New genera and species of Leptophlebiidae (Ephemeroptera) from New Zealand

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New genera *Isothraulus, Arachnocolus,* and *Penniketellus* are established for three species of leptophlebiid mayfly from New Zealand. Each genus is monotypic and endemic to New Zealand. *Isothraulus* and *Arachnocolus* are known only from the northern North Island, and *Penniketellus* is known only from the Arthur's Pass area of the central South Island. The male and female imago, nymph, and egg of *Isothraulus abditus* n.sp., the male imago, male subimago, and nymph of *Arachnocolus phillipsi* n.sp., and the male and female imago, female subimago, and egg of *Penniketellus insolitus* n.sp. are described. The relationships of each genus and the ecology of nymphs of each species are discussed.

INTRODUCTION

The following account establishes three new genera, two of which are among several undescribed leptophlebiid species collected during a study of the Waitakere River, near Auckland (Towns 1976, 1978a, b, 1979). Two species, *Austroclima jollyae* and *Mauiulus luma,* have recently been described from this material by Towns & Peters (1979). The new genera are established here for species listed as "*Zephlebia* sp. A" in Towns (1978b) and "Gen. nov. sp. A" in Towns (1978a, b). The third new genus is known only from imagos and subimagos collected at a single locality high in the Southern Alps of the central South Island.

Methods and conventions used here follow Towns & Peters (1978, 1979). Sample sizes are not given; all measurements are based on less than five specimens, except for nymphs of *Arachnocolus phillipsi.*

Abbreviations of collectors' names are as follows: BWH, B.W. Hayward; DRT, D.R. Towns; ELT, E.L. Towns; GCH, G.C. Hayward; GW, G. Watson; JAM, J.A. McLean; JGP, J.G. Penniket; JRJ, J.R. Jackson; LJD, L.J. Dumbleton; MB, M. Black.

Isothraulus n.gen.

IMAGO. Length: ♂ – body 6.7–7.9 mm, forewings 7.8–8.2 mm; ♀ – body 6.9–7.9 mm, forewings 7.5–8.8 mm.

Eyes: ♂ – fused on meson of head, lower portion a little more than 2/3 to 3/4 length of upper portion; ♀ – separated on meson of head by 2½× maximum width of eye.

Wings (Fig. 1–3). Forewings: width a little more than 1/3 length. Vein Rs forked 1/5 distance from base to margin. Vein MA forked half distance from base to margin, fork symmetrical. Vein MP not forked; MP_2 attached at base to CuA and MP_1 with a cross vein, attachment of MP_2 to MP_1 a little less than 1/5 distance from base to margin, base of MP_2 closer to CuA than to MP_1. Vein ICu_1 attached at base to CuA and CuP with cross veins, remainder of Cu-A area as in Fig. 1, cross veins few. Hind wings: costal margin convex, with or without a concavity on midcostal margin (Fig. 3); apex acute. Width of hind wings a little less than 3/5 to 3/5 length, and length of hind wings 1/5 maximum length of forewings. Vein Sc a little less than 2/3 to 2/3 length of wings, R_1 a little less than 3/4 to a little more than 4/5 length of wings; cross veins few (Fig. 3).

Legs. Forelegs broken off and missing. Claws of a pair alike, apically hooked with an opposing hook (Fig. 7).

Male genitalia (Fig. 4–6). Forceps: segment 2 equal in length to segment 3 and a little less than 1/5 length of segment 1; apex of segment 3 rounded; base of forceps broad, inner margin forming an angular to smooth bend near midlength (Fig. 4). Styliger plate a little less than 9/10 as long medially as maximum width, apex slightly concave to slightly convex. Penes: lobes narrow, about as long as forceps, and fused to apex; a row of hairs on ventral surface at base of each penis opening (Fig. 5).

Ninth sternum of ♀ entire (Fig. 11); ovipositor or egg guide extended entire length of 8th sternum (Fig. 10).

Terminal filament a little longer than cerci.

NYMPH. Head prognathous. Antennae 2½× length of head.

Mouthparts (Fig. 13–18). Labrum: length half

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maximum width, with dorsal hair as in Fig. 14, and submedian, anterosubmedian, and anterolateral areas of hair ventrally; anterior margin concave, with small, subequal-sized denticles ventrally as in Fig. 13; lateral margins rounded (Fig. 14). Clypeus as in Fig. 14. Left mandible (Fig. 15) with small hair tuft on mid outer margin, outer margin rounded as in Fig. 15; incisors with unserrated apical teeth; prosthecal tuft reduced (Fig. 15). Hypopharynx: lingua with well developed lateral processes, each process with fine hairs on apical margin (Fig. 17), apex of submedian lobes triangular, with sclerotised processes on each anterolateral margin (Fig. 17); superlingua as in Fig. 17. Maxillae: apical half of galea-lacinia narrow, with a subapical row of 18–25 spines (Fig. 16); segment 2 of palpi about equal in length to segment 1, segment 3 7/10 length of segment 2 (Fig. 16). Labium as in Fig. 18; palpi slender, segment 2 9/10 length of segment 1, segment 3 7/10 length of segment 2; glossae dorsal to paraglossae; submentum as in Fig. 18, with long spines on lateral margins.

Pronotum with spines on anterolateral margin. Legs (Fig. 19): tibiae in cross-section circular, tarsi in cross-section oval (Fig. 20, 21); apical half of femora indented so tibia can draw into femur (Fig. 19); basal 2/3 of femora with pointed spines on dorsal surface (Fig. 19) and scattered over ventral surface (Fig. 19); fore tibiae with numerous large, finely and coarsely bipectinate spines on inner surface (Fig. 27); apex of claws hooked and narrow, denticles on claws well developed, progressively larger apically (Fig. 22).

Gills (Fig. 23) on segments 1–7 alike, progressively smaller posteriorly, dorsal and ventral portions of lamellae plate-like, margin fringed (Fig. 23). Abdomen with posterolateral spines on segments 7–9. Caudal filaments 2× body length, terminal filament a little longer than cerci, each segment with a distal whorl of prominent hairs.

EGG elongate oval (Fig. 25); chorion covered with closely packed, roughly hexagonal attachment structures each with outer margin notched as in Fig. 26.

ETYMOLOGY: isos, Gr., 'like'; *Thraulus*, a genus of Leptophlebiidae. Masculine.

TYPE SPECIES: *Isothraulus abditus* n.sp.

REMARKS. *Isothraulus* can be distinguished from all other leptophlebiid genera by the following combinations of characters. In the imago: (1) vein Sc of hind wings 2/3 (or a little less) length of wing (Fig. 3); (2) styliger plate narrow, elongated (Fig. 4); (3) penis lobes elongated, about as long as forceps, and fused to apex (Fig. 4); (4) penes with hairs at base of each penis opening (Fig. 5); (5) claws of a pair similar (Fig. 7); (6) ninth sternum of female entire (Fig. 11); (7) ovipositor or egg guide extended entire length of eighth sternum (Fig. 10). In the nymph: (1) labrum rounded on lateral margins and with a concave anterior margin (Fig. 14); (2) ventral denticles on anteromedian margin of labrum subequal in size (Fig. 13); (3) mandibles with a small marginal tuft of hair (Fig. 15); (4) galea-lacinia of maxillae narrow, with a subapical row of 18–25 spines (Fig. 16); (5) abdominal gills with plate-like, fringed, double lamellae (Fig. 23); (6) caudal filaments 2× body length, with a distal whorl of prominent hairs; (7) abdominal segments 7–9 with spines on posterolateral margins.

Isothraulus appears to be most closely related to *Thraulus*, and is therefore part of a complex of genera known previously only from the Ethiopian, Palearctic, and Oriental regions.

Isothraulus can be distinguished clearly from *Thraulus* in the imaginal stage, but separation of the nymphs is more difficult. *Thraulus* nymphs include several natural groups on the basis of gill structure, but these groups cannot be distinguished in the imagos (Peters & Edmunds 1970). More recently, Peters & Tsui (1972) have described two species of *Thraulus* from north-east New Guinea and two species from South-east Asia. We have re-examined this material, several undescribed species from New Guinea, and species from Africa and the Comoro Islands. On the basis of mouthparts, denticles on the claws, and abdominal gill structure at least four groups of nymphs can be recognised. Some of these groups can be distinguished from others by character states which in other leptophlebiids would separate genera or even generic complexes. Clearly the species groups in this genus require comprehensive study, as both nymphs and imagos, to determine whether they rate subgeneric or generic status.

In addition to similarities with *Thraulus*, *Isothraulus* has many morphological characters in common with *Zephlebia* of New Zealand. These include the outline shape of the hind wings (Fig. 2, 3), row of hairs at the base of each penis opening (Fig. 4, 5), venation of the forewings (Fig. 1), the similar apically hooked claws of the imago (Fig. 7), and glossae of the labium with a dense cover of fine hairs on the ventral surface (Fig. 18). Many of the character states shared by *Isothraulus* and *Zephlebia* imagos appear to be primitive, whereas the nymphs of *Isothraulus* have many derived character states in common with *Thraulus*. Further, several derived character states, such as the well developed ovipositor or egg guide in the female imago (Fig. 10) and the narrow styliger plate in the male imago (Fig. 4), occur in *Isothraulus* but

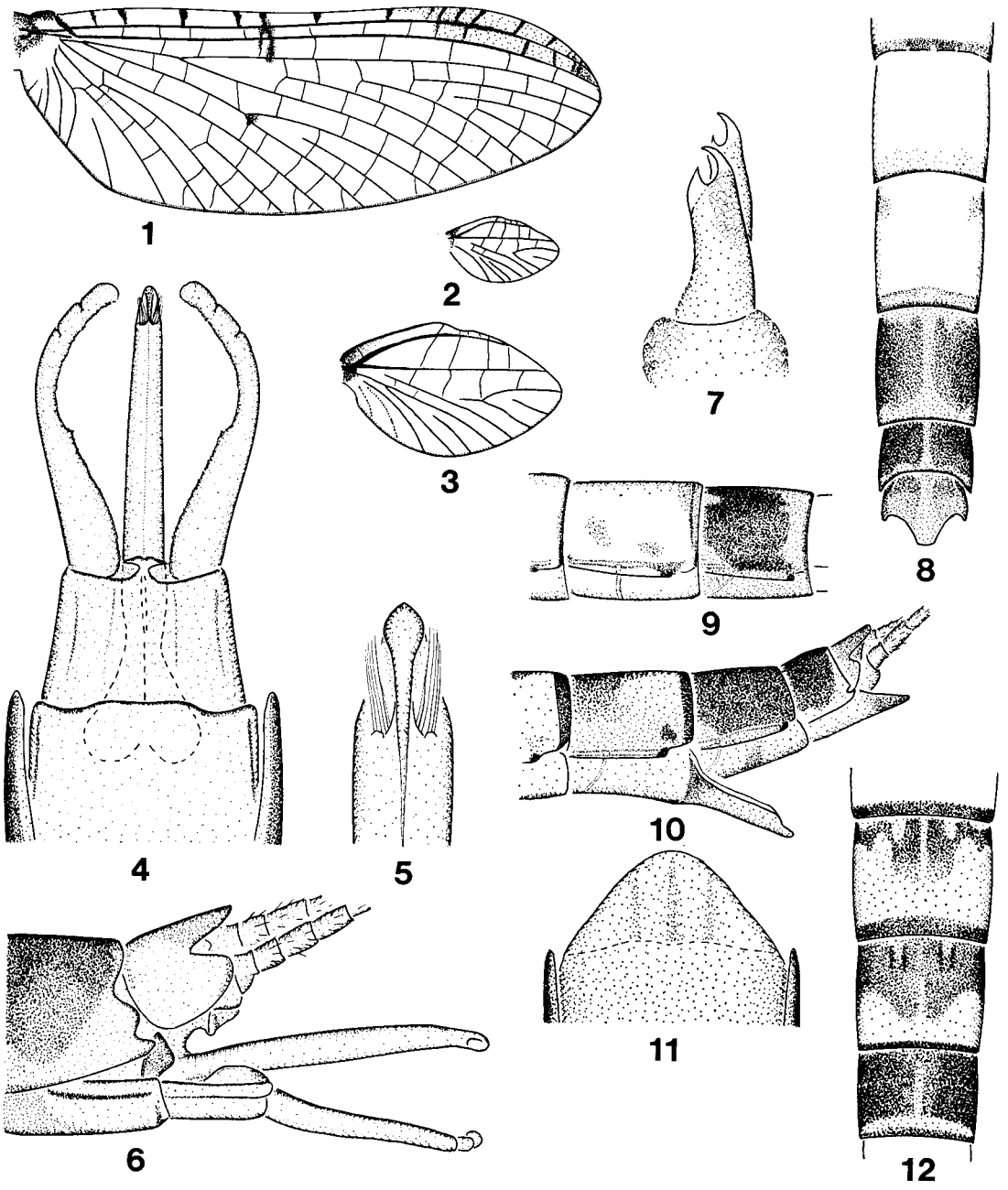

Fig. 1–12. *Isothraulus abditus.* **(1–9)** ♂ imago: 1, forewing; 2, hind wing; 3, hind wing, enlarged; 4, genitalia, ventral view; 5, apex of penes, enlarged; 6, genitalia, lateral view; 7, mid claws; 8, abdominal segments 6–10, dorsal view; 9, abdominal segments 7–8, lateral view. **(10–12)** ♀ imago: 10, abdominal segments 7–10, lateral view; 11, 9th sternum; 12, abdominal segments 6–8, dorsal view.

not in *Zephlebia* or *Thraulus*. We therefore consider *Isothraulus* to be worthy of generic rank until an extensive study of *Thraulus* and related genera is available.

Isothraulus can be distinguished from *Thraulus* by the following characters. In the imago: (1) claws of a pair similar (Fig. 7); (2) females with large ovipositor or egg guide (Fig. 10); (3) hind wings without costal projection (Fig. 2, 3); (4) penes fused, and with hairs at base of each penis opening (Fig. 4, 5). In the nymph: (1) labrum with well developed denticles (Fig. 13); (2) mandibles with hairs confined to mid outer margin (Fig. 15); (3) glossae of labium with dense cover of fine hairs on ventral surface (Fig. 18); (4) labial palpi with segment 3 less than 3/4 length of segment 2; (5) claws with denticles well developed, progressively larger apically (Fig. 22); (6) abdominal gills of segments 1–7 similar, plate-like, progressively smaller posteriorly (Fig. 23). The presence of hair only on the outer margin of the mandibles and the fine hairs on the ventral surface of the glossae will separate nymphs of *Isothraulus* from all species of *Thraulus* we have studied.

Isothraulus abditus n.sp. (Fig. 1–27)

Towns, 1978b: 409 (as *Zephlebia* sp. A).

MALE IMAGO (in ethanol). Head pale yellowish-brown with small black markings dorsally near scape of antennae and irregular black markings on venter. Upper portion of eyes pale brownish-orange, lower portion black. Antennae pale yellowish-brown, flagellum paler. Basal half of ocelli greyish-black, apical half greyish-white.

Thorax. Pronotum pale yellowish-brown, irregularly washed with black submedially and on margins; mesonotum pale brown, except margins, carinae, and posterior scutellum dark brown. Pleura pale, whitish, except a large, irregular, blackish-brown transverse band around pleura and sterna at articulation with each coxa; remainder of sterna whitish. Legs. Forelegs broken off and missing; middle and hind legs pale, with a narrow, dark-brown band on femora at articulation with tibiae; coxae brown, irregularly washed with black. Wings (Fig. 1–3): longitudinal and cross veins of fore and hind wings pale to dark brown; membranes hyaline, except base washed with pale brown and apical 1/3 of cells C and Sc of forewings translucent, whitish; cross veins of forewings in cell C, apical 1/3 of cell Sc, veins Sc and R_1 at bulla, and fork of MA surrounded with narrow, purplish-brown clouds, those of cells C, Sc, and R_1 fused near bulla.

Abdomen (Fig. 8, 9). Terga 1–7 hyaline, with a narrow, diffuse to distinct, transverse black band on posterior margin; tergum 7 with paired, indistinct, greyish anterolateral markings (Fig. 8); terga 8 and 9 dark brown, paler on midline and margins, as in Fig. 8 & 9; tergum 10 pale brown, often paler on midline, as in Fig. 8; spiracular area black, tracheae hyaline. Sterna 1–7 hyaline, sternum 1 with diffuse brown markings on mid anterior margin; sterna 8 and 9 translucent, whitish, sternum 8 sometimes washed with brown on posterior margin. Genitalia pale, whitish. Caudal filaments white.

FEMALE IMAGO (in ethanol). Head. Colour and markings as in ♂ imago, except midline dark brown and large, paired, dark-brown maculae present on posterior margin of head between eyes. Eyes black. Antennae and ocelli as in ♂ imago.

Thorax. Colour and markings of thorax, legs, and wings as in ♂ imago.

Abdomen (Fig. 10, 12). Terga 1–7 pale, brownish, with a narrow, dark-brown transverse band on posterior margin; terga 1–5 or 2–5 with a broad, mid-dorsal, dark-brown line entire length of tergum; anterior 2/3 of terga 6 and 7 dark brown (Fig. 12); terga 2–7 with transverse, dark-brown markings on anterior margin and paired, pale-brown, anterior, submedian maculae (Fig. 12); terga 8 and 9 dark brown; tergum 10 pale brown (Fig. 10, 12); spiracular area black, tracheae hyaline, edged with dark grey (Fig. 10). Sterna pale, brownish, markings as in ♂ imago. Caudal filaments pale, whitish, with pale-brown annulations at articulations.

MALE AND FEMALE SUBIMAGO. Unknown.

NYMPH (in ethanol). Head pale brown, midline black from posterior margin of head to ocelli, dark-brown markings posteriorly and laterally to eyes (Fig. 24). Ocelli as in ♂ and ♀ imago. Upper portion of eyes of ♂ pale reddish-brown, lower portion black, eyes of ♀ unknown. Antennae pale, whitish.

Thorax. Nota pale brown, pronotum with darker markings medially and on posterior margin, mesonotum with complex darker markings as in Fig. 24, metanotum darker medially and on anterior and posterior margins (Fig. 24); pleura and sterna as in ♂ and ♀ imago. Legs: femora pale brown, darker near apex (Fig. 19); tibiae and tarsi pale brown (Fig. 19).

Abdomen. Colour and markings as in ♂ and ♀ imago. Gills (Fig. 23): lamellae greyish purple, tracheae and tracheal branches a little darker. Caudal filaments pale brown.

MATERIAL EXAMINED. **Holotype** ♂ imago, small trib. of Waitakere R. nr Anderson's Track, Auckland, light trap, 16 Feb 1977, MB; **allotype** ♀ imago,

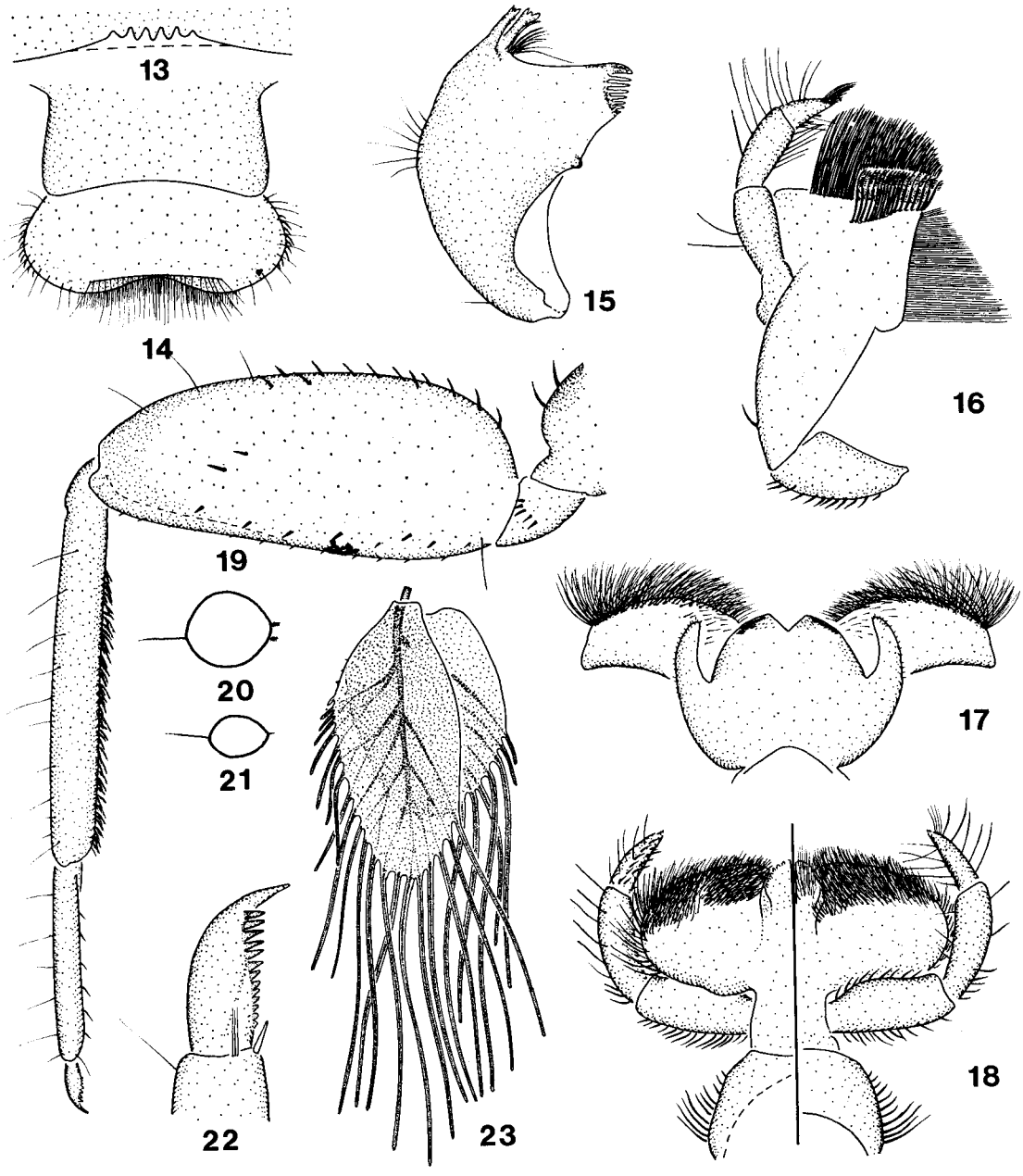

Fig. 13–23. *Isothraulus abditus,* nymph: 13, denticles in anteromedian emargination of labrum, enlarged; 14, labrum and clypeus, dorsal view; 15, left mandible, dorsal view; 16, right maxilla, ventral view; 17, hypopharynx; 18, labium, dorsal (left) and ventral views; 19, foreleg; 20, cross-section through tibia; 21, cross-section through tarsus; 22, fore claw; 23, abdominal gill 4.

data as for holotype. **Paratypes.** North Island. **AK.** Data as for holotype: 7 ♂ imagos; 1 ♂ imago, 22 Feb 1977. Cascade Stm: 1 ♀ imago, 1 ♀ subimago, light trap, 9 Mar 1977, MB. Waitakere R.: 1 nymph, from pool margin, 16 Jun 1976, ? coll.; 8 nymphs, from algal detritus in pool, 24 Jan 1974, DRT; 1 nymph, drift sample, 1970, GW.

Association of nymphs and adults is by comparison of colour patterns.

Repositories (all type specimens are in ethanol): holotype, allotype, 5 ♂ imaginal paratypes, 1 ♀ imaginal paratype, 1 ♀ subimaginal paratype, and 8 nymphal paratypes – Entomology Division, DSIR, Auckland; 2 ♂ imaginal paratypes and 2 nymphal paratypes – Florida A & M University, Tallahassee.

REMARKS. A single male imago collected from the Kauaeranga River valley in the Coromandel Ranges (DRT) appears to be a second species of *Isothraulus*. It differs from *I. abditus* in general colour and in colour patterns on the wings and abdominal terga. However, the specimen is slightly damaged, and will not be described until more material is available.

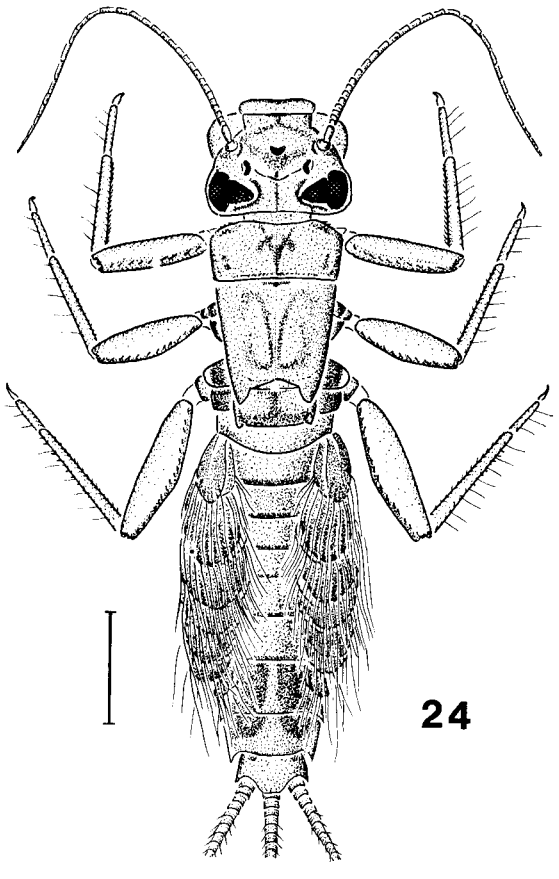

Fig. 24. *Isothraulus abditus*, nymph (scale line 1 mm).

ETYMOLOGY: abditus, L., 'hidden', in reference to the biology of the nymphs.

BIOLOGY. *Isothraulus abditus* is known only from streams in the Waitakere Ranges, near Auckland. The few nymphs collected have been obtained in pools, either on vegetation at the pool margins or under stones partly buried in algal detritus. Nymphs very similar to those described here occur in pools with little or no flow in streams on Little Barrier Island (T.K. Crosby, pers. comm.).

Arachnocolus n.gen.

MALE IMAGO (female imago unknown). Length: body 6.6–7.2 mm, forewings 6.9–7.5 mm.

Eyes fused on meson of head, lower portion a little more than 2/3 to a little less than 3/4 length of upper portion.

Wings (Fig. 31–33). Forewings: width 1/3 length. Vein Rs forked a little less than 1/5 distance from base to margin. Vein MA forked half distance from base to margin, fork symmetrical. Vein MP not forked, MP_2 attached at base to CuA and MP_3 with a cross vein, attachment of MP_2 to MP_1 1/5 distance from base to margin, base of MP_2 closer to CuA than MP_1. Vein ICu_1 attached at base to CuA and CuP by cross veins, remainder of Cu–A area as in Fig. 31, cross veins few. Hind wings: costal margin convex, apex acute (Fig. 33). Width of hind wings 6/10 length, length of hind wings a little less than 1/5 length of forewings. Vein Sc 3/4 length of wings, R_1 9/10 length of wings; cross veins few.

Legs. Ratios of segments in ♂ forelegs 0.69: 1.00 (2.7 mm): 0.04: 0.39: 0.39 : 0.28 : 0.11. Claws of a pair alike, apically hooked, with an opposing hook (Fig. 36).

Genitalia (Fig. 34, 35). Forceps: segment 2 3/4 length of segment 3 and 1/8 length of segment 1; apex of segment 3 rounded; base of forceps broad, inner margin of segment 1 with a small lobe and forming an angular bend near midlength (Fig. 34). Styliger plate 2/5 as long medially as maximum width, apex shallowly cleft (Fig. 34). Penis lobes half length of forceps segment 1, fused except for apical 1/10, a row of hairs on ventral surface of each lobe at base of penis opening (Fig. 34). Terminal filament a little longer than cerci.

MATURE NYMPH. Length: body 6.6–7.2 mm. Head prognathous. Antennae 2× length of head.

Mouthparts (Fig. 39–44). Labrum: length half (to a little less) maximum width, dorsal hair as in Fig. 40, submedian, anterosubmedian, and anterolateral areas of hair ventrally; anteromedian emargination concave, with broad-based, rounded, anteromedian denticles (frequently indistinct) as in

Fig. 39; lateral margins rounded (Fig. 40). Clypeus as in Fig. 40, anterior margin concave. Left mandible (Fig. 41) with hair row from mid outer margin almost to base of incisors, as in Fig. 41; outer margin of basal half smoothly curved, apical half straight (Fig. 41); incisors with unserrated apical teeth; prosthecal tuft reduced (Fig. 41). Hypopharynx: lingua with well developed lateral processes, apex of submedian lobes rounded, with sclerotised processes on each anterolateral margin (Fig. 43); superlingua as in Fig. 43, with a row of hairs along anterior margin and blunt lateral margins. Maxillae: apical half of galea-lacinia narrow, with a subapical row of 29–32 spines (Fig. 42); segment 2 of palpi subequal in length to segment 1, segment 3 3/5 to 2/3 length of segment 2 (Fig. 42). Labium as in Fig. 44; palpi slender, segment 2 4/5 to equal length of segment 1, segment 3 3/5 to 3/4 length of segment 2; glossae broad, dorsal to paraglossae; lateral margins of submentum with 4–6 spines, as in Fig. 44.

Pronotum with small spines on anterolateral margin. Legs (Fig. 45): tibiae and tarsi in cross-section elongate oval, slightly concave on anterior surface (Fig. 46, 47); apical 2/3 of femora indented so tibia can draw into femur (Fig. 45); basal half of femora with bipectinate spines on ventral surface; foretibiae with numerous, large, coarsely bipectinate spines on inner surface (Fig. 28); apex of claws hooked, narrow, denticles on claws well developed, progressively larger apically (Fig. 48).

Gills (Fig. 49, 50) on segments 1–6 alike, progressively smaller posteriorly, gill 7 reduced to a single, thread-like filament (Fig. 50); dorsal and ventral portions of lamellae of gills 1–6 oval, dorsal portion narrower than ventral, each portion terminated in a long, slender, median filament, filament longer on dorsal portion of lamellae (Fig. 49). Abdomen with posterolateral spines on segments 6–9 or 7–9. Terminal filament a little longer than cerci.

EGG unknown.

ETYMOLOGY: arachne, Gr., 'spider'; kolon, Gr., 'limb'; in reference to the unusually long, slender legs of the nymph. Masculine.

TYPE SPECIES: *Arachnocolus phillipsi* n.sp.

REMARKS. *Arachnocolus* can be distinguished from all other leptophlebiid genera by the following combinations of characters. In the male imago: (1) hind wings with a convex costal margin, and vein Sc 3/4 maximum length of wings (Fig. 33); (2) penes half length of segment 1 of forceps, fused except for apical 1/10, and with hairs at base of each penis opening (Fig. 34); (3) claws of a pair alike (Fig. 36); (4) forewings without distinct clouds of pigment or tinted costal margin. In the nymph: (1) labrum rounded on lateral margins, and with a

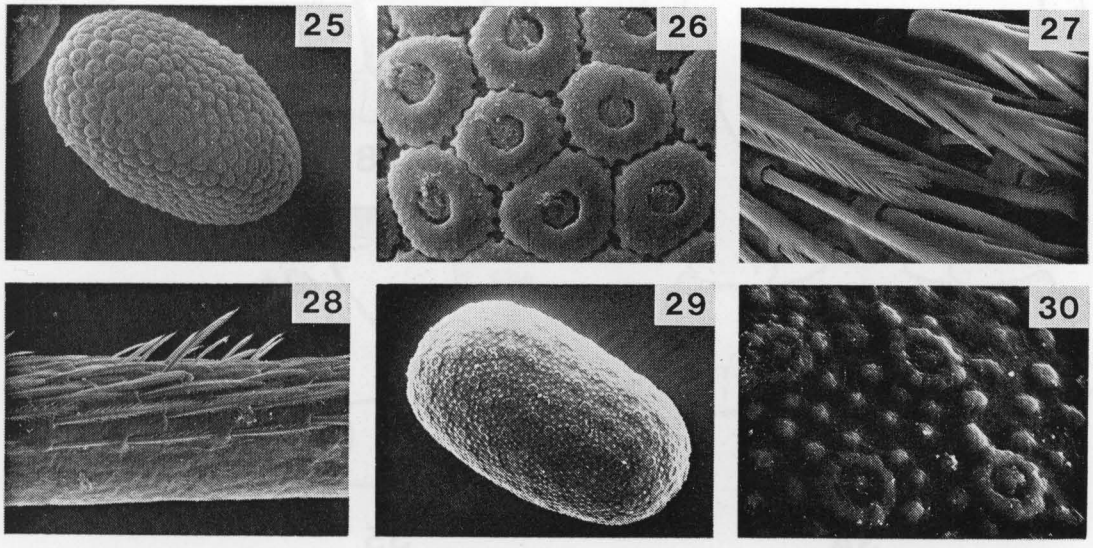

Fig. 25–30. Scanning electron micrographs of eggs and tibial spines: 25, *Isothraulus abditus*, egg (×240); 26, *I. abditus*, attachment structures of egg (×1300); 27, *I. abditus*, inner margin of fore tibia (×850); 28, *Arachnocolus phillipsi*, inner margin of fore tibia (×230); 29, *Penniketellus insolitus*, egg (×230); 30, *P. insolitus*, ornamentation on chorion of egg (×1500).

concave anterior margin (Fig. 40); (2) anteromedian emargination of labrum with broad-based, rounded denticles (Fig. 39); (3) outer margin of mandibles with basal half smoothly curved and apical half straight, hair extended from mid outer margin to near incisors (Fig. 41); (4) galea-lacinia of maxillae with a subapical row of 29–32 spines (Fig. 42); (5) abdominal gills 1–6 with double oval lamellae, gill 7 reduced to a single filament (Fig. 49, 50); (6) legs long, slender (Fig. 45); (7) caudal filaments 2× body length; (8) abdominal segments 6–9 or 7–9 with spines on posterolateral margin.

Arachnocolus appears to be related to several undescribed genera from New Caledonia (Peters & Peters, in prep.).

Arachnocolus phillipsi n.sp. (Fig. 28, 31–52)

Towns, 1978a: 367, 369. –Towns, 1978b: 411 (as Gen. nov. sp. A).

MALE IMAGO (in ethanol). Head whitish, blackish-brown on anterior margin, with blackish-brown

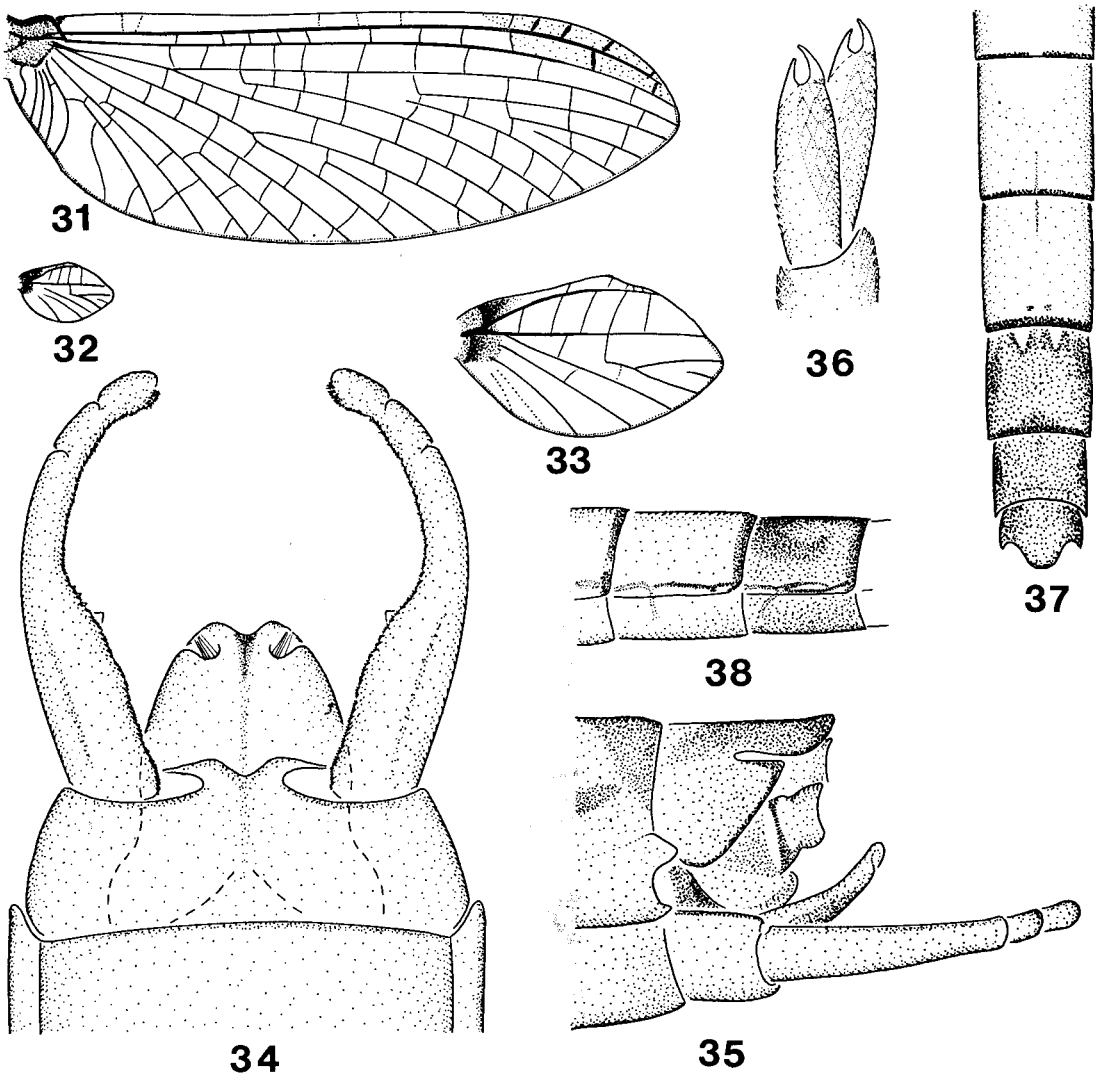

Fig. 31–38. *Arachnocolus phillipsi*, ♂ imago: 31, forewing; 32, hind wing; 33, hind wing, enlarged; 34, genitalia, ventral view; 35, genitalia, lateral view; 36, fore claws; 37, abdominal segments 6–10, dorsal view; 38, abdominal segments 7–8, lateral view.

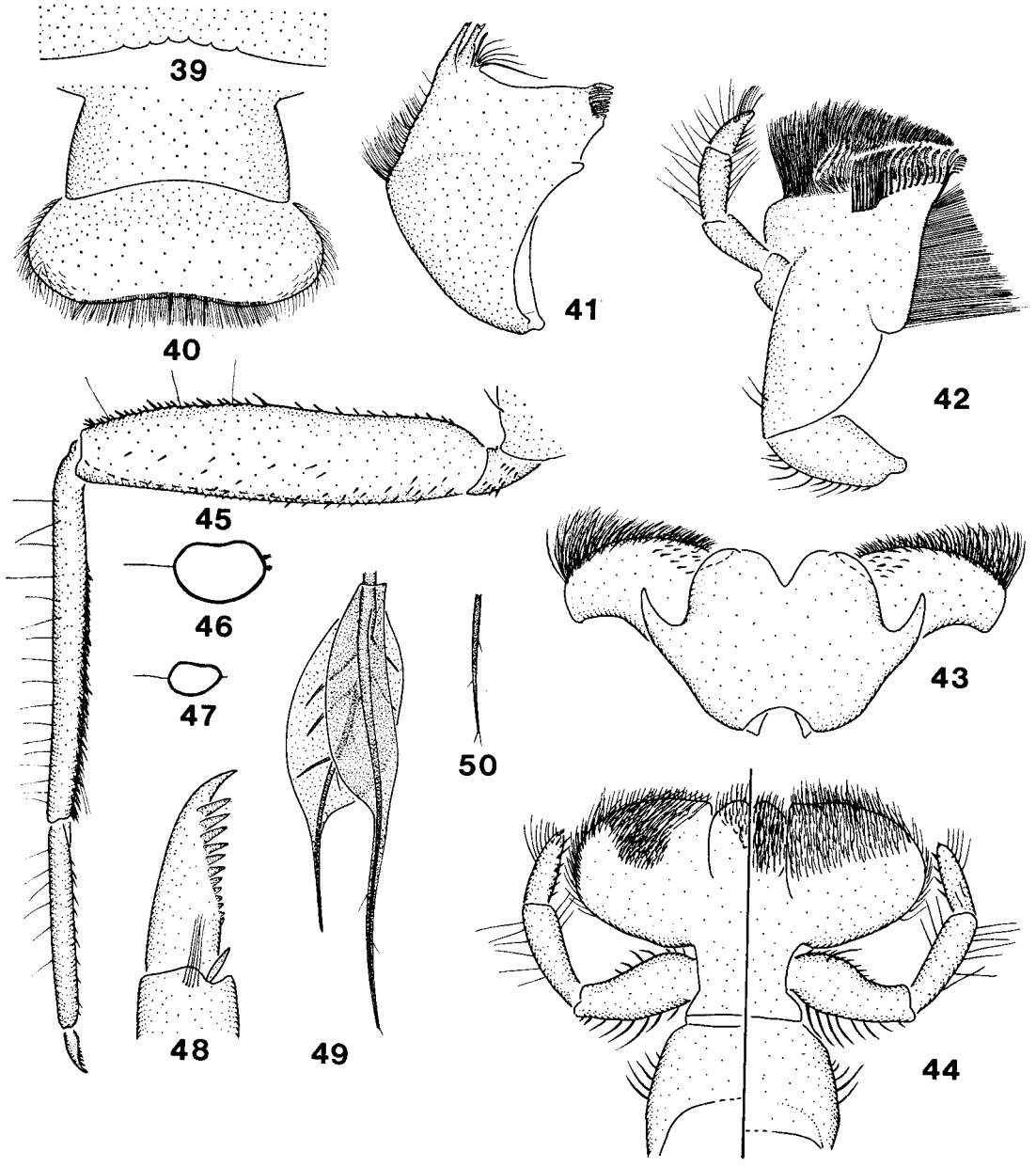

Fig. 39–50. *Arachnocolus phillipsi*, mature nymph: 39, denticles in anteromedian emargination of labrum, enlarged; 40, labrum and clypeus, dorsal view; 41, left mandible, dorsal view; 42, right maxilla, ventral view; 43, hypopharynx; 44, labium, dorsal (left) and ventral views; 45, foreleg; 46, cross-section through tibia; 47, cross-section through tarsus; 48, fore claw; 49, abdominal gill 4; 50, abdominal gill 7.

markings dorsal to scape of antennae and extended to lower portion of eyes. Upper portion of eyes pale brownish-orange, lower portion dark grey. Scape of antennae brown, pedicel whitish, flagellum pale brown. Basal half of ocelli black, apical half white.

Thorax. Pronotum pale brown, dark brown on margins, and with paired, dark-brown submedian lines; meso- and metanota pale brown, except carinae and scutellum darker. Pleura pale brown, irregularly washed with dark brown. Sterna pale brown, carinae darker, sutures whitish-brown. Legs pale yellowish-white, brown at articulation of forefemora/tibiae and foretibiae/tarsi, pale brown at articulation of mid and hind femora/tibiae; coxae pale brown. Wings (Fig. 31–33): longitudinal veins of forewings pale brown, except veins Sc and R_1 brown at apical 1/3 of wings; cross veins of forewings and all veins of hind wings colourless, except cross veins in cells C and Sc at apical 1/3 of forewings brown and surrounded with narrow, brown clouds; membranes hyaline, except base of forewings washed with pale brown, base of hind wings washed with pale and dark brown, and apical 1/3 of cells C and Sc of forewings translucent, whitish.

Abdomen (Fig. 37, 38). Terga 1–7 hyaline, with a narrow, indistinct, dark-brown transverse band on posterior margin; tergum 1 occasionally washed with pale brown on anterior margin; terga 6–7 or tergum 7 translucent, whitish; tergum 8 with pale, paired, submedian maculae; terga 8–10 pale brown, darker on lateral margins (Fig. 38); spiracular area brownish-black; tracheae hyaline, edged with dark brownish-grey, to dark brownish-grey (Fig. 38). Sterna 1–7 hyaline, sterna 8 and 9 pale brown. Genitalia pale brown, except apical 2/3 of forceps whitish. Caudal filaments broken off and missing.

MALE SUBIMAGO (in ethanol) (female subimago unknown). Colour and markings of head, ocelli, and antennae as in ♂ imago. Upper portion of eyes pale brown, lower portion dark grey.

Thorax. Pronotum as in ♂ imago, but paler; dorsal mesonotum whitish-brown, except a broad, whitish band along posterior 2/3 of dorsum and inside outer parapsidal sutures (Fig. 52); mesonotum between outer parapsidal sutures and notal wing processes pale brown, darker anteriorly and along outer parapsidal sutures; lateral margins of basal humps of scutellum pale brown, dorsum whitish; posterior scutellum whitish, lateral margins brownish-white, posterior margin purplish-grey (Fig. 52). Pleura whitish, washed with pale and dark brown. Sterna whitish, furcasternum washed with pale brown. Wings: longitudinal veins of forewings pale brown, longitudinal and cross veins of hind wings and cross veins of forewings translucent, whitish, except cross veins in apical 1/3 of cells C and Sc of forewings pale brown; membranes translucent, greyish-white; base of membranes as in ♂ imago. Legs: colour and markings as in ♂ imago, except markings at articulations paler.

Abdomen. Colour and markings of terga as in ♂ imago, except general colour paler and terga

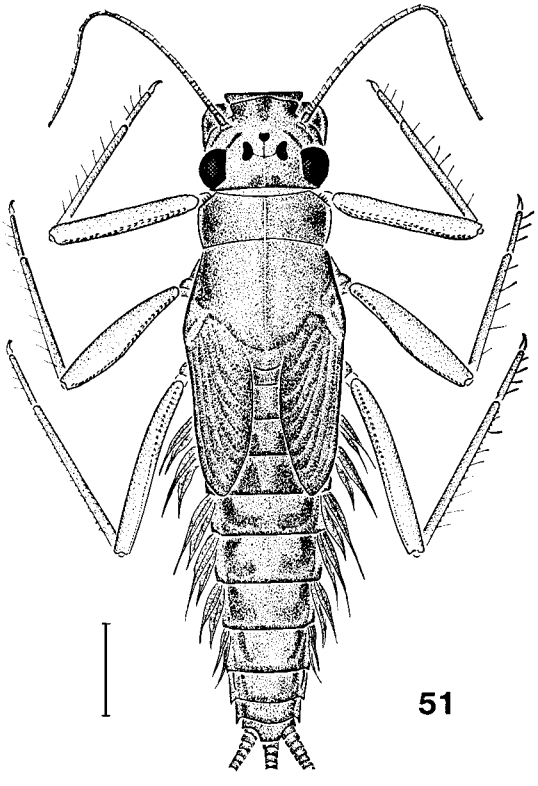

Fig. 51. *Arachnocolus phillipsi*, mature nymph (scale line 1 mm).

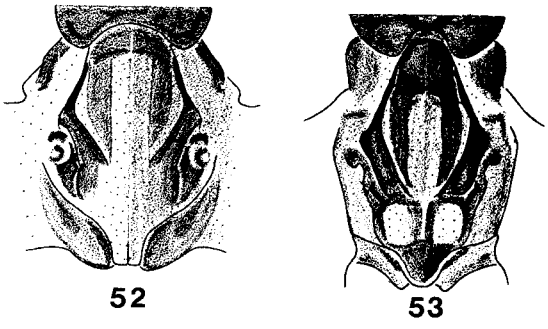

Fig. 52, 53. Mesothorax of subimago, dorsal view: 52, *Arachnocolus phillipsi*; 53, *Penniketellus insolitus*.

5–7 translucent, whitish. Sterna as in ♂ imago, except sterna 1–7 translucent and sterna 8 and 9 paler. Male genitalia pale brown. Caudal filaments pale brownish-white.

MATURE NYMPH (in ethanol). Head yellowish-brown to pale brown, markings as in ♂ imago. Ocelli black. Eyes of ♀ black; upper portion of eyes of ♂ brownish-red, lower portion black. Antennae pale yellowish-brown.

Thorax. Pronotum pale yellowish-brown to pale brown, markings as in ♂ imago (Fig. 51); mesonotum pale yellowish-brown to pale brown, occasionally darker on anterolateral margin; metathorax pale yellowish-brown. Legs: pale yellowish-brown, occasionally darker at articulation of femora and tibiae.

Abdomen. Colour and markings of ♂ as in ♂ subimago. Terga of ♀ pale yellowish-brown, terga 1–9 with pale to dark-brown lateral markings, as in Fig. 51; terga 2–5 or 2–6 with paired, submedian brown markings, as in Fig. 51. Gills (Fig. 49, 50): lamellae translucent, yellowish-brown; tracheae and tracheal branches dark brown. Caudal filaments pale yellowish-brown, each segment with a distal whorl of dark-brown denticles.

MATERIAL EXAMINED. **Holotype** ♂ imago, Cascade Stm, Auckland, reared from nymph, 5 Apr 1976, DRT. **Paratypes.** North Island. **ND.** Wairau R.: 5 nymphs, pools in ditch, 4 Apr 1963, LJD. **AK.** Small trib. of Waitakere R., nr Anderson's Track: 1 ♂ imago, light trap, 16 Feb 1977, MB. Cascade Stm: 1 ♂ subimago, reared from nymph, 5 May 1976, DRT; 7 nymphs, on overhanging *Elatostema*, 23 Feb 1976, DRT; 6 nymphs, 23 Mar 1976, DRT. Kitekite Stm, pool nr Kitekite Falls: 3 nymphs, 27 Dec 1976, DRT, ELT, BWH, GCH. **CL.** Trib. of Kauaeranga R.: 25 nymphs, in emergent and overhanging dead vegetation, 2 Jan 1977, DRT, ELT, BWH, GCH.

Association of nymphs and adults is by rearing.

Repositories (all type specimens are in ethanol): holotype, 1 ♂ imaginal paratype, 1 ♂ subimaginal paratype, and 36 nymphal paratypes – Entomology Division, DSIR, Auckland; 5 nymphal paratypes – Canterbury Museum, Christchurch; 5 nymphal paratypes – Florida A & M University, Tallahassee.

ETYMOLOGY: named in recognition of the early work on New Zealand Leptophlebiidae by Capt. J.S. Phillips.

BIOLOGY. *Arachnocolus phillipsi* is known only from the northern North Island of New Zealand. Nymphs of this species appear to be most abundant in slow-flowing parts of streams, particularly in vegetation trailing into the water. A distinctive mayfly fauna occurs with *A. phillipsi* in this habitat, which is described in more detail by Towns (1978a).

Penniketellus n.gen.

IMAGO. Length: ♂ – body 8.2–9.0 mm, forewings 10.0–11.4 mm: ♀ – body 7.8–8.8 mm, forewings 9.4–10.3 mm.

Eyes: ♂ – fused on meson of head, lower portion a little more than 3/4 to 4/5 length of upper portion; ♀ – separated on meson of head by a little more than 2× to 2½× maximum width of eye.

Wings (Fig. 54, 55). Forewings: width 2/5 length. Vein Rs forked 1/5 (to a little more) distance from base to margin. Vein MA forked half distance from base to margin, fork symmetrical. Vein MP not forked, MP_2 attached at base to CuA and MP_1 with a cross vein, attachment of MP_2 to MP_1 1/5 distance from base to margin, base of MP_2 closer to CuA than MP_1. Vein ICu_1 attached at base to CuA and CuP with cross veins; remainder of Cu-A area as in Fig. 54, with numerous long cross veins. Hind wings: costal margin slightly concave basally to midlength, wing apex rounded (Fig. 55). Width of hind wings 2/3 (to a little less) length, length of hind wings 1/3 length of forewings. Vein Sc a little more than 9/10 length of wings, R_1 equal to length of wings (Fig. 55).

Legs. Ratios of segments in ♂ forelegs 0.71 : 1.00 (3.5 mm) : 0.06–0.09 : 0.41–0.44 : 0.44–0.47 : 0.32–0.38 : 0.15. Claws of a pair alike, apically hooked (Fig. 59).

Male genitalia (Fig. 56, 57). Forceps: segment 2 equal in length to segment 3, 1/5 length of segment 1; apex of segment 3 indented; base of forceps broad, inner margin forming a strongly angular bend near midlength of segment 1. Styliger plate a little less than 1/3 as long medially as maximum width, slightly concave at apex, as in Fig. 56. Penes: lobes fused to apex, with a large, ventral, fleshy appendage extended to slightly beyond lateral margins of styliger plate, appendage reinforced on lateral margin and oriented ventrally to penes, as in Fig. 56 & 57.

Ninth sternum of ♀ cleft apically (Fig. 58), occasionally with a longitudinal groove along midline. Terminal filament a little longer than cerci.

NYMPH unknown.

EGG elongate oval (Fig. 29); chorion ornamented with small, scattered tubercles and tubercles formed into circular ridges, as in Fig. 30.

ETYMOLOGY: named after Mr J.G. Penniket, in recognition of his work on the New Zealand Ephemeroptera; -ellus, L., a diminutive ending. Masculine.

TYPE SPECIES: *Penniketellus insolitus* n.sp.

REMARKS. *Penniketellus* can be distinguished from all other leptophlebiid genera by the following combinations of imaginal characters: (1) hind wings large, 1/3 length of forewings; (2) hind wings with a slightly concave costal margin and with vein Sc 9/10 length of wings; (3) penes fused, and with a large, ventral, fleshy appendage (Fig. 56, 57); (4) ninth sternum of ♀ apically cleft (Fig. 58); (5) claws of a pair alike, apically hooked, without opposing hooks (Fig. 59).

Penniketellus has several extremely distinctive characters, including particularly large hind wings and unusual penes. However, in the absence of nymphal specimens its affinities remain speculative. On the basis of hind-wing shape and venation *Penniketellus* may be related to species from Australia at present assigned to *Atalophlebioides*, although it should be emphasised that generic placement of this Australian material remains uncertain (see Towns & Peters 1978).

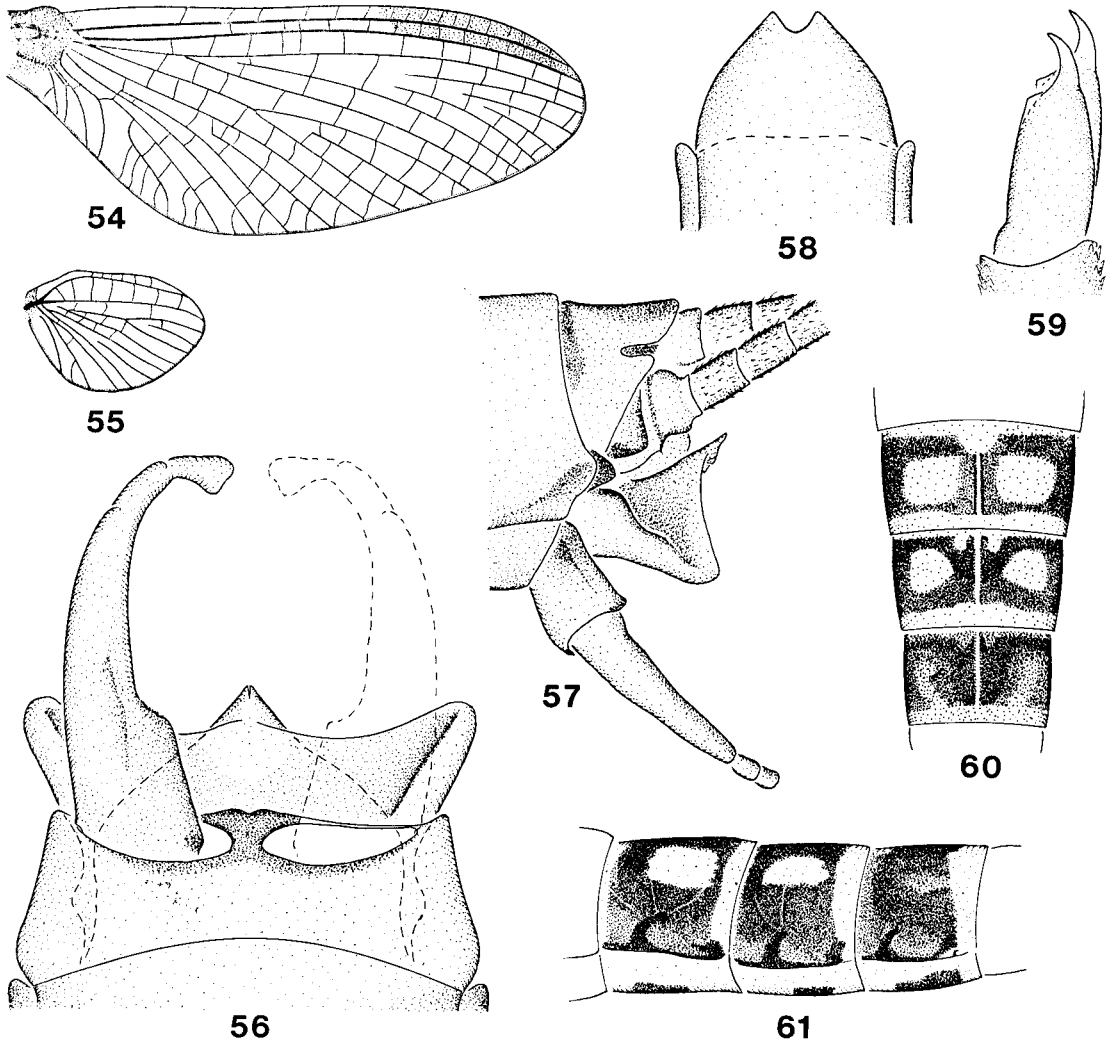

Fig. 54–61. *Penniketellus insolitus*. (**54–57**) ♂ imago: 54, forewing; 55, hind wing; 56, genitalia, ventral view; 57, genitalia, lateral view. **58**, ♀ imago, 9th sternum. (**59–61**) ♂ imago: 59, fore claws: 60, abdominal segments 5–7, dorsal view; 61, abdominal segments 5–7, lateral view.

Penniketellus insolitus n.sp. (Fig. 29, 30, 53, 54–61)

MALE IMAGO (in ethanol). Head brownish-black, except anteroventral margin pale brown, blackish medially. Upper portion of eyes orange-brown, lower portion black. Pedicel of antennae dark brown, black near apex, flagellum brown. Basal half of ocelli black, apical half pale brown, white at apex.

Thorax. Pronotum greyish-brown, washed with black; meso- and metanotum brownish-black, carinae black, sutures greyish-white. Sterna dark brown, carinae darker, sutures greyish-white. Legs brown, margins of femora and articulations of femora/tibiae darker; coxae dark brown, washed with black dorsally and on margins. Wings (Fig. 54, 55). Longitudinal and cross veins brown; membrane of forewings hyaline, except base washed with pale brown and apical 1/3 of cells C and Sc translucent, whitish; membrane of hind wings tinted with brown, darker near base.

Abdomen (Fig. 60, 61) dark greyish-brown; terga 2–7 with a hyaline, mid-dorsal line edged with black; terga 2–8 with black anterolateral marks, as in Fig. 61; terga 8 and 9 with a pale-brown mid-dorsal line; terga 2–6 with a narrow, transverse hyaline band; tergum 7 with a narrow, pale-brown transverse band; terga 3–7 with small, paired, sub-median hyaline maculae and large, paired, lateral hyaline maculae, as in Fig. 60 & 61, maculae largest on tergum 5; posterior 1/5 of tergum 8 and posterior half of terga 9 and 10 pale brown. Spiracular area and tracheae black (Fig. 61). Sterna 1–7 hyaline; sternum 8 translucent, whitish; sternum 9 pale brown; abdominal ganglia dark greyish-brown. Genitalia (Fig. 56, 57) pale brown, except penes pale to dark brown. Caudal filaments pale brown, darker annulations at articulations.

FEMALE IMAGO (in ethanol). Head brownish-black, except ventral anterior margin and posterior margin brown. Eyes black. Ocelli and antennae as in ♂ imago.

Thorax. Pronotum dark brown, washed medially and laterally with black; remainder of thorax as in ♂ imago, except sterna paler and thoracic ganglia grey. Legs and wings: colour and markings as in ♂ imago.

Abdomen (Fig. 60, 61). Colour and markings as in ♂ imago, except large maculae on terga 3–7 and posterior bands on terga 2–8 pale brown. Sterna pale brown, ganglia as in ♂ imago. Caudal filaments broken off and missing.

FEMALE SUBIMAGO (in ethanol) (male subimago unknown). Colour and markings of head, ocelli, and antennae as in ♀ imago, except ocellar area and posterior margin of head greyish-white.

Thorax. Colour and markings of pronotum as in ♀ imago; anterior 1/3 of mesonotum and narrow area along inner parapsidal sutures brown, remainder of mesonotum inside outer parapsidal sutures pale brown (Fig. 53); mesonotum between outer parapsidal sutures and notal wing processes dark brown, black along suture; basal humps of scutellum pale brown, brown on lateral margins, black longitudinal lines either side of midline extended to dorsum of posterior scutellum (Fig. 53); posterior scutellum pale brown on posterior margin and brown on lateral margins (Fig. 53). Pleura as in ♀ imago. Sterna pale, whitish, except furcasternum pale brown and thoracic ganglia dark grey. Wings: membranes translucent, whitish brown, longitudinal and cross veins pale brown.

Abdomen. Colour and markings as in ♀ imago. Caudal filaments pale brown.

MATERIAL EXAMINED. **Holotype** ♂ imago, Edwards Vly, nr Arthur's Pass, North Canterbury, above bushline, 23–29 Apr 1962, JRJ; **allotype** ♀ imago, data as for holotype. **Paratypes.** South Island. **NC.** Data as for holotype: 3 ♀ imagos and 2 ♀ subimagos; 1 ♂ imago, 28 Apr 1962, JGP. Arthur's Pass: 1 ♂ imago, ? date, JGP.

Repositories (all type specimens are in ethanol): holotype, allotype, 1 ♂ and 2 ♀ imaginal paratypes, and 2 ♀ subimaginal paratypes – Entomology Division, DSIR, Auckland; 1 ♂ and 1 ♀ imaginal paratypes – Florida A & M University, Tallahassee.

ETYMOLOGY: insolitus, L., 'unusual'; in reference to the distinctive hind wings and genitalia of the imago.

REMARKS. A female subimago in collections from the Arthur's Pass area may represent a second species of *Penniketellus*. It differs from *P. insolitus* in general colour and pigmentation of the abdominal terga. However, there is insufficient material on which to base a description.

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