

A new genus and species of Leptophlebiidae (Ephemeroptera) from northern New Zealand

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Abstract A new species of Leptophlebiidae is described from the far north of New Zealand and a new genus *Aupouriella* is erected to contain it. The new genus is unique among New Zealand Ephemeroptera in that eyes of adult males are not divided into upper and lower portions. The penes terminate in a prominent ventrally-projecting spine partially enclosing the sperm groove, and the posterior margin of the styliger plate has a prominent, upwardly curved projection, medially. Nymphs, subimagos and adults of *Aupouriella pohei* n. sp. have very slender legs, and are easily recognised by their bold abdominal markings. Nymphs were found on stony substrata in a small coastal stream at the type locality near North Cape along with nymphs of at least five other leptophlebiid species.

Keywords Atalophlebiinae; *Aupouriella*; Ephemeroptera; Leptophlebiidae; New Zealand; taxonomy

INTRODUCTION

The Leptophlebiidae is the largest family of Ephemeroptera in New Zealand where all species belong to the subfamily Atalophlebiinae. In their revision of the New Zealand leptophlebiid fauna, Towns & Peters (1996) recognised 12 genera and 30 species, all of which are endemic. A new species of *Deleatidium* (*Penniketellum*) was described by Hitchings (2008) and three further species of *Delea-*

tidium are in the process of description (T. Hitchings pers. comm.). Eight of the 12 New Zealand genera are monotypic and are defined by combinations of adult and nymphal characters. These characters include, but are not limited to, features of wing venation, form of the adult eyes and claws, external genitalia of males and females, nymphal mouthparts and gills.

Six generic lineages of Leptophlebiidae with representatives in much of the Southern Hemisphere including New Zealand have been identified (Pescador & Peters 1980; Towns & Peters 1996). However, a recent genetic study of 69 leptophlebiids from six continents found that most of the New Zealand genera grouped together, suggesting the New Zealand fauna has been evolving independently for longer than previously hypothesised (O'Donnell & Jockusch 2008).

In this paper a new species is described from the far north of New Zealand and placed in a newly erected genus defined by a unique combination of adult and nymphal characters.

METHODS AND CONVENTIONS

Imagos and subimagos were collected by light trapping and nymphs by hand collecting and “kick netting”. Nymphs were associated with adults by proximity, the highly distinctive abdominal pigment patterns present in all life history stages, and the very narrow thoracic legs. Descriptions follow the conventions of Towns & Peters (1996). The examination of morphological detail and the drawing of figures were aided by digital photography and scanning electron microscopy. Measurements were made with a calibrated eyepiece inserted in a stereoscopic microscope at 10–35X. Body and wing lengths are given as ranges with means in parentheses. Length ratios of leg segments (femur: tibia: tarsomeres 1–5) are based on the length of the tibia (absolute measurement in millimetres, in parentheses). All material is from Northland, region ND of Crosby et al. (1998). Repositories: NZAC (New Zealand

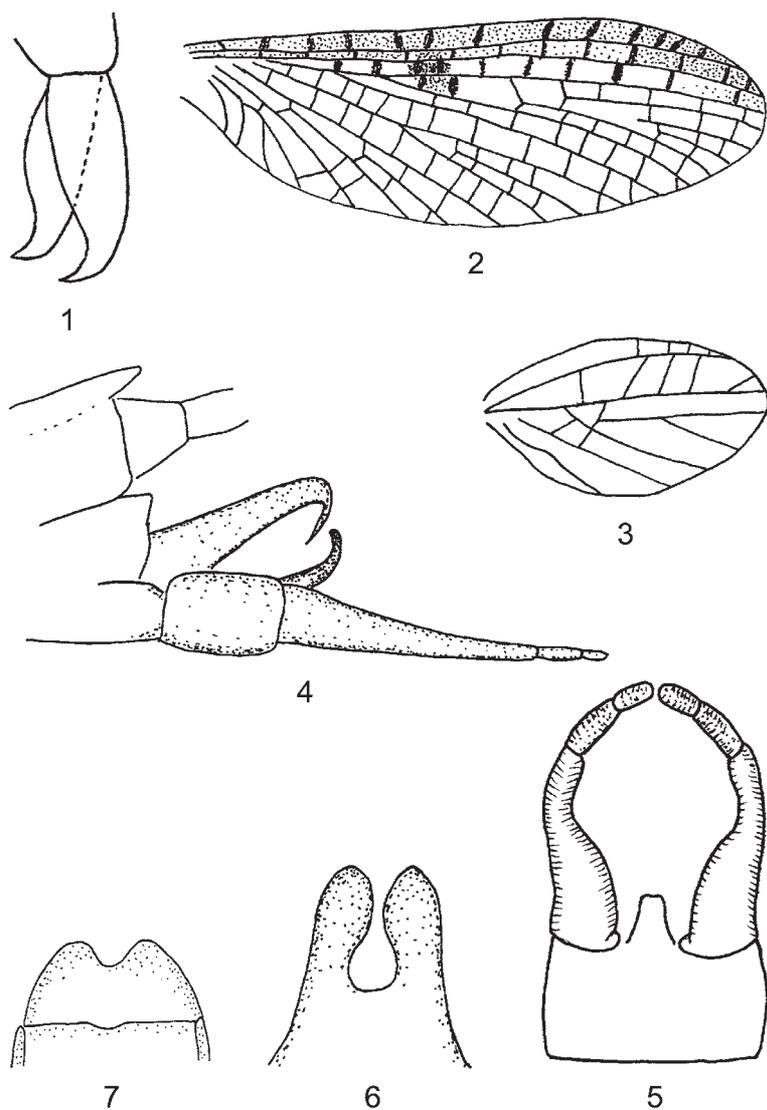


Fig. 1–7 *Aupouriella pohei*. 1–6, Male imago: 1, fore claws; 2, forewing; 3, hind wing; 4, genitalia, lateral view; 5, genitalia, ventral view showing median projection of styliger plate; 6, penes, dorsal view. 7, female imago: 9th sternum.

Arthropod Collection, Landcare Research, Auckland, New Zealand), CMNZ (Canterbury Museum, Christchurch, New Zealand).

LEPTOPHLEBIIDAE BANKS, 1900

Aupouriella new genus

TYPE SPECIES: *Aupouriella pohei* Winterbourn

IMAGO: Eyes of male and female without separate upper and lower portions, and separated by about their own width. Ocelli prominent.

Legs. Legs very slender; tibia and tarsal segments (except tarsal segment 1) each with a distal spine; claws paired, alike, apically hooked as in Fig. 1. Length ratios of segments: male forelegs 0.50: 1.00 (2.6 mm): 0.03: 0.41: 0.23: 0.28: 0.05; male mid legs 0.50: 1.00 (2.5 mm): 0.02: 0.07: 0.05: 0.03: 0.05; male hind legs 0.59: 1.00 (2.5 mm): 0.03: 0.06: 0.04: 0.02: 0.05.

Wings (Fig. 2, 3). Forewing three times as long as maximum width; vein Rs forked one-quarter of distance from base to margin; vein MA asymmetrically forked at half distance from base to margin; vein MP_2 attached at base to CuA and MP_1 by a cross

vein; attachment of MP_2 to MP_1 about one-third distance from base to margin; MP_2 with base closer to MP_1 than CuA ; vein ICu_1 attached at base to CuA and CuP by cross veins. Hind wing twice as long as greatest width and 0.14–0.16 as long as forewing; costal margin convex and slightly angled at about 0.6 of length; vein Sc about 0.9 length of wing; cross veins few, mainly in cells C and Sc ; posterior margin with a fringe of long setae.

Genitalia. Male (Fig. 4, 5, 6). Styli-plate about 0.4 times as long medially as its maximum width, with a short, black projection curving dorsally between the bases of the forceps; forceps broadest basally, inner margin of segment 1 narrowing abruptly at mid-length; length ratio of segments 0.71: 0.17: 0.12; penes fused to about half their length, each with a prominent ventrally directed spine. The spines partially enclose the sperm grooves and their apices diverge laterally.

Female. Sternum 7 not extended medially; sternum 9 deeply cleft (Fig. 7). Terminal filament and cerci of equal length.

NYMPH (FINAL INSTAR) (Fig. 8). Head prognathous; antennae a little longer than head.

Mouthparts. Clypeus (Fig. 9): slightly broader anteriorly, length: width ratio 1: 2.2. Labrum (Fig. 9): broader than clypeus, lateral margins rounded; antero-medial margin concave with 5 laterally rounded, broad-based, shallow denticles (Fig. 10). Mandible (Fig. 11) with outer margin slightly angled and with two groups of hairs near midpoint; incisors with unserrated apical teeth; prosthecal tuft of about 9 setae ranging in length from a little shorter to a little longer than apical teeth. Hypopharynx (Fig. 12): lingua with well developed lateral processes, submedian lobes rounded; superlingua with rounded margins and a prominent hair fringe anteriorly. Maxillae (Fig. 13): galea-lacinia broad, sub-apical spines difficult to see; palp segments decreasing in length distally in the ratio 1:0.9: 0.75; segment 3 extending beyond the maxillary brush and with abundant hairs. Labium (Fig. 14): palps with sparse hair cover, segments decreasing in length distally in ratio 1:0.85: 0.7; glossae, recurved, elongate, covered in short dark hairs; paraglossae extending beyond glossae with extensive hair cover as in Fig. 14.

Thorax. Pronotum with lateral margins moderately rounded, anterior margin shallowly concave, posterior margin deeply incised medially; antero-lateral angles of pronotum without spines. Femora elongate, narrow, strongly dorso-ventrally flattened, margins

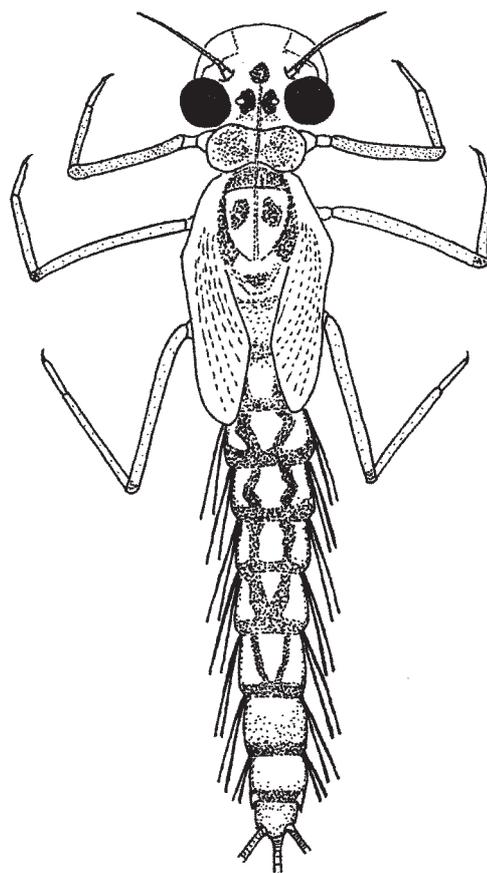


Fig. 8 *Aupouriella pohei*, mature nymph (caudal filaments truncated). Body length 5.9 mm.

sub-parallel with short widely spaced setae most prominent on fore-femur; tibiae more rounded in cross section with rows of fine setae most abundant on fore-leg where they form a fringe; tarsal claws (Fig. 15) slightly hooked with about 8 denticles, increasing in length apically.

Abdomen. Narrow with very small pointed postero-lateral projections on segments 8 and 9. Gills bifid (Fig. 16), those on segments 1–6 alike, each about as long as two abdominal segments; gills of segment 7 about two-thirds as long as others; lamellae with dorsal and ventral portions very narrow and sometimes varying in length from each other; tracheae un-branched and over half width of lamella. Caudal filaments at least 2.5 mm long (broken).

REMARKS: The most distinctive and unusual feature of *Aupouriella* is the presence in the adult male of compound eyes in which the normally well-defined

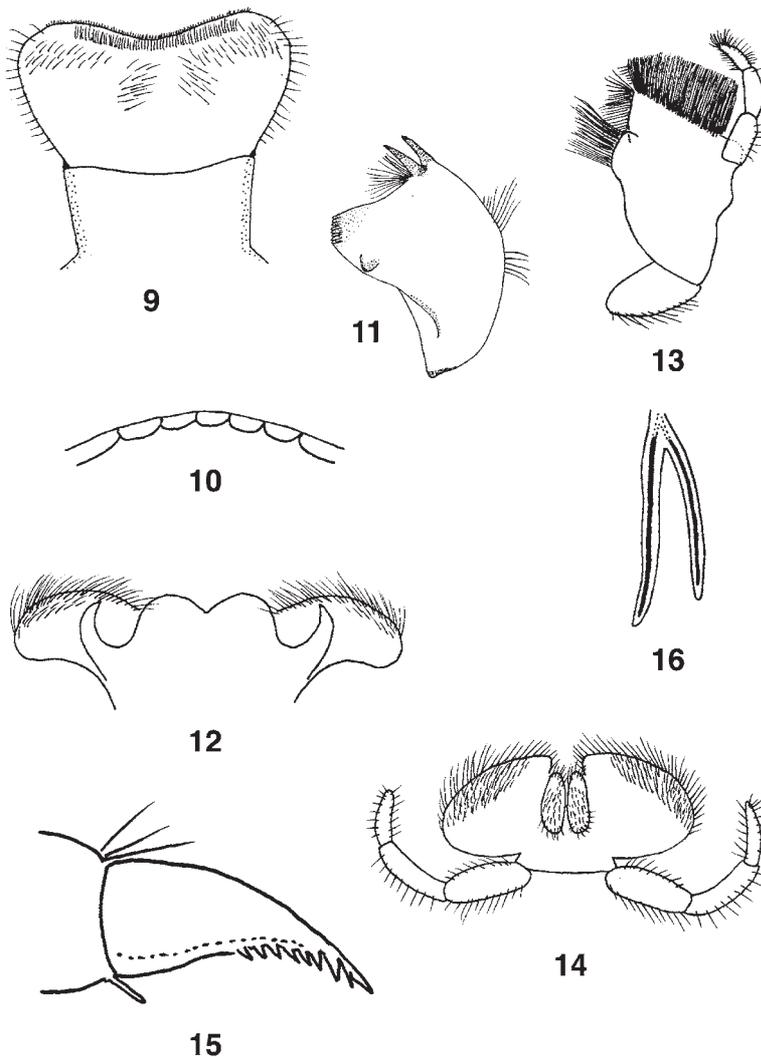


Fig. 9–16 *Aupouriella pohei*, mature nymph. 9, Labrum and clypeus; 10, denticles in anteromedian emargination of labrum; 11, right mandible; 12, hypopharynx; 13, right maxilla; 14, labial glossae, paraglossae and palps; 15, fore claw; 16, abdominal gill 4.

dorsal portion is missing (Fig. 17). As in the central African genera *Fulleta* and *Fulletomimus* (Peters & Edmunds 1964) the entire eye consists of “ventral” hexagonal facets as found in female Atalophlebiinae; square facets typical of the dorsal portion of most male eyes (Peters & Gillies 1995; Towns & Peters 1996) are absent.

The form of the male penes with the downward pointing spines, and the upward curving posterior extension of the styliger plate are also highly distinctive among New Zealand genera. The large penial spines partially enclose the sperm grooves (Fig. 18), which extend almost to the tip and are not unlike those described in *Habroleptoides confusa* Sartori

& Jacob by Gaino & Rebori (1995). Small inwardly directed sub-apical spines, and stout retractile apical spines are present on the penes of *Tillyardophlebia dostinei* Dean & Suter and *Manggabora wapitja* Dean & Suter (Atalophlebiinae) from the Northern Territory, Australia (Dean & Suter 2004), but they appear to be very different structures from those of *A. pohei*. Recurved glossae as found in the nymphal labium of *A. pohei* have not been described in other New Zealand species. However, they occur in *Penaphlebia* and *Hapsiphlebia*, genera of Atalophlebiinae from South America (Pescador & Peters 1980) and in several Australian genera including *Atalomicria*, *Neboissophlebia*, *Loamaggalangta* and

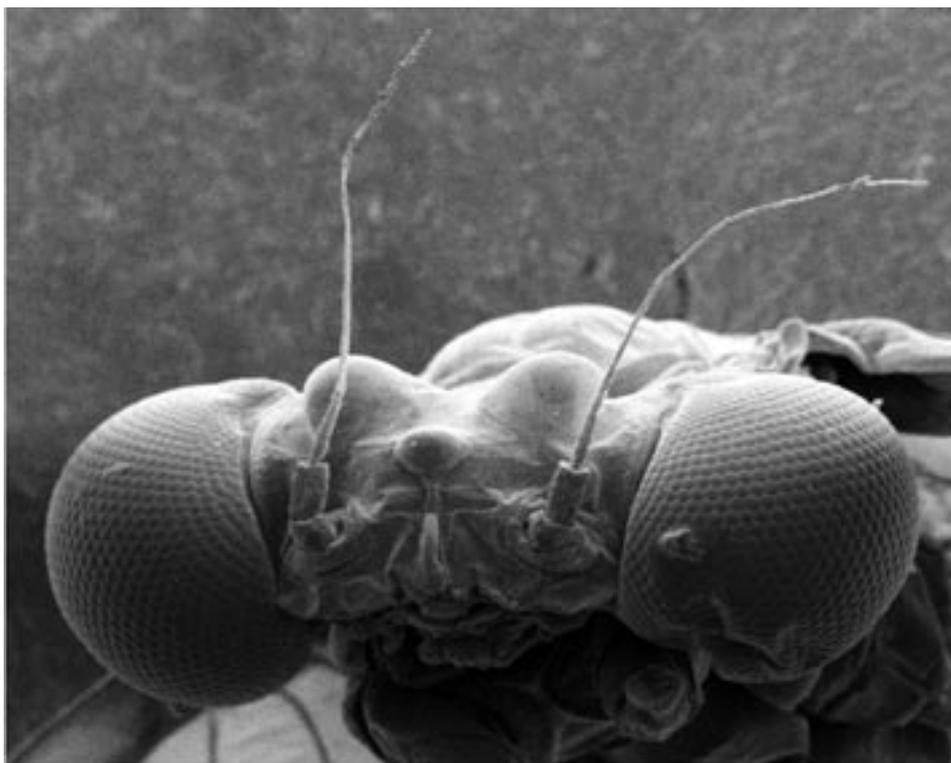


Fig. 17 *Aupouriella pohei*. Scanning electron micrograph of the male imago head showing the compound eyes with hexagonal facets and the lack of distinct upper and lower portions.

Marmenuera (Campbell & Peters 1993; Dean 1988; Dean et al. 1999, 2008).

ETYMOLOGY: From the Maori Aupouri, the name of the peninsula in northern New Zealand that includes the type locality, and *-ella* meaning small.

DIFFERENTIAL DIAGNOSIS: *Aupouriella* can be distinguished from all other genera of Atalophlebiinae by the following combination of characters. Adult: (1) eyes of male lacking distinct upper and lower portions; (2) claws of a pair similar; (3) penes broad, fused to half their length with a prominent terminal spine partly enclosing the sperm groove; (4) presence of a prominent dorsally-curving median projection of the styliger plate; (5) sternum 9 of female with a deep rounded cleft. Nymph: (1) labrum with 5 broad, flat denticles; (2) glossae recurved; (3) outer margin of mandibles with 2 tufts of hairs; (4) gills very narrow with unbranched tracheae; (5) claws with denticles increasing in length apically; (6) all leg segments very narrow.

Of the New Zealand genera *Aupouriella* superficially resembles *Arachnocolus* in having narrow legs, similar shaped labral denticles and similar adult and larval claws. *Aupouriella pohei* and *Arachnocolus phillipsi* Towns & Peters, the only known species in their respective genera, also have very different compound eyes and male genitalia. The adult female of *A. phillipsi* is unknown. The forewings of *Aupouriella* most resemble those of *Austronella* and *Isothraulius* in having narrow bands of pigment around the cross veins in cells C and Sc and a cloud of dark pigment at about mid wing length across cells C, Sc and R1. However, the yellow-orange colour of the distal third of cells C and Sc in *Aupouriella* is distinctive. The deeply cleft posterior margin of female sternum 9 most resembles that of *Neozephlebia*. The very narrow nymphal gills resemble those of *Austronella*, whose sole species *Austronella planulata* (Towns) has short, stout legs, in contrast to those of *Aupouriella*.



Fig. 18 *Aupouriella pohei*. Scanning electron micrograph showing the male penis spine with its semi-enclosed sperm channel, and the finely grooved, dorsally curved extension of the styliiger plate. Sperm can be seen at the expanded proximal end of the channel.

Aupouriella pohei new species

DIMENSIONS (mm): Male: length of body 5.8–7.0 (6.4); forewing 5.3–6.6 (6.0). Female: length of body 6.5–7.0 (6.7); forewing 5.6–7.3 (6.5). Final instar nymph: length of body 5.7–6.1 (5.9).

MALE IMAGO: Head white dorsally; eyes grey-black; ocelli prominent; antennae pale yellow-grey with prominent unpigmented bases.

Thorax. Pronotum pale with black markings; meso- and metanota light grey-white, tending darker laterally. Legs: coxae and trochanters grey-brown, femora of prothoracic legs brown, all other leg segments and claws pale, yellowish apart from a dark mark at each femoro-tibial joint. Wings (Fig. 2, 3). Forewing: membranes hyaline except the costal region and distal quarter of the subcostal cell are light golden brown; longitudinal veins brown except the proximal halves of Sc and R1 which are hyaline; cross

veins in anterior section of wing (cells Sc, R1, R2) surrounded by narrow bands of dark pigment giving them a “fuzzy” appearance; a small but prominent dark patch in cell R1 just beyond RS. Hindwing: hyaline, brownish at base; veins indistinct.

Abdomen. Dorsally with highly distinctive dark markings (as in nymph, Fig. 8) on a light-medium brown background, paler near the midline, especially on segments 7–10. The dark markings comprise broad stripes either side of the midline, most widely spaced anteriorly and coalescing posteriorly to a variable extent on some segments, e.g., segments 3 and 6. Dark pigment also forms a narrow band at the posterior margin of each segment. Sterna white with dark bands posteriorly, best developed on sterna 5–8. Caudal filaments pale yellow-grey up to 1.1 times longer than body (often broken). Genitalia pale apart from the black posterior-median projection of the styliiger plate.

FEMALE IMAGO: As for the male, including eyes, but with forelegs not elongated.

SUBIMAGO: As for the imago but with wings slightly cloudy. Male eyes black with a reddish tinge not apparent in the female subimago.

FINAL INSTAR NYMPH (Fig. 8): Head pale brown; ocelli white, the median ocellus surrounded by a patch of dark pigment, prominent kidney-shaped patches of dark pigment on the inner side of each lateral ocellus; eyes black, spherical; antennae pale yellow.

Thorax. Pronotum pale-medium brown with dark patches either side of the midline. Mesonotum and metanotum pale-medium brown, washed submedially and laterally with dark brown. Forewing pads reach to abdominal segment 3. Legs: pale yellowish-brown with a darker patch on the femur at the tibio-femoral joint. Dorsal surface of abdomen with the same pigment pattern as in the imago and subimago (see above). Ventral surface of abdomen pale with variably well developed lines of dark pigment at the posterior margins of most segments; abdominal ganglia not visible. Gills (Fig 16): lamellae translucent, very narrow, tracheae black. Caudal filaments light brown.

TYPE DATA: Holotype male imago, ND, Whiriwhiri Stream, North Cape, 34°24.96'S, 173°1.45'E, 8 May 2009, S. R. Pohe, in alcohol (CMNZ). Allotype female imago: same data as holotype (CMNZ). Paratypes. ND. Type locality: 37 male and 8 female imagos, 10 male and 8 female subimagos, 19 nymphs, 8 May 2009, S. R. Pohe; 5 female imagos, 2 male and 5 female subimagos, 24 October 2008, S. R. Pohe; 4 nymphs, 20 November 2008, O. Ball & M.J. Winterbourn; 2 nymphs 28 April 2008, S. R. Pohe.

ETYMOLOGY: The species is named after Stephen Pohe (NorthTec, Whangarei) who collected most of the nymphs and winged stages and realised they were something different.

DISCUSSION: *Aupouriella pohei* is known only from the type locality, Whiriwhiri Stream, near North Cape. Nymphs were found in the lower 100 m of the stream where it flowed through native coastal forest and had a width of 3–4 m. Nymphal habitat was mainly cobbles and gravel. Associated invertebrates included several other leptophlebiid species (*Zephlebia borealis* (Phillips), *Z. spectabilis* Towns, *Acanthophlebia cruentata* (Hudson), *Austroclima jollyae* Towns & Peters, *Deleatidium* spp.) and also *Coloburiscus humeralis* (Walker) (Coloburiscidae). Larvae of several caddisflies (*Hydrobiosis*, *Polyplectropus* and *Olinga*) and the megalopteran *Archichauliodes diversus* (Walker) were also present.

Collections made in other coastal streams in the far north of New Zealand by Stephen Pohe and Department of Conservation personnel (W. L. Chadderton pers. comm.), and examined by the author, contained no nymphs of *A. pohei*, despite the presence of other leptophlebiid species associated with it in Whiriwhiri Stream. *Aupouriella pohei* appears to be a genuinely rare species which remained undiscovered until very recently despite considerable collecting and searching for mayflies in northern New Zealand in the 1970s and 80s (Towns & Peters 1996). Its known habitat, Whiriwhiri Stream, lies outside the North Cape Scientific Reserve and is protected principally by its remoteness and difficulty of access.

Finally, the unusual male eyes may be related to the mating behaviour of the species. Mayflies exhibit a wide range of swarming behaviours (Fischer 1984) and the males of some species with non-divided eyes do not swarm high above the water (Brodsky 1973). This behaviour is consistent with the square facets of dorsal eyes being sensitive only to ultraviolet light, as in an Australian *Atalophlebia* species (Horridge & McLean 1978) and may enable males to see females against the background of the sky more clearly (Horridge et al. 1982). Therefore, the absence of square facets in the eyes of *A. pohei* may indicate that it does not have mating swarms, or perhaps has limited swarming behaviour over small streams within forest.

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REFERENCES

- Brodsky AK 1973. The swarming behavior of mayflies. *Entomological Review* 52: 33–39.
- Campbell IC, Peters WL 1993. A revision of the Australian Ephemeroptera genus *Atalomicria* Harker (Leptophlebiidae: Atalophlebiinae). *Aquatic Insects* 15: 89–107.

- Crosby TK, Dugdale JS, Watt JC 1998. Area codes for recording specimen localities in the New Zealand subregion. *New Zealand Journal of Zoology* 25: 175–183.
- Dean JC 1988. Description of a new genus of leptophlebiid mayfly from Australia (Ephemeroptera: Leptophlebiidae: Atalophlebiinae). *Proceedings of the Royal Society of Victoria* 100: 39–45.
- Dean JC, Suter PJ 2004. Descriptions of new species and a new genus of leptophlebiid mayflies (Insecta: Ephemeroptera) from the Northern Territory, Australia. *Memoirs of Museum Victoria* 61: 111–118.
- Dean JC, Forteath GNR, Osborn AW 1999. *Loamagga-langta pedderensis* gen. & sp. nov.: a new mayfly from Tasmania (Ephemeroptera: Leptophlebiidae: Atalophlebiinae). *Australian Journal of Entomology* 38: 72–76.
- Dean JC, Forteath GNR, Osborn AW 2008. *Marmenuera*, a new genus of leptophlebiid mayfly (Insecta: Ephemeroptera) endemic to Tasmania. *Memoirs of Museum Victoria* 65: 43–50.
- Fischer C 1984. The swarming behaviour of stream inhabiting mayflies (Ephemeroptera). In: Landa V, Soldán T, Tonner M ed. *Proceedings of the IVth International Conference on Ephemeroptera*, Czechoslovak Academy of Sciences. Pp. 281–282.
- Gaino E, Rebora M 1995. Comparative study of the mating apparatus of three species of Leptophlebiidae (Ephemeroptera). *Aquatic Insects* 17: 95–104.
- Hitchings T 2008. A new species of *Deleatidium* (*Penniketellum*) and the adult of *D. (P.) cornutum* Towns and Peters (Ephemeroptera: Leptophlebiidae) from New Zealand. *Records of the Canterbury Museum* 22: 31–43.
- Horridge GA, McLean M 1978. The dorsal eye of the mayfly *Atalophlebia* (Ephemeroptera). *Proceedings of the Royal Society of London B* 200: 137–150.
- Horridge GA, Marcelja L, Jahnke R 1982. Light guides in the dorsal eye of the male mayfly. *Proceedings of the Royal Society of London B* 216: 25–51.
- O'Donnell BC, Jockusch EL 2008. Phylogenetic relationships of leptophlebiid mayflies as inferred by *histone H3* and *28S ribosomal DNA*. *Systematic Entomology* 33: 651–667.
- Pescador ML, Peters WL 1980. Phylogenetic relationships and zoogeography of cool-adapted Leptophlebiidae (Ephemeroptera) in southern South America. In: Flannagan JF, Marshall KE ed. *Advances in Ephemeroptera Biology*. New York, Plenum. Pp. 43–56.
- Peters WL, Edmunds GF Jr 1964. A revision of the generic classification of the Ethiopian Leptophlebiidae (Ephemeroptera). *Transactions of the Royal Entomological Society of London* 116: 225–253.
- Peters WL, Gillies MT 1995. Square facets in a hexagonal world. In: Corkum L, Ciborowski J ed. *Current directions in research on Ephemeroptera*. Toronto, Canadian Scholars Press. Pp. 371–375.
- Towns DR, Peters WL 1996. Leptophlebiidae (Insecta: Ephemeroptera). *Fauna of New Zealand* 36.