A new species of *Zelandobius* (Plecoptera: Gripopterygidae: Antarctoperlinae) from the upper Rangitata River, Canterbury, New Zealand

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**Abstract**  *Zelandobius edensis* n. sp. is described from a spring-fed creek in the headwaters of the Rangitata River catchment, South Canterbury, New Zealand. Adult males exhibit varying degrees of brachyptery and the only female collected also had short wings. Larvae are easily identified by their covering of long translucent hairs not found in other members of the *Zelandobius confusus* group. The link between adult and nymph was confirmed by comparing 600-base-pair sequences of the mitochondrial gene, cytochrome c oxidase 1. Observations suggest the life cycle may be strongly synchronised by temperature constraints on nymphal growth and development, and/or a short season suitable for feeding and reproduction by the terrestrial adults.

**Keywords**  stoneflies; brachyptery; taxonomy; alpine; SEM

**INTRODUCTION**

The stonefly genus *Zelandobius* Tillyard, 1921 is endemic to New Zealand and contains 29 described species in two species groups, the *Z. confusus* group (23 species) and the *Z. furcillatus* group (6 species) (McLellan 1993, 2008). Here a distinctive new species from material collected in a spring-fed tributary of the Frances River, Rangitata River system, Canterbury is described.

**MATERIALS AND METHODS**

All material was collected from a spring-fed tributary of the Frances River, Rangitata River catchment (NZMG 5757710N, 2328340E), South Canterbury, at 950 m altitude. Initial larval material was collected 22 April 2007, adults and further larvae were collected 18 May 2008. Both adult and larvae were collected by hand, in and adjacent to the stream. The holotype was a male and paratypes were 10 males, 1 female, and 5 nymphs. All material was stored in 100% ethanol. The description and measurements (to 0.01 mm) were performed using a 40× magnification dissecting microscope and 1 mm graticule. The link between adult and nymphal stages was confirmed by comparing the DNA from 5 individuals of each life stage. A 600-base-pair segment of the mitochondrial gene, cytochrome c oxidase 1 (COI) was sequenced. DNA was extracted from a tissue sample from the thorax or leg using the PureLink™ Genomic DNA Mini Kit (Invitrogen, New Zealand) according to the tissue extraction protocol supplied by the manufacturer. Polymerase chain reactions (PCR) were performed in 50 µl volumes with the reaction mixture containing 20 ng of DNA, 400 nM of each primer LC01490 and HC02198 (Folmer et al. 1994), 0.2 mM dNTPs (Roche Diagnostics, New Zealand), 1 × Taq PCR buffer (Invitrogen, New Zealand), 1 U Taq DNA polymerase (Invitrogen, New Zealand) and 1.5 mM MgCl2 (Invitrogen, New Zealand). The reaction mixture was held at 94°C for 2 min followed by 35 cycles at 94°C for 30 s, 45°C for 30 s, 72°C for 1 min, with a final extension at 72°C for 7 min. PCR reactions were run on an iCycler thermal cycler (Biorad, United States). PCR products were visualised on 1.5% agarose gel and then purified using a High Pure PCR product purification kit (Roche Diagnostics, New Zealand). Sequencing was undertaken using Big Dye v.3.1 on an ABI Prism 3100 Genetic Analyzer (Applied Biosystems). Sequences obtained in this study were deposited in the NCBI GenBank database under accession numbers FJ424816 – 25. The holotype was deposited in Canterbury Museum (CMNZ), Christchurch, New...
Zealand, and 2 paratype adult males and two nymphs were deposited in New Zealand arthropod collection (NZAC), Auckland.

**SYSTEMATICS**

**Family** GRIPOPTERYGIDAE  
**Sub-family** ANTARCTOPELINAE  
**Genus** Zelandobius Tillyard, 1921  
**Species** Zelandobius edensis n. sp.

**Material examined**  
**Holotype** Adult male from a spring-fed tributary of the Frances River, Rangitata River catchment (NZMG 5757710N, 2328340E), South Canterbury, at 950 m altitude. Deposited in Canterbury Museum (CMNZ).

**Paratypes** Ten males, 1 female and 5 nymphs collected from the same location. Same data as holotype. Two male adults and two nymphs deposited in New Zealand arthropod collection (NZAC).

**Additional material** Twenty-four nymphs from type locality.

**Description** Male body length 7.7–8.2 mm (mean 7.9 ± 1.1 mm SD), forewing length 4.0–8.5 mm (mean 6.7 ± 0.7 mm SD), head capsule width 1.4–1.7 mm (mean 1.5 ± 0.1 mm SD), antenna length 7.5–10.2 mm (mean 8.5 ± 4.2 mm SD), cercus 0.7–1.0 mm (mean 0.9 ± 0.3 mm SD). Female body length 9.0 mm, forewing 4.8 mm, head width 2.0 mm, antenna 6.0 mm, cercus 0.5 mm. Nymph (final instar): body length 11.5–12.0 mm; head width 1.8–1.9 mm; antenna 4.0–4.2 mm; cercus up to 2.0 mm (broken in most larvae).

**Adult** Wings of variable length (4.0–8.0 mm, mean 6.7 ± 1.0 mm SD): fully-formed or showing various degrees of brachyptery (Fig. 1A–C). Short wings with fewer cross-veins and all wings may lack the posterior radial fork characteristic of most Zelandobius species. Forewings sub-hyaline and variably patterned with irregular, sometimes coalescing, grey patches surrounding distal cross-veins (Fig. 1A,B). Hindwings uniformly hyaline (Fig. 1C). General body colour dark brown; body with a coating of short pale hairs and some longer translucent hairs around pronotal margins and on ventral and lateral surface of thorax and pleurites. Antennae longer than body, of about 50 segments covered in short dark setae. Head with a coating of pale hairs, dark brown anteriorly with a variably distinct pale patch on the frontoclypeus. Epicranium lightly mottled. Ocelli difficult to see. Segment 5 of maxillary palp about twice the length of segment 4. Pronotum light-medium brown with variably dark motting, but paler marginally and with a dark longitudinal groove in the mid-line (Fig. 1D); width: length ratio 1.2–1.5; all pronotal margins angled upwards slightly giving a flange-like appearance. Metanotum about 0.75 times width of mesonotum. Legs a uniform golden-brown with a coating of short setae most obvious on the tibiae and tarsi; ventral margins of femora with parallel
Gray—A new species of Zelandobius from New Zealand

607

Gray—A new species of Zelandobius from New Zealand

Fig. 2 Lateral view of: A, male tergite 10 and epiproct; B, male paraproct of Zelandobius edensis n. sp. Scale bar = 1 mm.

ridges bearing long translucent hairs. Abdomen of male chestnut-brown ventrally with parallel-sided pale patches laterally on each sternite. In the single female, the pale patches on sternites 2–7 were triangular and broader anteriorly. Abdominal tergites with a dark band posteriorly.

Male genitalia (Fig. 2–3) Medial sclerite of tenth tergite with strongly sclerotised margins; membranous cone with a short, narrow, parallel-sided neck and a coating of tiny black setae; posterior margin of tenth tergite produced as an almost spherical upturned knob, ventrally concave. Epiprocts with 5–7 pairs of marginal teeth, the basal tooth three times the size of the others; tip of basal tooth weakly bifid (Fig. 3D,E); epiproct tip slightly curved, parallel-sided and rounded terminally; ventral hook sharply pointed. Paraprocts narrowest basally, with a strong curved apical spine; upper margin with a shallow bulge below spine. Subgenital plate covered in pale hairs around its posterior margin. Cerci 9-segmented, curving ventrally.

Female genitalia (Fig. 4) Subgenital plate (sternite 8) unicolorous with a pronounced rounded concavity on its posterior margin; this margin upturned in ventral view to form a ridge that extends over sternite 9. Sternite 9 membranous, extending slightly onto sternite 10. Sternite 10 fully sclerotised, its posterior margin and the subanal lobes with medium-length translucent hairs.

Nymph (Fig. 5A–C) General colour sandy brown/tan, the body including head and legs covered in translucent hairs up to about 0.25 mm long in the final instar. Epicranium lightly mottled in mid-instar larvae but plain in later instars. Scape of antenna bearing a few long translucent hairs, but these are absent from the pedicel and flagellum. Labrum hairy. Ocelli prominent. Pronotum rectangular with rounded angles and edges curved upward as in the adult; width: length ratio 1.4–1.6 in middle instars, 1.3–1.7 in late instars. Hairs cover the entire pronotum but are denser along the margins. Meso- and metanota covered in hair, their posterior margins re-entrant. Legs coated in hairs; tibiae and femora of equal length. Abdomen lacking a longitudinal dorsal ridge; each segment with a ring of darker pigmentation anteriorly and a fringe of dense, dark, medium length hairs posteriorly. Tergite 10 slightly longer than broad, straight sided with a distinct fringe of medium length dark hairs along its posterior margin. Cerci less than one quarter length of abdomen. Anal gills a well developed rosette. Subanal lobes tongue shaped. There was 98.7% similarity between 600-base-pair sequences of the COI gene providing conclusive evidence that both nymphs and adults were the same species.

Diagnosis Both nymph and adult of Zelandobius edensis n. sp. are readily distinguishable from other members of Zelandobius. Zelandobius edensis n. sp. is a typical member of the Z. confusus-species group, in that the distal cross-veins of the forewing are surrounded by dark, coalescing ovals of pigment, and the nymphal meso- and metanota have distinctly re-entrant hind margins (Fig. 5) (McLellan 1993). It can be distinguished from all other described species, by a combination of genitalic characters in the male and female and the well-developed hairiness of the nymphs. The form of the male epiproct of Z. edensis n. sp. differs from that of all other described species in having 5 or 6 pairs of small marginal teeth, a very large pair of proximal teeth, and a sharply pointed ventral hook. Similarly large proximal teeth are
Fig. 3  Male genitalia of *Zelandobius edensis* n. sp.: A, dorsal view; B, lateral view; C, oblique view showing epiproct and tergite 10, note bifid basal tooth of epiproct; D, bifid basal tooth of epiproct; E, posterior view of male reproductive organs.
Gray—A new species of Zelandobius from New Zealand

also found in Z. confusus Hare (1910), Z. cordatus McLellan (1993), and Z. dugdalei McLellan (1993), but not in combination with the other features mentioned above. The paraprocts of Z. edensis n. sp. are most similar to those of Z. patricki McLellan (1993) as they possess a long curved apical spine and a shallowly bulged dorsal surface. However, the epiprocts of Z. patricki lack the very large proximal teeth found in Z. edensis n. sp., the ventral epiproct hook of Z. patricki is markedly blunter and the tip of tergite 10 is noticeably more bulbous in Z. edensis n. sp. than in Z. patricki. In the female, the combination of unicolorous subgenital plate (sternite 8), membranous sternite 9, and fully sclerotised sternite 10 distinguish Z. edensis from all other Z. confusus-group species.

The hairy nymph of Z. edensis n. sp. is most likely to be confused with that of Z. pilosus Death (1990), which also has its head, body and legs covered with long (c. 0.2 mm) translucent hairs.

Fig. 4  Female genitalia of Zelandobius edensis n. sp., ventral view. Scale bar = 1 mm.

Fig. 5  A, Re-entrant hind margin of the meso- and metanotum of Zelandobius edensis n. sp. (Z. confusus-group); B, straight hind margins of Z. pilosus (Z. furcillatus-group); C, late instar larva of Z. edensis n. sp. without hairs on antennae; D, late instar larva of Z. pilosus with antennae covered in hairs.
However, *Z. pilosus* belongs to the *Z. furcillatus*-group, and is distinguished by the straight rather than re-entrant hind margins of the meso- and metanota. Additionally, the antennae of *Z. pilosus* are hairy (Death 1990), whereas those of *Z. edensis* are not.

**Etymology** The specific name *edensis* refers to a large icefield, The Garden of Eden, which dominates the Frances River and forms its source. Eden is a Hebrew word meaning delight or pleasure.

**DISCUSSION**

*Zelandobius edensis* n. sp. is known only from a single 30-m-long spring creek, which emerges from the base of a debris flow on Tauroa creek adjacent to the Frances River, a tributary of the Rangitata River. The creek is approximately 1.5 m wide, with a maximum depth of 30 cm, and lies at an altitude of 950 m a.s.l. about 4 km east of the main divide. Adults were found beneath stones alongside the creek, and nymphs in clusters on the undersides of cobbles and boulders in the water. Neither nymphs nor adults were found in association with the nearby Frances River. Alpine habitats are characteristic of *Z. confusus*-group species, with at least 13 of the other 21 described species being known only at altitudes greater than 900 m (McLellan 1993).

Middle-sized nymphs were collected on 22 April 2007, but neither adults nor larvae were seen on 25 August despite intensive searching. But on 18 May 2008, numerous late instar nymphs and adults were found at the site. These observations suggest the life cycle may be strongly synchronised. Seasonal synchrony has been postulated for various invertebrates that occupy high altitude habitats (Danks 2007; Hollmann & Miserendino 2008) and may be regulated by temperature constraints on nymphal growth and development, and/or a short season suitable for feeding and reproduction by the terrestrial adults.

Wing length of male *Z. edensis* collected in the alpine spring stream varied considerably and the single female found had short wings. Of the other 21 *Z. confusus*-group species, some degree of brachyptery has been found in the males of six species and the females of five species, one of which is wingless (McLellan 1993). However, males have not been described for five further species and females are unknown in three, so the incidence of wing length reduction in the species group as a whole may be greater than known at present. Both sexes of three alpine species, *Z. foxi* McLellan (1993), *Z. macburneyi* McLellan (1993) and *Z. montanus* McLellan (1993) exhibit some degree of brachyptery. In Plecoptera, reduced wing size and loss of flight have been associated with rarity: short-winged or wingless taxa are rarer than fully-winged species (Malmqvist 2000). In *Zelandobius*, constraints imposed by the alpine climate may have promoted wing size reduction, thereby contributing to the isolation of species like *Z. edensis* and their consequent rarity.

Lastly, females are more commonly flightless than males in insects in general, but the reverse has been found in stoneflies (Roff 1990). Flightless male insects are frequently associated with flightless but mobile females (Roff 1990). This mobility presumably compensates for any reduction in the ability of the male to find a mate. Stoneflies in general have high non-flight mobility (Hynes 1967) and flightless stoneflies may rely primarily on drumming (in many Northern Hemisphere species; Stewart 1997) or perhaps chemical attractants to facilitate the finding of mates.

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**REFERENCES**


