Two further species of *Deleatidium* (*Deleatidium*) (Ephemeroptera: Leptophlebiidae) from New Zealand

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Two new species of mayfly, *Deleatidium* (*Deleatidium*) *acerbum* sp. nov. and *D.* (*D.*) *kawatiri* sp. nov., from the western South Island of New Zealand are described. The principal life stages are included and have been associated by rearing. Notes on ecology and distribution in weakly acidic streams are given. Diagnostic characters of the new species are illustrated and compared with similar species.

Keywords: Ephemeroptera, key, mayflies, Leptophlebiidae, *Deleatidium*

Introduction

The New Zealand mayfly fauna described at present comprises 8 families in 22 genera. The largest family, the Leptophlebiidae, which is distributed world-wide, includes the New Zealand endemic genus *Deleatidium* Eaton, 1899. Currently *Deleatidium* has 16 species. The genus was described by Eaton (1899) and was added to by Phillips (1930). It was further increased and revised by Towns and Peters (1979, 1996) who divided the genus into two subgenera, *Deleatidium* (*Deleatidium*) and *D.* (*Penniketellum*). Further species were included by Hitchings (2008, 2009a, 2009b, 2010). This work adds another two species. Information is provided for their identification and to distinguish them from similar species. A distribution map and habitat information are included.

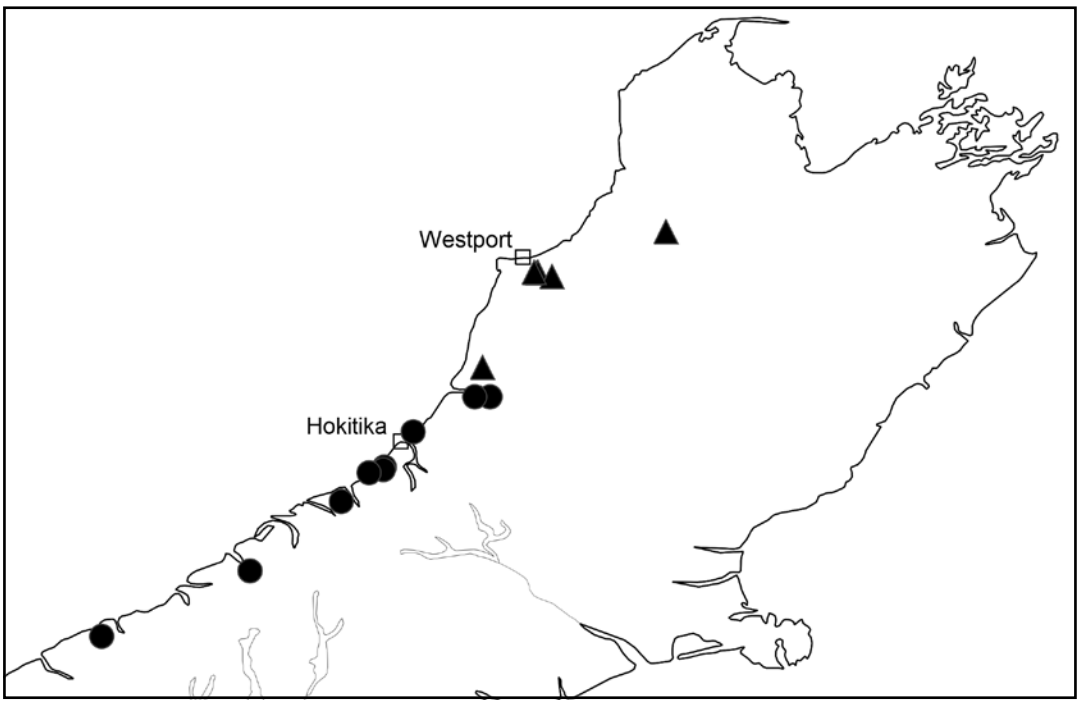
Materials, methods and conventions

Larvae were associated by proximity and rearing in aquaria. All specimens are stored in 80% ethanol. Body, fore and hind wing lengths of imagos and larvae are given, with means in parentheses, length ratios of the foreleg segments (femur: tibia: tarsomeres 1–5) are based on the length of the tibia (absolute measurements in mm, in parentheses). Species variation was not noted as both species were collected from restricted ranges. Species variation is more likely to be observed when collecting has been done over wider areas.

In the case of one of the species (*D.* (*D.*) *acerbum* sp. nov.), it seemed relevant to measure the acidity of the habitat. These streams were monitored using a Digital 222 PE12 pH meter calibrated with pH 4.0 and 7.0 buffers. After the conclusion of the investigation the buffers were found to measure pH 3.95 and 6.95 respectively. Where possible, stream pH was determined at the mountain forest/plain boundary and again in the same stream at a lower point on the plain.

Stream locations were measured from the topographical map series NZ GD 2000/WGS 84 and gradients expressed as a ratio of altitude difference to the map distance between two locations.

Collecting sites are grouped into regions of New Zealand using the system of Crosby et al. (1976) in which each is allocated a two letter code. Regions referred to in this paper are: BR



Collecting sites of *Deleatidium acerbum* ● and *D. kawatiri* ▲ in the western South Island.

- Buller, NC - North Canterbury, NN - Nelson and WD - Westland. Reference is also made to the Westland Forest Ecological Region proposed by Harding and Winterbourn (1997).

Map references are given as latitude and longitude in degrees and decimals of a degree. Heights above sea level are given in metres.

Collections: all material is held at Canterbury Museum, Christchurch (CMNZ), the New Zealand Arthropod Collection, Landcare Research, Auckland (NZAC) and the Swedish Museum of Natural History (SMNH).

Systematics

Order	Ephemeroptera Hyatt & Arms, 1891
Family	Leptophlebiidae Banks, 1900
Genus	*Deleatidium* Eaton, 1899 As diagnosed by Towns and Peters 1996: 27–28.
Subgenus	*Deleatidium* (*Deleatidium*) Towns & Peters, 1996 As diagnosed by Towns and Peters 1996: 30.

Deleatidium (*Deleatidium*) *acerbum* sp. nov. Figs 1–8

Description: Dimensions (mm). Imago, male: length of body 7.3–8.8 (8.0), forewing 10.1–10.5 (10.3). Imago, female: length of body 8.0–8.8 (8.4), forewing 10.7–11.1 (10.9). Mature larva: length of body 6.5–8.5 (7.3).

Male imago: Head dark brown between the eyes; antennal scapes, pedicel and antennae brownish; eyes, dorsal half yellowish brown and ventral half blackish brown, eyes almost in contact on meson of head. Thorax. Pronotum brownish, darker at margins and with a median longitudinal mark. Mesonotum and metanotum dark brown with paler paired longitudinal marks which continue on to the scutellum. Thoracic sterna pale brown, darker at the margins. Legs brownish yellow, blackish at the articulations of the femora and tibiae, paler apically. Length ratios of the foreleg segments 0.70–0.79: 1.00 (2.40–3.25 mm): 0.04–0.08: 0.21–0.34: 0.08–0.13. Tarsal claws of a pair dissimilar, one with a pad only and the other with a pad and hook. By contrast, *D. lillii* Eaton, 1899, has a hook and

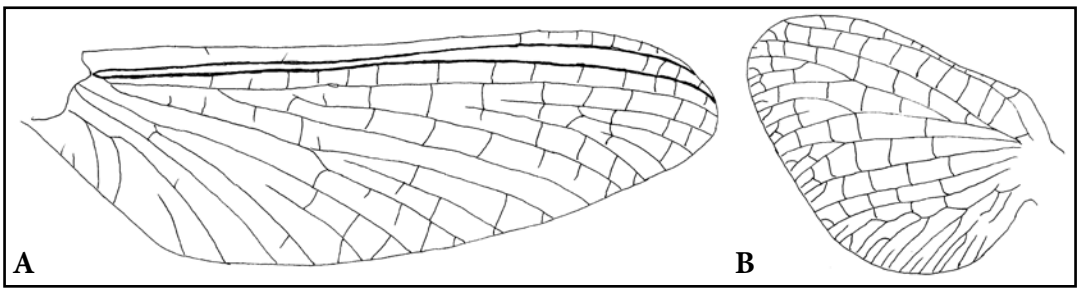


Figure 1. Wings of male imago of *D. acerbum*. **A,** Forewing. **B,** Hindwing (not in proportion).

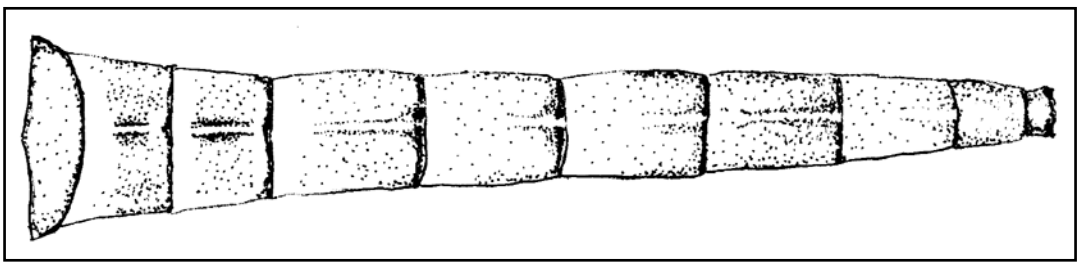


Figure 2. Dorsal abdomen of male imago of *D. acerbum*.

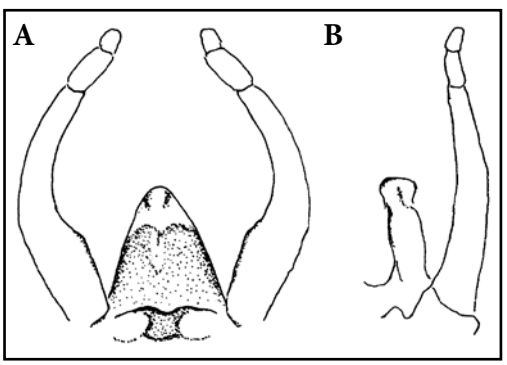


Figure 3. Genitalia of male imago *D. acerbum*. **A,** ventral view. **B,** lateral views.

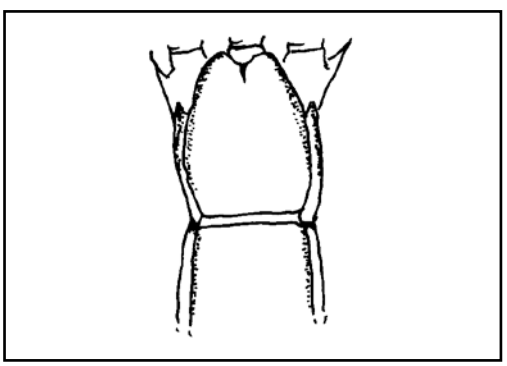


Figure 4. Sternum 9 of female imago of *D. acerbum*.

Figure 5. Dorsal abdomen of mature larva (antennae and caudal filaments truncated) of *D. acerbum*.

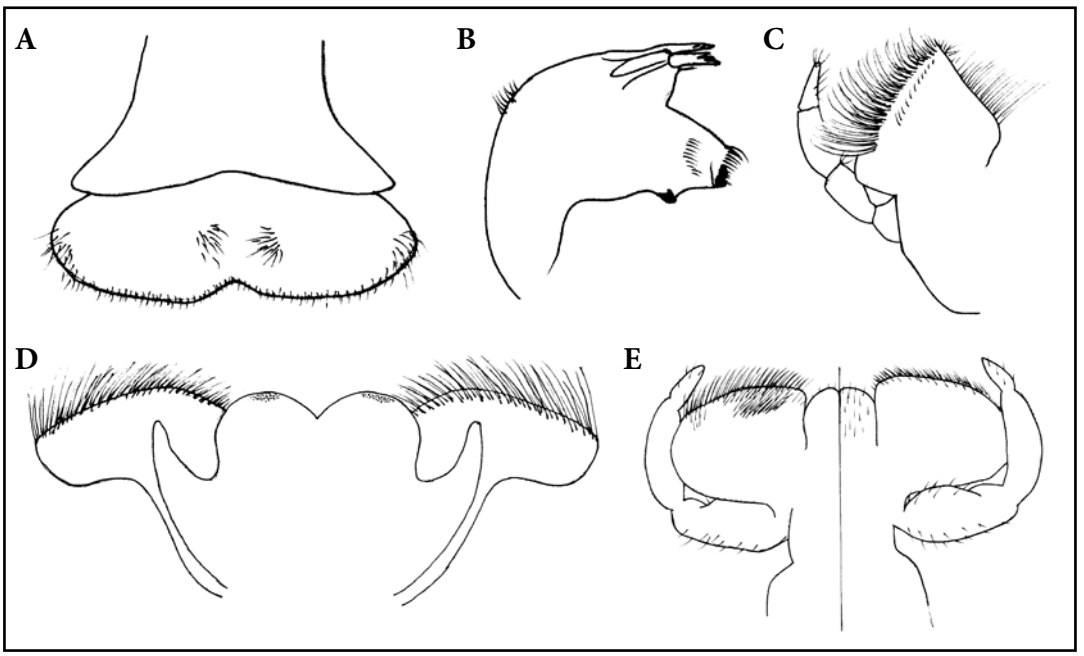


Figure 6. Mouth parts of larvae of *D. acerbum*. **A,** clypeus and labrum. **B,** mandible. **C,** maxilla. **D,** labium. **E,** hypopharynx.

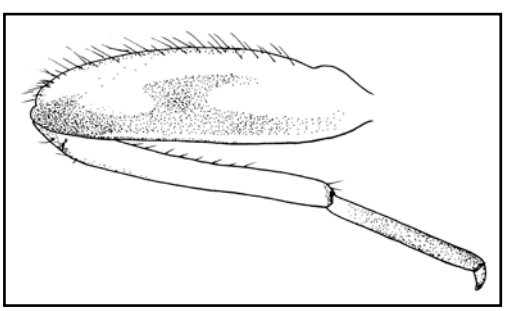


Figure 7. Foreleg of larva of *D. acerbum*.

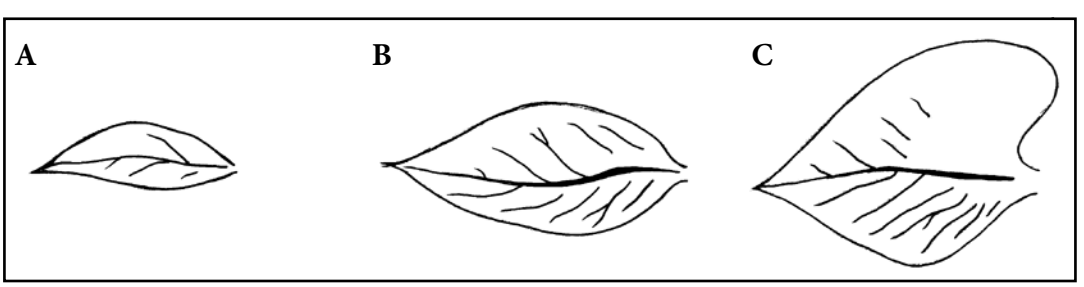


Figure 8. Abdominal gills of larva of *D. acerbum*. **A,** gill 1. **B,** gill 4. **C,** gill 7

also a small opposing hook on the pretarsal pad. Wings (Figs 1a, b). Forewing maximum width 0.31 x length; longitudinal veins: costa and subcosta yellowish brown, the remainder, including cross veins, dark brown. Crossveins between costa and subcosta in the basal portion faint or missing. Membranes hyaline. Hindwing width 0.55 x length and length 0.23 x that of forewing; vein Sc 0.93 x wing length. Cross veins few and faint in the dorsal half of the hindwing. Membranes hyaline. Abdomen (Fig. 2). Terga: yellowish brown, darker at the posterolateral margins; darker diffuse submedian marks separated dorsally by a whitish longitudinal line from terga 1 to 7. Sterna: pale brownish, lighter at posterior margins; ganglia hyaline. Genitalia (Figs 3a, b). Forceps and penes greyish yellow, darker basally. Penes fused to apices, rounded and slightly expanded at mid-length. In ventral view the apical portion with a paler V-shaped mark extending to mid-length. In lateral view penes with a shallow ventral indentation with a darker basal margin. Styliger plate brownish, emarginated. Caudal filaments greyish yellow, darker at the annulations.

Female imago: As in the male imago except as follows: Eyes uniformly blackish grey, head yellowish white, darker at the margins, pedicel brown, ocelli whitish. Eyes separated by about three times an eye width. Pronotum dark brown, meso- and metanotum paler. Forewing width 0.32–0.33 (0.33) x that of the length; length of hind wing 0.20–0.23 (0.22) x that of forewing. Egg guide reduced to a small thickening on the posterior margin of sternum 7. Sternum 9 with a V-shaped cleft extended by a basal cleavage mark (Fig. 4).

Subimago: The male and female as in the imago except as follows: head yellowish brown between the eyes; eyes above yellowish orange and blackish below. Pronotum brownish, divided by a narrow mesial, longitudinal orange line. Mesonotum orangeish with submedian brown marks and lateral black marks. Metanotum orangeish, black laterally. Pleura orangeish, darker at the margins. Ventral thorax pale brown, darker at the margins except for the dark brown lateral sterna. Legs yellowish orange, darker brown at the prolateral and retrolateral margins and the articulations. Wings uniformly greyish with veins C, Sc and R1 pale yellowish. Remaining longitudinal and cross veins greyish. Dorsal abdomen greyish brown with dark brown posterolateral bands. Terga I–7 with paired submedian dark brown marks. Terga 7 and 8 with submedian broad brownish marks. Ventral abdomen pale brown. In the male, genitalia yellowish grey, forceps darker at margins.

Late Instar Larva: Length 6.5–8.5 mm. Head yellowish washed with brownish black especially at margins of clypeus. Eyes of female black; male upper portion yellowish black, lower portion black. Antennae 1.5–1.7 x length of head. Mouth parts (Figs 6a–e) Clypeus and labrum (Fig. 6a). Labrum: length 0.71–0.78 (0.75) x that of clypeus, width 1.09–1.26 (1.17) x that of clypeus. Anterior margin smoothly curved with deep broad anteromedian cleft, no denticles. Mandibles (Fig. 6b). Maxillae (Fig. 6c). Galea-lacinia with subapical row of 20–22 spines. Palp segment 2, 0.94–1.07 (0.99) x length of segment 1; segment 3, 0.67–0.96 (0.78) x length of segment 2. Labium (Fig. 6d). Palp segment 2, 0.86–0.95 (0.88) x length of segment 1; segment 3, 0.42–0.54 (0.48) x length of segment 2. Hypopharynx (Fig. 6e). Thorax brownish yellow. Pronotum with irregular darkish markings towards lateral margin. Pleura pale yellow washed irregularly with brown-black. Foreleg (Fig. 7). Legs yellowish washed with darker black, each femur with a distinct long oval whitish macula proximally and a less distinct oval whitish macula distally. Abdomen. Posterolateral projections generally small on segments 2–9 but increasing in size posteriorly. Terga pale yellow brown to dark brown and with a well-defined posterior transverse band on segments 1–8. Prominent dark lateral maculae on terga 2–6, can be obscured by gills. Pale dorsal median line interrupted by the terminal transverse bands. Sterna pale yellow with ganglia hyaline or faintly pigmented on segment 7. Abdominal gills shown in Figs 8a–c. Gills broad near base, tapering acutely to point at apex. Gill 1 pointed and with small ventral lobe, maximum width 0.5–0.6 x length (Fig. 8a). Gill lamellae translucent with numerous blackish tracheal elements varying between equally developed in

dorsal and ventral lobes to less marked in the ventral lobes. Caudal filaments up to 1.9 x body length, yellowish with whorl of small brown denticles.

Holotype: Male imago, WD, Camp Creek, 42.8518°S, 170.8797°E, 20 m, 25 October 2015, Terry & Tim Hitchings (CMNZ 2016.66.1).

Allotype: Female imago, WD, Camp Creek, 42.8505°S, 170.8780°E, 40 m, 25 October 2015, Terry & Tim Hitchings (CMNZ 2016.66.2).

Paratypes: Male imago, WD, Camp Creek, 42.850°S, 170.878°E, 20 m, 24 January 2016, Terry & Tim Hitchings (CMNZ 2016.66.3); male imago, WD, Camp Creek, 42.850°S, 170.878°E, 20 m, 24 January 2016, Terry & Tim Hitchings (CMNZ 2016.66.4); male subimago, WD, Camp Creek, 42.8518°S, 170.8797°E, 20 m, 25 October 2015, Terry & Tim Hitchings (CMNZ 2016.66.5); 14 female subimagos, WD, Frosty Creek, 42.802°S, 170.942°E, 15 m, 20 January 2001, J B & G M Ward (CMNZ 2014.2.34536–34549); 7 larvae, WD, Stenhouse Creek, 42.8583°S, 170.8717°E, 30 m, 10 July 2014, EOS Ecology Laboratory (CMNZ 2014.2.34550–34556); 3 larvae, WD, Stafford Loop Creek, 42.667°S, 171.031°E, 30 m, 25 October 2015, Terry & Tim Hitchings (CMNZ 2016.66.6–8); male imago, WD, Camp Creek, 42.850°S, 170.875°E, 30 m, 25 January 2016, Terry & Tim Hitchings (NZAC); male subimago, WD, Frosty Creek, 42.8059°S, 170.9421°E, 15 m, 24 October 2015, Terry & Tim Hitchings (NZAC); female imago, WD, Camp Creek, 42.8518°S, 170.8797°E, 20 m, 25 October 2015,Terry & Tim Hitchings (NZAC); female subimago, WD, Frosty Creek, 42.802°S, 170.942°E, 15 m, 28 January 2001, J B & G M Ward (NZAC); 4 larvae, WD, Woolhouse Creek, 42.881°S, 170.800°E, 110 m, 26 January 2016, Terry & Tim Hitchings (NZAC).

Other material examined: 9 larvae, BR, Glenn Creek, Aratika Forest, 42.5687°S, 171.41777°E, 160 m, 14 November 1998, T R Hitchings (CMNZ 2014.2.15527–15535); larva, BR, Kokiri Stream, Arnold, 42.4989°S, 171.3843°E, 60 m, 16 March 1993, T R Hitchings (CMNZ 2014.2.15544); 6 larvae, WD, Camp Creek, 42.850°S, 170.878°E, 40 m, 24 October 2015, Tim Hitchings (CMNZ 2016.66.10–15); female imago, WD, Camp Creek, 42.850°S, 170.878°E, 20 m, 24 January 2016, Tim & Terry Hitchings (CMNZ 2016.66.22); 6 larvae, WD, Camp Creek, 42.8505°S, 170.8780°E, 40 m, 24 October 2015, Tim & Terry Hitchings (CMNZ 2016.66.16–21); female subimago, WD, Canavans Creek, 43.394°S, 170.178°E, 150 m, 20 January 1996, J B Ward (CMNZ 2014.2.34557); 6 female subimagos, WD, Duffers Creek, 43.031°S, 170.655°E, 70 m, 2 February 2002, J B & G M Ward (CMNZ 2014.2.34558–34563); larva, WD, Fox River, 42.041°S,171.394°E, 20 m, 17 May 2014, P E Penney (CMNZ 2014.2.34564); male subimago, WD, Kiwi Creek, near Lake Paringa, 14 February 2002 43.736°S, 169.402°E, 30 m, J B & G M Ward (CMNZ 2014.2.34565); larva, WD, Stenhouse Creek, 42.855°S, 170.860°E, 20 m, 10 July 2014, EOS Ecology Laboratory (CMNZ 2014.2.34566); larva, WD, Woolhouse Creek, 42.881°S, 170.900°E, 110 m, 23 January 2016, Terry & Tim Hitchings (CMNZ 2016.66.9).

Distribution and habitat: Deleatidium acerbum seems to be restricted in distribution to small streams of the coastal plain of Westland between the Buller River in the north and streams flowing into Lake Paringa in the south. This is part of the Westland Forest (WD) ecoregion of Harding and Winterbourn (1997). Much of the region is 5–10 km wide and sloping (gradient 1/50) from east to west into the Tasman Sea. The underlying geology is greywacke and glacial schist gravels derived from the Southern Alps, which form the eastern boundary of the plain (Harding & Winterbourn 1997). Major rivers and many streams originate from rain and snowmelt on tussock and mixed podocarp forest on mountain slopes. In addition, small streams and drains arise on the plain itself and have cut channels sometimes up to 10 metres deep into the alluvium. Many are lightly stained brown with humic acids, a complex mixture of compounds that function as weak dibasic or tribasic acids. These streams are lightly coloured due to microbial degradation of dead plant matter such as lignin. Brown stained streams are typically small (widths up to 3 metres) and acidic, having pH sometimes as low as 4.7 (Harding & Winterbourn 1997, Leathwick et al.

2003). Much of this plain in the area collected is now improved grassland used for pastoral farming.

The impact of acid waters on mayfly populations has been widely studied. Mayflies generally have been found to be relatively sensitive to low pH (Rowe et al. 1989). In several Northern Hemisphere studies, species of Leptophlebiidae have been found to be the most acid tolerant mayflies (Winterbourn & McDiffett 1996). In New Zealand, species of the leptophlebiid genus *Deleatidium* are the most abundant mayflies in acidic brown-water streams (Winterbourn & Collier 1987). Winterbourn and McDiffett (1996) found *Deleatidium* at 32 of 37 sites in northern Westland, in coastal plain streams (pH 5.5–6.7).

In their study of the population dynamics of some acid and alkaline streams, Collier and Winterbourn (1990) were of the opinion that at some of the acidic stream sites they described, only one species of *Deleatidium* (of the informally called "lillii group") was present, whereas in the alkaline studied streams two or three species of both the "lillii" and "myzobranchia" groups were present (Winterbourn et al. 2006). It is possible that *Deleatidium acerbum*, described here, is also the prevalent species in the browner, more acidic waters of relatively unmodified forest streams.

Mayflies were collected from six streams of the coastal plain between Hokitika and Ross and the acidity of the water measured.

Discussion: In general, streams sourced above this part of the Westland coastal plain and draining the steeper slopes tend to be slightly alkaline. As they flow across the plain, now much modified from the original lowland forest, they become weakly acidic. The extent to which this relatively minor lowering of the pH results from the removal of forest cover and modern farming practices can only be conjectured. It has been pointed out that waters containing the salts of weak acids such as the humic acids can act as buffer solutions, which resist a decrease in pH (Kullberg et al. 1993). The addition of weak organic acids to stream water does not necessarily result in much lowering of the pH. Humic substances may significantly increase the survival of mayflies (Holland et al. 2014). The removal of cations such as Fe+++ or Al+++ by the buffering effect may have physiological consequences for aquatic invertebrates. However, it has been found that the richness of ephemeropteran taxa in streams such as these is not correlated with pH down to about 4.5 (Winterbourn & Collier 1987). Mayfly mortality may be linked to additional physical and chemical factors including the presence and concentration of ions other than H+ (Collier et al. 1990). It is also possible that the present distribution of *Deleatidium acerbum* is also, in part, a consequence of the past biogeography of coastal Westland.

Deleatidium acerbum sp. nov. appears to most closely resemble *Deleatidium lillii*. In the imaginal forewing the crossveins between the costa and R1 are mainly indistinct or missing as in *D. lillii* (Towns & Peters 1996: 80). Characters useful for distinguishing *D. acerbum* include: in the male imago; (1) tarsal claw pad without a hook, (2) penes in lateral view with a prominent ventral indentation, the basal surface of which bears a darkened mark. In the female, sternum 9 with a V-shaped cleft, which extends with a cleavage mark. In the larva; (1) fore-femur with a basal whitish oval macula at least 1/3 length

Table 1. Physical characteristics of streams where *Deleatidium acerbum* were collected.

Stream	Region	Altitude (m)	Colouration	Temperature (°C)	pH
Halton Creek	WD	180	Clear	16.2	7.9
Fox Creek	WD	180	Clear	16.4	7.5
Unnamed creek	WD	100	Brown	15.6	6.6
Harvey Creek	WD	50	Brown	15.9	7.0
Woolhouse Creek	WD	20	Brown	17.0	6.3
Camp Creek	WD	20	Brown	21.0	7.0

of femur, (2) gill lamellae with blackish tracheal elements equally developed in dorsal and lateral elements, (3) the presence of prominent dark maculae laterally on terga 2–6.

Deleatidium acerbum also resembles *Deleatidium fumosum* Phillips, 1930, but can be distinguished in the male imago by penes lacking in mid apical ventral appendages and in both sexes by lack of well-defined blackish maculae on any sterna. In the larva, gills broad near the base and tapering to extended filamentous apices on all laminae.

Furthermore larvae of this species, particularly from the Arnold River catchment (BR), closely resemble those of *Deleatidium cerinum* Phillips, 1930. They can be distinguished from the latter by the abdominal body pattern with a pale mid-dorsal line and paired lateral dark dorsal maculae on terga 2–6.

Etymology: The species name is derived from "acerbum" (Latin), "acidic", with reference to the preference of the species for acidic waters.

Deleatidium (*Deleatidium*) *kawatiri* sp. nov. Figs 9–16

Description: Dimensions (mm). Imago, male: length of body 7.8–10.1 (9.0), forewing 8.5–9.8 (9.2). Imago, female: length of body 8.8–9.0 (8.9), forewing 9.5–11.1 (10.3). Mature larva: length of body 6.5–9.1 (8.4).

Male Imago: Head blackish between the eyes and antennal scapes; antennal scapes, pedicel and antennae yellowish brown; eyes, dorsal half yellowish, ventral half black, eyes almost in contact on the meson of the head. Thorax. Pronotum, meso- and metanotum brownish with darker median longitudinal mark and dark margins. Posterior portion of the scutellum dark brown. Thoracic sterna yellowish brown, darker at the margins. Legs yellowish white, articulations of the femora and tibiae darker. Length ratios of the foreleg segments 0.8: 1.0 (2.5 mm): 0.06: 0.30: 0.30: 0.10 (1 specimen only). Tarsal claws of a pair, one with a pad hooked and with an opposing hook, the other with a small unopposed hook. Wings. (Figs 9 a, b). Forewing maximum width 0.35–0.42 x length; longitudinal veins yellowish, darker at costal brace; cross-veins and membrane hyaline. Hind wing maximum width 0.56 x length and length 0.24 x that of forewing; vein Sc 0.96 x wing length; cross-veins few and faint in the dorsal half of the wing, veins greyish, membranes hyaline. Abdomen (Fig. 10). Terga: brownish yellow, anterior and posterior of each tergum darker; a pale mid-dorsal line from terga 1–7; paired, dark brown lateral submedian marks and a transverse posterior band on each segment. Sterna: pale brownish, ganglia usually hyaline but may have faint signs of greyish ganglia markings. Genitalia (Figs 11a, b). Forceps and penes greyish, darker greyish yellow basally; penes tapering uniformly to a narrowing at 2/3 length to apex. Penes fused to a dome-shaped apex and with a prominent ventral mid-apical black inverted U-shaped mark. Styliger plate yellowish brown, slightly emarginated. Caudal filaments greyish yellow with dark brown annulations at articulations.

Female imago: As in imago, except as follows: Eyes uniformly blackish, head greyish, ocelli white, black basally and between them. Eyes separated by about twice an eye width. Thorax greyish brown with similar dark brown submedian maculae on terga 2–6. Sterna brownish grey, darker anteriorly and posteriorly; ganglia faintly greyish. Sternum 9 (Fig. 12) with a deep V-shaped apical cleft.

Subimago: As in the imago except as follows: pronotum and mesonotum brownish, dark brown at the lateral margins, with paler paired median longitudinal marks. Posterior scutal protuberances grey, scutellum darker. Pleura greyish brown, darker at the margins. Legs pale greyish yellow, darker at the femorotibial articulations. Wings uniformly greyish with veins C, Sc and R1 pale greyish yellow. Dorsal abdomen brownish, darker at posterior margins. Ventral thorax and abdomen pale yellowish brown, darker at the posterior margins of the forked sternum and sterna 6–8. Male abdominal body pattern more strongly marked than that of the female. Male genitalia greyish yellow, penes pale grey apically.

Larva: Head yellowish grey, darker at the margins; labrum greyish laterally, clypeus

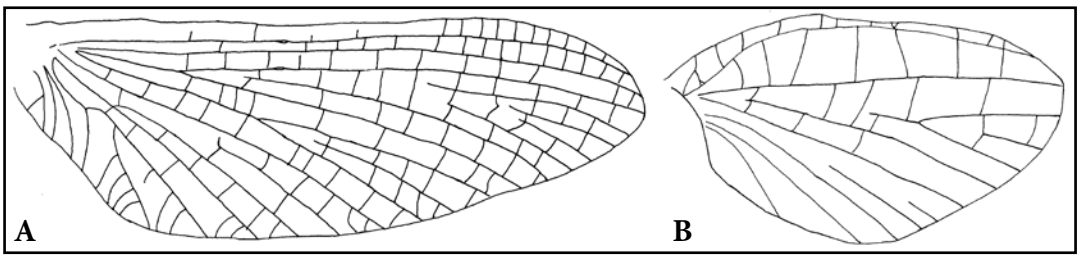


Figure 9. Wings of male imago of *D. kawatiri.* **A,** Forewing. **B,** Hindwing (not in proportion).

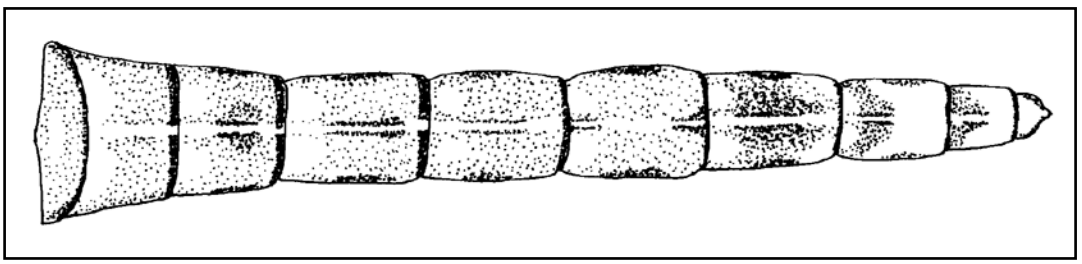


Figure 10. Dorsal abdomen of male imago of *D. kawatiri.*

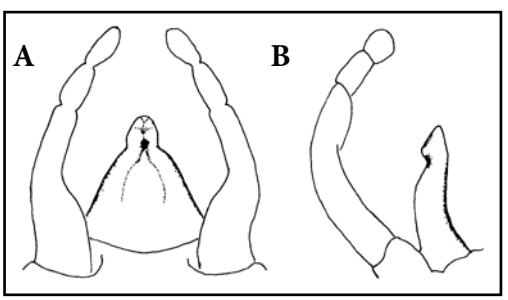


Figure 11. Genitalia of male imago of *D. kawatiri.* **A,** ventral view. **B,** lateral views.

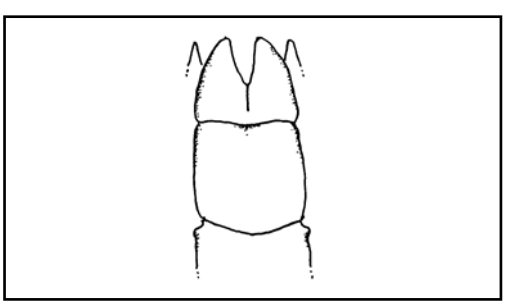


Figure 12. Sternum IX of female imago of *D. kawatiri.*

Figure 13. Dorsal abdomen of mature larva (antennae and caudal filaments truncated) of *D. kawatiri.*

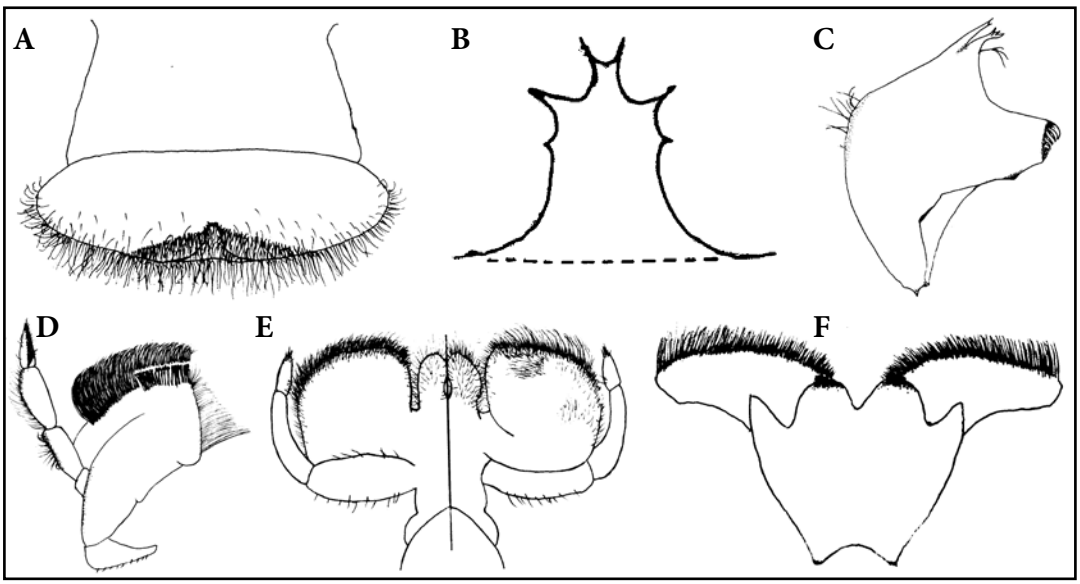


Figure 14. Mouth parts of larvae of *D. kawatiri.* **A,** clypeus and labrum, **B,** enlarged anteromedian emargination of the clypeus. **C,** mandible. **D,** maxilla. **E,** labium. **F,** hypopharynx.

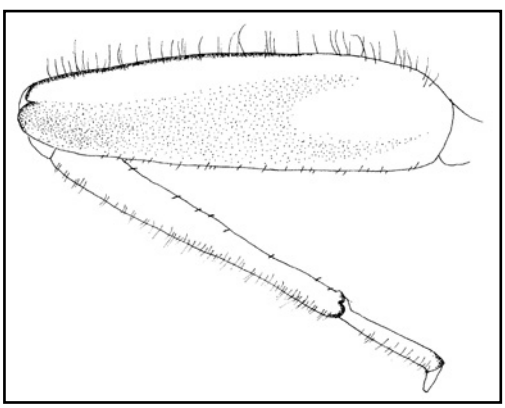


Figure 15. Foreleg of larva of *D. kawatiri.*

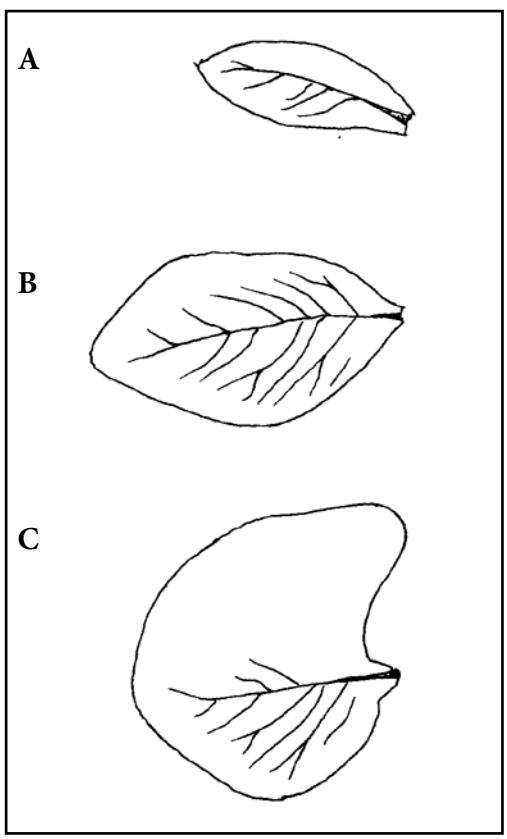


Figure 16. Abdominal gills of larva of *D. kawatiri.* **A,** gill 1. **B,** gill 4. **C,** gill 7.

flecked blackish submesially as is the region of the frons. Eyes of female black and those of the male grey above and black below. Antennae 1.64–1.90 x as long as head. Mouth parts (Figs 14a–f).Clypeus and labrum (Fig. 14a): labrum length 0.59–0.76 x that of clypeus, width 1.14–1.24 x that of clypeus; anterior margin with deep median cleft with 5 small rounded denticles. The anterior dorsal surface well supplied with hairs. Mandibles (Fig. 14b): 5–9 hairs at the centre of the outer margin, outer incisors with 4 serrations on the mesial surface, inner incisors with 3 serrations. Maxillae (Fig. 14c): galea-lacinia with a subapical row of 17–19 spines; palp segment 2, 0.75–1.00 x as long as segment 1, segment 3, 0.75–0.91 x as long as segment 2. Labium (Fig. 14d): submentum shoulder without spines. Palp segment 2, 0.76–0.88 x as long as segment 1, palp segment 3, 0.36–0.38 x as long as segment 2. Segment 2 without long spines. Hypopharnyx (Fig. 14e): lobes of the lingua separated by a deep, narrow V-shaped emargination. A sclerotised bunch of short hairs borne apically on each lobe. Thoracic terga yellowish brown, darker at the margins particularly at the anterolateral margins of the mesonotum. Sternum paler with thoracic ganglia sometimes visible. Legs yellowish white, darker at the femoro-tibial articulations. Ventral thorax and sterna whitish. Foreleg (Fig. 15). Each leg with a prominent yellowish-white macula on the proximal anterior surface of each femur. Abdomen: terga 2–4 and 7–8 each with a posterior blackish band divided mesially by a whitish longitudinal mark. Terga 2–7 or 8 with paired black submedian maculae. Posterolateral projections small on all abdominal segments, that on tergum 9 the largest. Sternal ganglia hyaline. A small tuft of about 12 hairs on the ventral surface of segment 9. Abdominal gills shown in Figs 16a–c. Gills single, plate-like and rounded apically, except gills 3–7, which sometimes have small apical points. Gill 1 wider than long (1.2–1.6: 1.0) (Fig. 16a); gill 7 not folded ventrally (Fig. 16c). Gills overlapping but not forming a deflection disc. Lamellae translucent with numerous tracheae. Caudal filaments yellowish, 1.4–1.6 x as long as the body.

Holotype: Male imago, BR, Little Ten Mile Creek, 41.836°S, 171.684°E, 30 m, 7 December 2001, T R Hitchings (CMNZ 2014.2.34501).

Allotype: Female imago, BR, Little Ten Mile Creek, 41.836°S, 171.684°E, 30 m, 7 December 2001, T R Hitchings (CMNZ 2014.2.34502).

Paratypes: 2 male subimagos, BR, Ten Mile Creek, 41.836°S, 171.677°E, 20 m, 4 April 1964, VM Stout (CMNZ 2014.2.34503–34504); female subimago, BR, Little Ten Mile Creek, 41.836°S, 171.684°E, 30 m, 9 December 2001, T R Hitchings (CMNZ 2014.2.34505); 3 male subimagos, BR, Nine Mile Creek, 41.835°S,171.663°E, 20 m, 24 November 2004, J B & G M Ward (CMNZ 2014.2.34506–34508); female subimago, BR, Little Ten Mile Creek, 41.837°S, 171.684°E, 20 m, 9 December 2001, Terry Hitchings (CMNZ 2014.2.34509); 6 larvae, BR, Batty Creek, 41.856°S, 171.757°E, 50 m, 28 January 2011, Terry & Tim Hitchings (CMNZ 2014.2.34510–34515); larva, BR, Ten Mile Creek, 41.836°S,171.677°E, 20 m, 4 April 1964, VM Stout (CMNZ 2014.2.34516); male subimago, BR, Nine Mile Creek, 41.835°S, 171.663°E, 20 m, 24 November 2004, J B & G M Ward (CMNZ 2014.2.34517); female subimago, BR, Ten Mile Creek, 41.836°S, 171.677°E, 20 m, 24 November 2004, J B & G M Ward (CMNZ 2014.2.34524); male subimago, BR, Little Ten Mile Creek, 41.834°S, 171.684° E, 9 December 2001, T R Hitchings (CMNZ 2014.2.34525); larva, BR, Batty Creek, 41.856°S, 171.757°E, 40 m, 23 January 2011, Terry & Tim Hitchings (CMNZ 2014.2.34526); male imago, BR, Fuchsia Creek, 41.836°S, 171.684°E, 20 m, 4 January 2005, KA Johansen (NZAC); male subimago, BR, Fuchsia Creek, 41.836°S, 171.664°E, 20 m, J B & G M Ward (NZAC); female imago, BR, Ten Mile Creek, 41.836°, 171.677°E , 20 m, 24 November 2004, J B & G M Ward (NZAC); female subimago, BR, Nine Mile Creek, 41.834°S, 171.664°E, 10 m, 24 November 2004, J B & G M Ward (NZAC); 3 larvae, BR, Little Ten Mile Creek, 41.837°S, 171.684°E, 20 m, 6 December 2002, T R Hitchings (NZAC); female subimago, BR, Fuchsia Creek, 41.837°S, 171.684°E, 40 m, 4 January 2005, K A Johansen (SMNH); male subimago, BR, Nine Mile Creek, 41.834°S, 171.664°E, 10 m, 24 November 2004, J B & G M Ward (SNMH); 4 larvae, BR, Little Ten Mile Creek, 41.837°S, 171.684°E, 20 m, 9 December

2001, T R Hitchings (SNMH).

Other material examined: 3 larvae, NN, Matiri River above lake, 41.6212°S, 172.3532°E, 398 m, 26 October 2015, L Hartley (CMNZ 2016.67.1–3); 4 larvae, BR, Nine Mile Creek, 41.834°S, 171.663°E, 30 m, 23 January 2011, Terry & Tim Hitchings (CMNZ 2014.2.34518–34521); larva, BR, Smoke-ho Creek, 42.331°S, 171.394°E, 270 m, 15 May 2014, P E Penney (CMNZ 2014.2.34522); female subimago, BR, Fuchsia Creek, 41.847°S, 171.682°E, 20 m, 24 December 2000, J B & G M Ward (CMNZ 2014.2.34523); 9 subimagos, BR, Ten Mile Creek, 41.836°S, 171.678°E, 20 m, 24 December 2000, J B & G M Ward (CMNZ 2014.2.34527–34535).

Distribution and habitat: D. kawatiri has been found in forested tributaries of the Buller River and one site in the catchment of the Grey River. These first and second order streams descend steeply through podocarp or beech forest to almost sea level. This species does not have the dark dorsal colouration of some other New Zealand alpine Leptophlebiidae (Hitchings, 2009a). Its distribution may be restricted to well shaded forest. However, larvae have a small tuft of hairs on sternum 9, as found in other *Deleatidium* species adapted to fast water alpine habitats.

Discussion: A change in morphological shape of the larval gills with maturation is particularly noticeable with *D. kawatiri*. As successive instars develop, corresponding gills widen in proportion to their length and the apices of gills 2–7, initially pointed, become more rounded. Stream gradients can exceed 0.5 in places where *D. kawatiri*, and *D. myzobranchia* Phillips, 1930 are found. The late instars of both species have large ovate gills, which probably help them maintain their position in fast water through current deflection. Thus down-force increases when the gills are tilted into the current (Hitchings 2016). It is possible that with growth and development, larvae are enabled to migrate out of boundary layer close to the substrate and from crevices into flows.

Deleatidium kawatiri most closely resembles *D. autumnale* Phillips, 1930 and *D. angustum* Towns & Peters, 1996. In the imago, it may be distinguished from both of these by the presence of a ventral mid apical U-shaped black mark on the penes of the male and in the female by the deep V-shaped emargination on sternum 9. In the subimago, the genitalia are sufficiently developed to afford the same characters for identification. The subimaginal wings of *D. autumnale* are marbled but those of *D. kawatiri* are uniformly grey.

In the larva, *D. kawatiri* can be distinguished from *D. angustum* by a cluster of hairs on sternum 9 in the former but only a few scattered hairs in the latter, and from *D. autumnale* by the absence of blackish sternal ganglia.

One specimen from Little Ten Mile Creek, a subimago, showed gynandromorphic characters, with a partially developed right forceps (male) and on the left an emarginated ninth sternite (female).

Etymology: The species name is derived from "Kawatiri", which is a Māori name for the Buller River and is believed to mean "deep and swift".

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