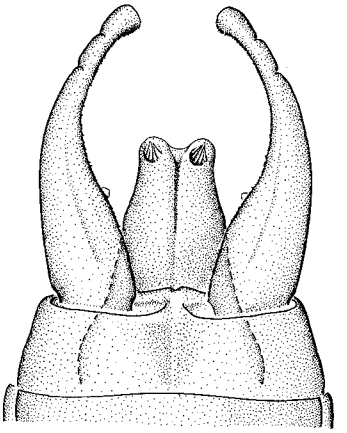

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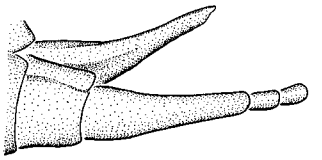


(146)

Fig. 134–146 Genitalia of male imagos, ventral and lateral views: (134, 135) *Neozephlebia scita*; (136, 137) *Tepakia caligata*, with (138) enlargement of dorsal apex of penes; (139, 140) *Zephlebia versicolor*; (141, 142) *Z. borealis*; (143, 144) *Z. dentata*; (145, 146) *Z. inconspicua*.

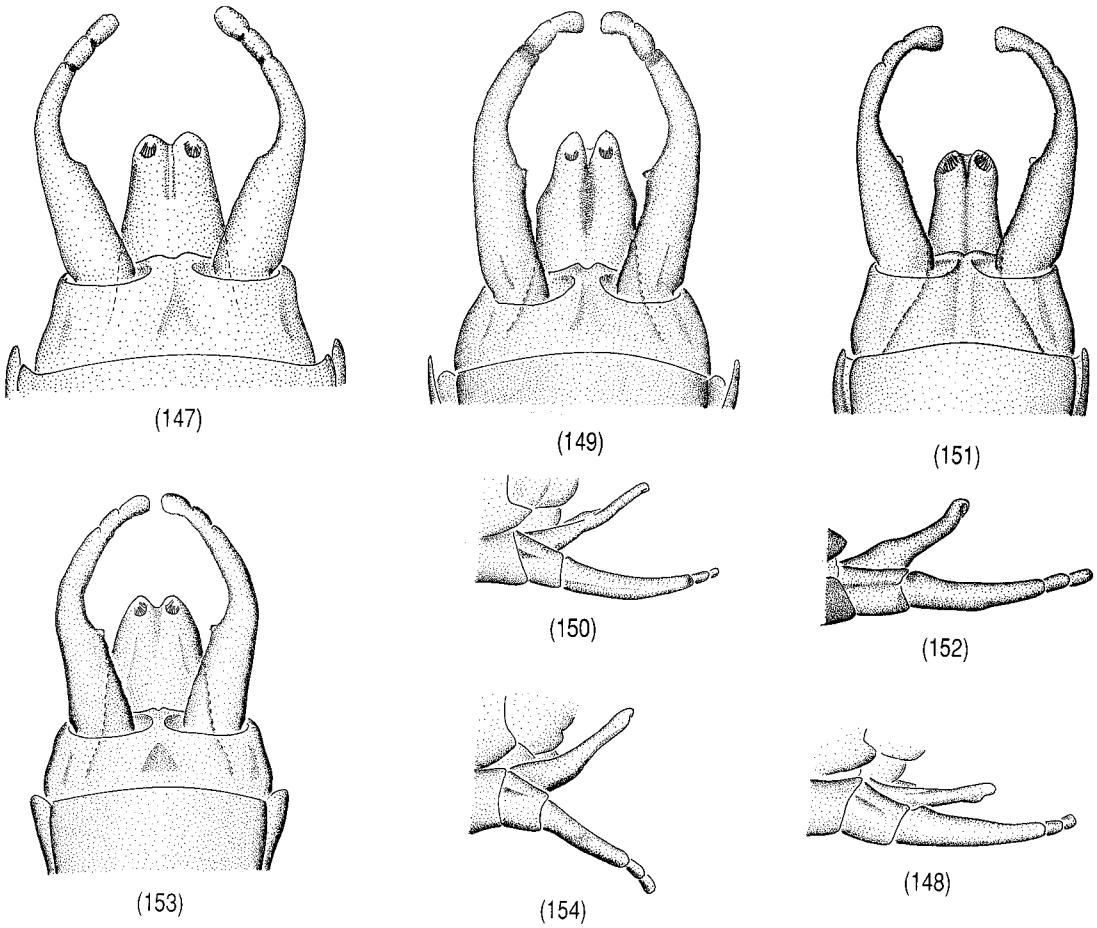
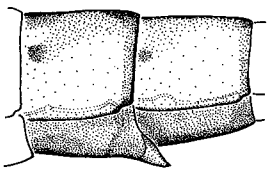


Fig. 147–154 Genitalia of male imagos, ventral and lateral views: (147, 148) *Zephlebia nebulosa*; (149, 150) *Z. pirongia*; (151, 152) *Z. spectabilis*; (153, 154) *Z. tuberculata*.



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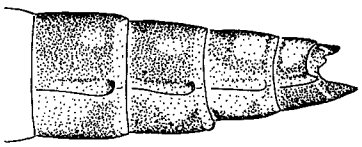

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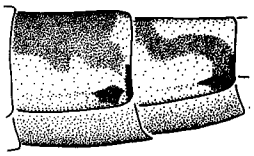

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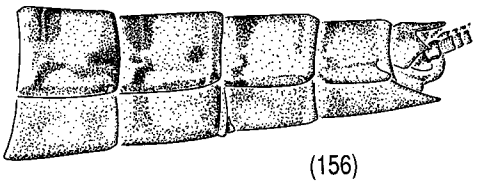

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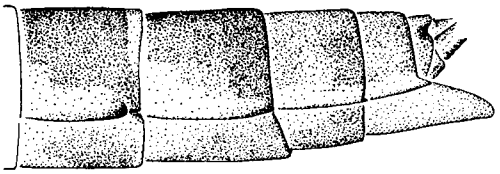

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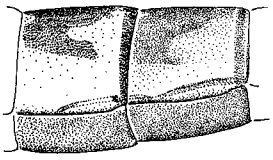

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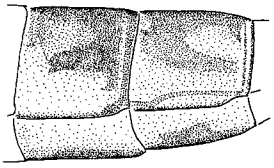

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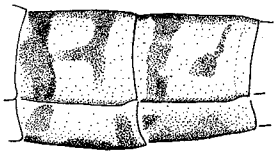

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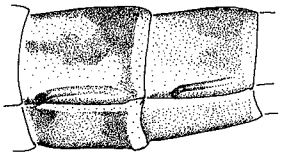

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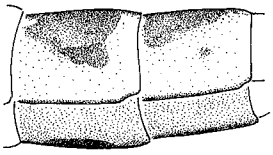

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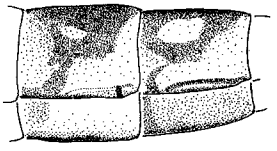
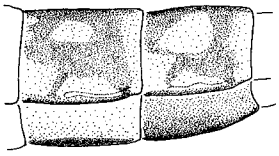


(165)



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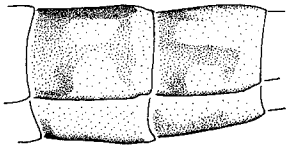

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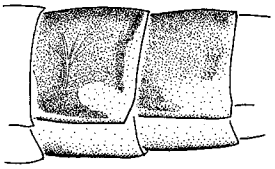
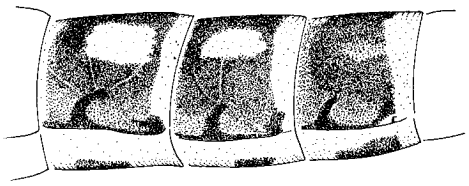
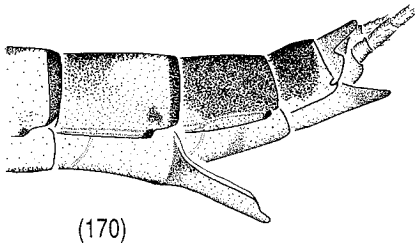


(169)

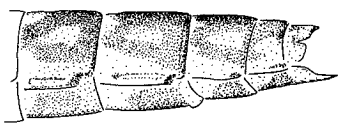
Fig. 155–167 Abdominal segments (S) of female imagos, lateral view: (155) *Acanthophlebia cruentata*, S7+8; (156) *Atalophlebioides cromwelli*, S6–10; (157) *Austroclima sepia*, S6–10; (158) *Austronella planulata*, S7+8; (159) *Cryophlebia aucklandensis*, S6–10; (160) *Deleatidium lillii*, S7+8; (161) *D. angustum*, S7+8; (162) *D. autumnale*, S7+8; (163) *D. cerinum*, S7+8; (164) *D. fumosum*, S7+8; (165) *D. magnum*, S7+8; (166) *D. myzobranchia*, S7+8; (167) *D. vernale*, S7+8.



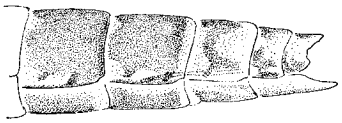
(168)



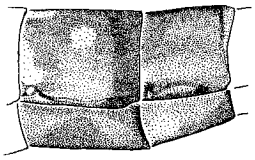
(170)



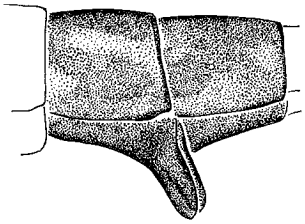
(171)



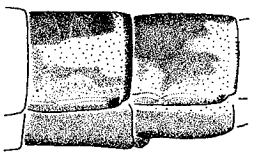
(172)



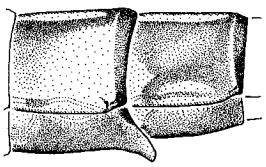
(173)



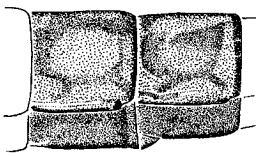
(174)



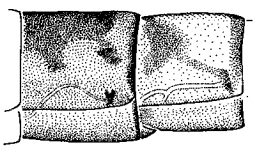
(175)



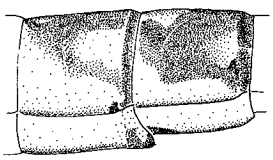
(176)



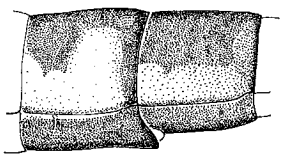
(177)



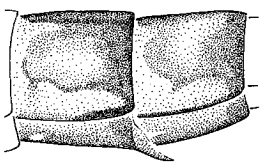
(178)



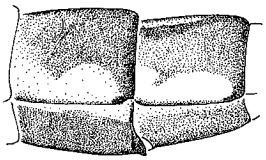
(179)



(180)



(181)



(182)

Fig. 168–182 Abdominal segments (S) of female imagos, lateral view: (168) *Deleatidium (Penniketellum) insolitum*, S5–7; (169) *D. (P.) cornutum*, S7+8; (170) *Isothraulus abditus*, S6–10; (171) *Mauiulus luma*, S6–10; (172) *M. aquilus*, S6–10; (173) *Neozephlebia scita*, S7+8; (174) *Tepakia caligata*, S7+8; (175) *Zephlebia versicolor*, S7+8; (176) *Z. borealis*, S7+8; (177) *Z. dentata*, S7+8; (178) *Z. inconspicua*, S7+8; (179) *Z. nebulosa*, S7+8; (180) *Z. pirongia*, S7+8; (181) *Z. spectabilis*, S7+8; (182) *Z. tuberculata*, S7+8.

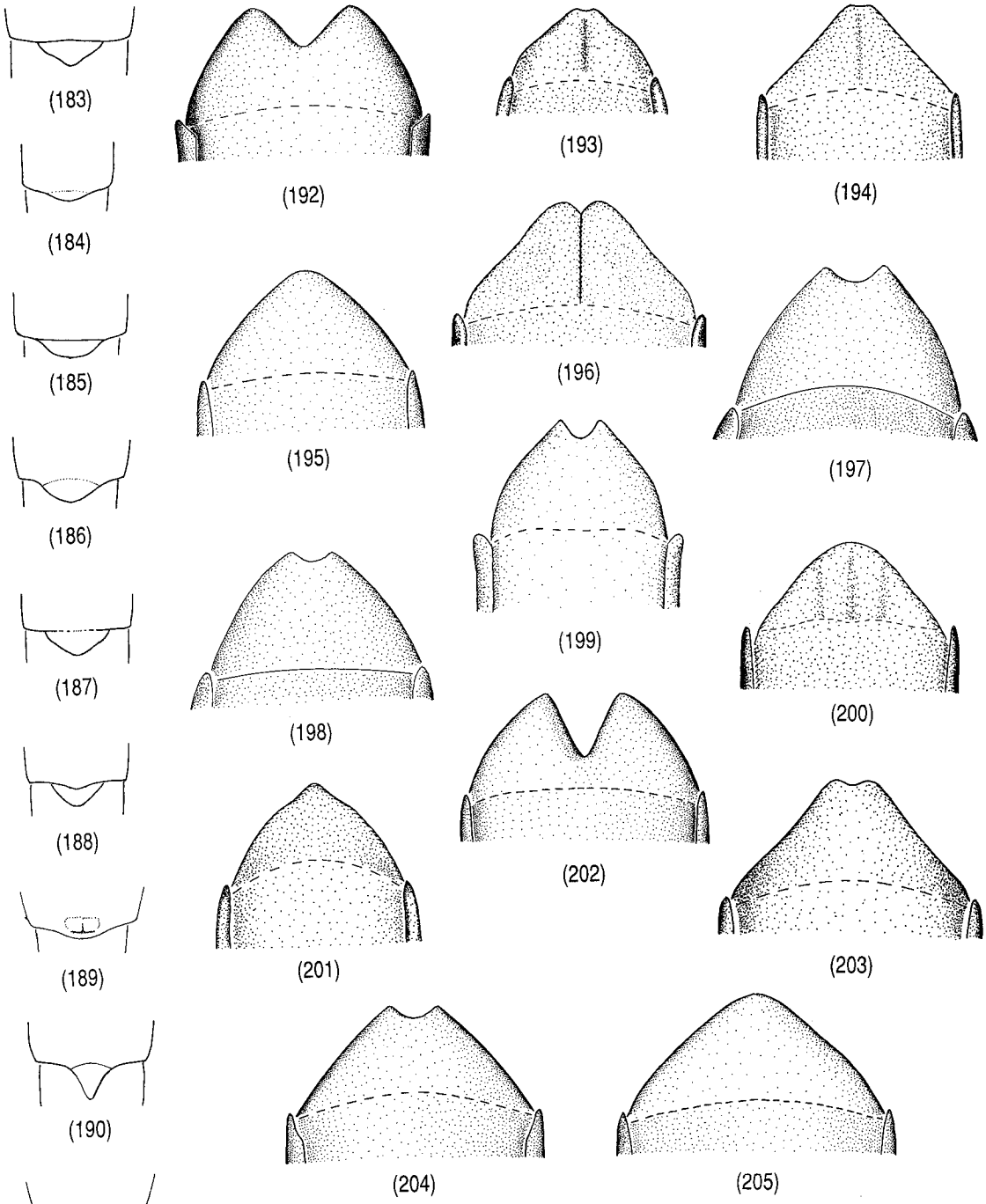


Fig. 183–191 Sterna 7 and 8 of female imagos, showing genital extension: (183) *Acanthophlebia cruentata*; (184) *Austronella planulata*; (185) *Zephlebia versicolor*; (186) *Z. borealis*; (187) *Z. dentata*; (188) *Z. inconspicua*; (189) *Z. nebulosa*; (190) *Z. spectabilis*; (191) *Z. tuberculata*. **Fig. 192–205** Sternum 9 of female imagos: (192) *Acanthophlebia cruentata*; (193) *Atalophlebioides cromwelli*; (194) *Austroclima sepia*; (195) *Austronella planulata*; (196) *Cryophlebia aucklandensis*; (197) *Deleatidium lillii*; (198) *D. cerinum*; (199) *D. (Penniketellum) insolitum*; (200) *Isothraulus abditus*; (201) *Mauiulus luma*; (202) *Neozephlebia scita*; (203) *Zephlebia versicolor*; (204) *Z. borealis*; (205) *Z. spectabilis*.

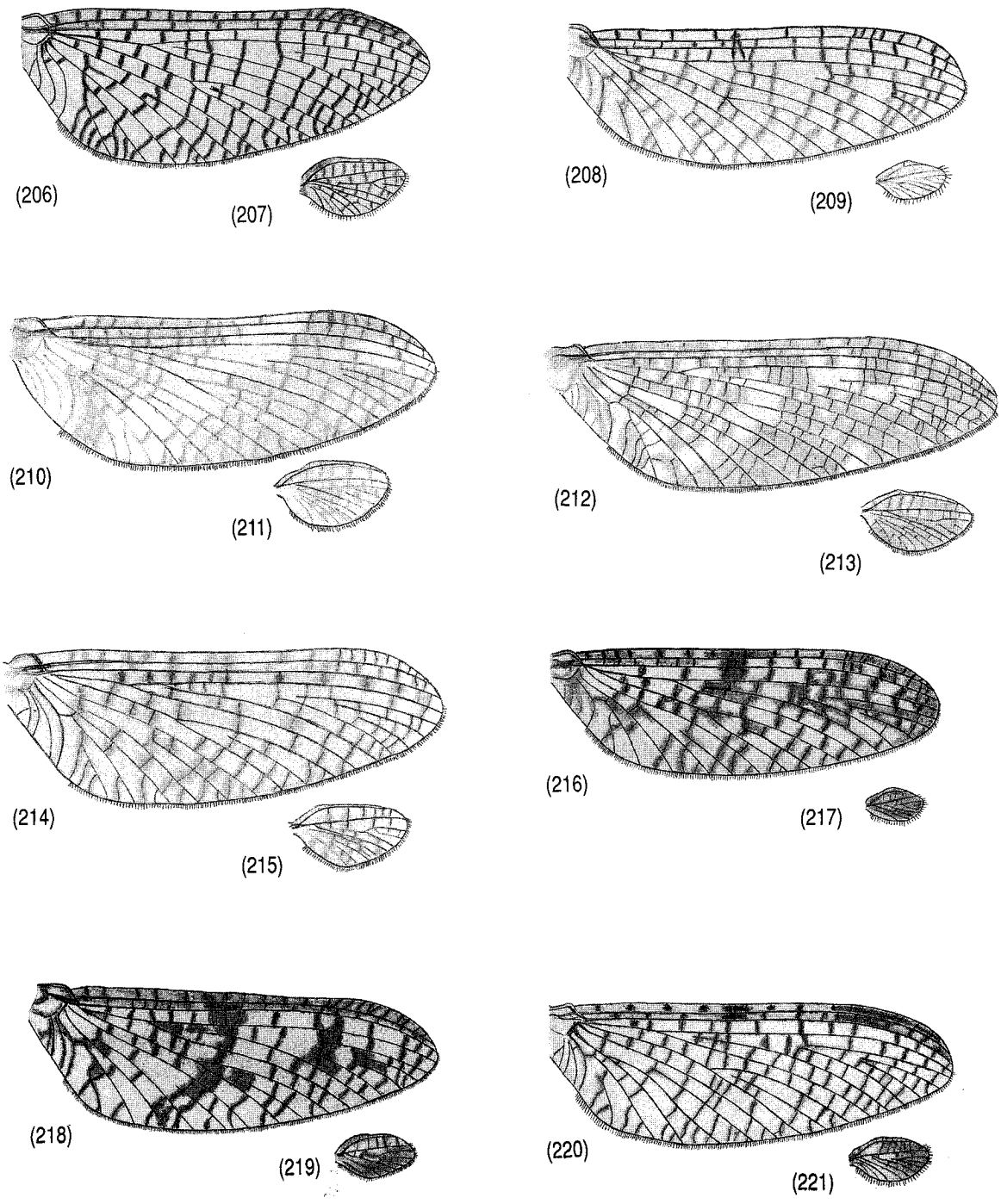


Fig. 206–221 Wings of male subimagos: (206, 207) *Acanthophlebia cruentata*; (208, 209) *Austronella planulata*; (210, 211) *Deleatidium autumnale*; (212, 213) *D. myzobranchia* (female); (214, 215) *D. vernale*; (216, 217) *Neozephlebia scita*; (218, 219) *Zephlebia versicolor*; (220, 221) *Z. borealis*.

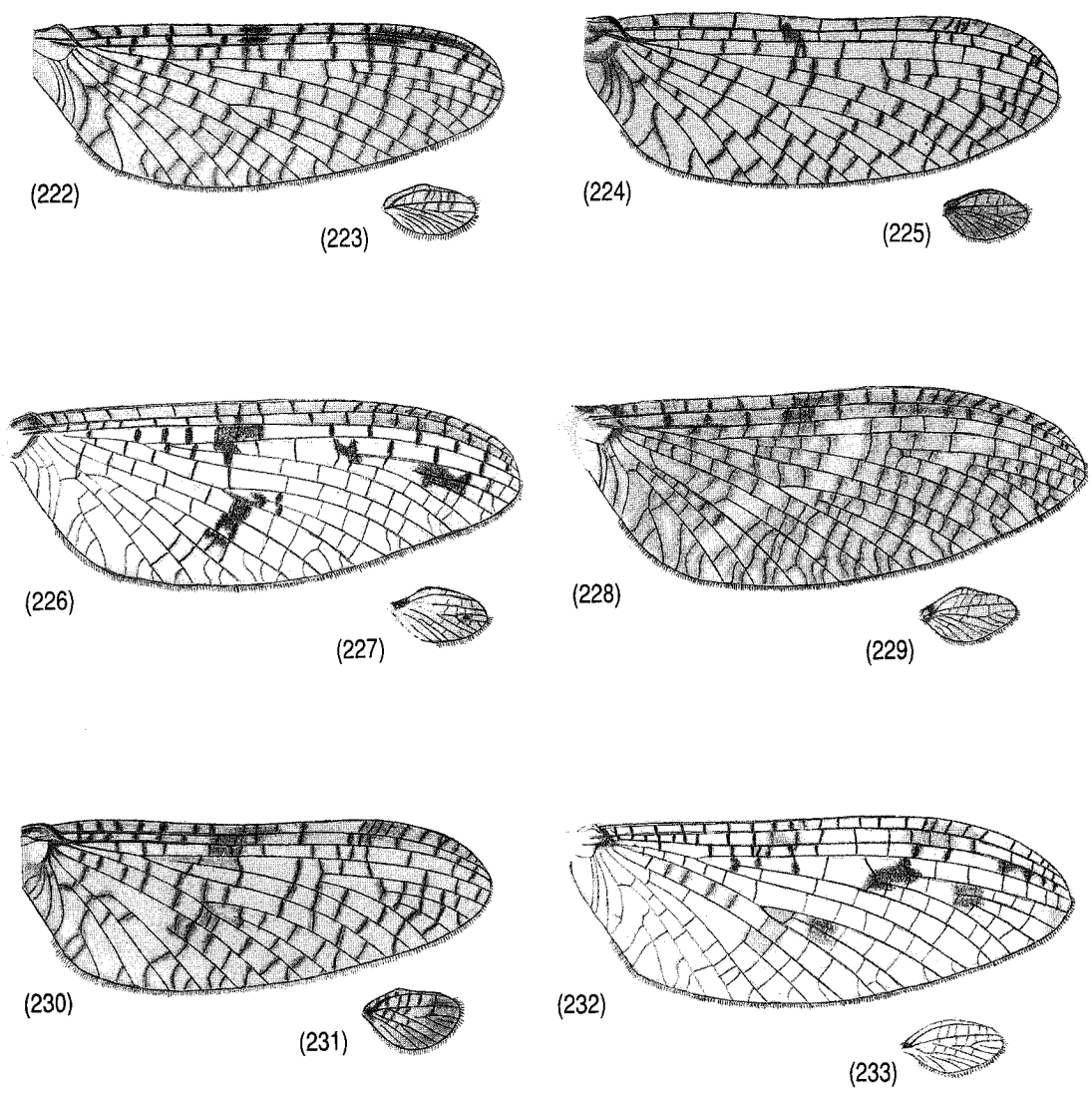
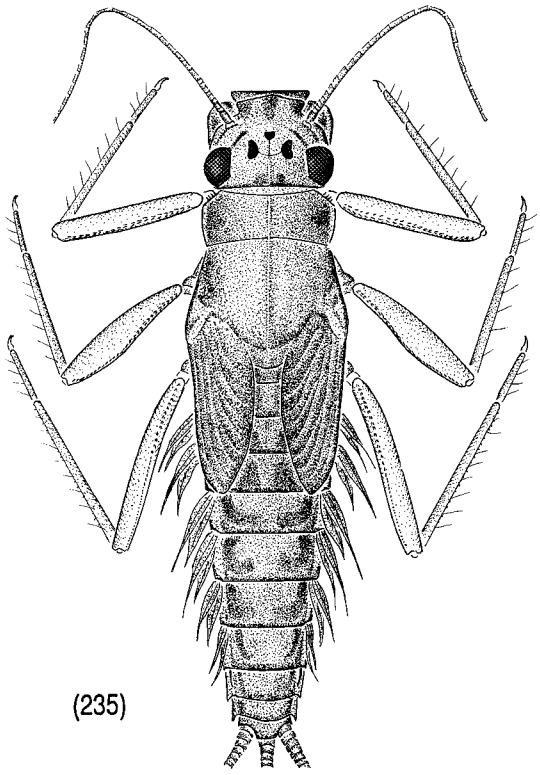
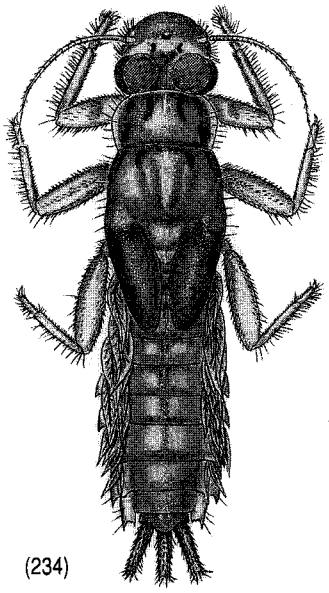


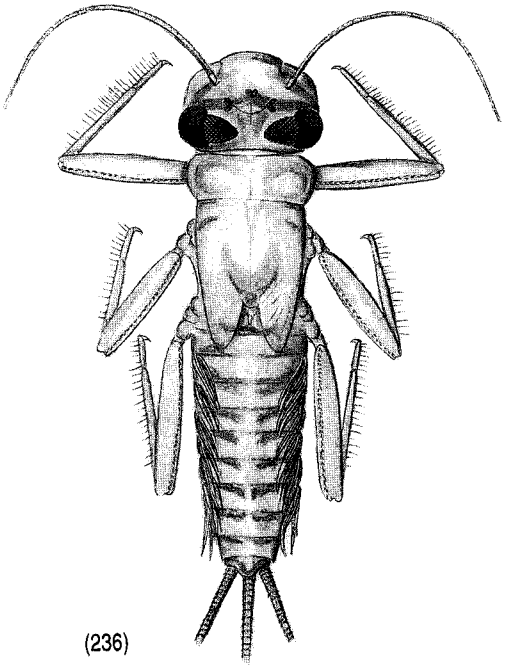
Fig. 222–233 Wings of male subimagos: (222, 223) *Zephlebia dentata*; (224, 225) *Z. inconspicua*; (226, 227) *Z. nebulosa*; (228, 229) *Z. pirongia*; (230, 231) *Z. spectabilis*; (232, 233) *Z. tuberculata*.



(235)

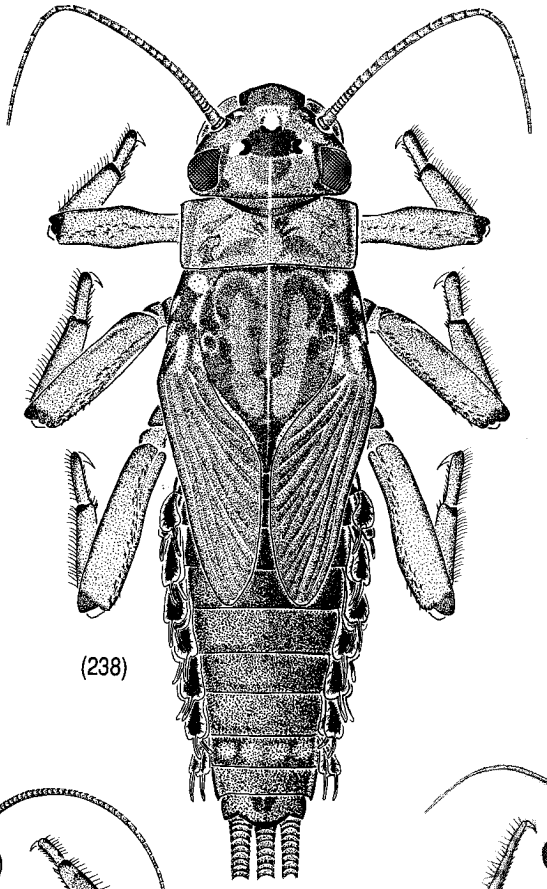


(234)

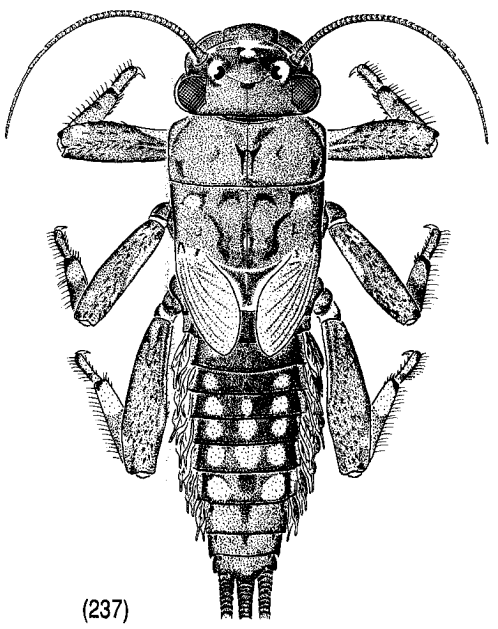


(236)

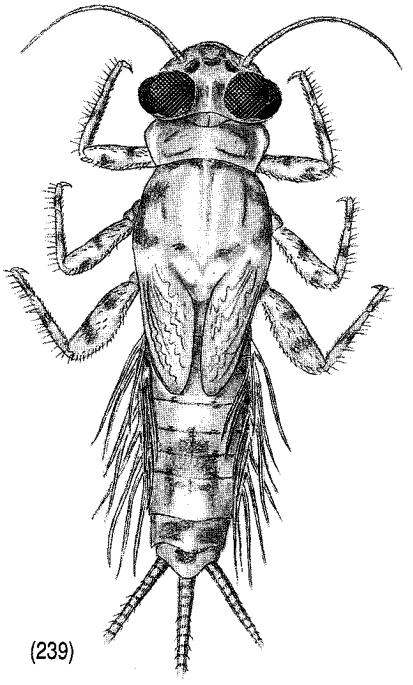
Fig. 234–236 Mature nymphs (caudal filaments truncated):
(234) *Acanthophlebia cruentata*; (235) *Arachnocolus phillipsi*; (236) *Atalophlebioides cromwelli.*



(238)

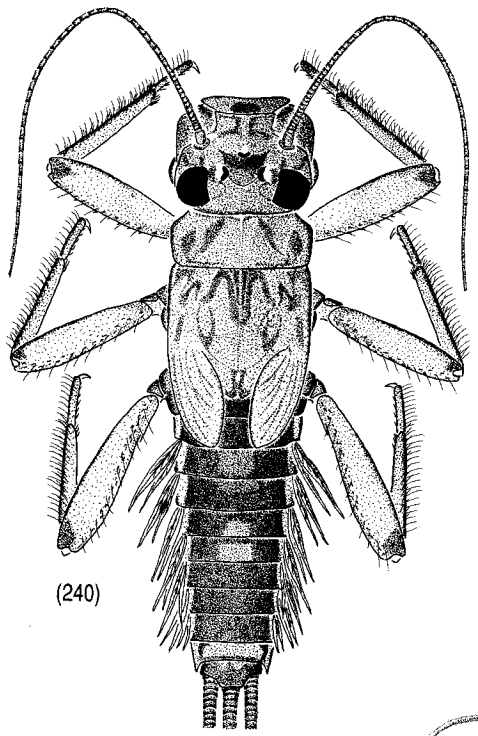


(237)

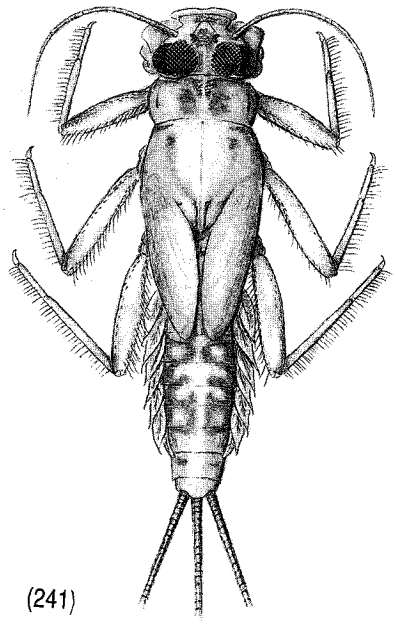


(239)

Fig. 237–239 Mature nymphs (caudal filaments truncated): (237) *Austroclima sepia*; (238) *A. jollyae*; (239) *Austronella planulata*.



(240)



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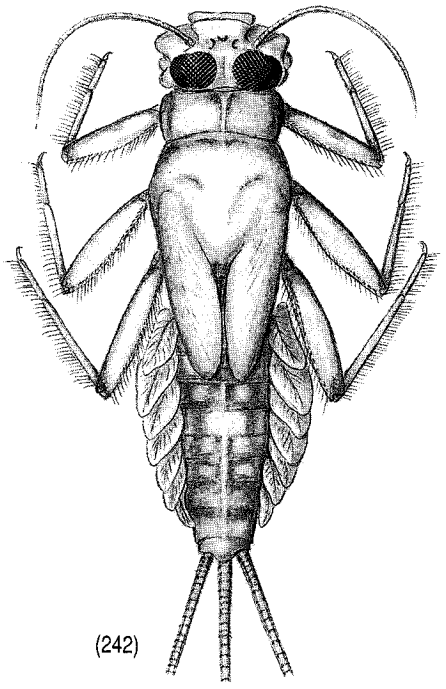


(242)

Fig. 240–242 Mature nymphs (caudal **filaments** truncated):
(240) *Cryophlebia aucklandensis*; (241) *Deleatidium lillii*; (242) *D. angustum*.

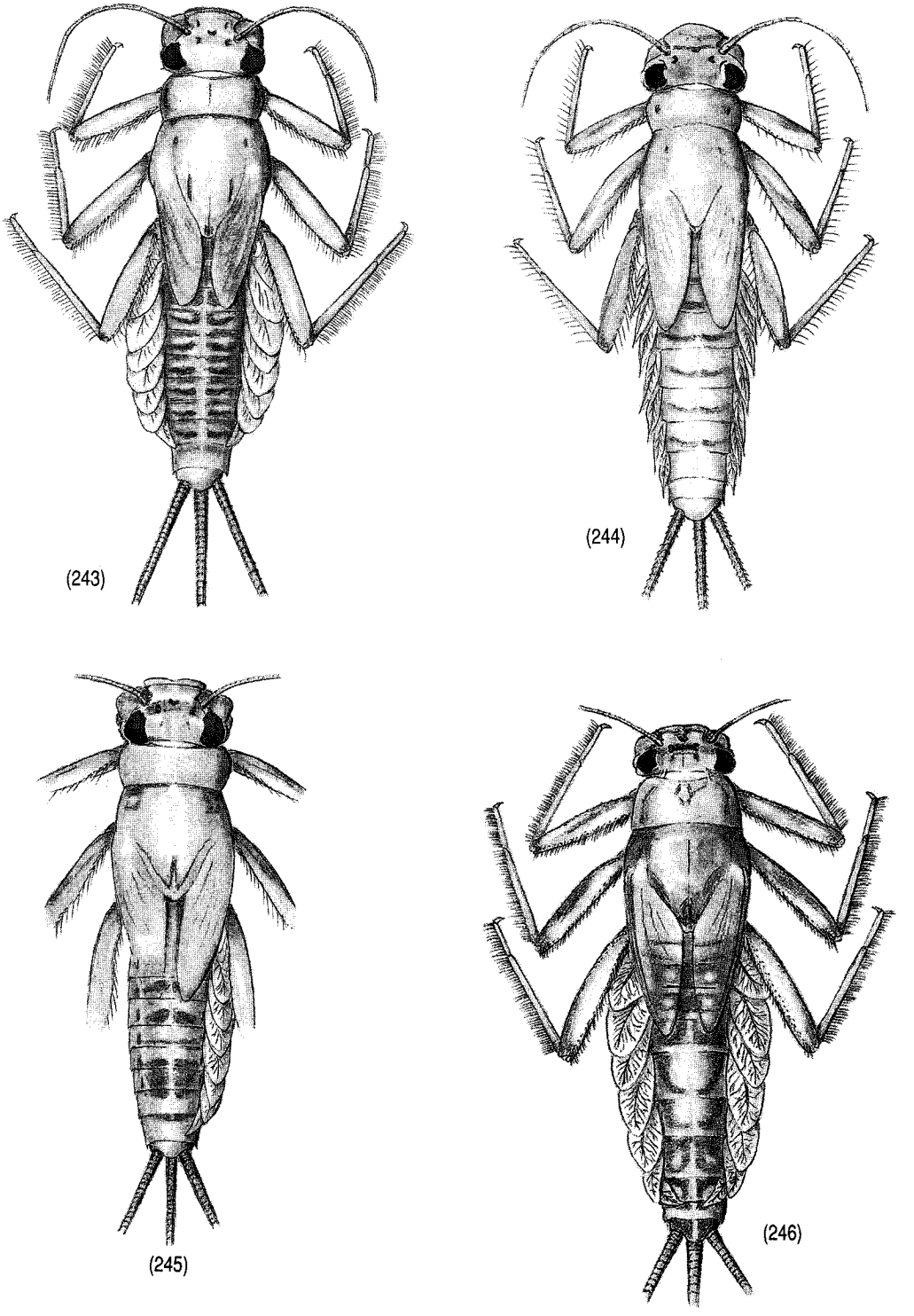
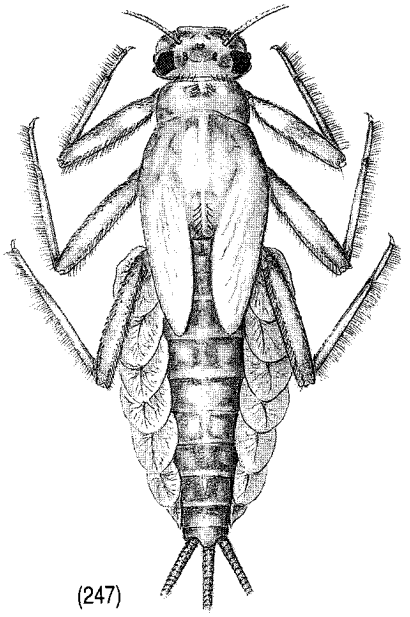
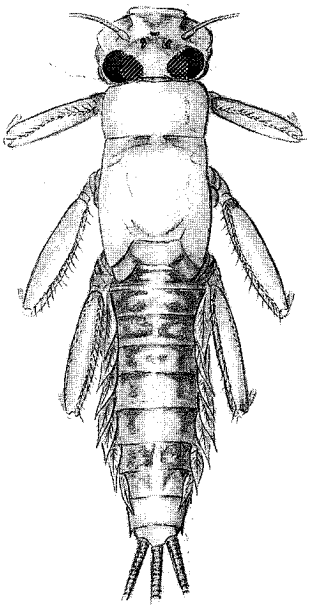


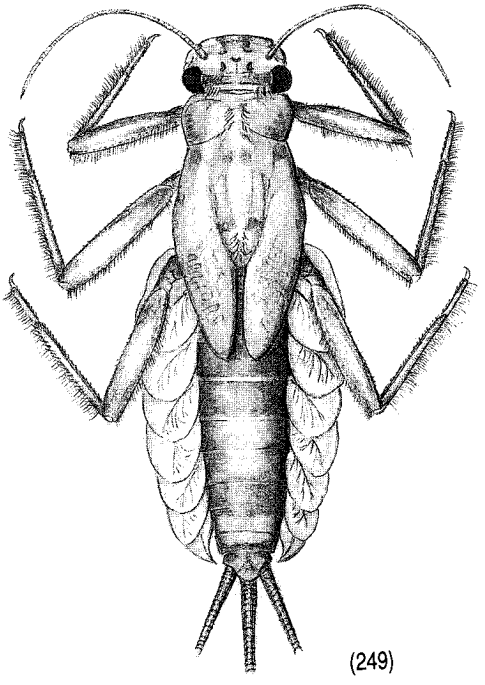
Fig. 243–246 Mature nymphs (caudal filaments truncated):
(243) *Deleatidium autumnale*; (244) *D. cerinum*; (245) *D. fumosum*; (246) *D. magnum*.



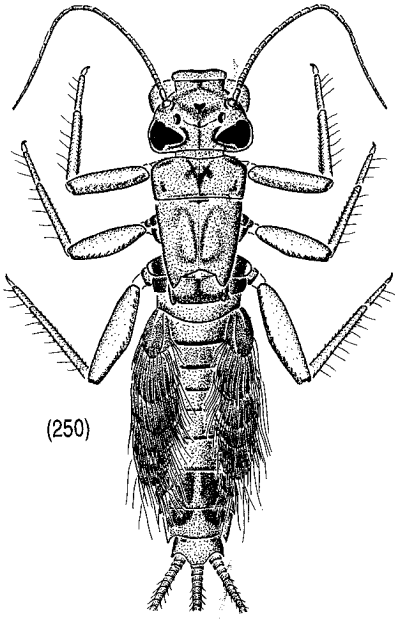
(247)



(248)

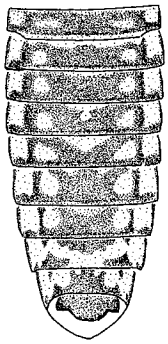


(249)

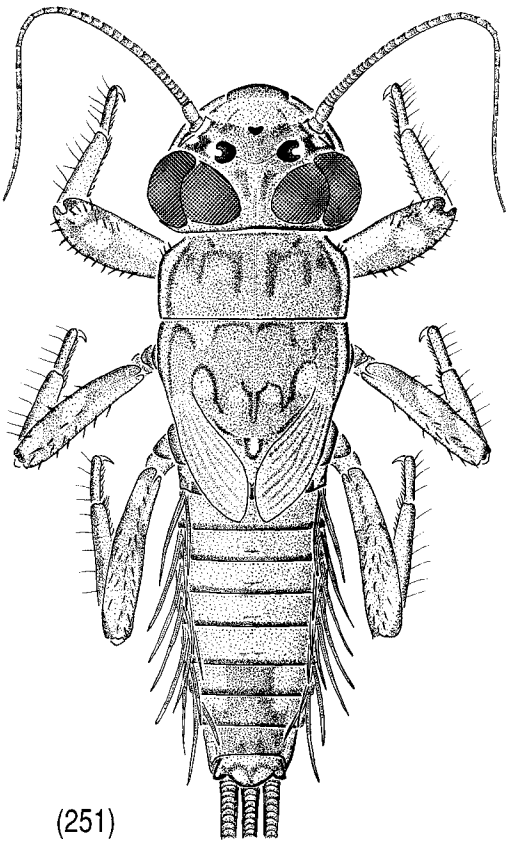


(250)

Fig. 247–250 Mature nymphs (caudal filaments truncated): (247) *Deleatidium myzobranchia*; (248) *D. vernale*; (249) *D. (Penniketellum) cornutum*; (250) *Isothraulus abditus*, immature.



(252)



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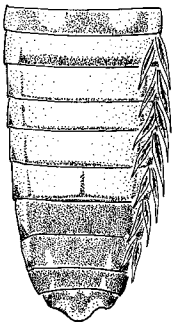

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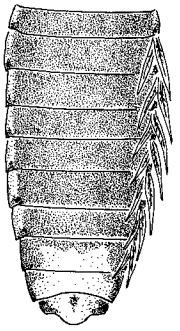
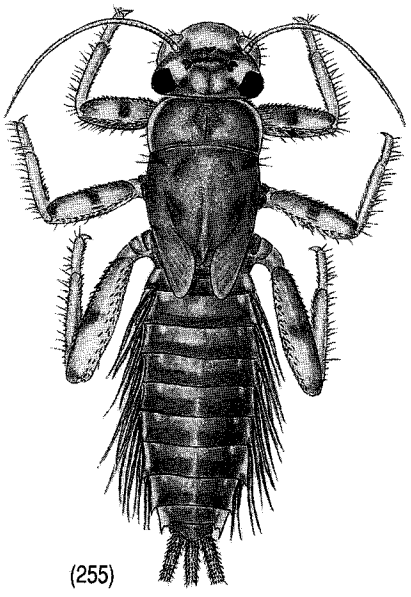


(254)



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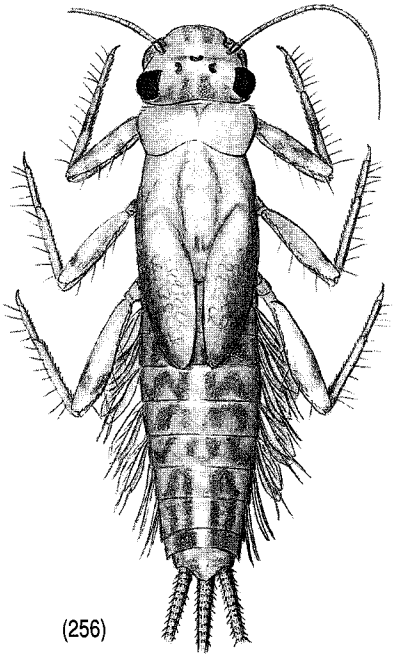
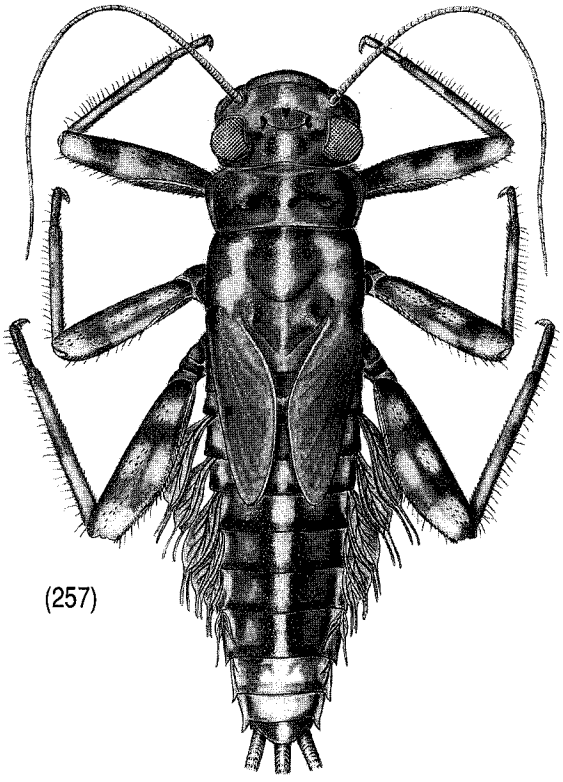


(256)

Fig. 251–256 Mature nymphs (caudal filaments truncated): (251) *Mauiulus luma*, with (252) abdomen of female; (253, 254) *M. aquilus*, abdomen of female and male; (255) *Neozephlebia scita*; (256) *Tepakia caligata*.



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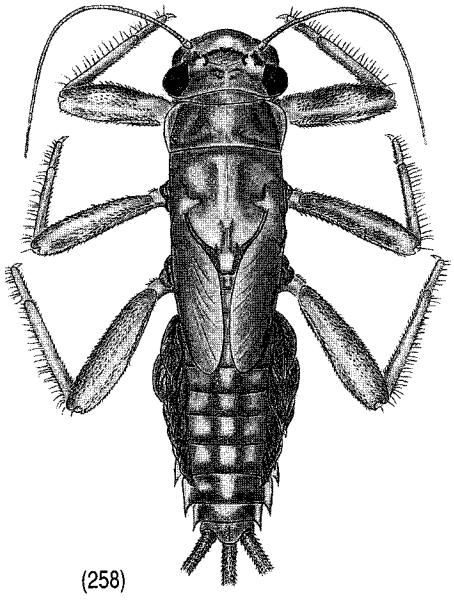

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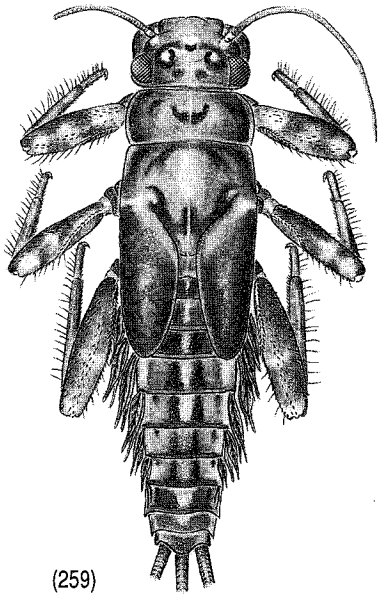
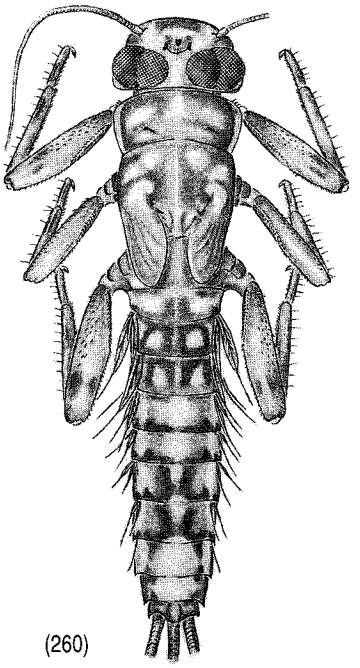


(259)

Fig. 257–259 Mature nymphs (caudal filaments truncated): (257) *Zephlebia versicolor*; (258) *Z. borealis*; (259) *Z. dentata*.



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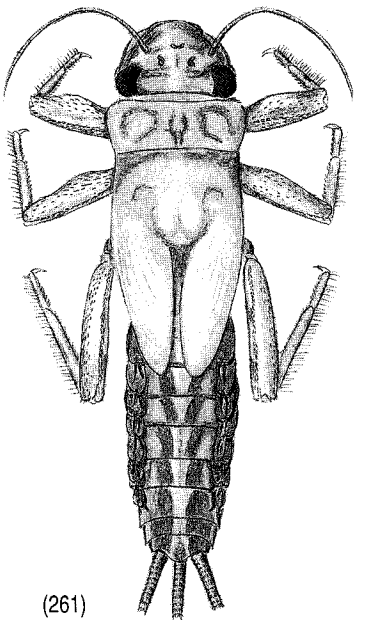

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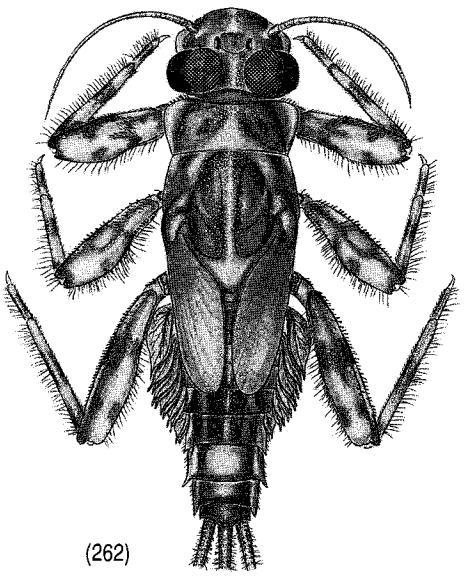
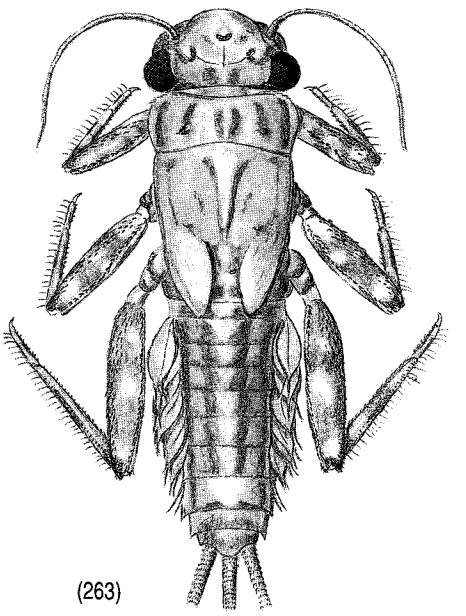


(262)



(263)

Fig. 260–263 Mature nymphs (caudal filaments truncated):
(260) *Zephlebia inconspicua*; (261) *Z. nebulosa*; (262) *Z. spectabilis*; (263) *Z. tuberculata*.

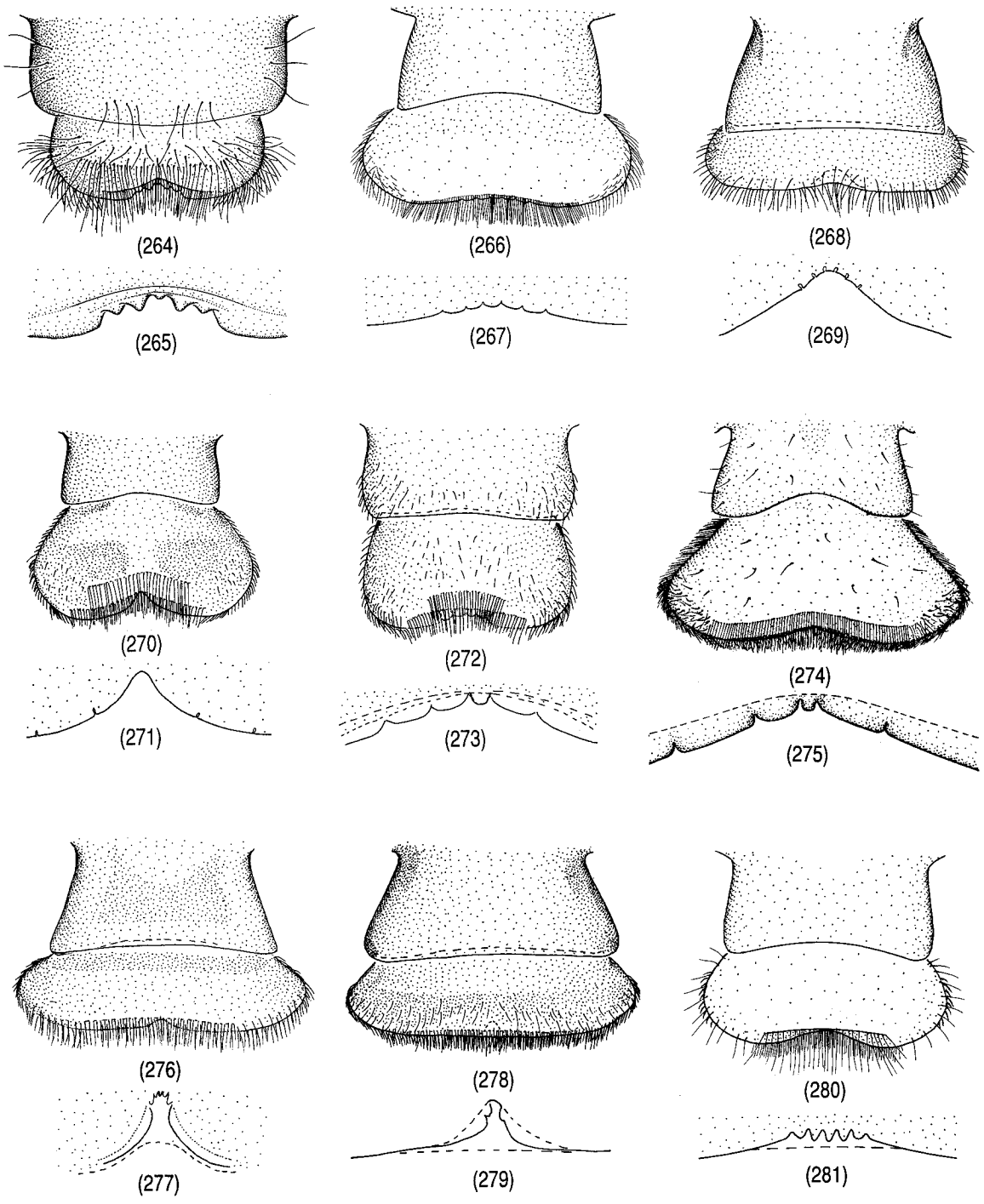


Fig. 264–281 Clypeus and labrum of nymphs, with (enlarged) anteromedian emargination of labrum: (264, 265) *Acanthophlebia cruentata*; (266, 267) *Arachnocolus phillipsi*; (268, 269) *Atalophlebioides cromwelli*; (270, 271) *Austroclima sepia*; (272, 273) *Austronella planulata*; (274, 275) *Cryophlebia aucklandensis*; (276, 277) *Deleatidium lillii*; (278, 279) *D. myzobranchia*; (280, 281) *Isothraulus abditus*.

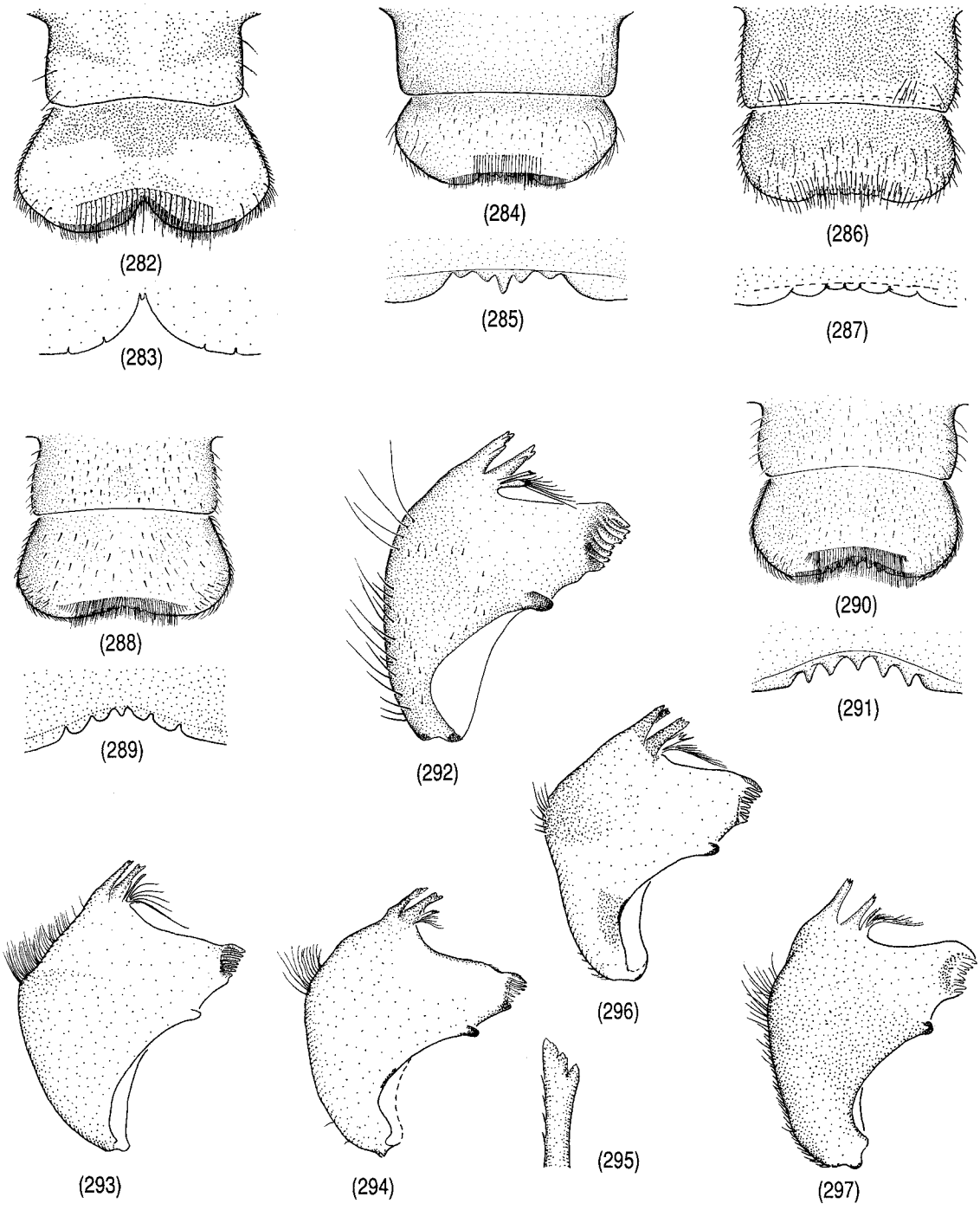


Fig. 282–291 Clypeus and labrum of nymphs, with (enlarged) anteromedian emargination of labrum: (282, 283) *Mauiulus luma*; (284, 285) *Neozephlebia scita*; (286, 287) *Tepakia caligata*; (288, 289) *Zephlebia versicolor*; (290. 291) *Z. borealis*.
Fig. 292–297 Left mandible of nymphs: (292) *Acanthophlebia cruentata*; (293) *Arachnocolus phillipsi*; (294) *Atalophlebioides cromwelli*, with (295) outer incisor, enlarged; (296) *Austroclima sepia*; (297) *Austronella planulata*.

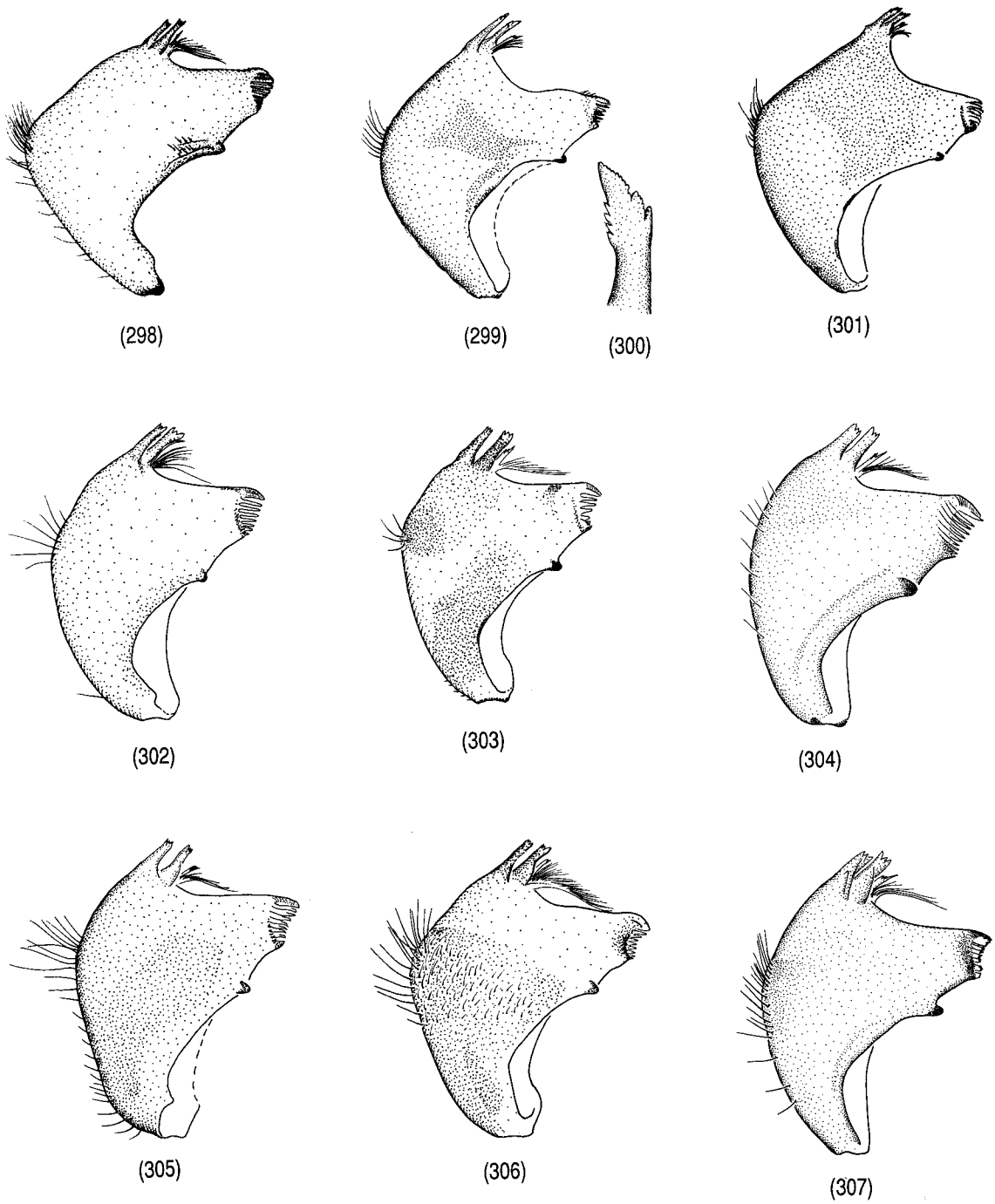


Fig. 298–307 Left mandible of nymphs: (298) *Cryophlebia aucklandensis*; (299) *Deleatidium lillii*, with (300) outer incisor, enlarged; (301) *D. myzobranchia*; (302) *Isothraulus abditus*; (303) *Mauiulus luma*; (304) *Neozephlebia scita*; (305) *Tepakia caligata*; (306) *Zephlebia versicolor*; (307) *Z. borealis*.

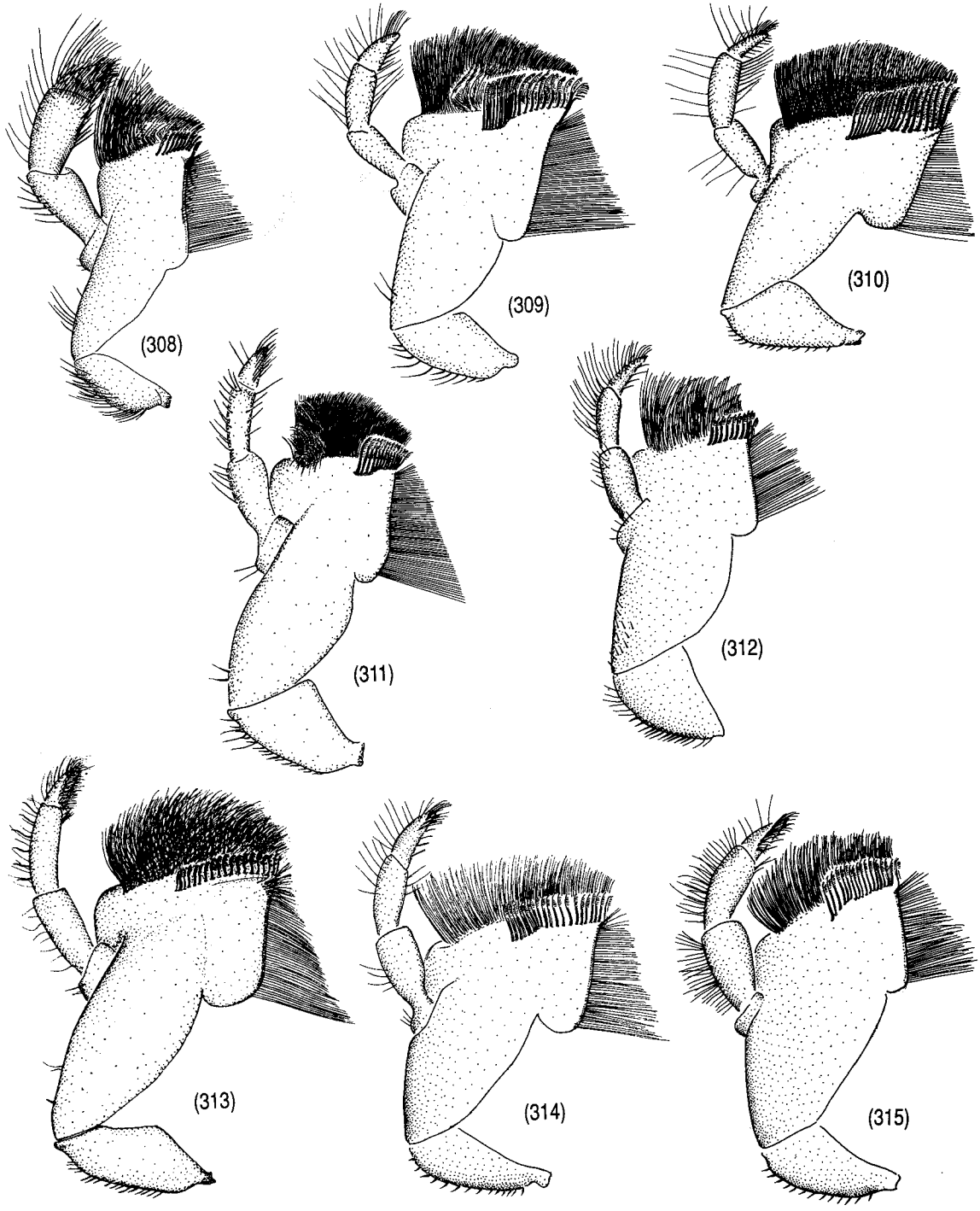


Fig. 308–315 Right maxilla of nymphs: (308) *Acanthophlebia cruentata*; (309) *Arachnocolus phillipsi*; (310) *Atalophlebioides cromwelli*; (311) *Austroclima sepia*; (312) *Austronella planulata*; (313) *Cryophlebia aucklandensis*; (314) *Deleatidium lillii*; (315) *D. myzobranchia*.

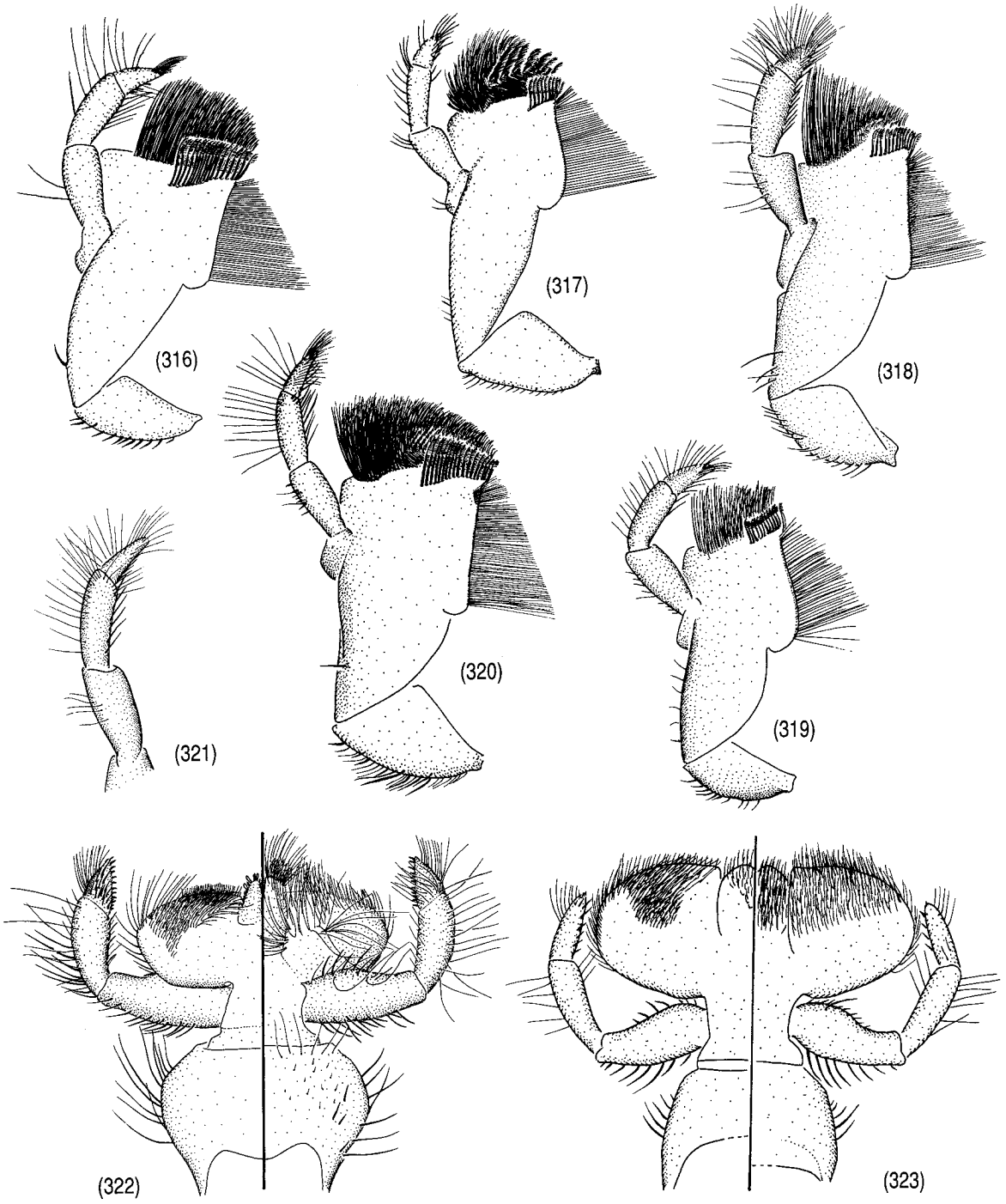


Fig. 316–323 Right maxilla of nymphs: (316) *Isothraulus abditus*; (317) *Mauiulus luma*; (318) *Neozephlebia scita*; (319) *Tepakia caligata*; (320) *Zephlebia versicolor*; (321) *Z. borealis*, palp only. **Fig. 322, 323** Labium of nymphs, dorsal (left) and ventral views: (322) *Acanthophlebia cruentata*; (323) *Arachnocolus phillipsi*.

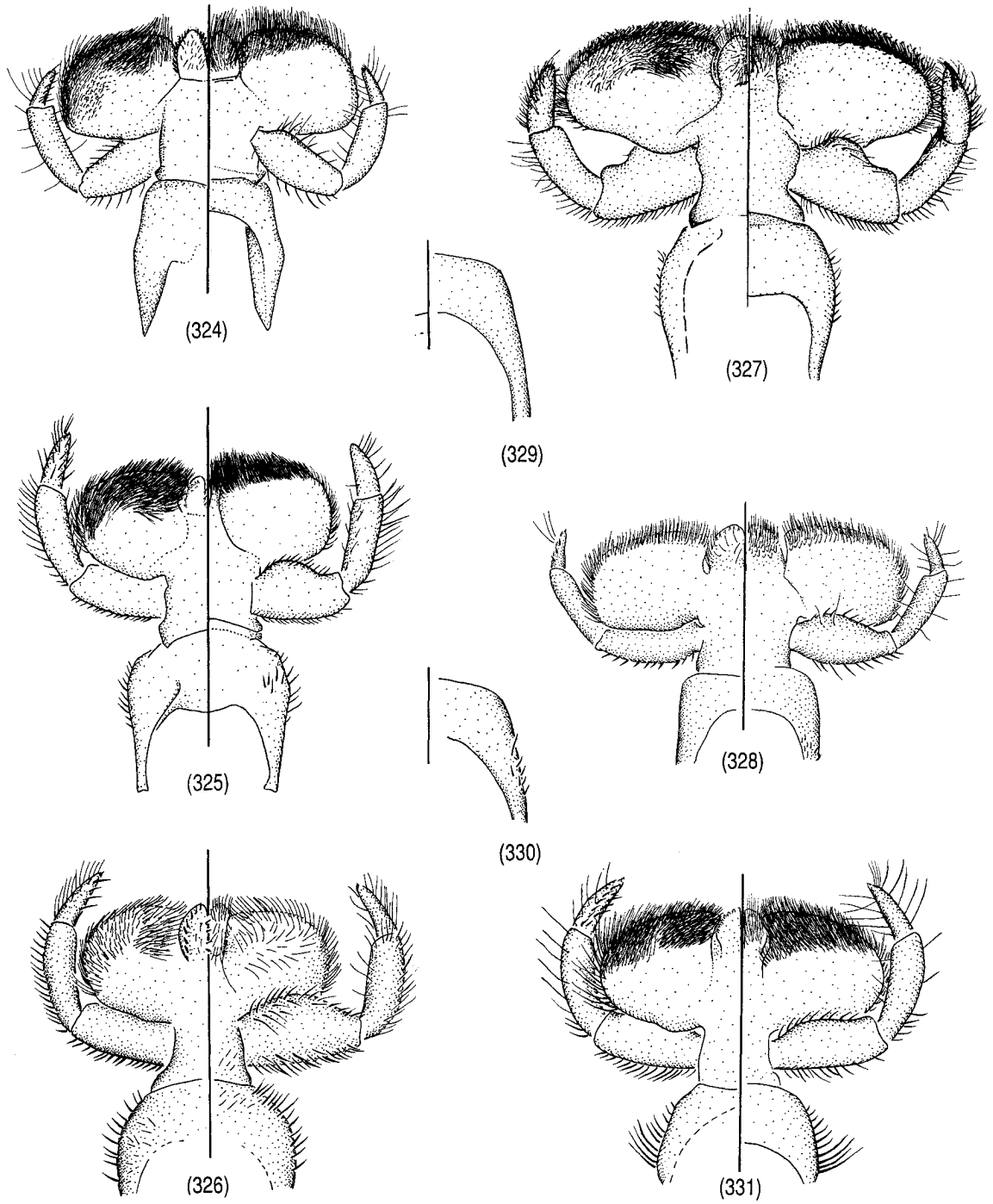


Fig. 324–331 Labium of nymphs, dorsal (left) and ventral views: (324) *Atalophlebioides cromwelli*; (325) *Austroclima sepia;* (326) *Austronella planulata*; (327) *Cryophlebia aucklandensis*; (328) *Deleatidium lillii*; (329) *D. myzobranchia*, ventral submentum; (330) *D. vernale*, ventral submentum; (331) *Isothraulus abditus*.

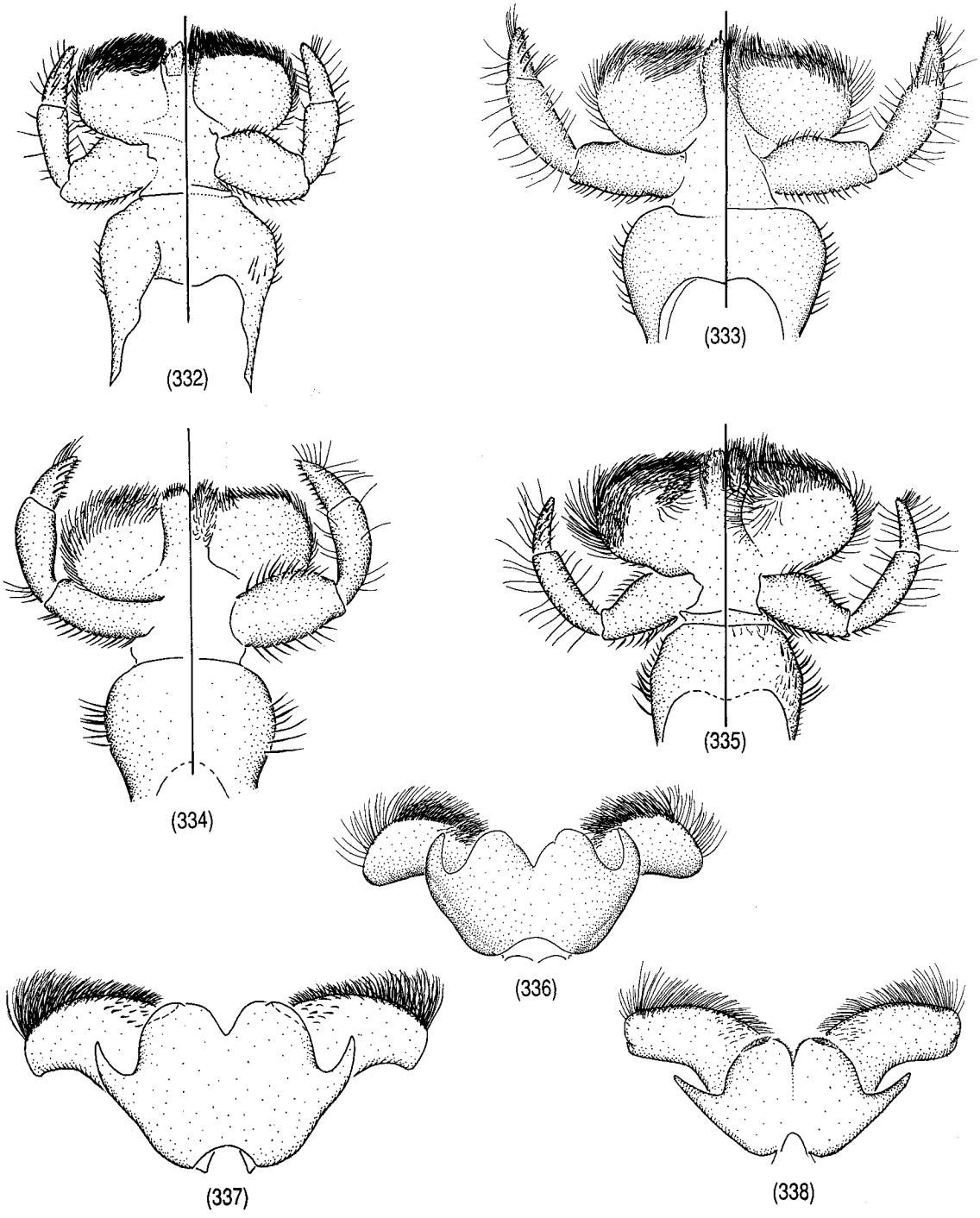


Fig. 332–335 Labium of nymphs, dorsal (left) and ventral views: (332) *Mauiulus luma*; (333) *Neozephlebia scita*; (334) *Tepakia caligata*; (335) *Zephlebia versicolor*. **Fig. 336–338** Hypopharynx of nymphs: (336) *Acanthophlebia cruentata*; (337) *Arachnocolus phillipsi*; (338) *Atalophlebioides cromwelli*.

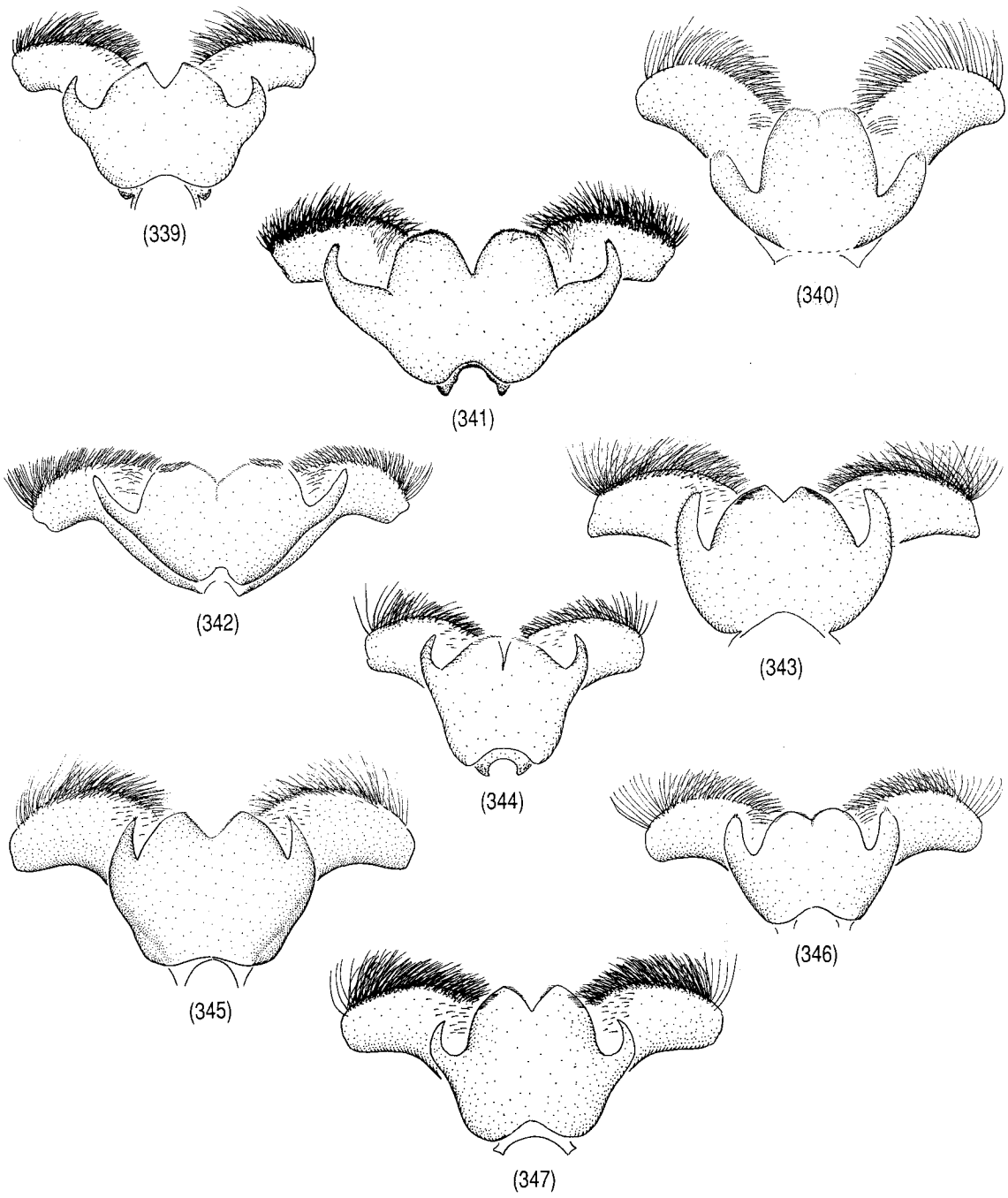


Fig. 339–347 Hypopharynx of nymphs: (339) *Austroclima sepia*; (340) *Austronella planulata*; (341) *Cryophlebia aucklandensis*; (342) *Deleatidium lillii*; (343) *Isothraulus abditus*; (344) *Mauiulus luma*; (345) *Neozephlebia scita*; (346) *Tepakia caligata*; (347) *Zephlebia versicolor*.

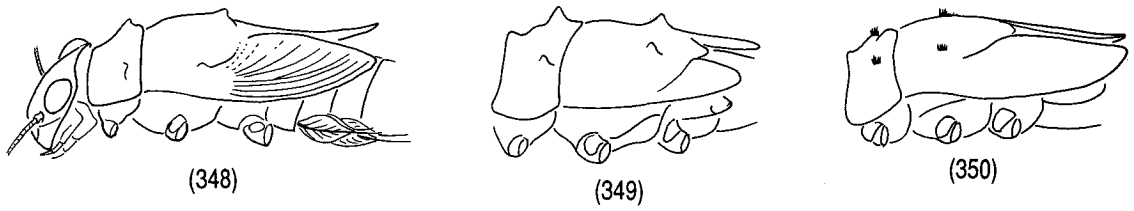


Fig. 348–350 Thorax of nymphs, oblique lateral view: (348) *Zephlebia versicolor*; (349) *Z. inconspicua*; (350) *Z. spectabilis*.

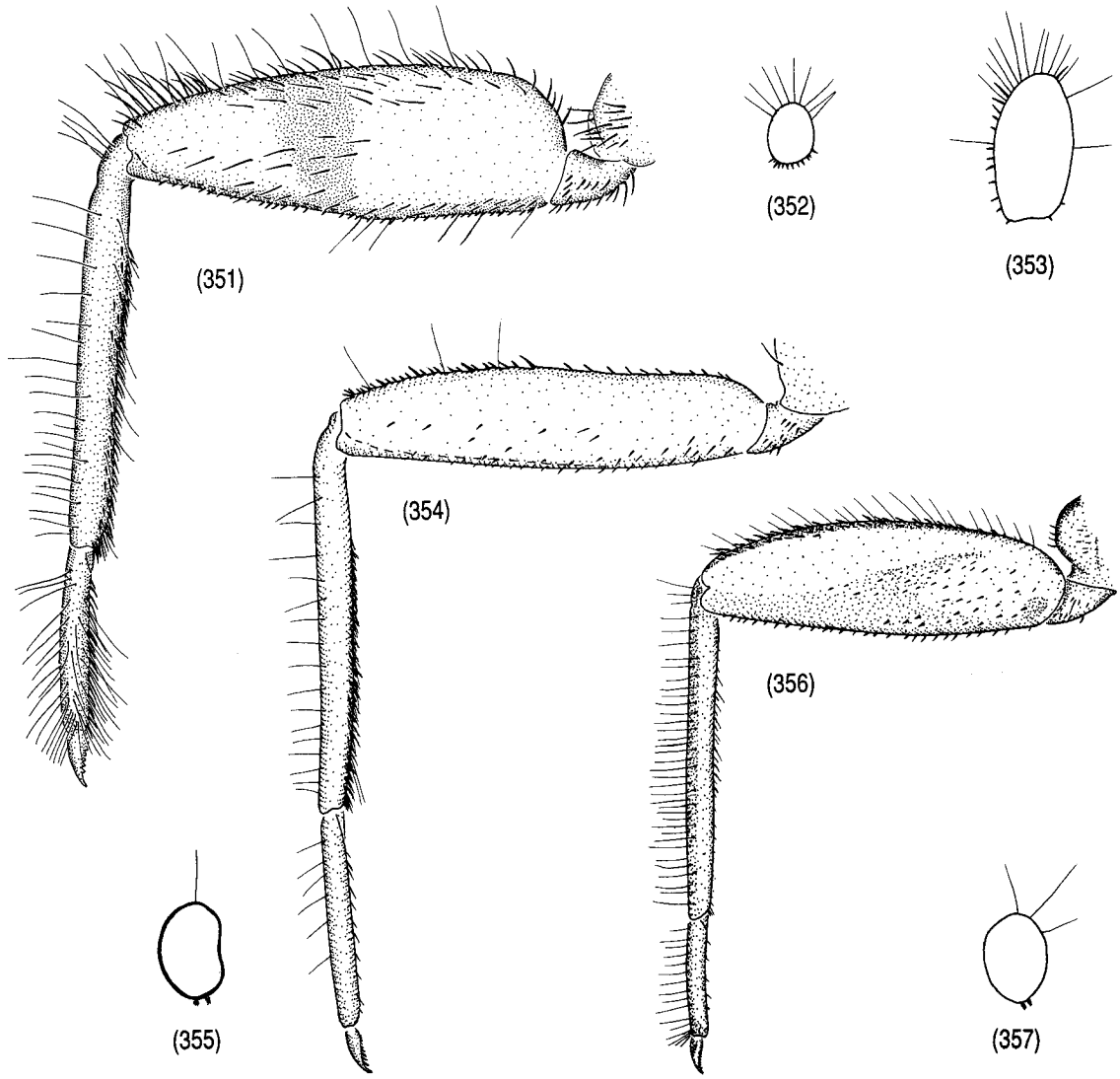


Fig. 351–357 Foreleg of nymphs, with cross-section through tibia: (351, 352) *Acanthophlebia cruentata*, with (353) cross-section through femur; (354, 355) *Arachnocolus phillipsi*; (356, 357) *Atalophlebioides cromwelli*.

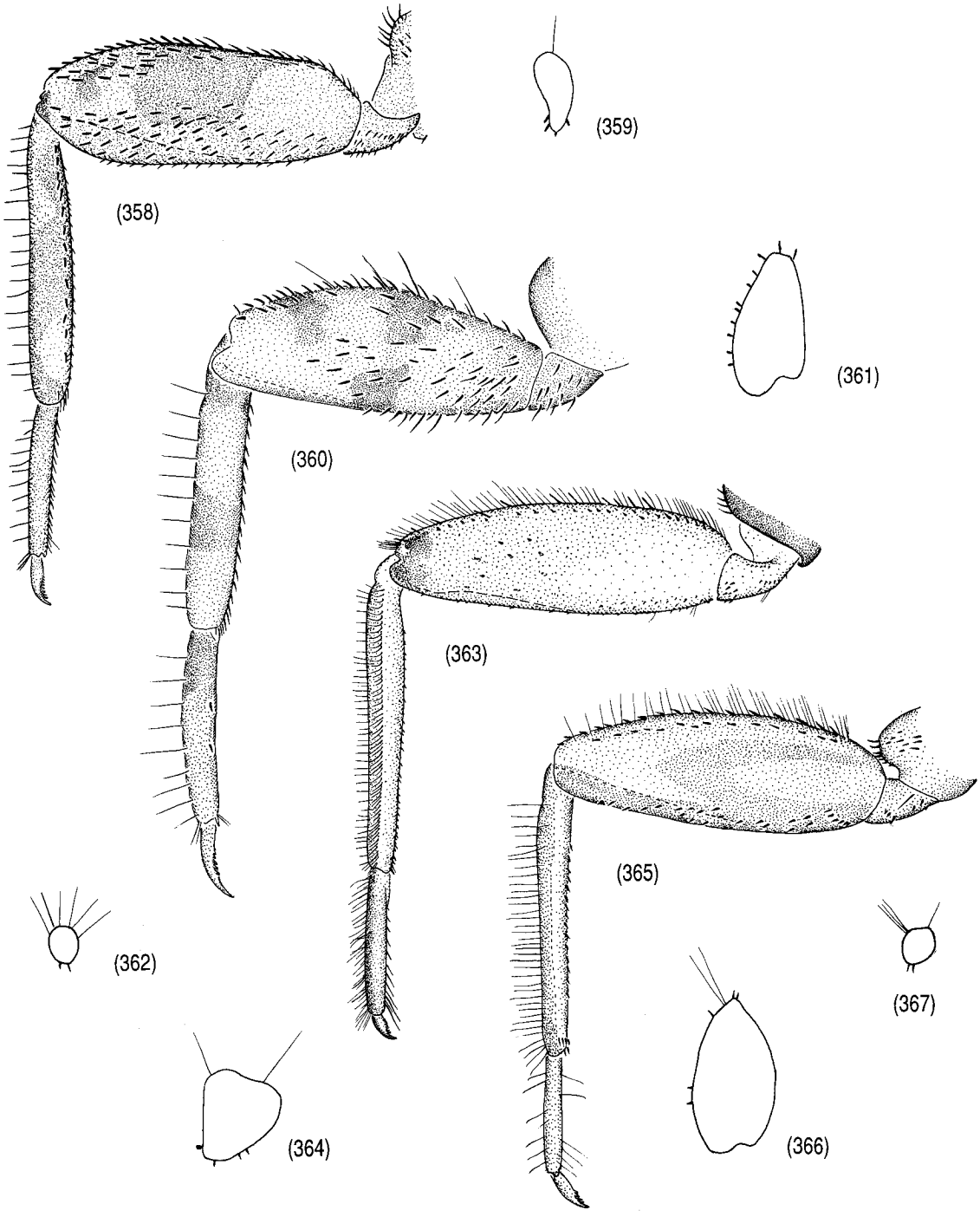


Fig. 358–367 Foreleg of nymphs, with transverse section (TS) through femur and tibia: (358, 359) *Austroclima sepia*, TS tibia only; (360–362) *Austronella planulata*; (363, 364) *Cryophlebia aucklandensis*, TS tibia only; (365–367); *Deleatidium lillii*.

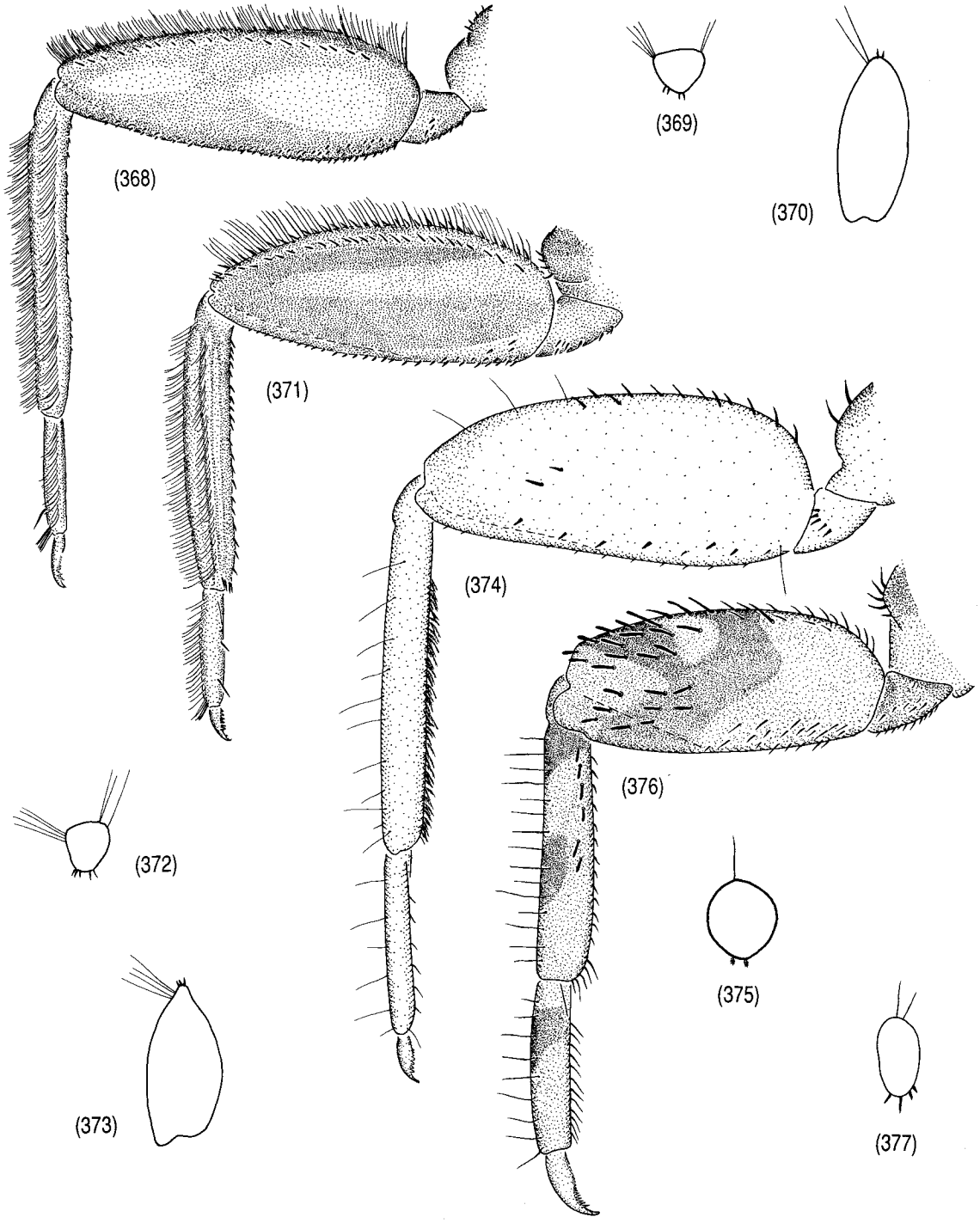


Fig. 368–377 Foreleg of nymphs, with transverse section (TS) through tibia: (368, 369) *Deleatidium myzobranchia*, with (370) TS femur; (371, 372) *D. (P.) cornutum*, with (373) TS femur; (374, 375) *Isothraulus abditus*; (376, 377) *Mauiulus luma*.

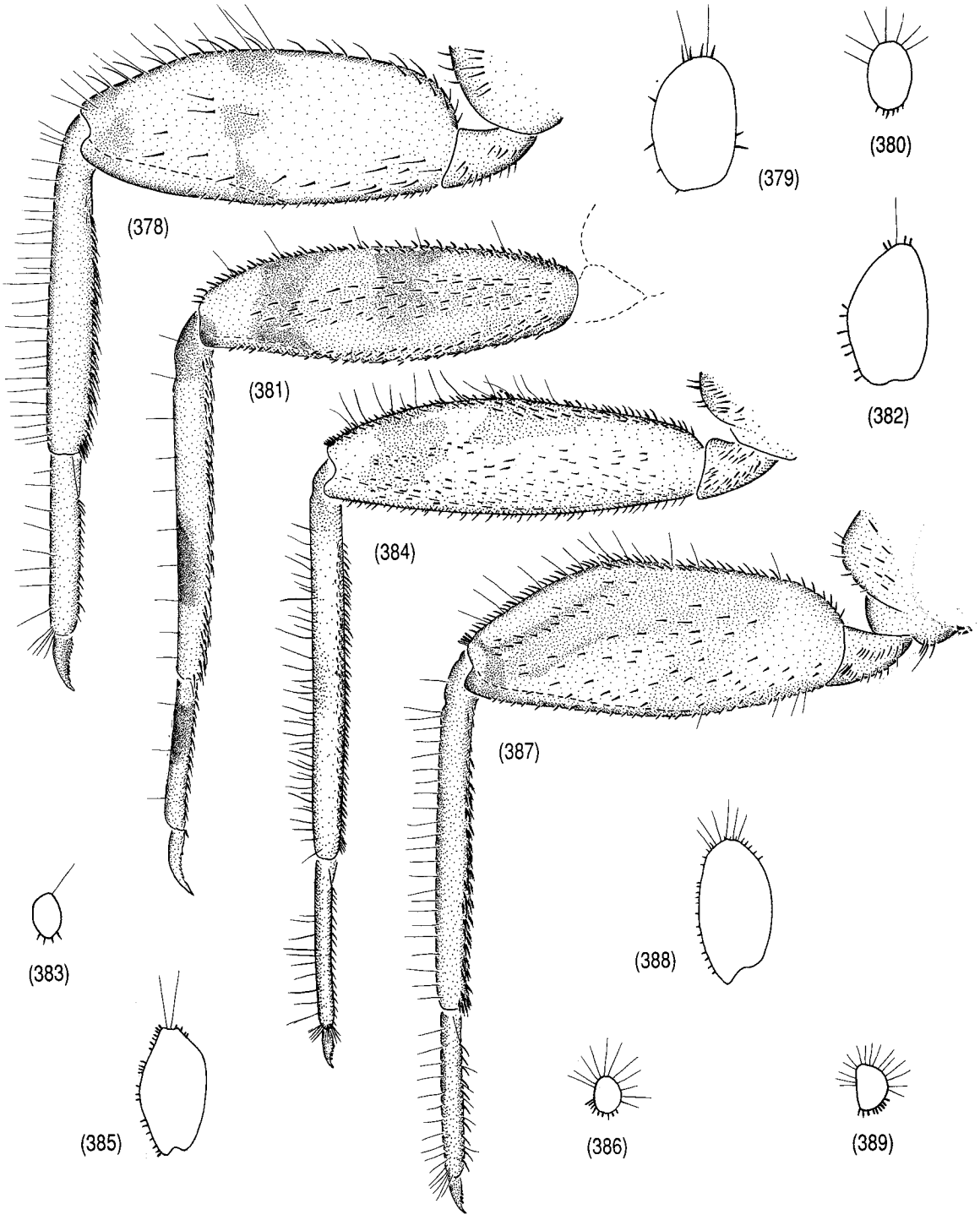


Fig. 378–389 Foreleg of nymphs, with cross-section through femur and tibia: (378–380) *Neozephlebia scita;* (381–383) *Tepakia caligata*; (384–386) *Zephlebia versicolor*; (387–389) *Z. borealis.*

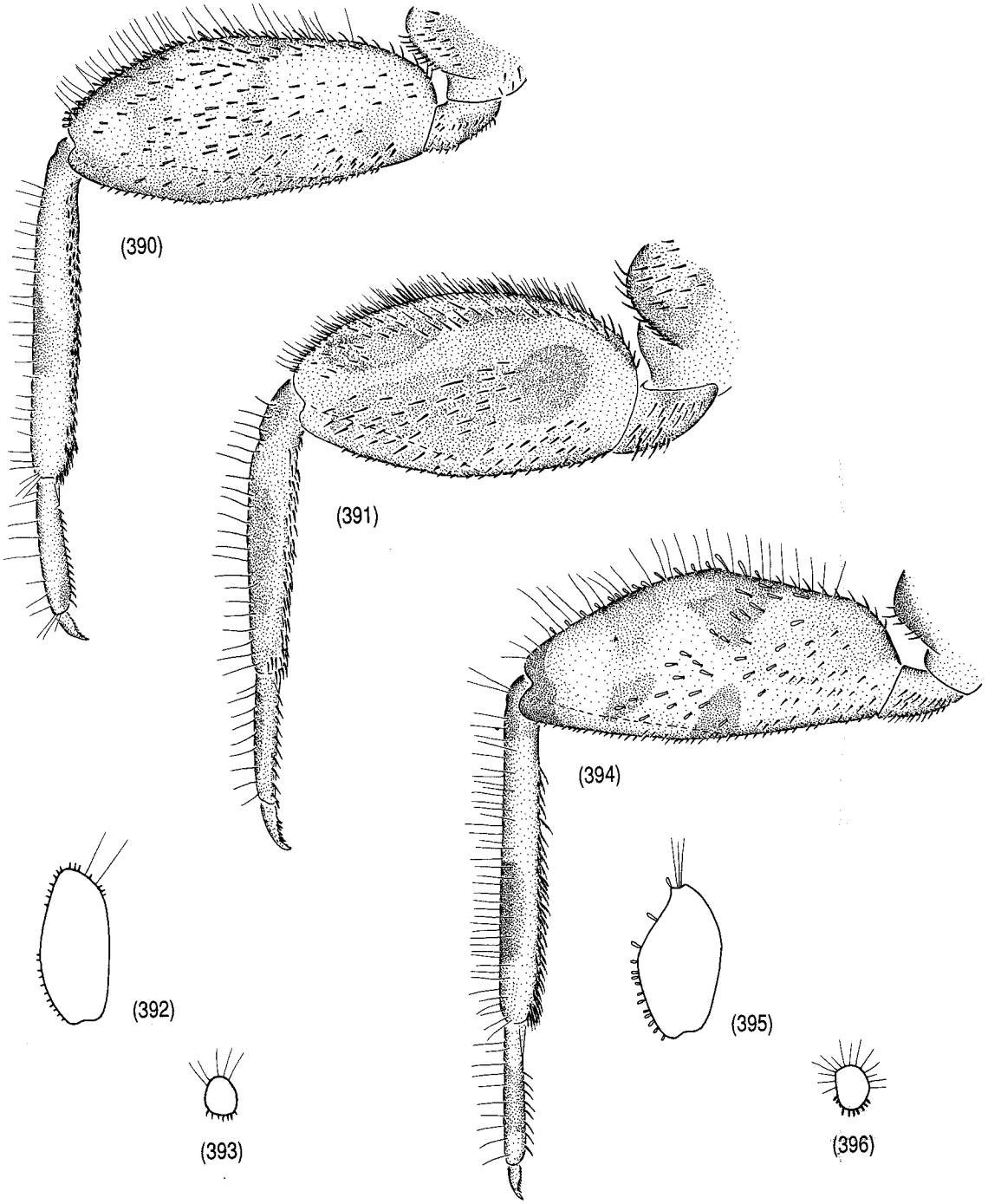


Fig. 390–396 Foreleg of nymphs, with cross-section through femur and tibia: (390) *Zephlebia dentata*, foreleg only; (391–393) *Z. nebulosa*; (394–396) *Z. spectabilis.*

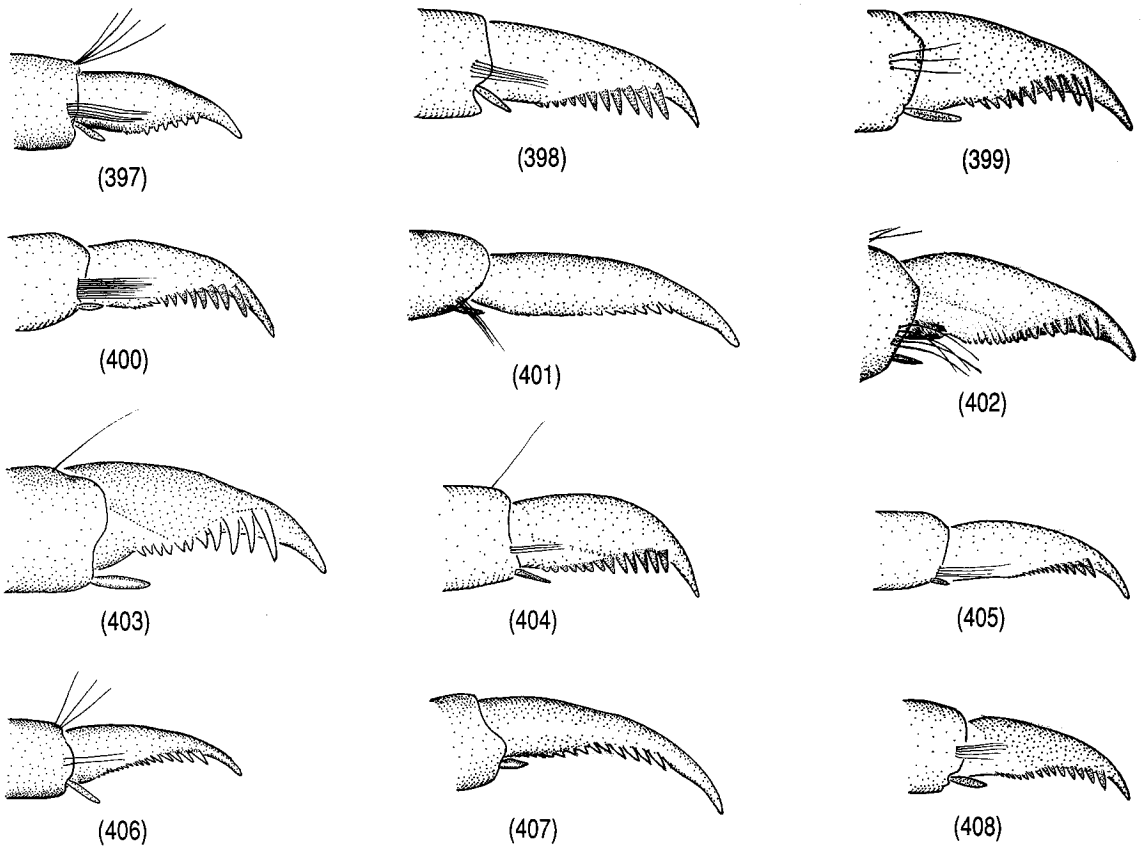


Fig. 397–408 Fore claw of nymphs: (397) *Acanthophlebia cruentata*; (398) *Arachnocolus phillipsi*; (399) *Atalophlebioides cromwelli*; (400) *Austroclima sepia*; (401) *Austronella planulata*; (402) *Cryophlebia aucklandensis*; (403) *Deleatidium lillii*; (404) *Isothraulus abditus*; (405) *Mauiulus luma*; (406) *Neozephlebia scita*; (407) *Tepakia caligata*; (408) *Zephlebia versicolor*.

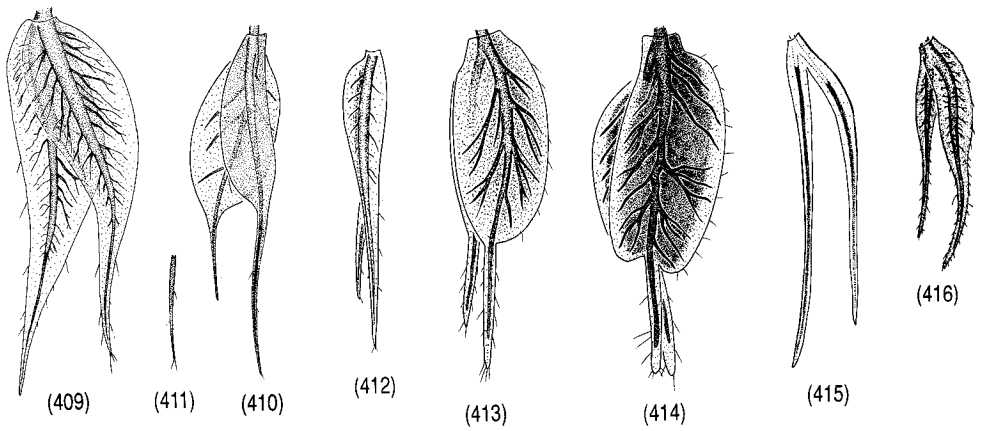


Fig. 409–416 Abdominal gill 4 of nymphs: (409) *Acanthophlebia cruentata*; (410) *Arachnocolus phillipsi*, with (411) gill 7; (412) *Atalophlebioides cromwelli*; (413) *Austroclima sepia*; (414) *A. jollyae*; (415) *Austronella planulata*; (416) *Cryophlebia aucklandensis*.

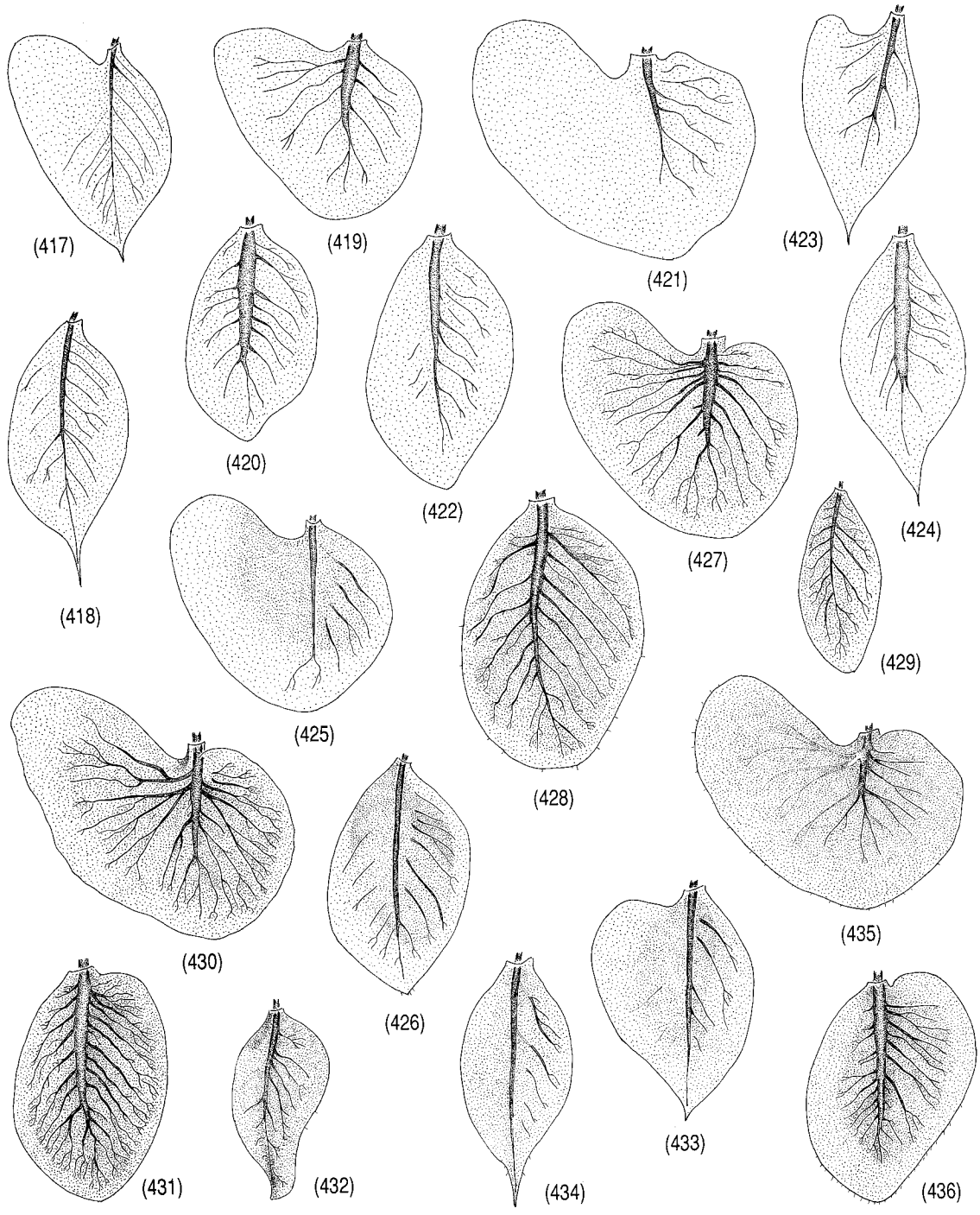


Fig. 425–436 Abdominal gills 1 and 4 of nymphs: (417, 418) *Deleatidium lillii*; (419, 420) *D. angustum*; (421, 422) *D. autumnale*; (423, 424) *D. cerinum*; (425, 426) *D. fumosum*; (427, 428) *D. magnum*, with (429) gill 7; (430, 431) *D. myzobranchia*, with (432) gill 7; (433, 434) *D. vernale*; (435, 436) *D. (Penniketellum) cornutum*.

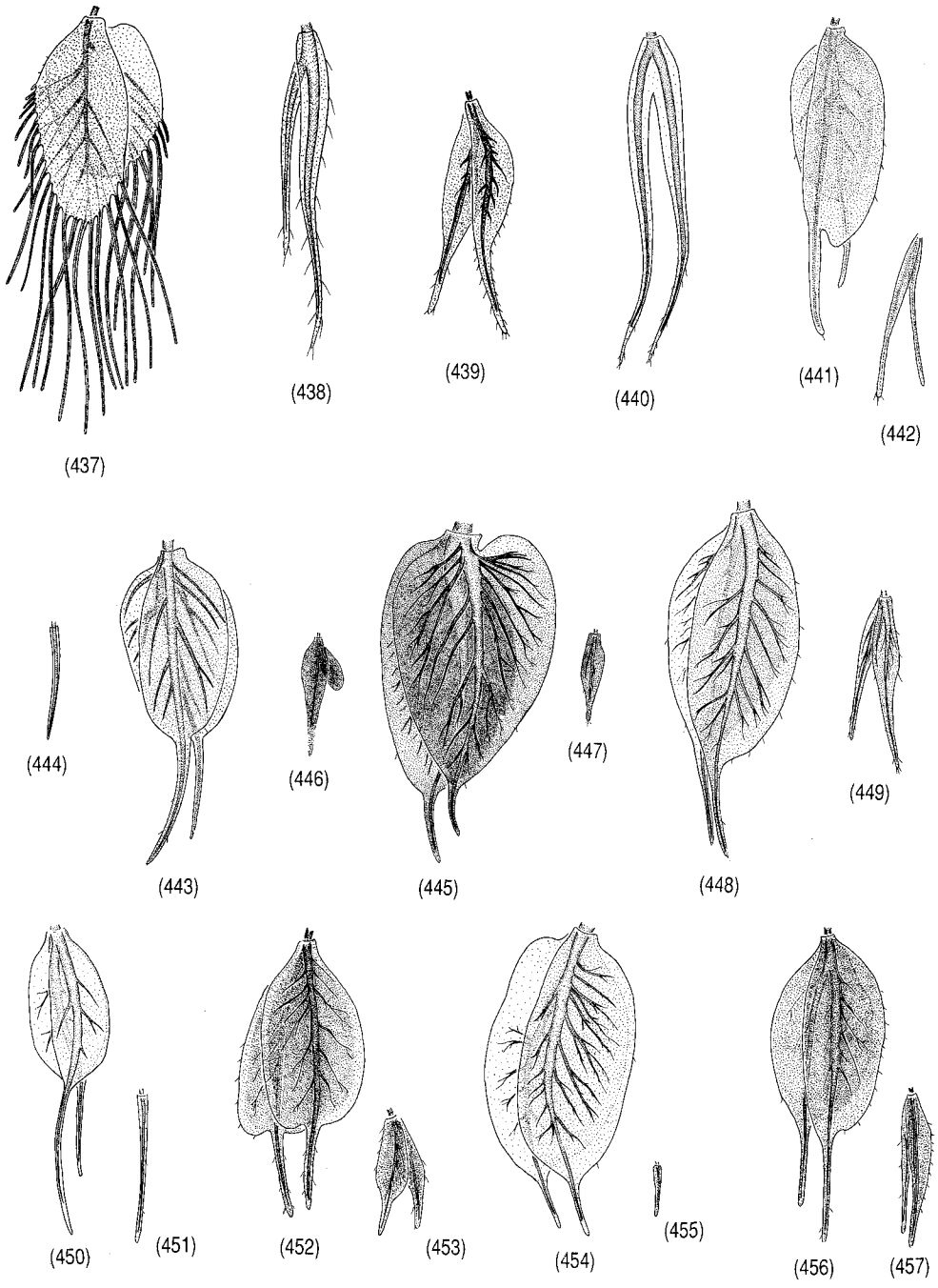
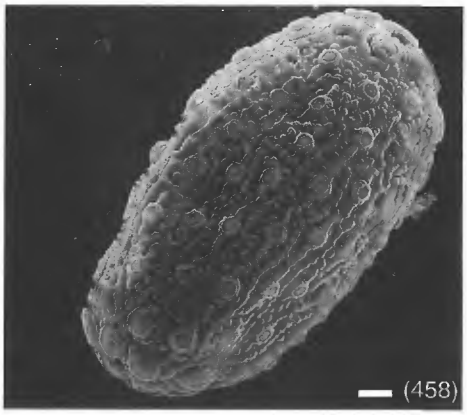


Fig. 437–457 Abdominal gills 4 and 7 of nymphs: (437) *Isothraulus abditus*, gill 4; (438) *Mauiulus luma*, gill 4; (439) *M. aquilus*, gill 4; (440) *Neozephlebia scita*, gill 4; (441, 442) *Tepakia caligata*, right side; (443, 444) *Zephlebia versicolor*, left side; (445–447) *Z. borealis*, left side (446, 447, variation in gill 7); (448, 449) *Z. dentata*, left side; (450, 451) *Z. inconspicua*; (452, 453) *Z. nebulosa*; (454, 455) *Z. spectabilis*; (456, 457) *Z. tuberculata*.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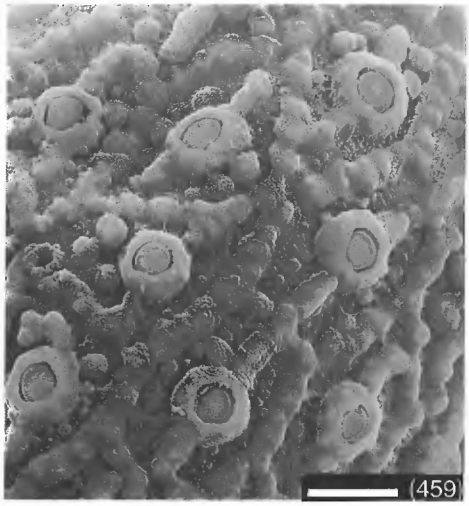
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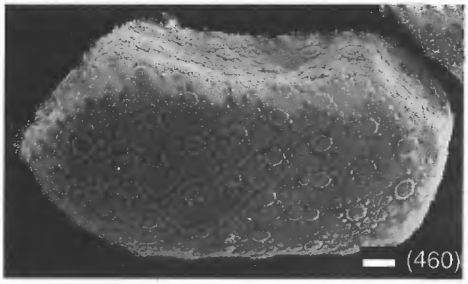
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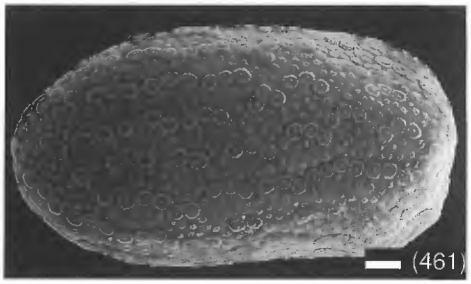
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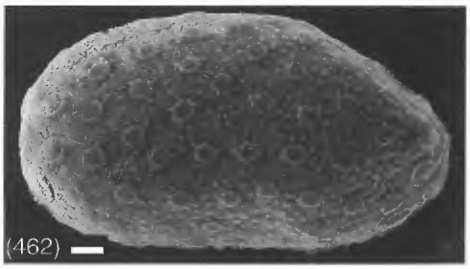
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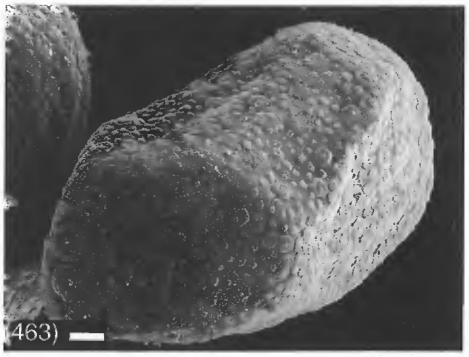
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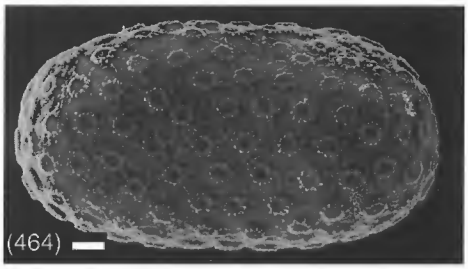
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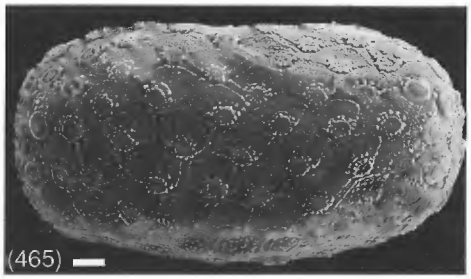
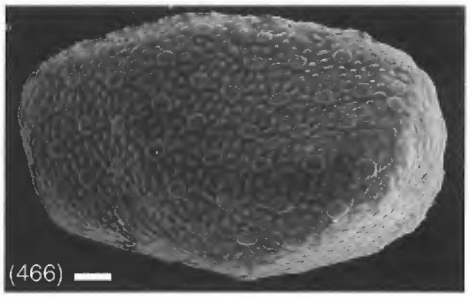

(465)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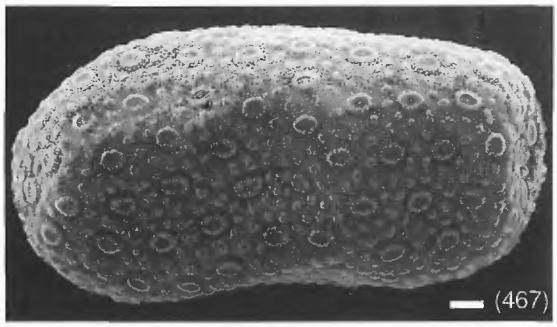
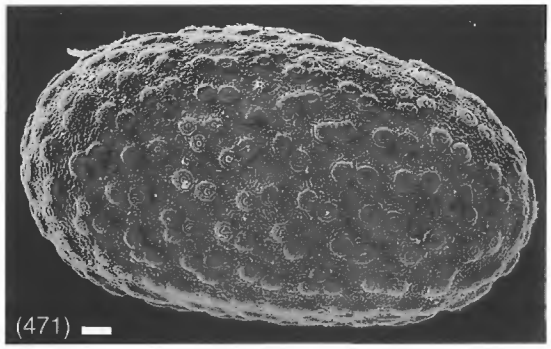
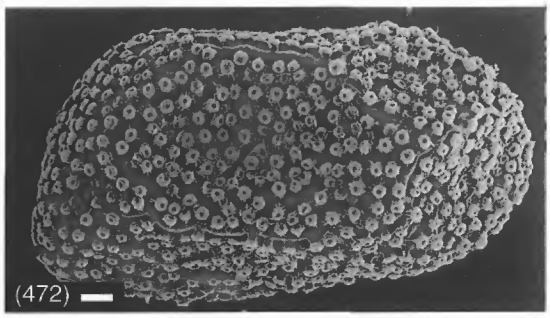
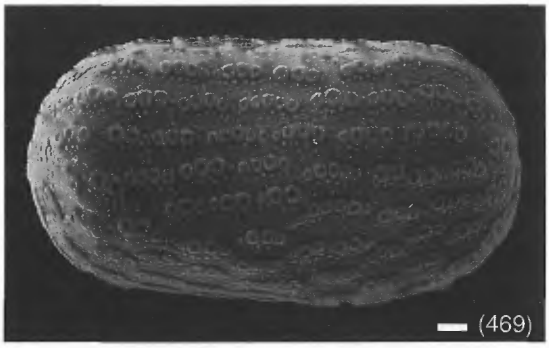
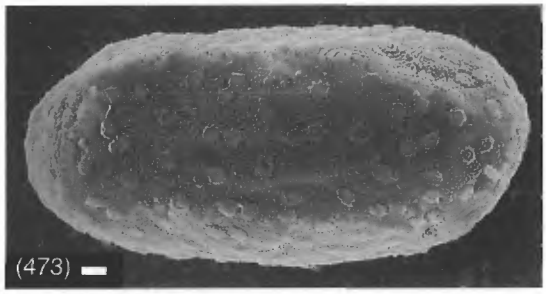
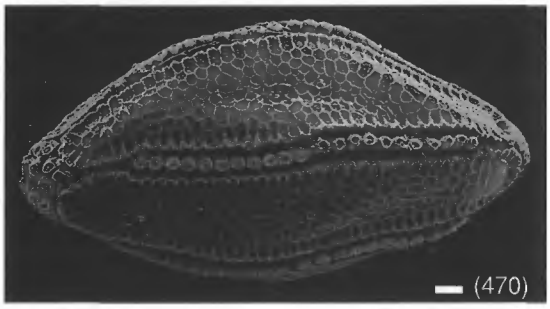












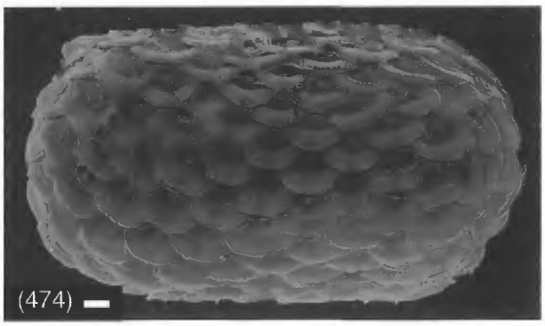
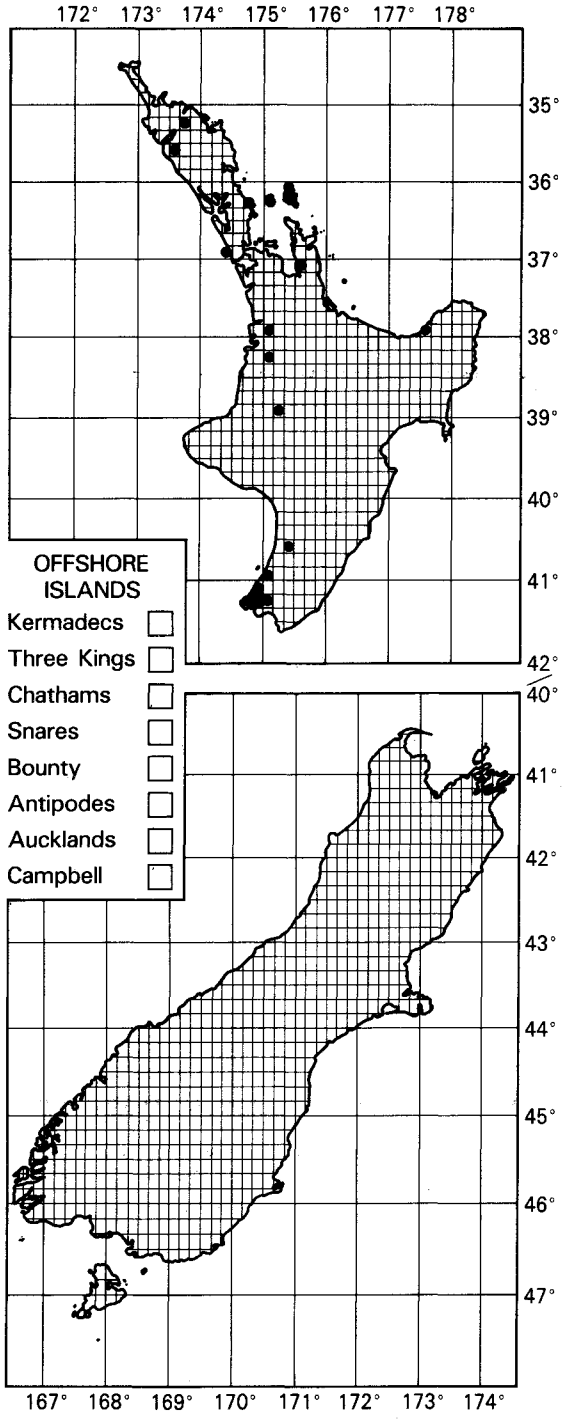
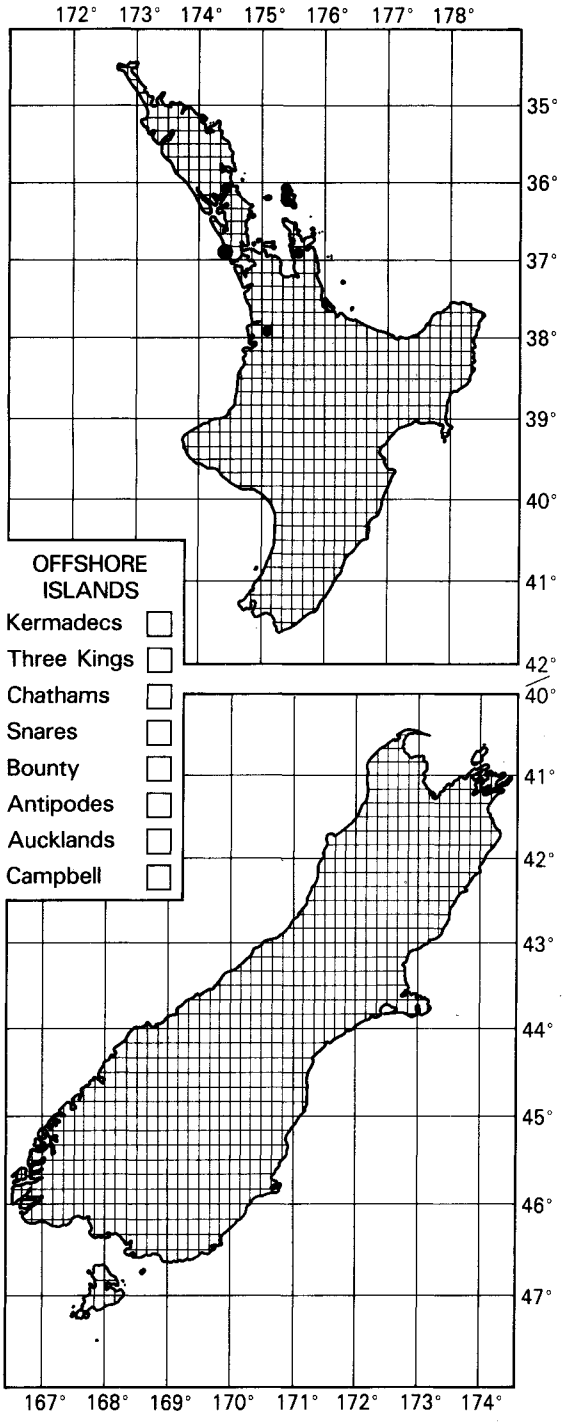


Fig. 458–474 Scanning electron micrographs of eggs: (458) *Austronella planulata*, with (459) detail of chorion; (460) *Deleatidium lillii*; (461) *D. angustum*; (462) *D. autumnale*; (463) *D. cerinum*; (464) *D. fumosum*; (465) *D. magnum*; (466, 467) *D. myzobranchia*, Wellington area and Mt Ruapehu; (468) *D. vernale*; (469) *D. (Penniketellum) cornutum;* (470) *Mauiulus aquilus*; (471) *Tepakia caligata*; (472) *Zephlebia nebulosa*; (473) *Z. pirongia*; (474) *Z. tuberculata*. Scale lines = 10 μm.

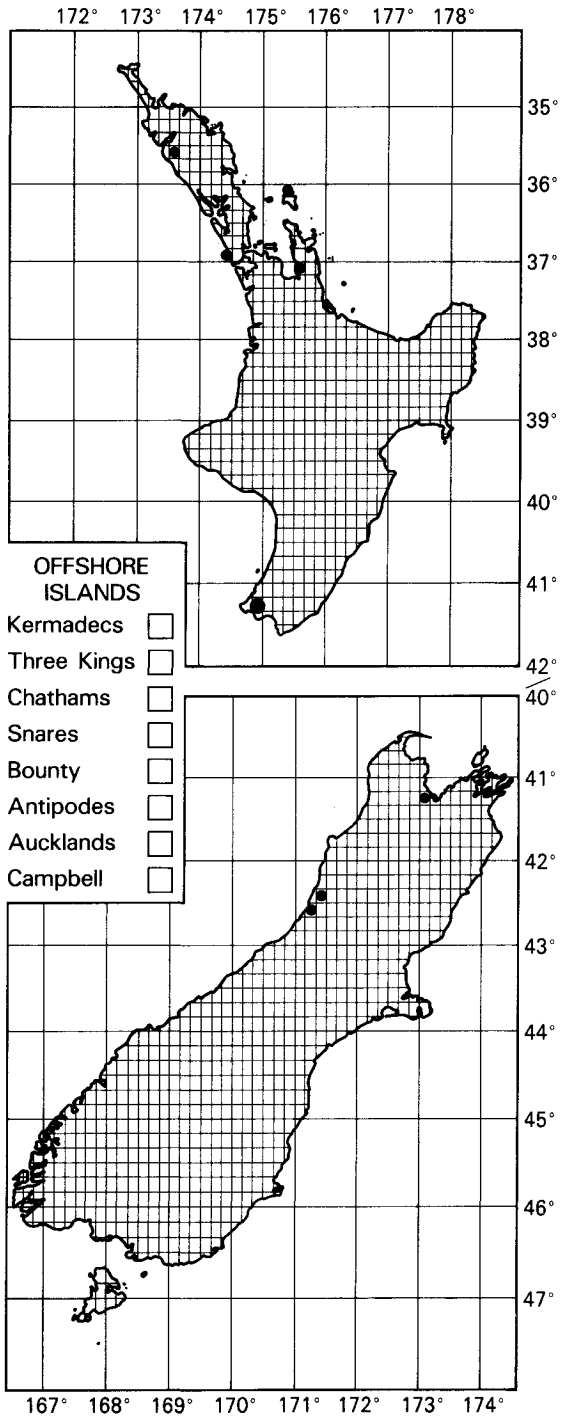
DISTRIBUTION MAPS



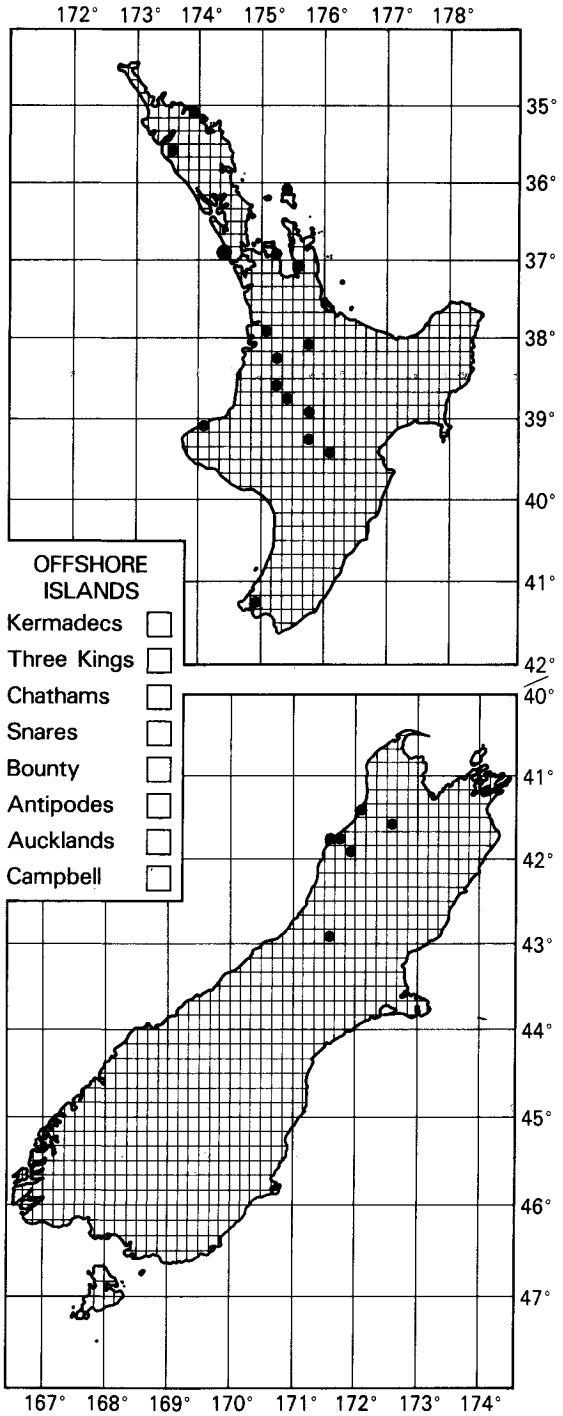
Map 1 Collection localities, *Acanthophlebia cruentata*



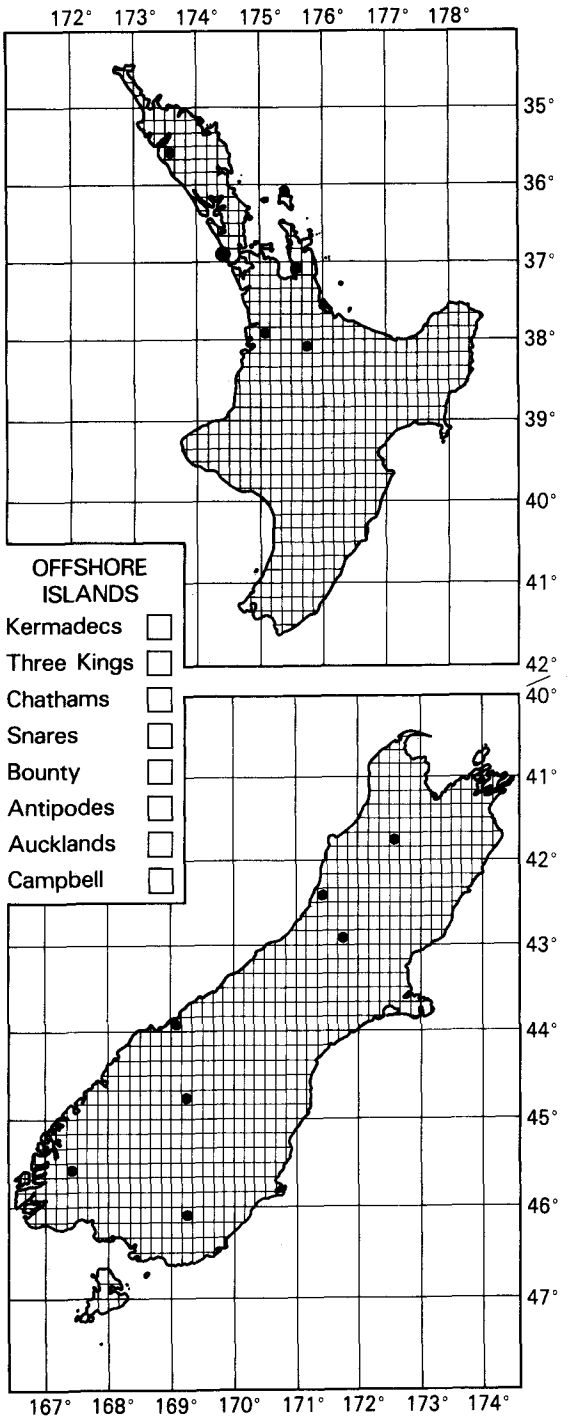
Map 2 Collection localities, *Arachnocolus phillipsi*



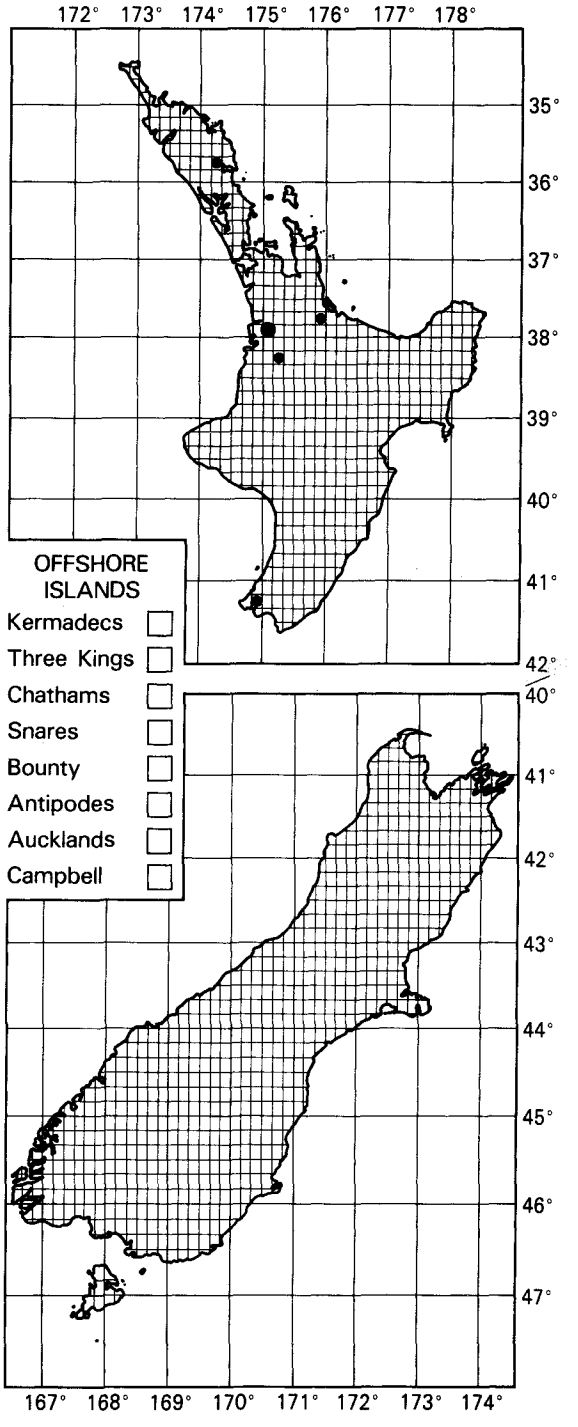
Map 3 Collection localities, *Atalophlebioides cromwelli*



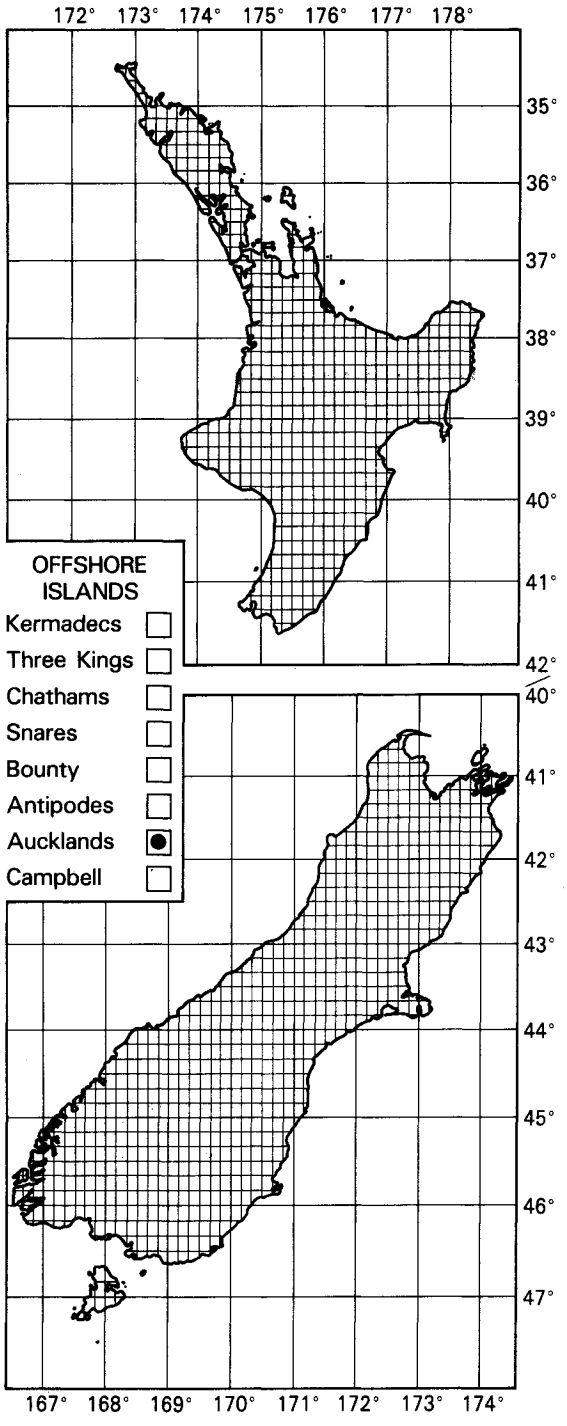
Map 4 Collection localities, *Austroclima sepia*



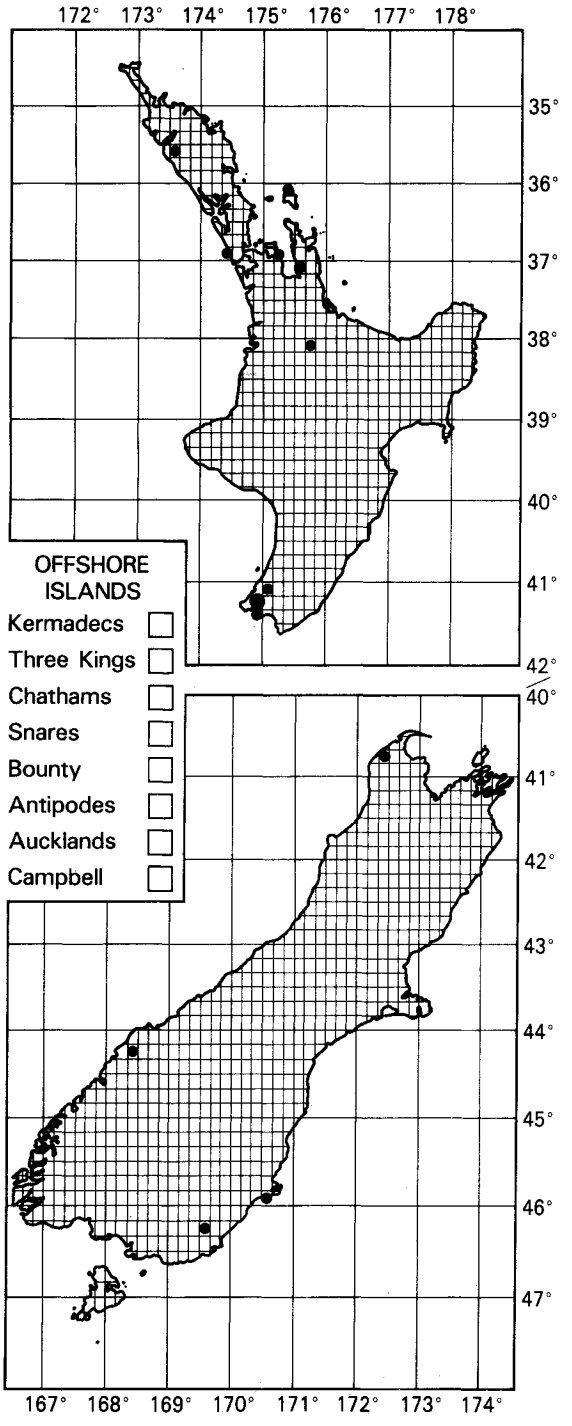
Map 5 Collection localities, *Austroclima jollyae*



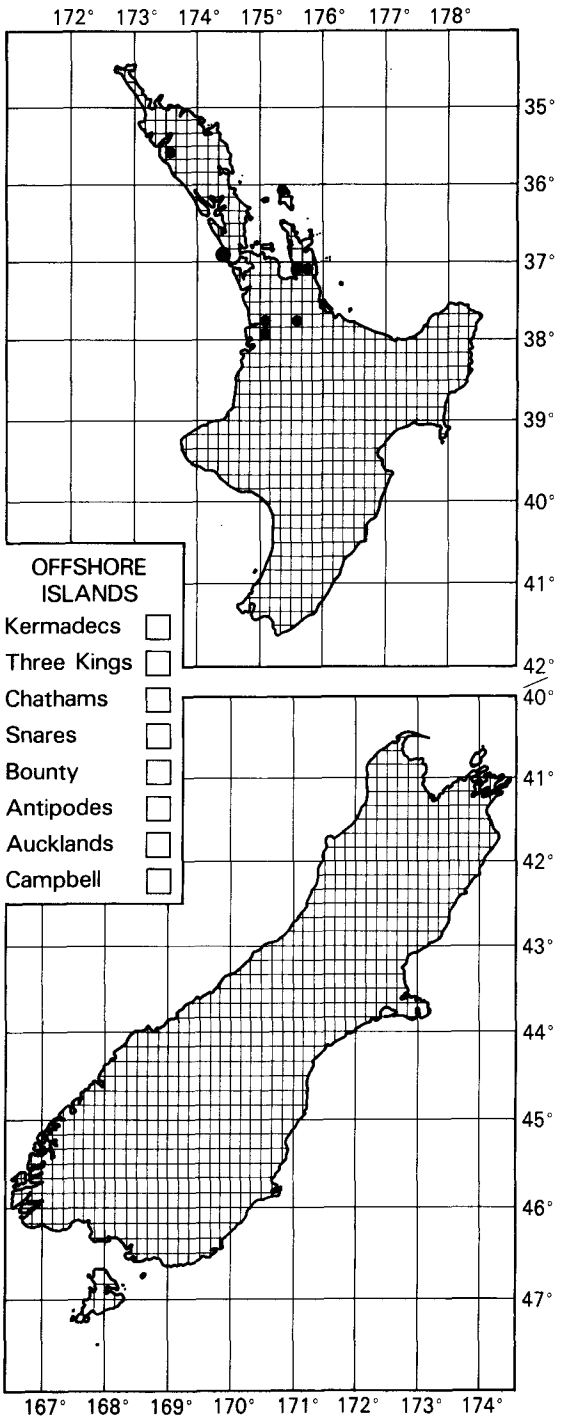
Map 6 Collection localities, *Austronella planulata*



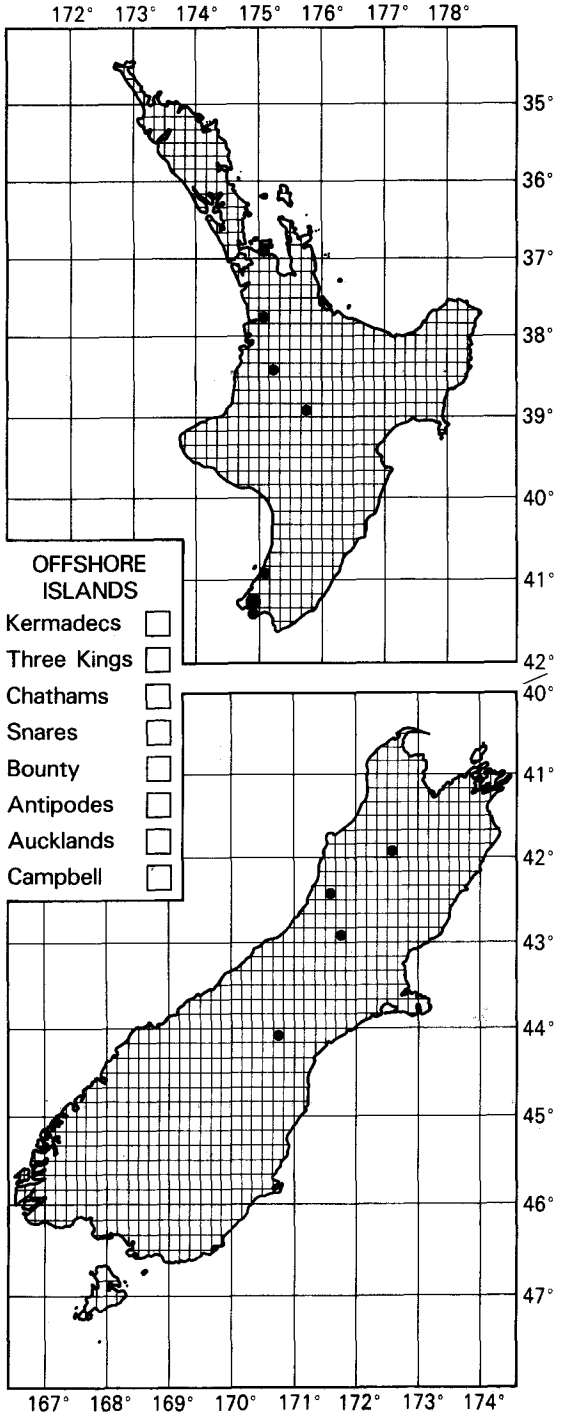
Map 7 Collection localities, *Cryophlebia aucklandensis*



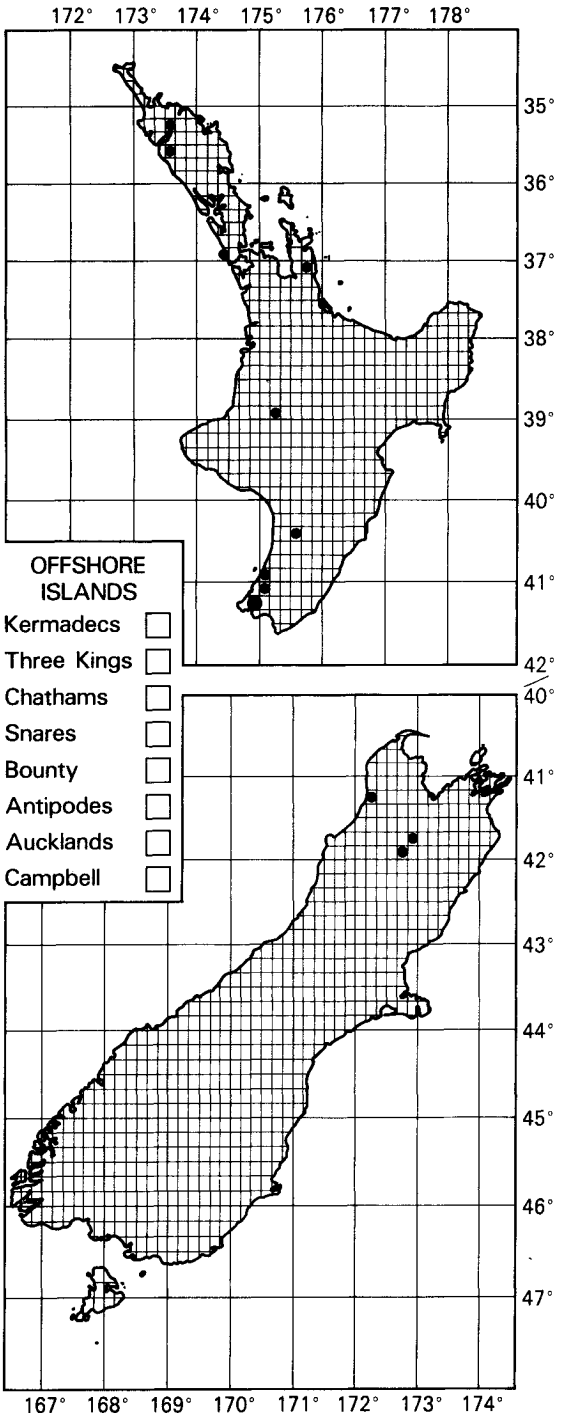
Map 8 Collection localities, *Deleatidium (D.) lillii*



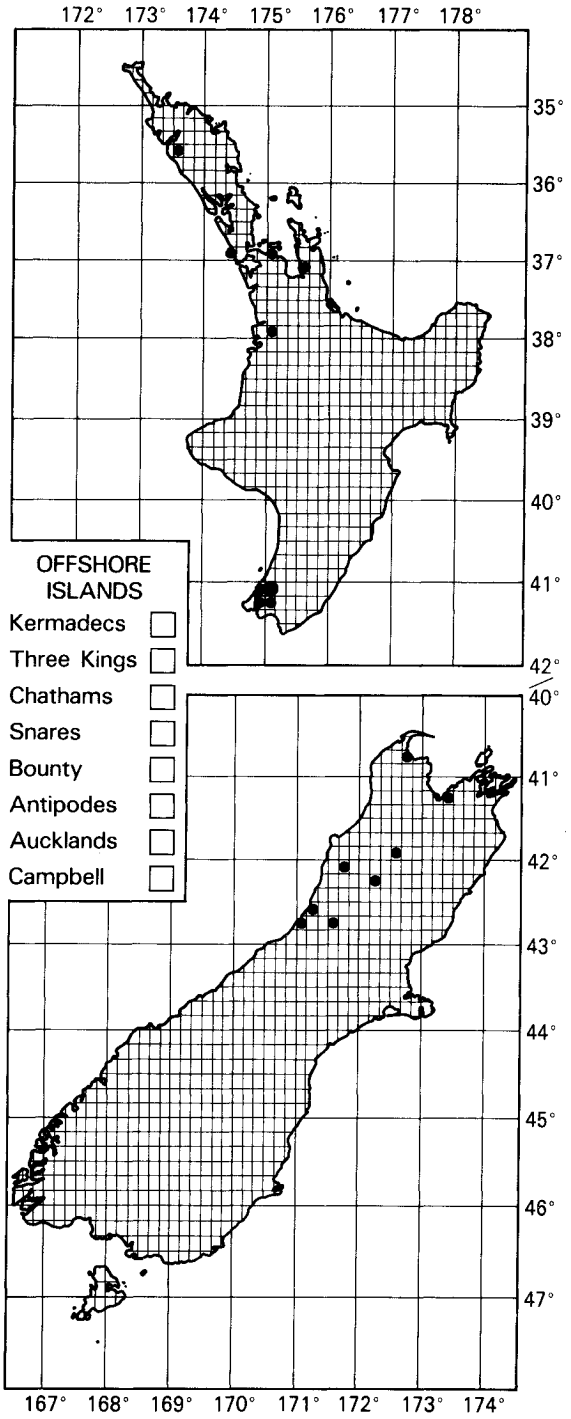
Map 9 Collection localities, *Deleatidium (D.) angustum*



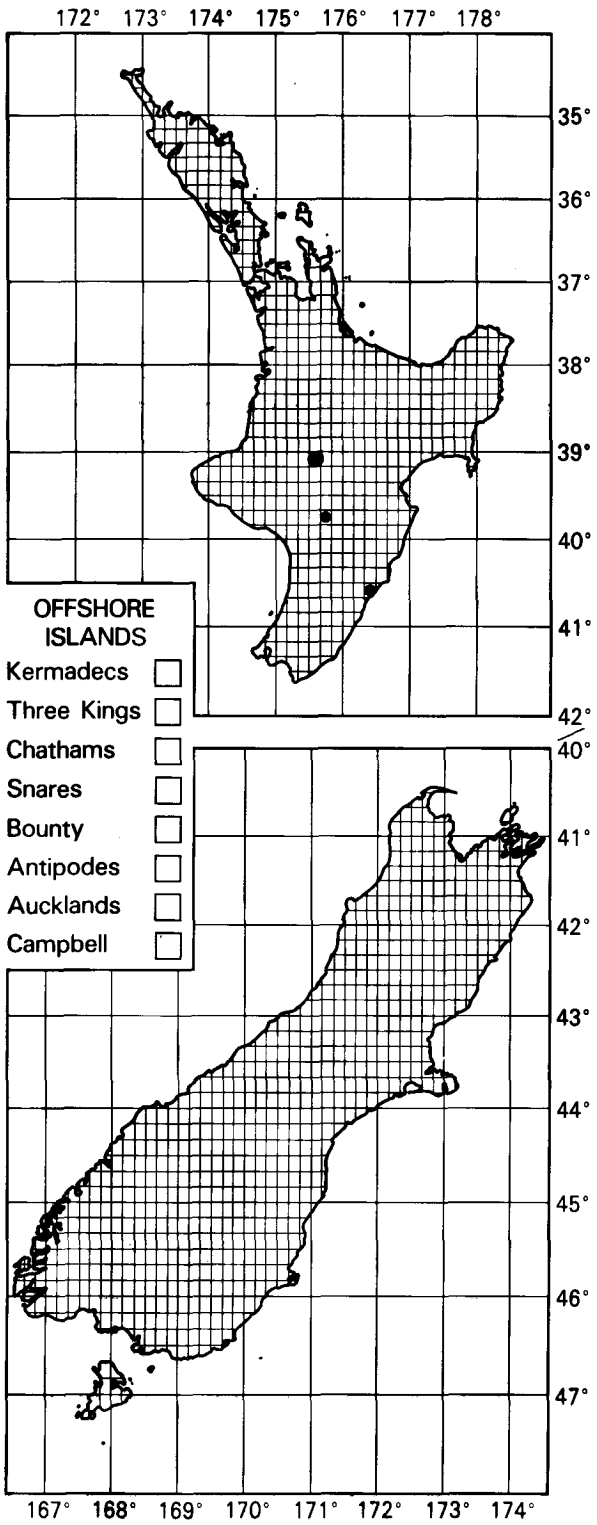
Map 10 Collection localities, *Deleatidium (D.) autumnale*



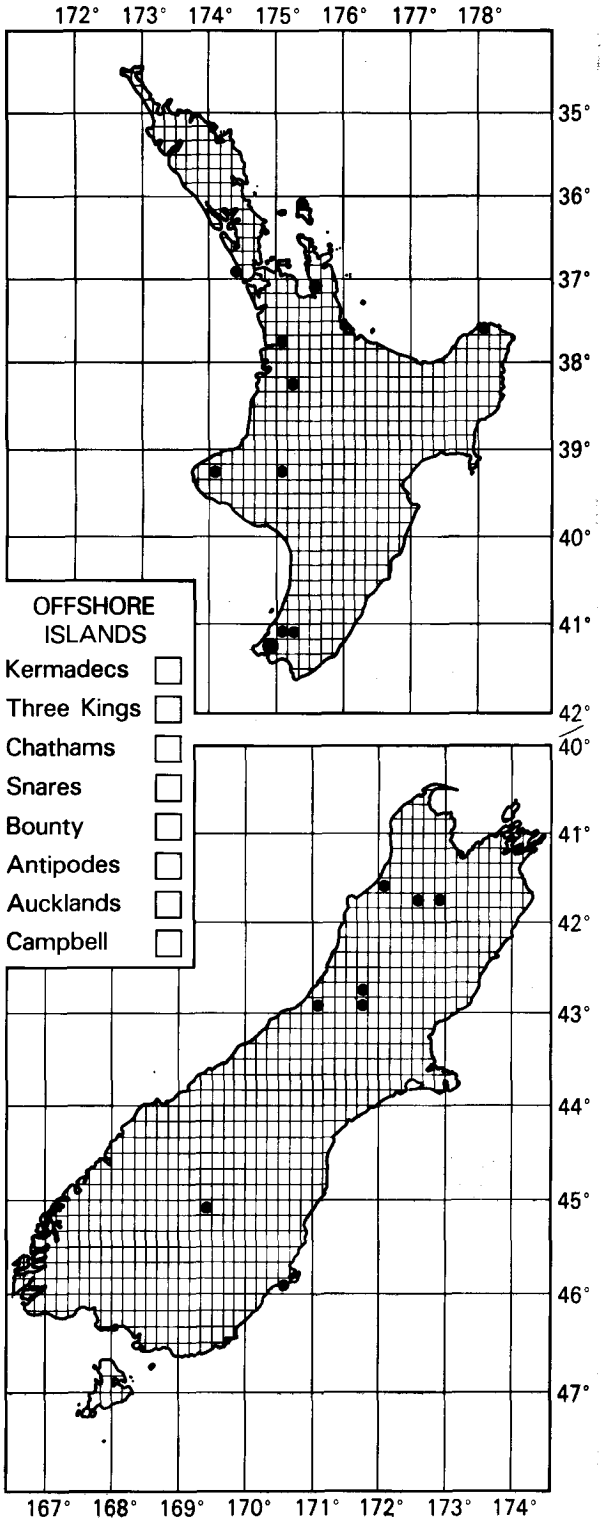
Map 11 Collection localities, *Deleatidium (D.) cerinum*



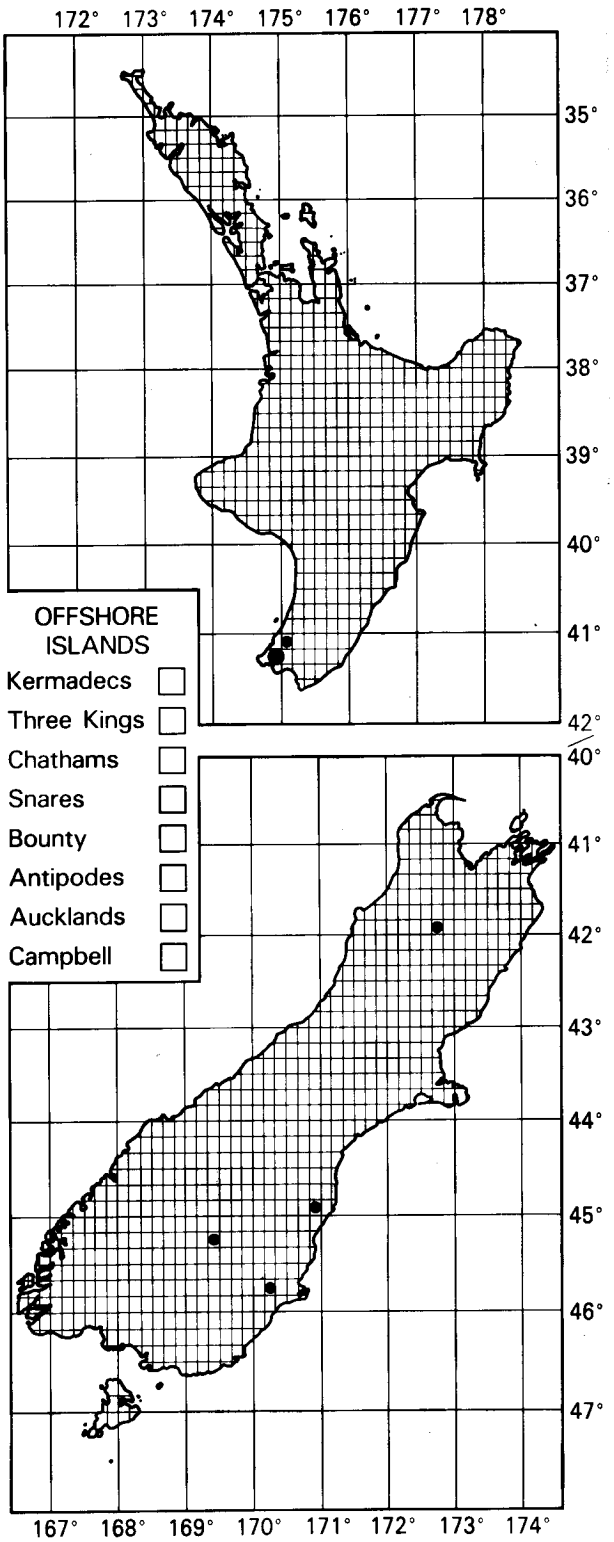
Map 12 Collection localities, *Deleatidium (D.) fumosum*



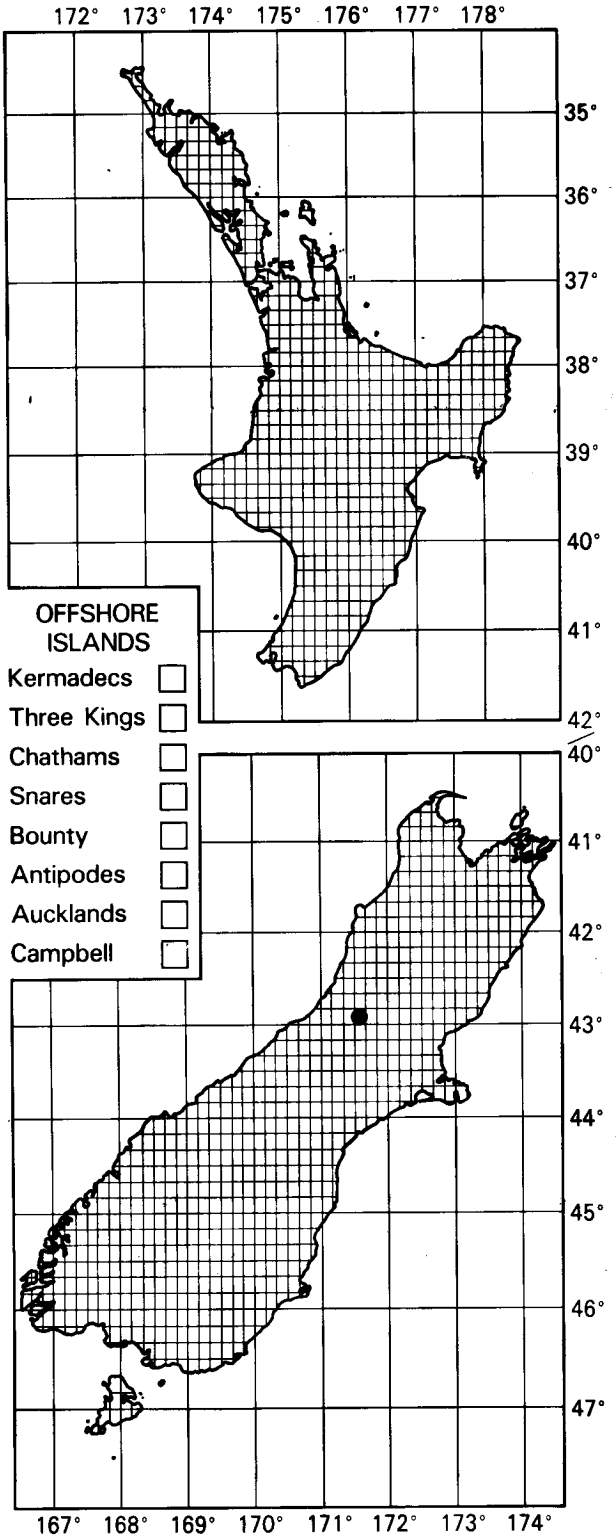
Map 13 Collection localities, *Deleatidium (D.) magnum*



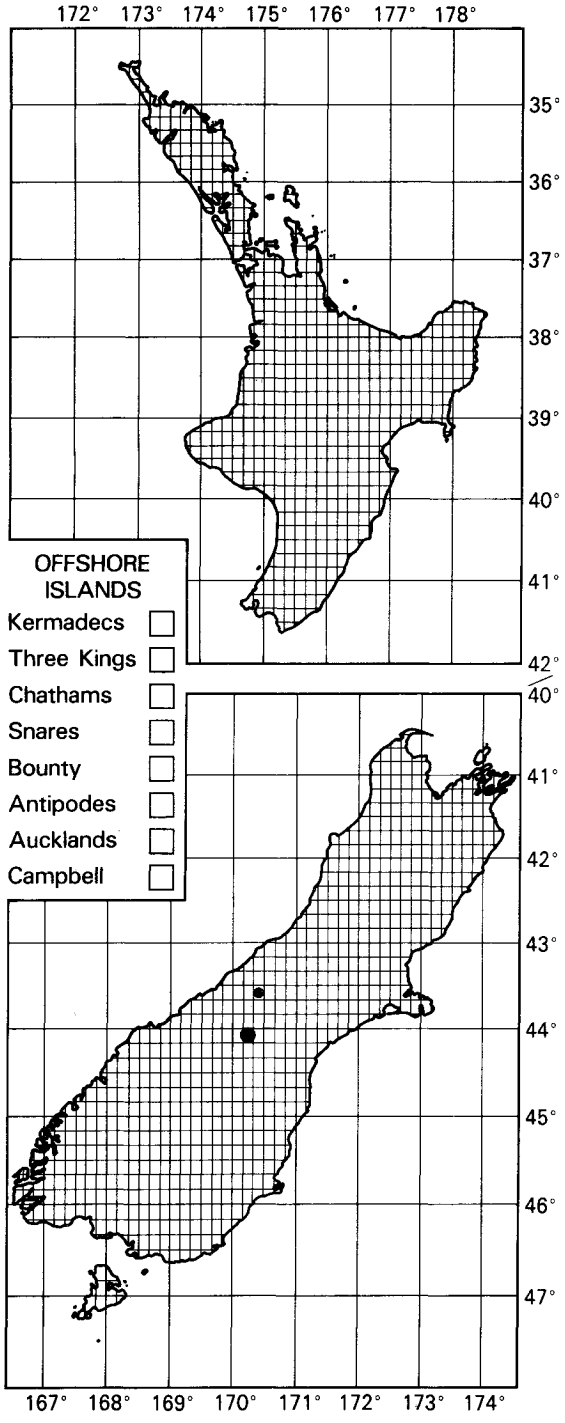
Map 14 Collection localities, *Deleatidium (D.) myzobranchia*



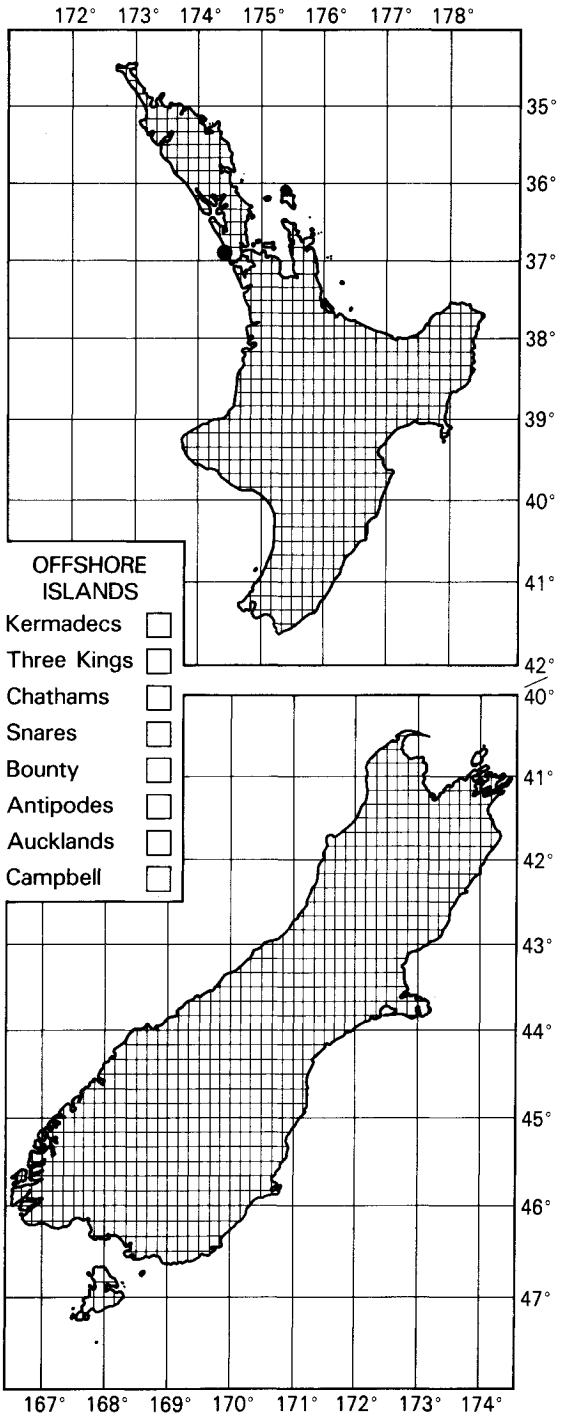
Map 15 Collection localities, *Deleatidium (D.) vernale*



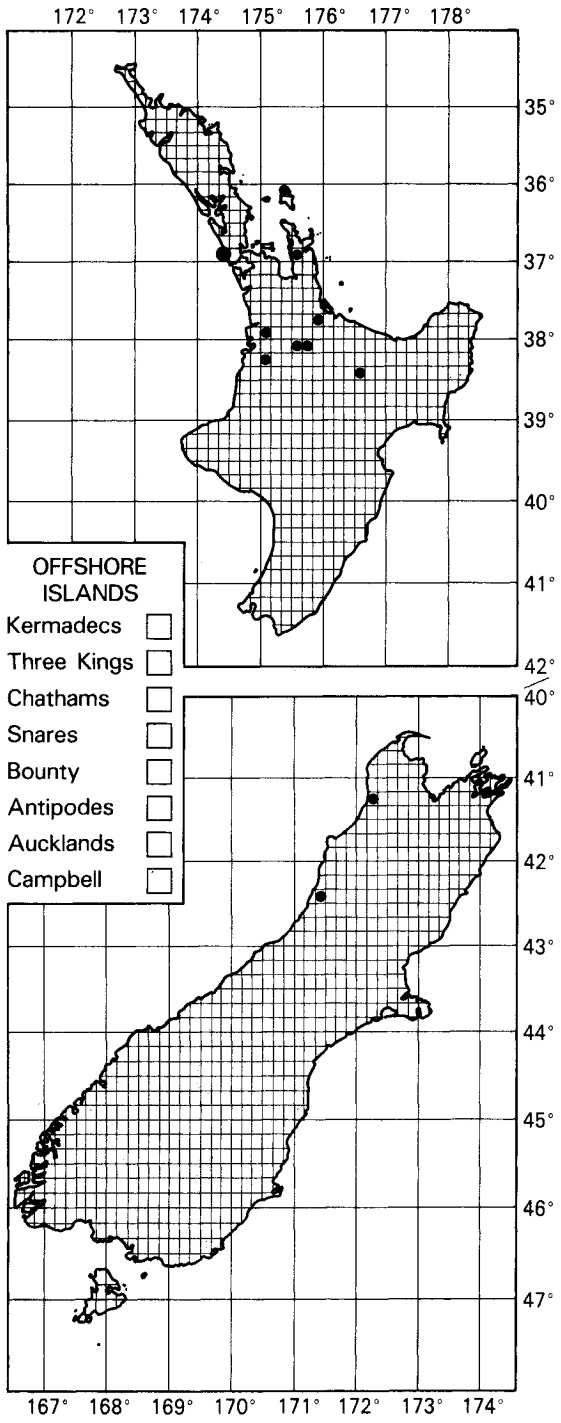
Map 16 Collection localities, *Deleatidium (P.) insolitum*



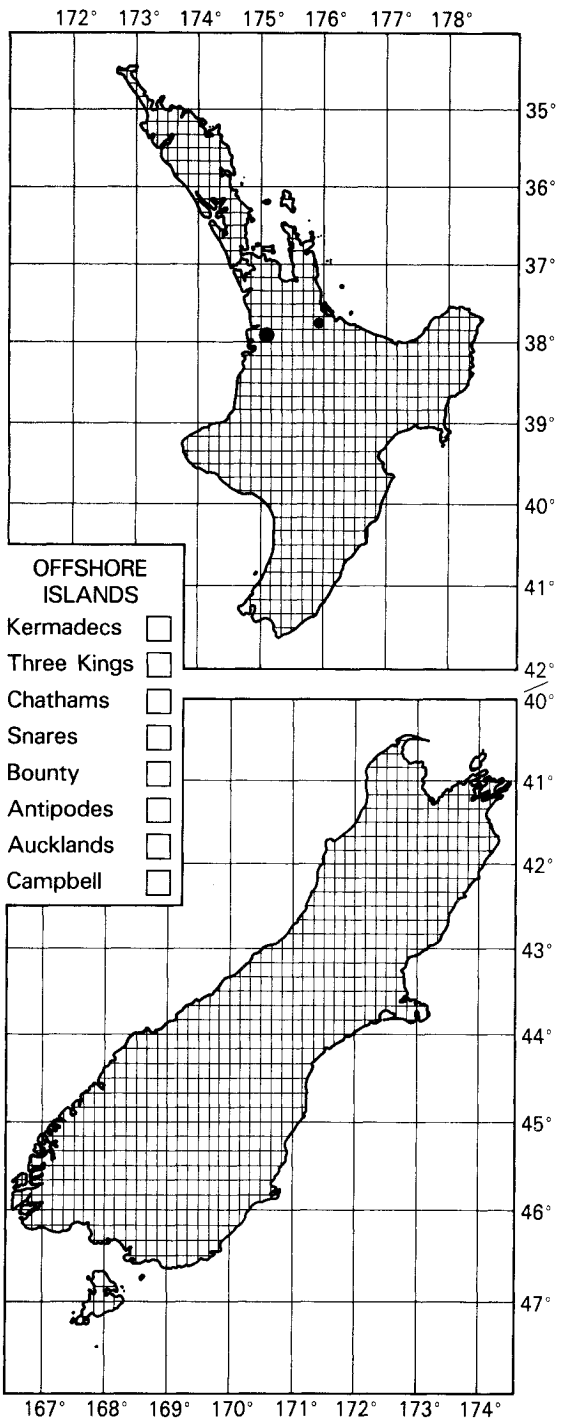
Map 17 Collection localities, *Deleatidium (P.) cornutum*



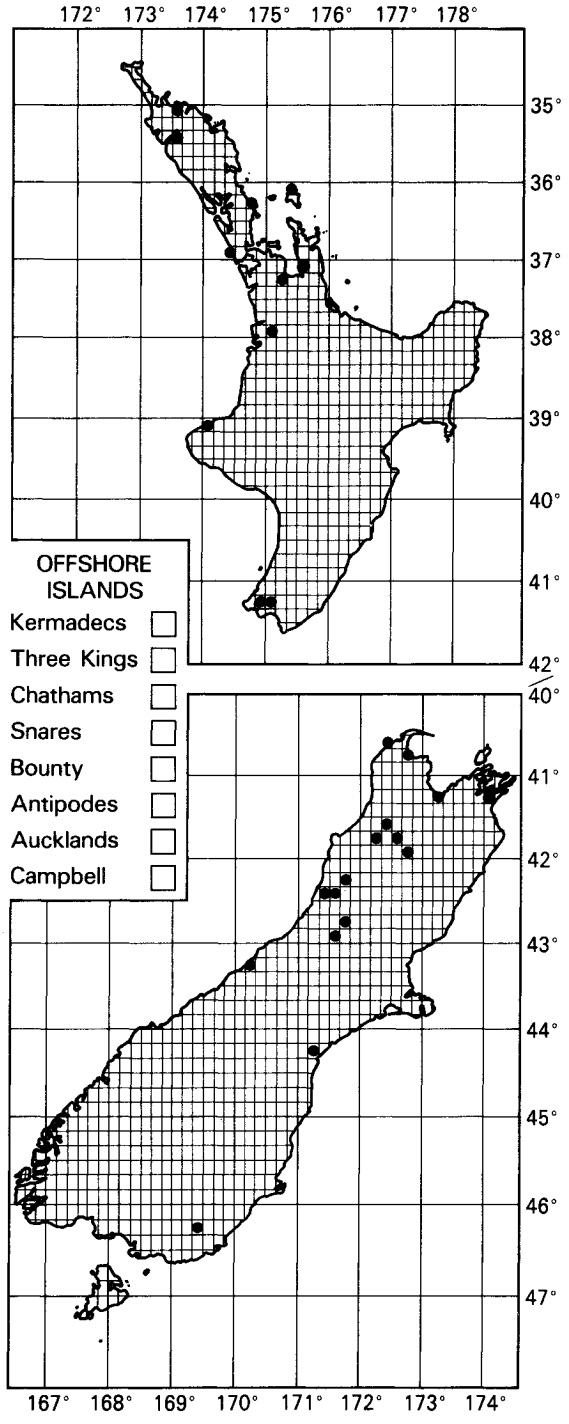
Map 18 Collection localities, *Isothraulus abditus*



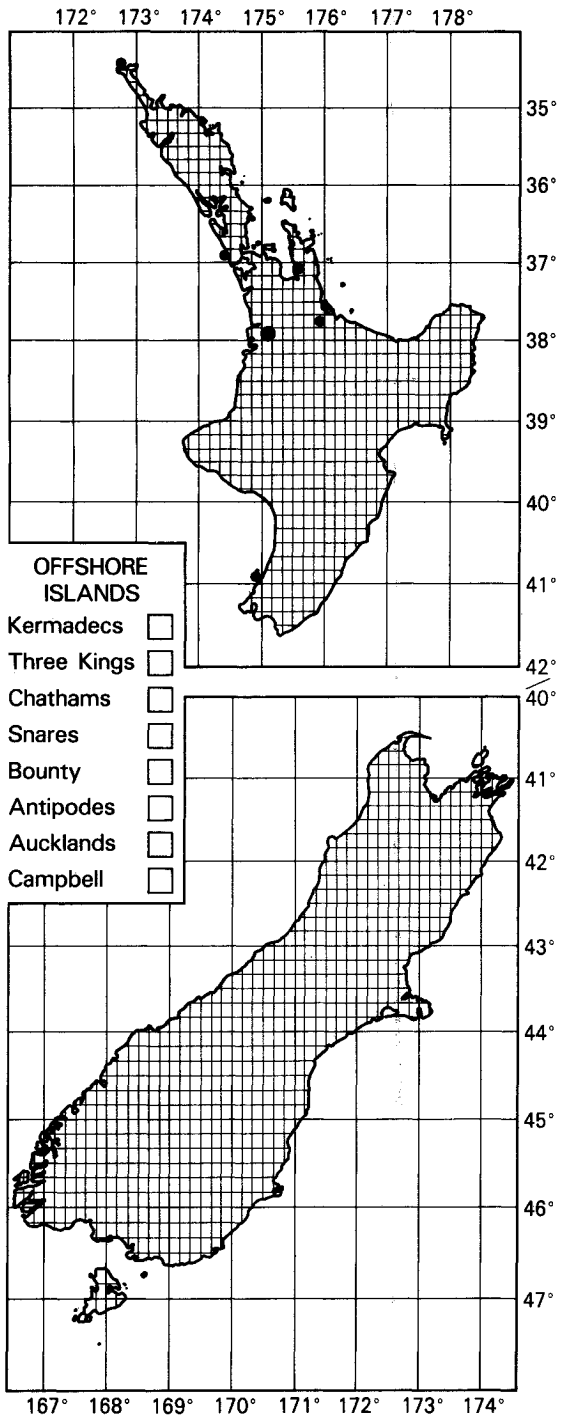
Map 19 Collection localities, *Mauiulus luma*



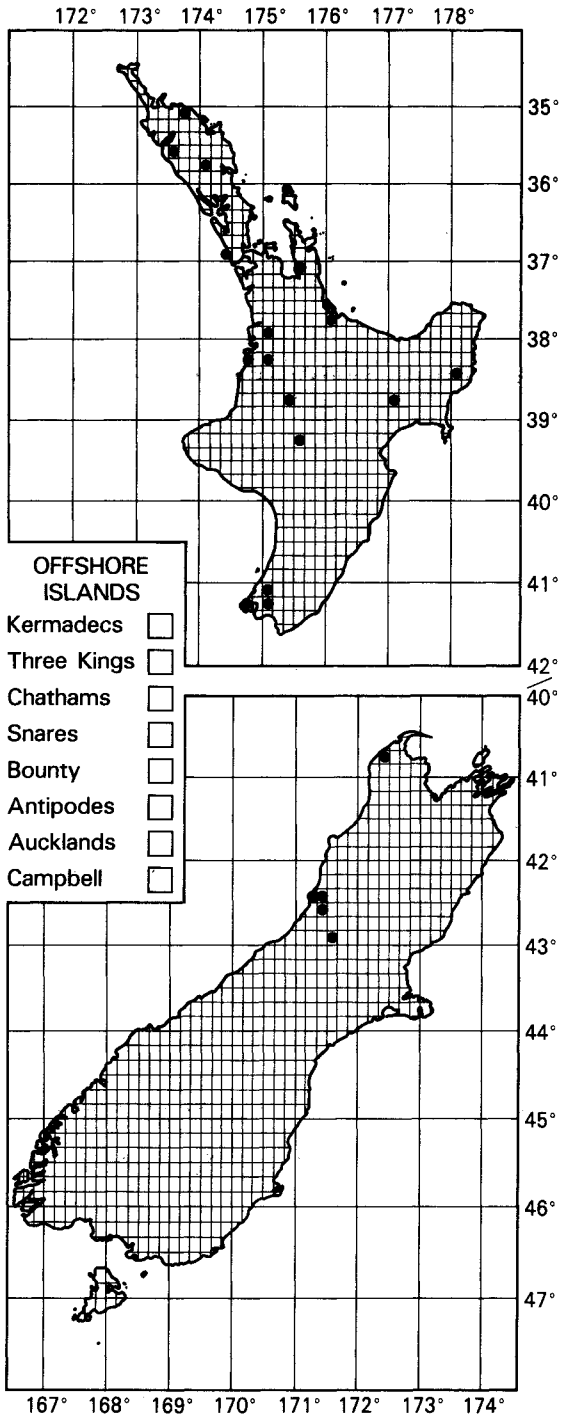
Map 20 Collection localities, *Mauiulus aquilus*



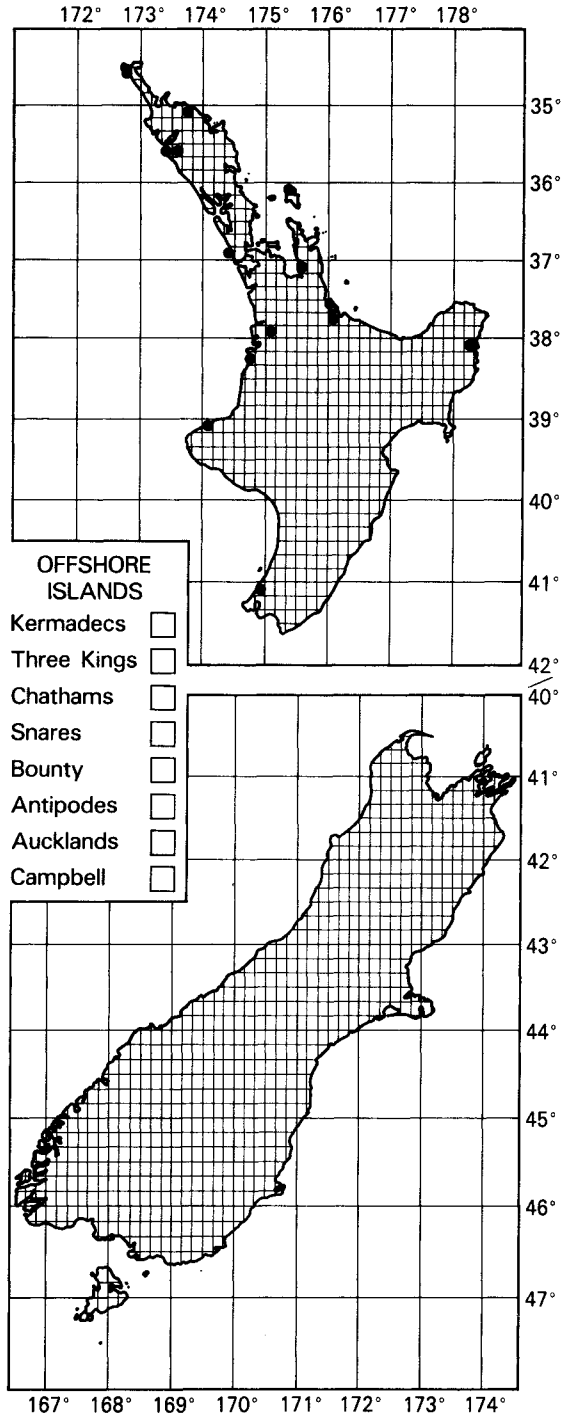
Map 21 Collection localities, *Neozephlebia scita*



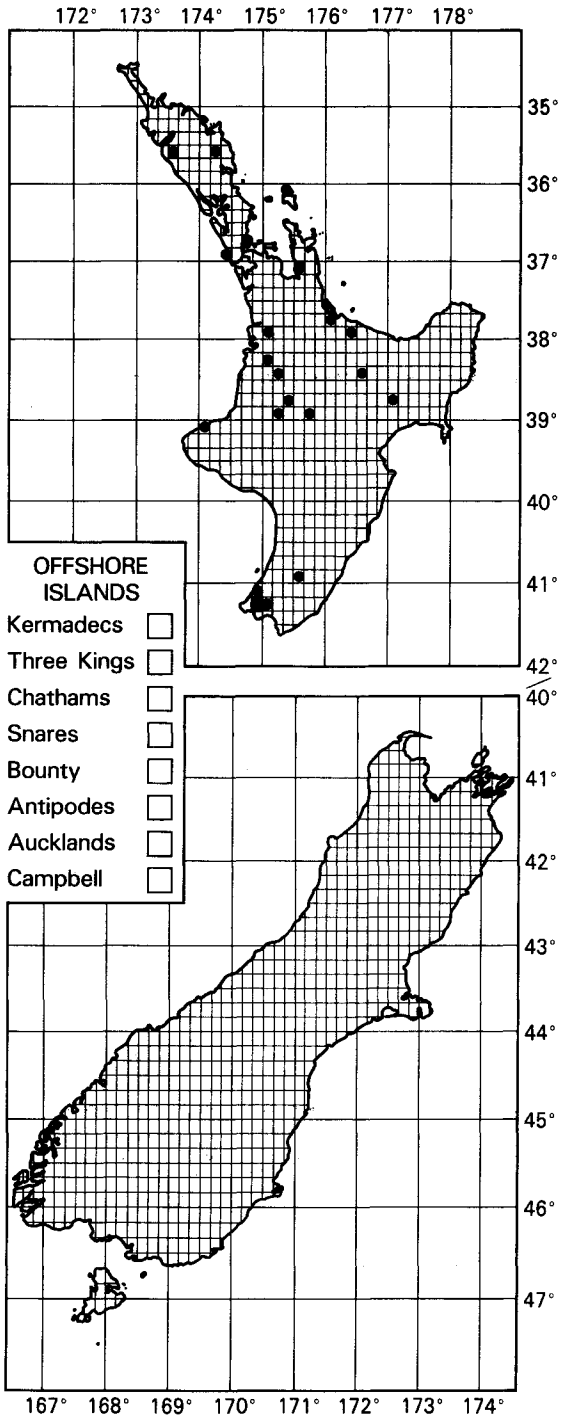
Map 22 Collection localities, *Tepakia caligata*



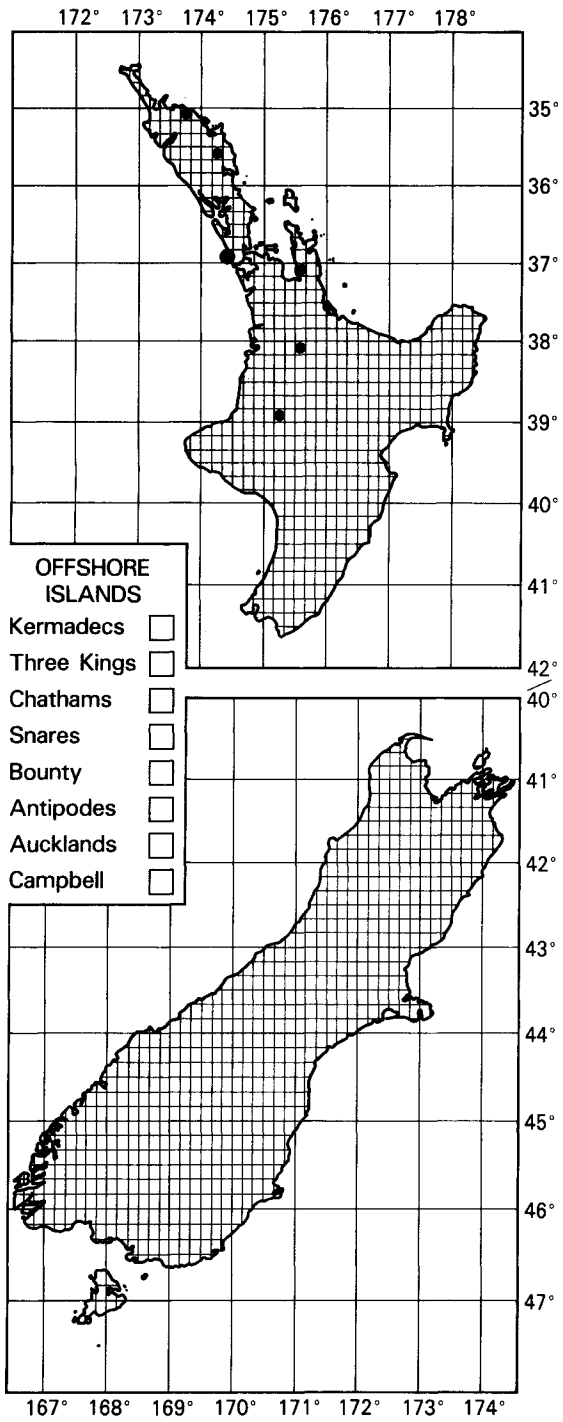
Map 23 Collection localities, *Zephlebia versicolor*



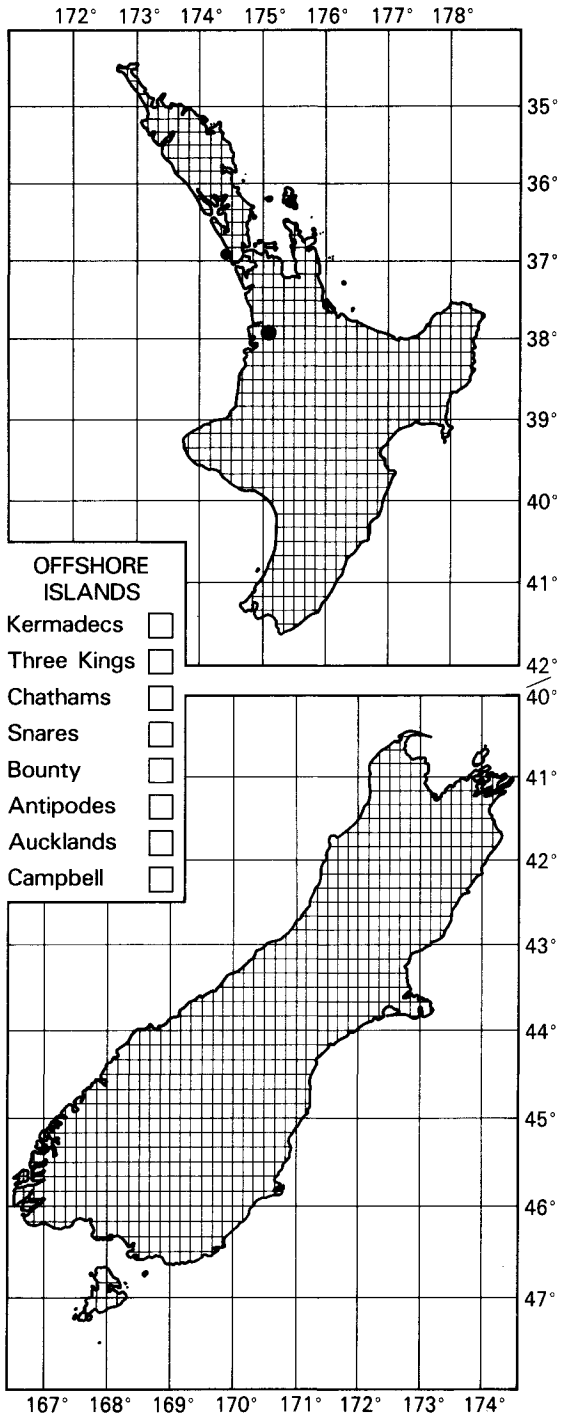
Map 24 Collection localities, *Zephlebia borealis*



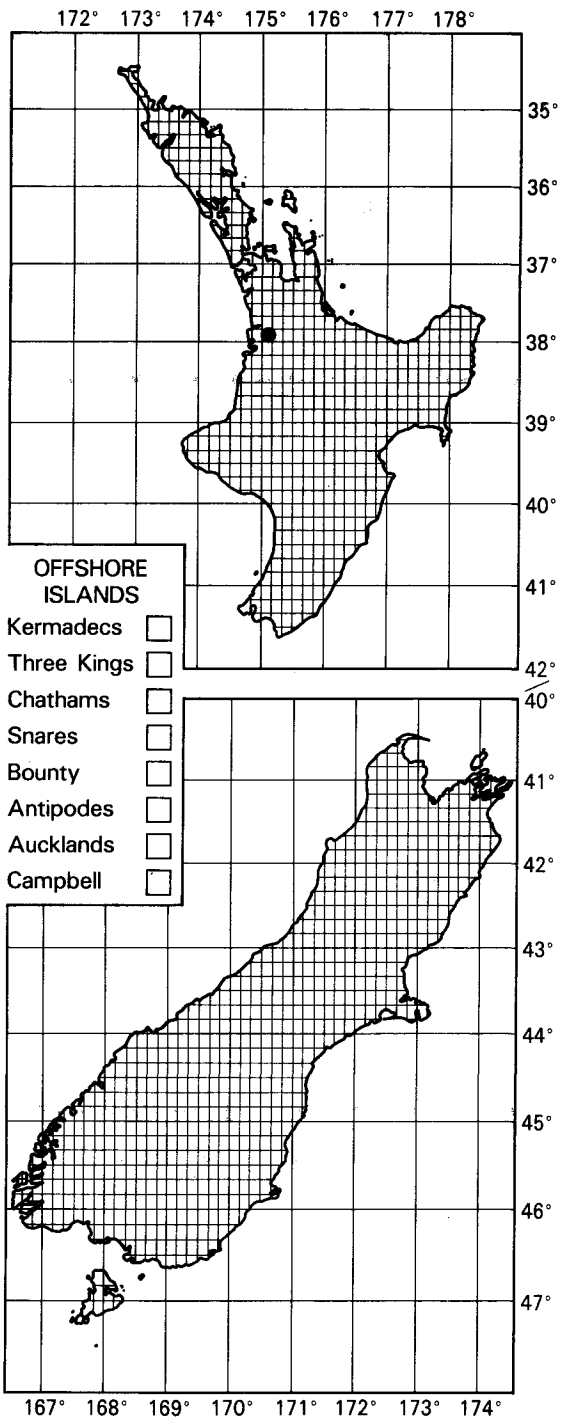
Map 25 Collection localities, *Zephlebia dentata*



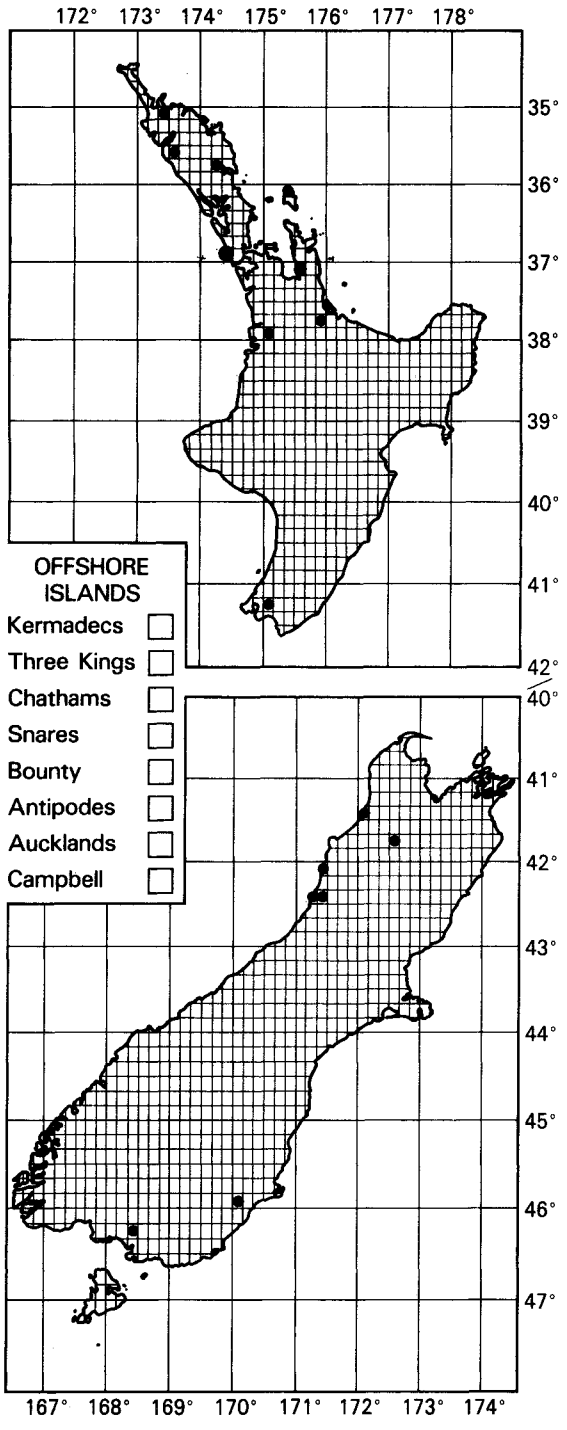
Map 26 Collection localities, *Zephlebia inconspicua*



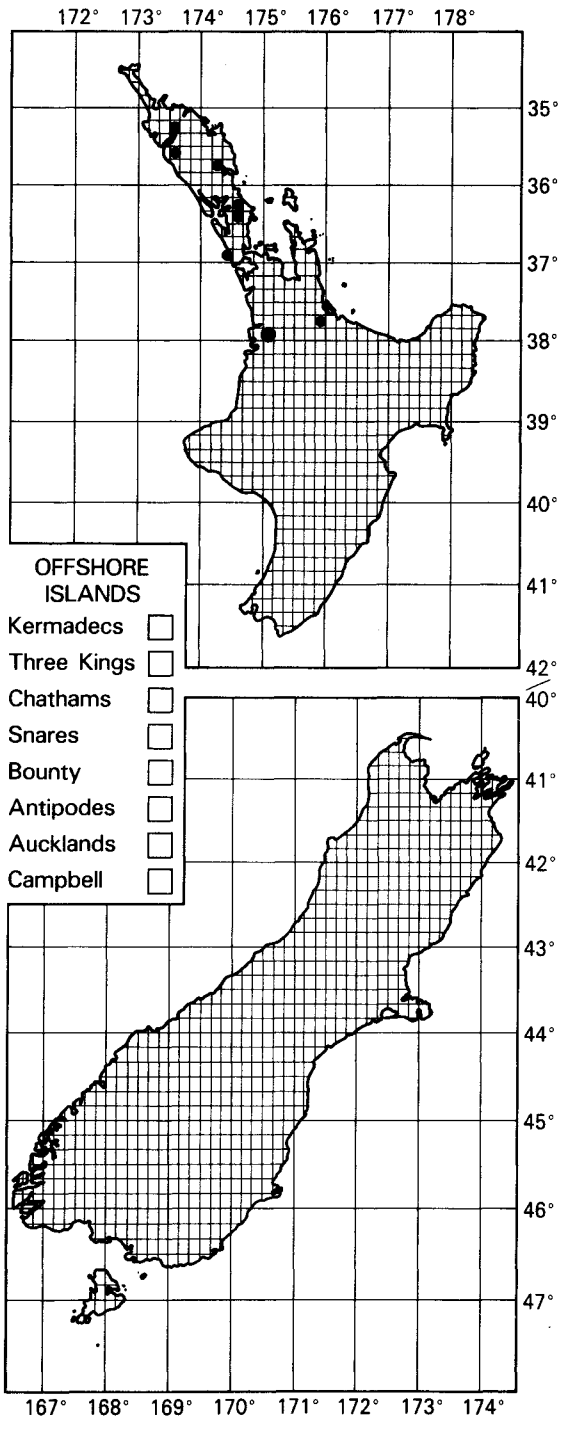
Map 27 Collection localities, *Zephlebia nebulosa*



Map 28 Collection localities, *Zephlebia pirongia*



Map 29 Collection localities, *Zephlebia spectabilis*



Map 30 Collection localities, *Zephlebia tuberculata*

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This index covers the nominal taxa mentioned in the text, regardless of their current status in taxonomy. Page numbers in bold type denote a description, and in italic type illustrations. A suffixed letter 'k' indicates a key, and 'm' a map.

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NOTICES

This series of refereed occasional publications has been established to encourage those with expert knowledge to publish concise yet comprehensive accounts of elements in the New Zealand fauna. The series is professional in its conception and presentation, yet every effort is made to provide resources for identification and information that are accessible to the non-specialist.

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Kua whakatūria tēnei rārangi pukapuka hei whakahauhau ki nga tohunga whai mātauranga kia whakātu i nga mea e pā ana ki nga kararehe o Niu Tīreni. 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, ā, kia whakārī i te mātauranga e pā ana ki a rātou.

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Tuhituhinga. Ko te tono ki nga tohunga kia tukua mai ā koutou pukapuka. E wātea ana te kohikohinga kararehe e kīa ana ko te New Zealand Arthropod Collection hei mātakitaki māu.

Me whākī ō koutou whakāro ki te mema o te kāhui tohutohu o 'Fauna' e tika ana, ki te Etita rānei, i mua i te tīmatanga tuhituhi.

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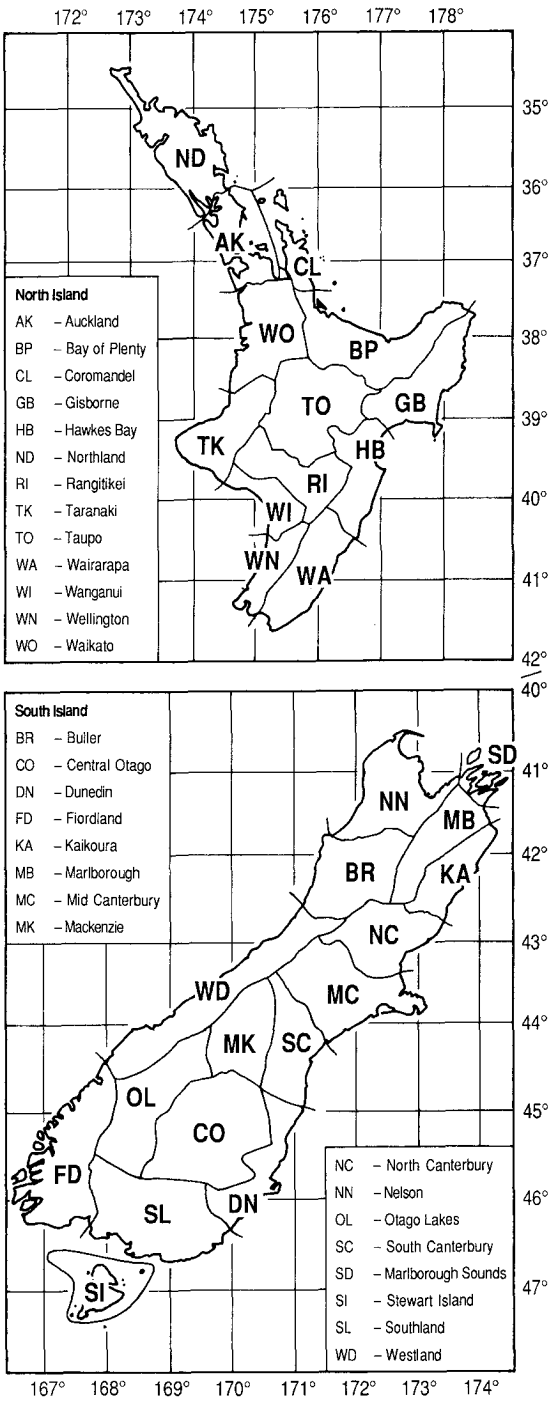
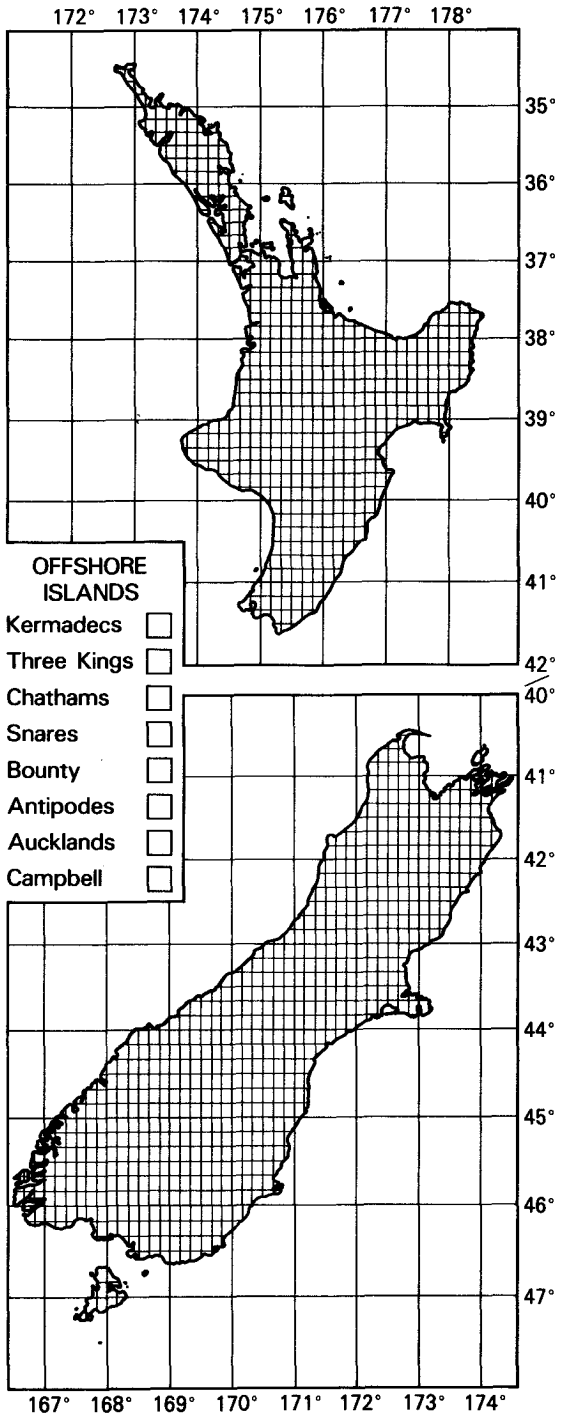
Te utu (tirohia te whārangi 142): Ko te kōpakitanga me te pane kuini kei roto i te utu. Me utu koutou e noho ana i Niu Tīreni me Āhitereiria ki nga tāra o Niu Tīreni. Ko ētahi atu me utu te whakaritenga i nga tāra Marikena.

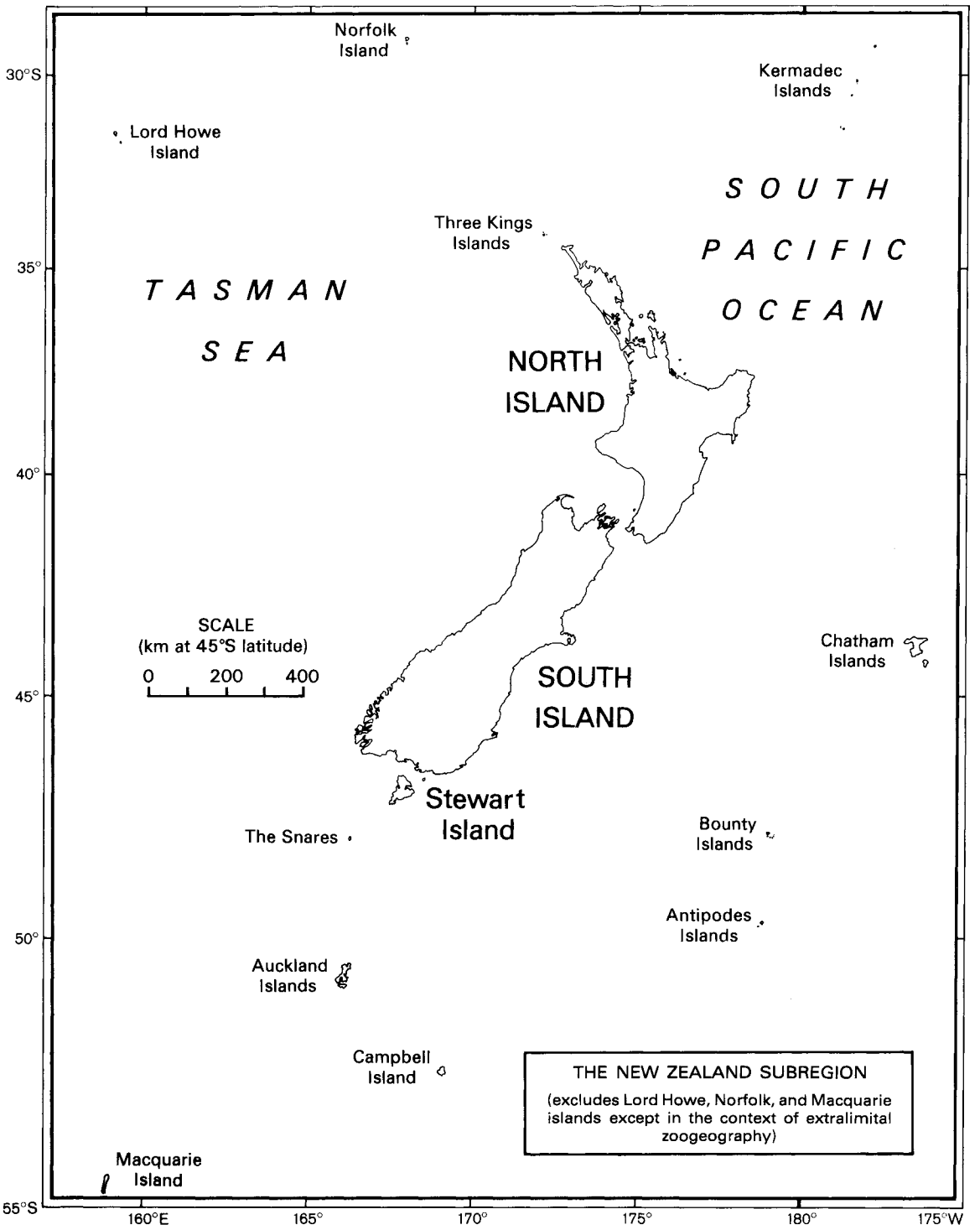
E toe ana nga pukapuka o mua. Mehemea e hiahia ana koe ki te katoa o nga pukapuka, tonoa mai kia heke iho te utu. E tekau pai hēneti te heke iho o te utu ki nga toa hoko pukapuka.



Area codes and boundaries used to categorise specimen locality data (after Crosby *et al.* 1976)



Base-map for plotting collection localities; this may be photocopied without copyright release


Norfolk Island
Kermadec Islands
Lord Howe Island
SOUTH PACIFIC OCEAN
Three Kings Islands
TASMAN SEA
NORTH ISLAND
SCALE
(km at 45°S latitude)
0 200 400
Chatham Islands
SOUTH ISLAND
Stewart Island
The Snares
Bounty Islands
Antipodes Islands
Auckland Islands
Campbell Island
THE NEW ZEALAND SUBREGION
(excludes Lord Howe, Norfolk, and Macquarie islands except in the context of extralimital zoogeography)
Macquarie Island
30°S
35°
40°
45°
50°
55°S
160°E
165°
170°
175°
180°
175°W

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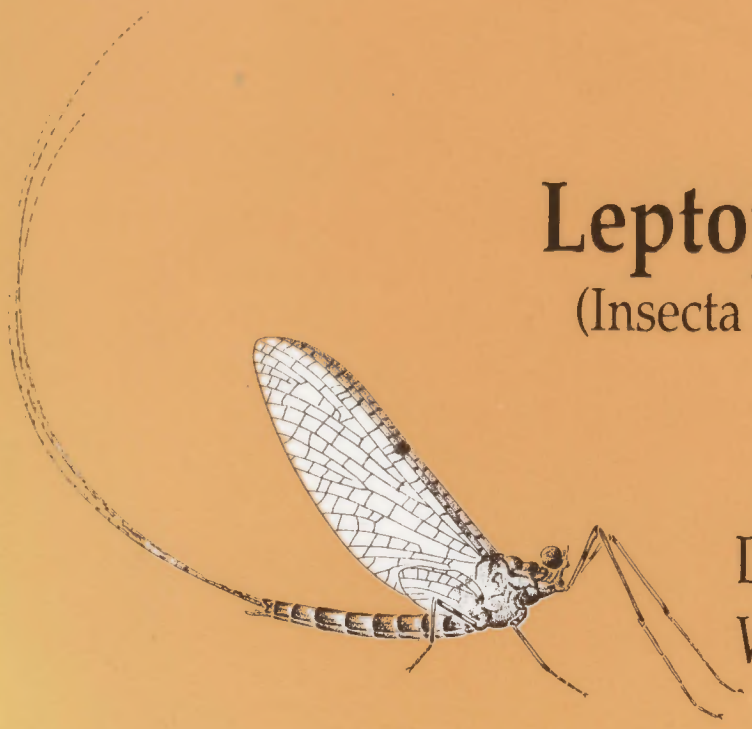

Leptophlebiidae

(Insecta : Ephemeroptera)

D. R. Towns and
William L. Peters

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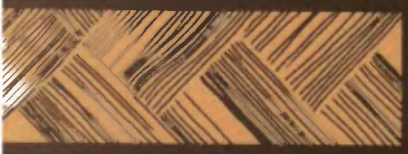

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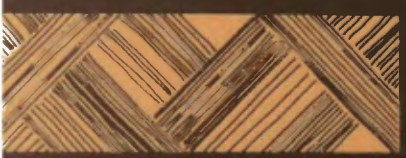

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