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

D. P. GRAY

School of Biological Sciences, University of Canterbury, Private Bag 4800, Christchurch, New Zealand

email: Duncan.Gray@pg.canterbury.ac.nz

ABSTRACT

*Zelandobius edensis* new species 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 has short wings. Larvae are easily identified by their coating of long translucent hairs not found in other members of the *Zelandobius confusus*-group.

Keywords: Stoneflies; Gripopterygidae; *Zelandobius*; brachyptery; New Zealand; taxonomy
INTRODUCTION

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

DESCRIPTION

*Zelandobius edensis* new species

DIMENSIONS (millimetres). Male: body length 7.7-8.2; forewing 4-8; head width 1.4-1.72; antenna 7.5-10.25; cercus 0.75-1.02. Female: body length 9; forewing 4.8; head width 2.05; antenna 6; cercus 0.53. Nymph (final instar): body length 11-12; head width 1.8-1.9; antenna 4-4.2; circus up to 2 mm (broken in most larvae). See also Table 1.

TYPE MATERIAL: Holotype male, New Zealand, tributary of Frances River, Rangitata River catchment (NZMG 2328340E, 5757710N), area code SC (Crosby et al. 1998), 950 m, collected 18 May 2008, D. P. Gray. Deposited in the Canterbury Museum, Christchurch, New Zealand, stored in ethanol. Paratypes: 10 males, 1 female, 5 nymphs, same data as holotype, also stored in ethanol, 2 individuals submitted to the New Zealand arthropod collection, Auckland.

ADULT: General 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 length of segment 4. Pronotum light-medium brown with variably dark mottling but paler marginally and with a dark longitudinal groove in the mid-line (Figure 1D); width: length ratio 1.2 – 1.5 (mean 1.3); all pronotal margins are angled upwards slightly giving them 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 ridges bearing long translucent hairs. Wings of variable length (4-8 mm): fully-formed or showing various degrees of brachyptery (Figure 1A–C). Short wings have 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 (Figure 1A-B). Hindwings uniformly hyaline (Figure 1C). Abdomen of male chestnut-brown ventrally with parallel sided pale patches laterally on each sternite. In the female, the pale patches on sternites 2-7 are triangular and broader anteriorly Abdominal tergites with a dark band posteriorly.
MALE GENITALIA (Figs 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 (Figure 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 clothed in pale hairs around it posterior margin. Cerci 9-segmented, curving ventrally.

FEMALE GENITALIA (Figure 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 (Figure 5A-C): General colour sandy brown/tan, the body including head and legs clothed 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 (mean 1.5) in middle instars, 1.3 - 1.7 (mean 1.5) in late instars. Hairs clothe 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.

NYMPH ADULT CONFIRMATION: The link between adult and nymph of Zelandobius edensis was confirmed by comparing the DNA from 5 individuals of each. We sequenced a 600-base-pair segment of the mitochondrial gene, cytochrome c oxidase 1 (COI). DNA was extracted from a small tissue piece from the thorax or leg using the PureLink(tm) Genomic DNA Mini Kit (Invitrogen, New Zealand) according to the tissue extraction protocol supplied by the manufacturer. PCR reactions 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 of 94°C for 30 sec, 45°C for 30 sec, 72°C for 1 min, with a final extension of 72°C for 7 min. PCR reactions were run on an iCycler thermal cycler (Biorad, USA). PCR products were visualized 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 v3.1 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. We found 98.7% similarity between 600 base pair sequences of the COI gene which is conclusive evidence that both nymph and adults were the same species.

DIFFERENTIAL DIAGNOSIS: *Z. edensis* is a typical member of the *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 (Figure 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 *edensis* 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 also found in *Z. confusus* (Hare), *Z. cordatus* McLellan and *Z. dugdalei* McLellan, but not in combination with the other features mentioned above. The paraprocts of *edensis* are most similar to those of *Z. patricki* McLellan as they possess a long curved apical spine and a shallowly bulged dorsal surface. However, the epiprocts of *patricki* lack the very large proximal teeth found in *edensis*, the ventral epiproct hook of *patricki* is much blunter and the tip of tergite 10 is noticeably more bulbous in *edensis* than *patricki*. In the female, the combination of unicolorous subgenital plate (sternite 8), membranous sternite 9, and fully sclerotised sternite 10 distinguish *edensis* from all other *confusus*-group species.
The very hairy nymph of *edensis* is most likely to be confused with that of *Z. pilosus* Death, (Figure 5) which also has its head, body and legs clothed with long (~0.2 mm) translucent hairs. However, *pilosus* belongs to the *furcillatus*-group, and is easily distinguished by the straight rather than re-entrant hind margins of the meso- and metanota. Additionally, the antennae of *pilosus* are very hairy (Death 1990), whereas those of *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.

NOTES ON BIOLOGY

*Zelandobius edensis* is known 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 (Figure 6). 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 *confusus*-group species, with at least 13 of the other 21 described species being known only at altitudes greater than 900 metres (McLellan 1993).
Middle sized nymphs were collected on 22 April 2007, but neither adults nor larvae were seen on 25 August despite intensive searching. However, on 18 May 2008 numerous late instar nymphs and adults were found at the site. These observations suggest the life cycle maybe strongly synchronized. 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 very short wings. Of the other 21 *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 this. Both sexes of three alpine species, *Z. foxi* McLellan, *Z. macburneyi* McLellan and *Z. montanus* exhibit some degree of brachyptery. In Plecoptera reduced wing size and loss of flight have been associated with rarity: short-winged or wingless taxa being rarer than fully-winged species (Malmqvist 2000). In *Zelandobius*, constraints imposed by the alpine climate may have 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 interestingly, the reverse has been found in stoneflies (Roff, 1990). Flightless male insects are frequently associated with flightless but mobile females (Roff, 1990), whose mobility presumably compensates for any reduction on the part of the male to look for a mate. Stoneflies in general are good runners (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.

ACKNOWLEDGEMENTS

I thank Mike Winterbourn for encouraging me to write this manuscript, Richard Purdon, Jo Ocock and Shannon Roughan for assistance in the field, and Bridget Allen for drawing the figures. Marek Kirs (Cawthron Institute) performed PCR extractions on larvae and adults to confirm identities of both. The Miss E. L. Hellaby Indigenous Grasslands Research Trust generously provided living expenses for DPG. Neil Andrews provided SEM images. I would also like to acknowledge the late Ian McLellan who was the authority on this group and confirmed the validity of our description.

REFERENCES


Malmqvist, B. 2000: How does wing length relate to distribution patterns of stoneflies (Plecoptera) and mayflies (Ephemeroptera)? Biological Conservation 93: 271-276.


Figures

Figure 1A) Forewings of male *Zelandobius edensis* showing variable lengths and patterning, scale bar = 1 mm, B) a very short male forewing, scale bar = 4 mm, C) short hindwing of male, scale bar = 1 mm, D) pronotum of adult male, scale bar = 1 mm.
Figure 2. Lateral view of, A) male tergite 10 and epiproct, B) male paraproct. Scale bar = 1 mm.
Figure 3. Male genitalia. 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.
Figure 4. Female genitalia, ventral view. Scale bar = 1 mm.
Figure 5. A) The re-entrant hind margin of the meso- and metanotum of *Z. edensis* (*confusus*-group), B) the straight hind margins of *Z. pilosus* (*furcillatus*-group), C) late instar larva of *Z. edensis* without hairs on antennae, D) late instar larva of *Z. pilosus* with antennae clothed in hairs.
Figure 6. A) The type locality, a short spring creek flowing into B) the upper Frances River.
Table 1. Leg dimensions (mm; range with mean in parentheses) of male (n = 11) and female (n = 1).

<table>
<thead>
<tr>
<th></th>
<th>Male</th>
<th>Female</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Foreleg</td>
<td>Midleg</td>
</tr>
<tr>
<td>Coxa</td>
<td>0.2 - 0.4 (0.3)</td>
<td>0.3 - 0.5 (0.4)</td>
</tr>
<tr>
<td>Trochanter</td>
<td>0.2 - 0.3 (0.2)</td>
<td>0.2 - 0.3 (0.4)</td>
</tr>
<tr>
<td>Femur</td>
<td>1.5 - 1.9 (1.7)</td>
<td>1.7 - 2.1 (1.9)</td>
</tr>
<tr>
<td>Tibia</td>
<td>1.8 - 2.3 (2.1)</td>
<td>2.0 - 2.5 (2.2)</td>
</tr>
<tr>
<td>Tarsus</td>
<td>0.9 - 1.3 (1.1)</td>
<td>0.9 - 1.3 (1.1)</td>
</tr>
</tbody>
</table>