

RESEARCH PAPER

## A review of the New Zealand *Berosus* (Coleoptera: Hydrophilidae) with descriptions of three new species

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**Abstract.** The New Zealand species of the water scavenger beetle genus *Berosus* Leach, 1817 are reviewed based on freshly collected material and museum specimens. Four species are recognized: *Berosus pallidipennis* (Sharp, 1884) widespread in the North and South Islands, *B. muellerorum* sp. nov. from the eastern part of the North Island, and *B. halasi* sp. nov. and *B. maru* sp. nov., both endemic to central part of South Island. The synonymy of *B. mergus* Broun, 1886 with *B. pallidipennis* is confirmed and lectotypes for both taxa are designated. The larval morphology of *B. pallidipennis* and *B. muellerorum* is briefly discussed. Distributional data of all species are reported and illustrated, indicating a noticeable lack of *Berosus* species in the northern part of North Island and in Stewart Island and the presence of two rare species in the South Island, east of Southern Alps. An identification key to New Zealand species of the genus is provided.

**Key words.** Coleoptera, Hydrophilidae, Berosini, adult morphology, larval morphology, taxonomy, new species, island fauna, endemism, New Zealand

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### Introduction

The fauna of New Zealand Hydrophilidae is highly endemic and taxonomically unusual. The majority of species belongs to Cylominae, a small relict lineage distributed across the Southern Hemisphere (New Zealand, Australia, austral South America and South Africa; SEIDEL et al. 2016, 2018). Most cylomine genera are, moreover, not aquatic but inhabit forest leaf litter and other habitats in association with decaying organic matter (SHORT & FIKÁČEK 2013). Only two New Zealand cylomine genera are aquatic: *Cylomissus* Broun, 1903 with adults and larvae aquatic (MINOSHIMA et al. 2015) and *Rygmodes* White, 1846 with aquatic larvae and terrestrial adults (MINOSHIMA et al. 2018). The remaining hydrophilid subfamilies, forming a dominant part of the water scavenger beetle diversity in most parts of the world, are represented in New Zealand by a few species only. Even these occur in specialized habitats: *Tormus* Sharp, 1884 inhabits moss cushions growing on the forest floor or on tree trunks (FIKÁČEK et al. 2013), *Horelo-*

*phus* d'Orchymont, 1913 is specialized in seepage habitats (FIKÁČEK et al. 2012) and *Cercyodes* Broun, 1886 in beach wrack accumulations (FIKÁČEK 2019). Consequently, only eight species inhabit typical aquatic habitats like riverside pools, lakes or temporary puddles in New Zealand, representing five genera: *Berosus* Leach, 1817 (one endemic species), *Limnoxenus* Motschulsky, 1853 (one species shared with Australia), *Paracymus* Thomson, 1867 (one species shared with Australia), *Enochrus* Thomson, 1859 (one endemic species, two species shared with Australia) and *Laccobius* Erichson, 1837 (two endemic species) (HANSEN 1999, unpublished data).

HANSEN (1991, 1997, 1999) summarized the available information about New Zealand taxa. He had initiated revisions of several genera but due to his early death, these studies remain largely unpublished. More recently, the authors of this study undertook an extensive survey of the New Zealand hydrophilid fauna based on museum material and intensive field work performed in 2010–2018. This



project has thus far resulted in taxonomic and biological treatments of New Zealand endemic genera *Tormus*, *Horelophus*, *Cylomissus*, *Rygmodes*, *Enigmahydus* Seidel, Minoshima, Leschen & Fikáček, 2020 and *Saphydus* Sharp, 1884 (FIKÁČEK et al. 2012, 2013; MINOSHIMA et al. 2015, 2018; SEIDEL et al. 2020). Only *Tormus*, *Saphydus* and *Enigmahydus* have been fully reviewed taxonomically; the remaining genera remain unrevised.

Fully aquatic New Zealand species have received very little attention so far. Among them, *Berosus* is represented in New Zealand by a single species *B. pallidipennis* (Sharp, 1884). It was originally assigned to a New Zealand endemic *Phelerosus* Sharp, 1884, but this taxon was later recognized as a subgenus of *Berosus* (KNISCH 1924). The second species, *B. mergus* Broun, 1886, was synonymized with *B. pallidipennis* by d'ORCHYMONT (1937), leaving *B. pallidipennis* the only *Berosus* species occurring in New Zealand. The goal of this paper is to revise the taxonomy of New Zealand *Berosus* based mainly on the new material collected across both New Zealand islands during the recent field work. Our study began primarily as a DNA-based survey of newly collected specimens for a broader biogeographic study presented elsewhere (SEIDEL et al. 2021). To our surprise, distinct genetic clades indicated unknown species. Further study of genitalic and external morphology of these clades confirmed their species status. The result, which we report herein, includes three new species, two of which with restricted distributions in the South Island, one endemic to the North Island, and *B. pallidipennis* widespread in both main islands.

## Material and methods

**Depository of examined specimens.** Vouchers specimens are deposited in the following collections:

BMNH	Natural History Museum [former British Museum (Natural History)], London, United Kingdom (M. Barclay);
DZRJ	Molecular Section of the Entomological Collection Prof. José Alfredo Pinheiro Dutra, Department of Zoology, Universidade Federal do Rio de Janeiro, Brazil;
DZUP	Entomological Collection Pe. J. S. Moure, Universidade Federal do Paraná, Curitiba, Paraná, Brazil;
EMEC	Essig Museum of Entomology, University of California, Berkeley, California, USA (C. Barr, W. Shepard);
MONZ	Museum of New Zealand Te Papa Tongarewa, Wellington, New Zealand;
NMPC	Department of Entomology, National Museum, Prague, Czech Republic (J. Hájek, L. Sekerka);
NZAC	New Zealand Arthropod Collection, Landcare Research, Auckland, New Zealand (R. Leschen);
ZMH	Zoologisches Museum, Centrum für Naturkunde, Universität Hamburg, Hamburg, Germany (M. Seidel).

**Morphological studies.** Abdomens were removed from vouchers and the male genitalia and abdominal morphology were examined in temporary glycerine or glycerine jelly mounts on slides and photographed using a Canon EOS1100D camera attached to an Olympus BX41 compound microscope. Some genitalia were embedded in a drop of alcohol-soluble Euparal resin. Habitus photographs were taken using a Canon D-550 digital camera with the attached Canon MP-E65mm f/2.8 1–5× macro lens. Mul-

tilayer photographs were stacked using Helicon Focus software and subsequently adapted in Adobe Photoshop CS2. Larval morphology was compared only externally, detailed studies on morphology and chaetotaxy were not performed.

## Results

### *Berosus pallidipennis* (Sharp, 1884)

(Figs 1A, E; 2A, E–F)

*Phelerosus pallidipennis* Sharp, 1884: 480. Transferred to *Berosus* by KNISCH (1924).

*Berosus mergus* Broun, 1886: 883. Synonymized by d'ORCHYMONT (1937).

**Type material examined.** *Berosus pallidipennis*: LECTOTYPE (hereby designated): ♂ (BMNH): “♀ / *Phelerosus pallidipennis* / Type D. S. / Dunedin. N. Z.<sup>d</sup>. / Thomson // Sharp Coll. / 1905-313. // TYPE / H.T. // SYN- / TYPE”. PARALECTOTYPES: 1 ♂ 1 ♀ (BMNH): “♀♂ / *Phelerosus pallidipennis*. / Greymouth. n.3. / Helms. 1883. // Greymouth, / New Zealand. / Helms. // Sharp Coll. / 1905-313. // SYN- / TYPE”.

*Berosus mergus*: LECTOTYPE (hereby designated): ♂ (BMNH): “Maungatua // 1572 // *Berosus mergus* // New Zealand / Broun Coll. / Brit. Mus. / 1922-482. // Type”.

**Additional material examined.** **ADULTS. NEW ZEALAND: NORTH ISLAND:** 1 spec. (NZAC): T. Broun lgt. **Bay of Plenty:** 1 spec. (NZAC): Te Rereauira Stream, Ditch near *Melicytus* swamp, 24.xi.1992, M. C. Lariviere lgt.; 2 spec. (NZAC): Te Araroa Rd, Mangaomeko Stream, 37.59162°S, 178.21096°E, 50 m, 23.i.2017, water collecting, Leschen & Maier leg., NZ17-0123-CM1; 1 spec. (FMNH): E of Opotiki, Opahe Beach Road, unnamed stream, 37.97854°S, 177.42752°E, 30 m, 24.i.2017, water collecting, Leschen & Maier leg., NZ17-0124-CM2. **Gisborne:** 1 spec. (NZAC): near Mangatiti Bridge, Waiorongomai River, 37.8641°S, 178.1892°E, 22.i.2017, 128 m, from flood debris, Leschen & Maier leg., NZ17-0122-CM1. **Hawkes Bay:** 1 spec. (NZAC): Dartmoor, Mangaone, 28.i.1959, B. M. May lgt.; 1 spec. (NZAC): Maraekakaho, 22.xi.1966, R. M. Bull lgt.; 1 spec. (NZAC): Waipatiki, 27.i.1959, B. M. May lgt.; 2 spec. (EMEC): N of Waipukurau, Tukituki River, 39°59.31'S, 176°33.52'E, 122 m, 20.ii.2016, W. D. Shepard leg., WDS-A-2003. **Rangitikei:** 1 ♂ (NZAC): Makiekie stream, Makoura road, 15.ii.1997; 1 spec. (NMPC): Ruahine Forest Park, Waipawa River S of Triplex hut, 39.8055°S, 176.19245°E, 600 m 26.xi.2016, stony stream with bare gravel banks, flowing from *Nothofagus*-podocarp forest: stream collecting, in side pools and submerged gravel with decaying leaves, Fikáček & Seidel lgt. MM29. **Waikato:** 3 spec. (NZAC): Rararimu Stream, 4.iii.2012, at large, 38°23.048'S, 174°44.212'E, M. Gimmel, R. Leschen, RL1671; 1 spec. (NMPC): Ruahoanga Scenic Reserve at Honikiwi Rd., 70 m, 38.1579°S, 175.0684°E, 16.xi.2017, in exposed muddy pools at sides of the road and on the track in Ruahoanga Reserve, partly vegetated, Fikáček, Sadílek & Sýkora lgt. **Wairarapa:** 1 spec. (NZAC): Martinborough, 26.xii.1917, A. C. O'Connor & A.E. Brookes lgt. **Wanganui:** 1 spec. (NZAC): Manawatu, Grasslands, 9.i.1952; 1 spec. (NZAC): Palmerston North, 5.xi.1961, C. Laurie & G. Laurie lgt.; 2 spec. (NZAC): Palmerston North, 20.i.1939, M. J. Esson lgt.; 4 spec. (EMEC, NMPC): Bulls, 40°11.17'S 175°23.47'E, 9.ii.2016, 33 m, pools near river, W. D. Shepard leg., WDS-A-1988A; 1 spec. (EMEC): Bulls, 40°11.17'S, 175°23.47'E, 33 m, 9.ii.2016, W. D. Shepard leg., pools near river, WDS-A-1988A. **Wellington:** 1 spec. (NZAC): Otaki Forks, Waiotauru River, 30.xii.1980, J. Nunn lgt.; 2 spec. (NZAC): Wellington, Hutt River, 2.i.1928, A. E. Brookes lgt.; 1 ♀ (BMNH): Wellington, Hutt River, 2.i.1928. **Taupo:** 2 spec. (NMPC): 7.5km SSE of Murupara, Mangawiri Bridge No. 184, 260 m, 22.xi.2012, 38°30.9'S, 176°44.1'E, Becker, Fikáček & Hájek lgt., NZ01. **SOUTH ISLAND: Buller:** 4 spec. (NZAC): Kawatiri, Hope River, 2.ii.2000, P. Cranston lgt.; 7 spec. (NZAC): Mawhera S. F., Wallaby Creek, BFUP, 9.i.1973, J. C. Watt lgt.; 1 spec. (NMPC): Lake Rotoiti, road to Mt. Robert, 42°47.82'S 172°49.68'E, 3.xii.2010, under rocks and along margin of small lake, Fikáček & Leschen leg, RL1535; 9 spec. (NMPC, NZAC): Little Grey River at road bridge 0.5 km S of Mawheraiti, water collecting in small exposed river: collecting in gravel, on stones and in side pools 42°11.91'S, 171°43.26'E, 140 m, 25.ii.2016, Seidel, Sýkora, Leschen,

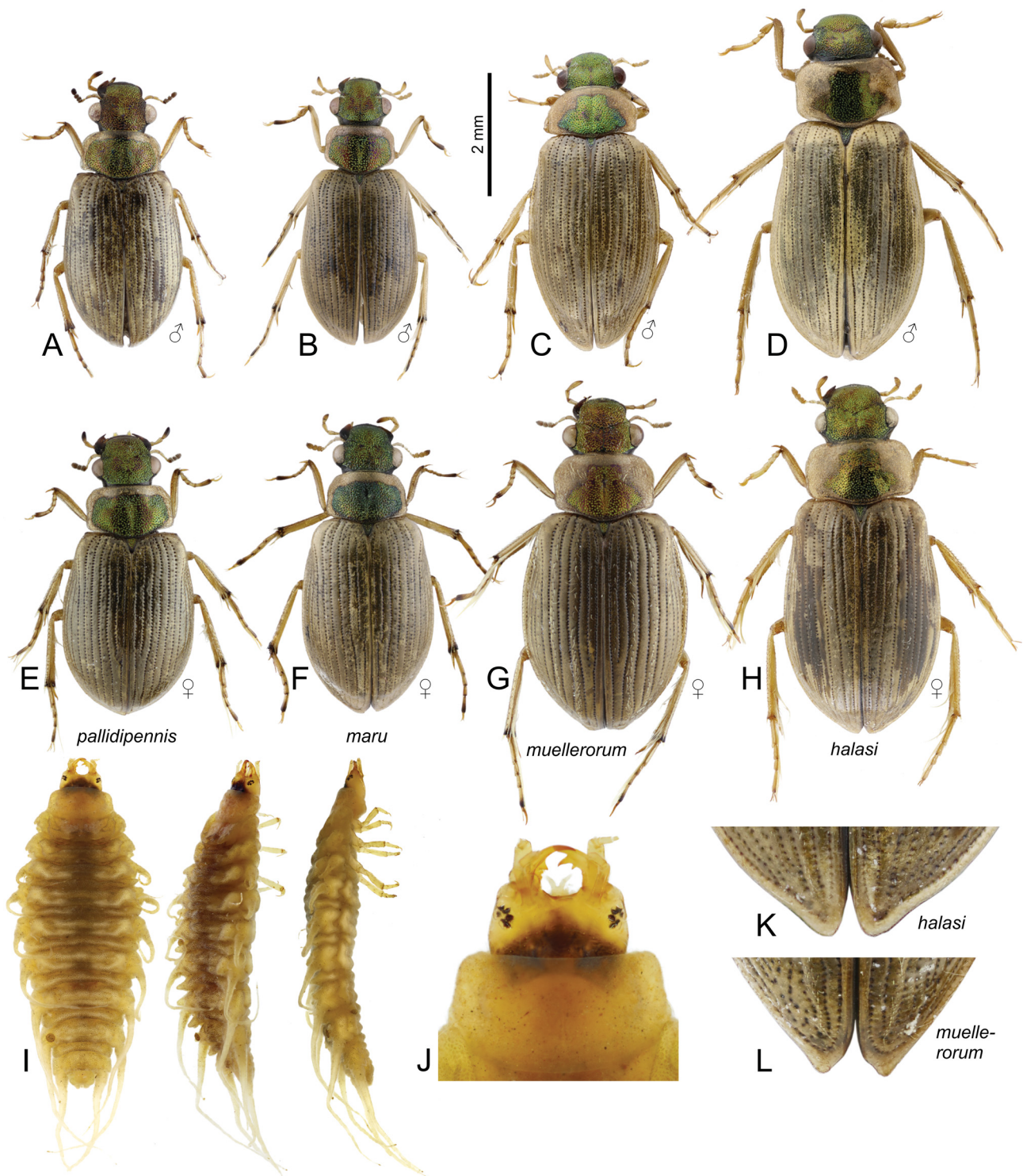


Fig. 1. External morphology of New Zealand *Berosus*, adults and larvae. A, E – *B. pallidipennis* (Sharp, 1884); B, F – *B. maru* sp. nov.; C–G, I–J, L – *B. muellerorum* sp. nov.; D–H, K – *B. halasi* sp. nov.; A–H – dorsal views; K–L – elytral apices; I–J – third instar larva (I – dorsal, semilateral and lateral view; J – head in dorsal view).

Maier & Lambert lgt., 2016-NZ-MS76; 1 spec. (NMPC): Nelson Lakes NP, St. Arnaud small lake at N end of Lake Rotoiti, 632 m, 41.7992°S, 172.8233°E, 5.xii.2016, water collecting in a small lake in the shrubby area, Fikáček & Seidel lgt. MM55. **Central Otago:** 1 spec. (NMPC): Little Kye Burn at Danseys Pass Road bridge, 45°02.63'S, 170°15.21'E, 480 m, 16.ii.2016, water collecting in small river among pastures: collecting in gravel and submerged vegetation, Seidel, Sýkora, Leschen & Maier lgt., 2016-NZ-MS16. **Dunedin:** 5 spec. (NMPC, NZAC, ZMH): 6 km W of Waitaki Bridge, Waitaki Riverbed, S44°55.2', E171°01.5', 35 m, J. Hájek & P. Hlaváč lgt.; 20 spec. (NMPC, NZAC): Silver Stream Valley Rd. at

Silver Stream, 45°48.71'S, 170°25.07'E, 95 m, 11.ii.2016, moderately large exposed polluted stream at partly degraded forest area, Seidel, Sýkora & Fikáček lgt., 2016-NZ072. **Fiordland:** 6 spec. (NMPC, NZAC): Monowai Lookout Tk at Monowai campsite, 45°48.67'S 167°31.21'E, 210 m, 26–28.i.2016 in submerged grasses and gravel banks of the wetland at the end of Lake Monowai, Seidel, Sýkora & Fikáček, 2016-NZ030; 1 spec. (NMPC): Pig Creek at Borland Road, 45°46.49'S, 167°32.01'E, 180 m, 31.i.2016, peaty forest stream with stony streambed flowing from *Nothofagus* forest, Seidel & Sýkora lgt., 2016-NZ045; 1 spec. (NMPC): at Borland Rd. 1.7 km W of Monowai, 45°46.72'S, 167°35.68'E 160 m,

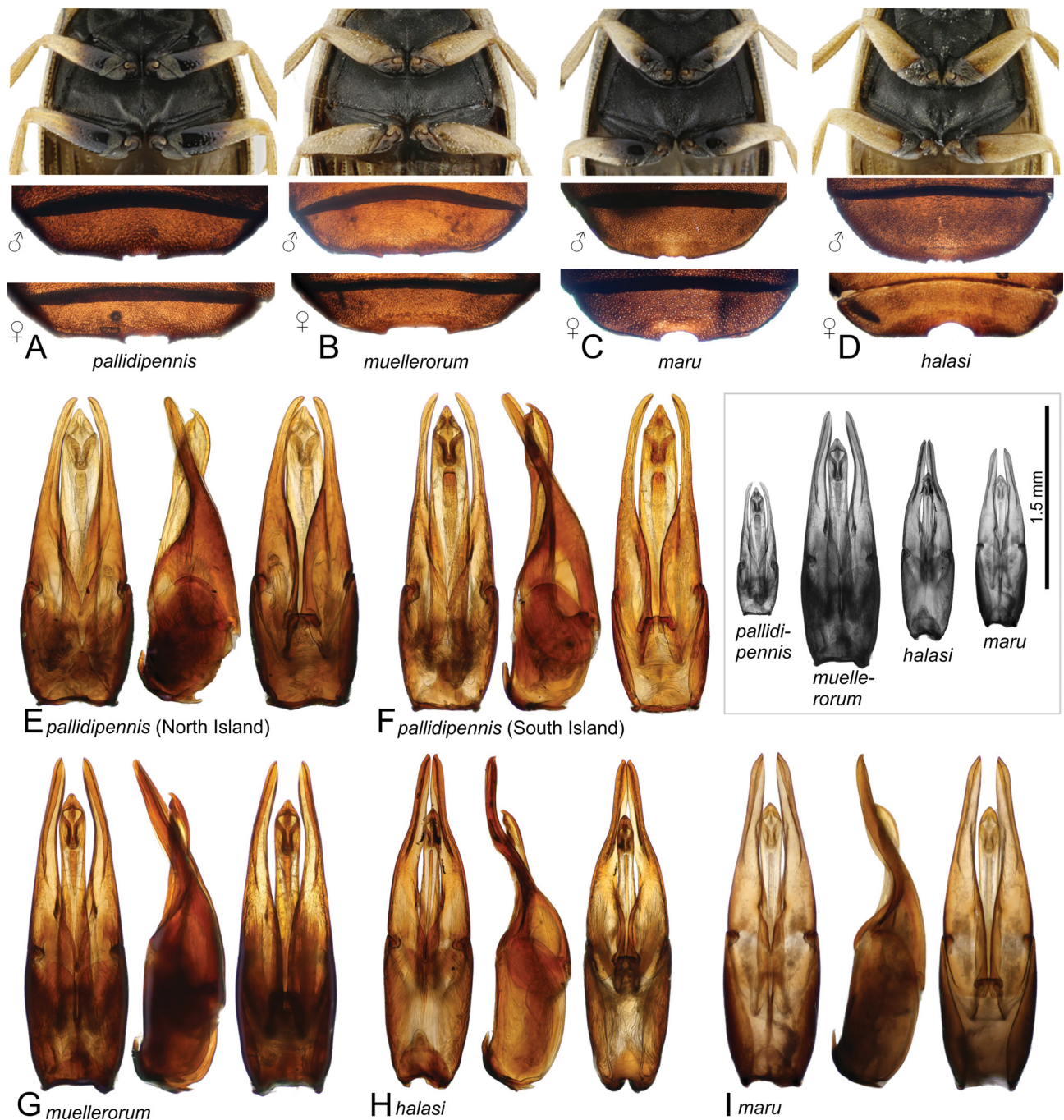


Fig. 2. New Zealand *Berosus*, details of adult morphology. A–D – coloration of meso- and metafemora; E–I – aedeagus in dorsal, lateral and ventral view; E–F – *B. pallidipennis* (Sharp, 1884) from North and South Island; G – *B. muellerorum* sp. nov.; H – *B. halasi* sp. nov.; I – *B. maru* sp. nov. The inset in grey: relative size of male genitalia of all species.

26.i.2016, stream collecting: slow-flowing exposed gravel stream among pastures, V. Sýkora lgt., 2016-NZ029. **Kaikoura**: 28 spec. (EMEC, NMPC): S of Mt. Lyford Village, Wandle River, 42°35.21'S, 173°05.99'E, 229 m, 18.ii.2016, W. D. Shepard leg., WSD-A-2000; 42 spec. (NMPC, NZAC, ZMH): Kahutara River at Inland Kaikoura Road, 42°23.07'S, 173°26.96'E, 181 m, 29.xi.2017, water collecting in small exposed puddles without vegetation in wide riverbed, Fikáček, Sadílek & Sýkora lgt. **Marlborough**: 4 spec. (NZAC): Pelorus Bridge, 7.viii.1957, J. I. Townsend lgt.; 5 spec. (NZAC): Pelorus Bridge, 7.xi.1957, M. J. Esson lgt.; 1 ♀ (NMPC): Stoney Creek, 42°42.95'S, 173°4.86'E, 3.xii.2010, along margins and under rocks in stream, Fikáček & Leschen leg., RL1537; 13 spec. (NZAC): Pelorus River, 9.xii.2018, gravel bar, 41°17.966'S, 173°34.780'E, R Leschen, V. Sýkora, RL2084; 1 spec. (NMPC): Stoney Creek, 3.xii.2010, M. Fikáček, R. Leschen, RL1537; 41 spec. (NMPC, NZAC, ZMH): Pe-

lorus Bridge Scenic Reserve Pelorus River at Totara Path, 41.30012°S, 173.57582°E, 35 m 11.xii.2016, water collecting in Pelorus River: in submerged gravel + in flooded vegetation at sandy/clayey steep banks and rocks, M. Fikáček & M. Seidel lgt. MM69c. **Mid Canterbury**: 1 ♀ (NZAC): Mt Algidus, 3.xii.1913, T. Hall & A. E. Brookes lgt.; 1 ♂ 2 ♀♀ (NZAC): Mt Somers, 1500 m, 17.i.1964, M. J. Esson & J. I. Townsend lgt.; 1 spec. (NZAC): Lincoln, Coes Ford, 20.i.1970, Ento. Dept Field Trip; 1 ♂ (NZAC): Ashley Gorge, river bed, 31.i.1994; 1 ♀ (NZAC): Mount Hutt Forest, 26.xii.1997; 2 ♂♂ 3 ♀♀ (NMPC): Rangitata River at Rangitata Gorge Road, Ashburton Lakes, 415 m, 16.xii.2018, huge exposed river and its side arms in enormous riverbed, R. Leschen & V. Sýkora lgt., 2018-NZ97. **North Canterbury**: 4 ♂♂ 6 ♀♀ (NZAC): Waitohei River at bridge, Medbury Road W of Medbury; 42.8782778°S 172.6509444°E; 253 m; 14.xii.2018, R. Leschen & V. Sýkora, RL2103;

Table 1. Diagnostic characters of the New Zealand *Berosus* species.

	<i>B. pallidipennis</i>	<i>B. muellerorum</i>	<i>B. halasi</i>	<i>B. maru</i>
Body size	3.7–4.8 mm	4.4–5.4 mm	5.3–6.0 mm	3.5–4.5 mm
Pronotal spot	rectangular	narrow anteriorly	narrow anteriorly	rectangular
Elytral apices	simple and tightly closing	projecting and diverging	projecting and diverging	simple and tightly closing
Meso- and metafemora	dark in basal half	pale	dark only very basally	dark in basal half
♀: apical abdominal emargination	rectangular, shallow	rectangular, shallow	semicircular, deep	semicircular, shallow
♀: elytral surface	smooth	microreticulate	microreticulate	microreticulate
♂: aedeagus length	1.1 mm	2.1 mm	1.7 mm	1.5 mm
♂: paramere apex in lateral view	straight	straight	strongly bent	weakly bent
♂: median lobe	wide and nearly reaching apices of parameres	narrow, shorter than parameres	very narrow, much shorter than parameres	narrow, shorter than parameres

1 ♀ (NMPC): 22.8 S of Lewis Pass, Boyle River at Windy Point, 515 m, 42.58546°S, 172.37549°E 8.xii.2016, in isolated rocky pools with sandy bottom on the cliffs above Boyle River next to the hanging bridge, Fikáček & Seidel lgt. MM64. **Nelson:** 2 spec. (NZAC): Buller River, T. Broun & A. E. Brookes lgt.; 10 spec. (NZAC): Tapawera, 23.i.1962, E. S. Gourlay lgt.; 4 spec. (NZAC): Wangapeka Valley, 2.xii.1934, E. S. Gourlay lgt.; 1 spec. (NZAC): Takaka River at Lindsays Bridge, Uruwhenua, 40.9877889°S 172.819775°E, 80 m, 2.xii.2018, R. Leschen & V. Sýkora, RL2046; 1 spec. (NZAC): St. Arnaud, Nelson Lakes, i.1977, M. J. Meads lgt.; 1 spec. (NZAC): Lake Tennyson, 22.i.1977, M. J. Meads lgt. **Otago Lakes:** 2 ♂♂ 2 ♀♀ (BMNH): Paradise, 10.i.1945, C. E. Clark lgt.; 11 spec. (EMEC, NMPC): Te Anau, Hwy 94, unnamed stream, 45°24.52'S, 167°44.36'E, 221 m, 14.ii.2016, W. D. Shepard leg., 11 spec. (EMEC, NMPC): OL, Te Anau, Hwy 94, unnamed stream, 45°24.52', 167°44.36', 221 m, 14.ii.2016, WDS-A-1996, W. D. Shepard leg.; 17 spec. (NMPC, NZAC): Pool at Wanaka Mount Aspiring Road, 44°30.30'S, 168°46.00'E, 348 m, 2.xii.2017, water collecting in small stony pool on side of the road, Fikáček, Sadílek & Sýkora lgt. **South Canterbury:** 1 spec. (EMEC): St. Andrews, Hwy 1, unnamed river, 44°29.665'S, 171°11.962'S, 17.ii.2016, W. D. Shepard leg.; 7 spec. (NMPC, NZAC): Peel Forest Reserve, 9. ii.2016, pasture pool, 43°53.9'S 171°13.8'E, 400 m, J. Hájek & P. Hlaváč lgt. **Southland:** 1 ♀ (BMNH): Invercargill, Thomsons Bush, flood debris, 27.i.1984, P. M. Hammond; 23 spec. (NMPC, NZAC): Whitestone River at Hillside Manapouri Rd. 13.2 km S of Te Anau, 45°31.67'S, 167°45.36'E, 230 m, 28.i.2016, large river in stony/gravelly riverbed: collecting in river + in gravel banks and isolated pools with submerged vegetation, Seidel, Sýkora & Fikáček lgt., 2016-NZ035; 4 spec. (NMPC, NZAC): Redcliff Creek at Blackmount-Redcliff Rd., 14.5 km SSE of Manapouri, 45°41.69'S, 167°39.27'E, 200 m, 28.i.2016, exposed moderately large stony stream, Seidel, Sýkora & Fikáček lgt., 2016-NZ034; 16 spec. (NMPC): Wairaki River 13 km N of Clifden, 45°56.05'S, 167°42.33'E, 90 m, 23.i.2016, small river in a wide gravel riverbed: water collecting in gravel, small rapids, in submerged plants at side of the river and in isolated pools in the riverbed, Seidel, Sýkora & Fikáček lgt., 2016-NZ019; 2 spec. (NMPC): Mataura River at Waikaia Rd. 3.7 km N of Riversdale, 45°52.20'S, 168°45.54'E, 130 m, 7.ii.2016, in large river in gravel riverbed: in the river, in side pools on gravel banks, among submerged vegetation, Seidel, Sýkora & Fikáček lgt., 2016-NZ066; 1 spec. (NMPC): Steeple Flat at Piano Flat Rd., 45°40.55'S, 168°52.86'E, 180 m, 7.ii.2016, exposed stony stream among pastures + isolated side pools in gravel river-bed, Seidel, Sýkora & Fikáček lgt. 2016-NZ065; 3 spec. (NMPC): Ligar Creek at Lake Monowai Rd., 45°47.35'S, 167°38.86'E, 140 m, 26.i.2016, stream collecting in large stream with gravel-stony banks, Seidel, Sýkora & Fikáček lgt., 2016-NZ031. **Westland:** 13 spec. (NMPC, NZAC): Pegleg Creek at Otira Hwy., collecting in medium-sized partly exposed forest stream, 42°53.70'S, 171°33.57'E, 830 m, 24.ii.2016, Seidel, Sýkora, Leschen, Maier & Lambert lgt., 2016-NZ-MS69; 11 spec. (NMPC, NZAC): Mount Aspiring NP, Pleasant Flat 27.2 km NNE of Makarora, at Mur Creek, 120 m, 11.xii.2012, 44°0.8'S 169°22.9'E, Fikáček, Hájek & Leschen lgt., NZ49.

**Larvae. NEW ZEALAND: SOUTH ISLAND: North Canterbury:** 8 larvae (NMPC): S of Mt. Lyford Village, Wandle River, 42°35.21'S, 173°05.99'E, 229 m, 18.ii.2016, W. D. Shepard leg., WSD-A-2000; 1 larva (NMPC): Wairaki River 13 km N of Clifden, 45°56.05'S, 167°42.33'E, 90 m, 23.i.2016, small river in a wide gravel riverbed: water collecting in gravel, small rapids, in submerged plants at side of the river and in isolated pools in the riverbed, Seidel, Sýkora & Fikáček lgt., 2016-NZ019.

**Redescription of adult.** Body length 3.7–4.8 mm. Shape ellipsoid, moderately elongate (Figs 2A, E).

**Coloration.** Labrum black with green and/or purple metallic reflections, dorsum of head black with varying degrees of metallic green or purple reflections. Pronotal ground coloration yellowish, bearing large rectangular dark metallic spot covering nearly whole surface except wide lateral and anterior margins. Scutellar shield with same color as head. Elytra testaceous with brown punctures. Ventral surface pitch-black. Maxillary palpi with palpomere 4 darkened in apical half. Legs with trochanters and basal half of femora black, other parts testaceous. Antennae testaceous.

**Dorsum.** Head densely punctate, punctures on clypeus 1.5–2.0 times as large as ommatidia, regularly spaced; punctures on frons 2.0–3.0 times as large as ommatidia, irregular, getting contiguous towards eyes. Pronotal punctures dense and coarse, getting denser towards lateral margins with punctures on disc about the same size as those on frons. Pronotal surface without apparent setae. Scutellar shield coarsely punctate with smooth lateral margins. Elytral striae well-impressed, consisting of small round punctures of about the same size as pronotal ones. All interstriae with sparse fine punctation, punctures about half the size of the striae ones; odd interstriae with large sparsely arranged dark-colored larger punctures (trichobotria), each with short indistinct seta only. Surface of elytra smooth in both sexes. Elytral apices in males and females simple, touching each other along suture even at very apex.

**Ventrum.** Mesoventral process reduced to a glabrous median ridge. Metaventricle with posterior elevation bearing medial groove; posterior part with short median projection, lateral projections absent. Abdominal ventrite I with very faint carina basally, without carina in posterior half. Ventrite 5 of both sexes with a wide, shallow apical

notch delimited laterally by two distinct teeth slightly more produced in females. Margins of all abdominal ventrites smooth.

**Legs.** Basal pubescence on basal sixth of meso- and metafemora. Male protarsus with adhesive soles on tarsomere 1 which is only slightly thicker than tarsomeres 2–4; tarsomere 4 ca. as long as tarsomeres 1–3 combined. Claws slender, weakly curved.

**Male genitalia.** Total length 1.1 mm. Aedeagus laterally compressed. Basal piece ca. two-fifths of total aedeagus length. Paramere long, narrow, gradually acuminate, straightly projecting towards ventral side in lateral view; apices rounded, slightly bent mesally in dorsal view. Median lobe slightly shorter than parameres, subcylindrical, its apical half much wider than apical half of paramere. Apex of median lobe acuminate forming a hook in lateral view.

**Larval morphology.** In all external characters examined corresponding to the larva of *B. muellerorum* sp. nov. characterized below.

**Differential diagnosis.** *Berosus pallidipennis* can be recognized as distinct from *B. muellerorum* sp. nov. and *B. halasi* sp. nov. by the pronotum with large rectangular dark spot covering nearly the whole surface, basal half of femora black, elytral apices simple and closing tightly, and females with smooth elytral surface; the aedeagus is smallest of all New Zealand species, with straight parameres in lateral view and median lobe wide and nearly reaching parameral apices. Externally it is very similar to *B. maru* sp. nov. with which it may co-occur; males of both species can be easily recognized by the morphology of male genitalia, females may be recognized by different microsculpture of the elytra and different shape of the apical abdominal emargination.

**Habitat.** *Berosus pallidipennis* inhabits a wide range of aquatic habitats, most frequently it is found along the vegetated river margins (Fig. 3G) and in side pools of stony rivers (with or without vegetation) (Fig. 3H). Less frequently it was found at margins and under stones in shallow mountain lakes with stony bottom, and only few findings come from standing vegetated pools outside of riverbeds.

**Distribution** (Fig. 3D). Widely distributed in the North Island (no records from Northland, Auckland, Coromandel and Taranaki) and South Island (no records from Mackenzie); the lack of records in the northern North Island may indicate that the species is absent from the northernmost New Zealand.

### *Berosus halasi* sp. nov.

(Figs 1D, H, K; 2D, H)

**Type material.** HOLOTYPE: ♂ (NZAC), “NEW ZEALAND: MC, Mid / Canterbury, 6km W of / Hakatere, Lake Roundabout, / S43°37.3', E171°05.9', 660m, / 8.ii.2018, J. Hájek & P. Hlaváč / lgt. // DNA isolate: / NZ355.1 / extracted by M. Seidel 2017 / DNA extract deposited in / Natural Museum, Prague // HOLOTYPE / *Berosus halasi* n. sp. / Seidel et al. 2019”. PARATYPES: NEW ZEALAND: SOUTH ISLAND: Mid Canterbury: 1 ♂ 1 ♀ (NMPC): same data as holotype. Central Otago: 1 ♀ (NZAC): Maniololo [=Maniototo], 94, Lewis coll., No. 5523; 1 ♀ (MONZ): “Maniololo [=Maniototo], 94, Lewis Coll., No 5524; 1 ♀ (MONZ): “Maniololo [=Maniototo], 94, Lewis Coll., No 5526.

**Description of adults** [characters identical to *B. pallidipennis* redescription are not repeated]. Body length 5.3–6.0 mm (holotype: body length: 5.8 mm; humeral width: 1.9 mm). Shape elongate ellipsoid (Figs 2D, H).

**Coloration.** Pronotum with yellowish ground coloration, bearing large median dark metallic spot which is narrowly rectangular in anterior half and widely semicircular posteriorly, not reaching posterior margin. Maxillary palpi with palpomere 4 darkened in apical fourth. Legs with trochanters and basal sixth of femora black, other parts testaceous.

**Dorsum.** Pronotal surface without apparent setae. Surface of elytra smooth in males, with mesh-like microsculpture in females. Elytral apices slightly projecting in both sexes (slightly more in females), making elytral apices slightly divergent from each other and leaving a small gap between them when elytra are closed.

**Ventrum.** Mesoventrite without median keel, only with a low posteromedian process. Abdominal ventrite 5 with a wide, very shallow apical notch delimited laterally by small teeth in male, with a deep semicircular notch in female.

**Legs.** Male protarsus with adhesive soles on tarsomere 1, which is ca. twice as thick as following tarsomeres; tarsomere 4 as long as tarsomeres 1–3 combined.

**Male genitalia.** Total length 1.65 mm. Paramere long, narrow, gradually acuminate, straightly projecting towards ventral side in lateral view. Apices pointed, slightly bent mesally in dorsal view. Median lobe much shorter than parameres, its width in apical half only slightly wider than the width of paramere.

**Differential diagnosis.** *Berosus halasi* sp. nov. is easy to distinguish from *B. pallidipennis* and *B. maru* sp. nov. by its large body size and anteriorly narrowing pronotal spot. In both these characters it resembles *B. muellerorum* sp. nov. from which it can be distinguished by the shape of the apical abdominal emargination in females, and the morphology of the aedeagus in males.

**Etymology.** This species is dedicated to Pavel Halaš (Prague, Czech Republic) as a thank for his support of the entomology. The name is a noun in genitive singular case.

**Habitat.** In 2016, this species was collected in the non-vegetated shallow littoral zone of Lake Roundabout where it was swimming among stones in clear water (Fig. 3E). The second attempt to collect the species at this locality in 2017 was unsuccessful, possibly because of high abundance of algae that were not present in the lake in 2016.

**Distribution** (Fig. 3A). The species is only known from two localities in the central montane non-forested part of the South Island (Mid Canterbury and Otago) and may be endemic to this zone.

### *Berosus maru* sp. nov.

(Figs 1B, F, I–J; 2C, I)

**Type material.** HOLOTYPE: ♂ (NZAC), “NEW ZEALAND: N / Canterbury 22.8 km S of Lewis / Pass, Boyle River at Windy / Point; 515 m 42.58546°S, / 172.37549°E 8.xii.2016; / Fikáček & Seidel lgt. MM64 // in isolated rocky pools / with sandy bottom on the cliffs / above Boyle River next to / the hanging bridge // DNA isolate: / NZ549.1 / extracted by M. Seidel 2016 / DNA extract deposited in / National Museum, Prague // HOLOTYPE / *Berosus maru* sp. nov. / Seidel et al. 2019”. PARATYPES: NEW ZEALAND: SOUTH ISLAND: Mid Canterbury: 4 ♂♂ 13 ♀♀

(NZAC, NMPC, BMNH, ZMH): Rangitata River at Rangitata Gorge Road, Ashburton Lakes, 415 m, 16.xii.2018, huge exposed river and its side arms in enormous riverbed, R. Leschen & V. Sýkora lgt. 2018-NZ97.

**Description of adults** [characters identical to *B. pallidipennis* description are not repeated]. Body length 3.5–4.5 mm (holotype: body length: 4.4 mm; humeral width: 1.7 mm). Shape elongate ellipsoid (Figs 2B, F).

**Coloration.** Maxillary palpi with palpomere 4 darkened in apical third.

**Dorsum.** Pronotal surface without long pale decumbent setae. Surface of elytra smooth in males, with mesh-like microsculpture in females. Elytral apices slightly to non-divergent in males, slightly divergent and rounded in females leaving a narrow gap between apices when elytra are closed.

**Ventrum.** Mesoventrite with low pubescent median ridge not projecting into a process posteriorly. Abdominal ventrite 5 with a shallow and narrow notch in males, and a wide, deeply rounded notch in females.

**Legs.** Male protarsus with adhesive soles on tarsomere 1, which is ca. twice as thick as following tarsomeres; tarsomere 4 as long as tarsomeres 1–3 combined.

**Male genitalia.** Total length 1.5 mm. Parameres long, narrow, gradually acuminate, apical half sinuate and not pointing ventrally in lateral view. In dorsal view the parameres curving in towards each other, apices pointed. Median lobe much shorter than parameres, very narrow.

**Differential diagnosis.** *Berosus maru* sp. nov. differs from *B. muellerorum* sp. nov. and *B. halasi* sp. nov. by its smaller body size and large rectangular spot on the pronotum; in both these characters as well as in most other external characters it is very similar to *B. pallidipennis* with which it may co-occur. For diagnosis from *B. pallidipennis*, see under that species.

**Etymology.** The species is named after Maru, the Maori god of fresh water also known as the god of war in Southern New Zealand. The name is a noun in the nominative case, standing in apposition.

**Habitat.** This species was collected in semi-permanent pools along rivers (Fig. 3F).

**Distribution** (Fig. 3B). Central part of the South Island (Mid Canterbury, North Canterbury).

### *Berosus muellerorum* sp. nov.

(Figs 1C, G; 2B, G)

**Type material.** HOLOTYPE: ♂ (NZAC), "NEW ZEALAND: GB, / Gisborne, Mangaone Road, W / of Route 2, Mangaone Stream, / -38.97138, 177.67152, 256m, / 18.i.2017, Leschen & Maier / leg., water collecting, NZ17-0118-CM3 // DNA isolate: / NZ635.1 / extracted by M. Seidel 2017 / DNA extract deposited in / Natural Museum, Prague // HOLOTYPE / *Berosus muellerorum* / n. sp. / Seidel et al. 2019". PARATYPES: **NEW ZEALAND: NORTH ISLAND: Hawkes Bay:** 1 ♀ (FMNH): same data as holotype; 3 ♂♂ 2 ♀♀ (NZAC, FMNH, NMPC): Putorino, nr. On Route 2, Waikiri River, 39.12945°S, 176.9974°E, 36 m, 20.i.2017, water collecting, Leschen & Maier lgt.; 2 ♀♀ (EMEC, NMPC): Hwy 2 McIntyre Acc. Rd., 39°15.18'S 176°52.76'S, 69 m, 21.ii.2016, William D. Shepard leg., WDS-A-2005. **Gisborne:** 3 ♀♀, 3 spec. (NZAC, NMPC, DZJR, DZUP): Te Urewera NP, Papakorito Falls, 1.4 km NEE of Aniwanuiwa, 650 m, 25.xi.2012, 38°44.4'S 177°10.6'E, in semipermanent/permanent puddles on the road at the beginning of Aniwanuiwa track, Becker, Fikáček, Hájek, NZ14; 2 ♀♀ (NZAC): Waimata Valley Road, Waimata River, 38.53309°S,

178.03939°E, 50 m, 21.i.2017, water collecting, Leschen & Maier leg., NZ17-0121-CM2; 1 ♀ (NMPC): Te Urewera NP, Lake Waikaremoana Motorcamp, 600 m, 22.–26.xi.2012, 38°45.3'S 177°9.4'E, exposed, muddy puddles at the side of the road, Becker, Fikáček, Hájek lgt.; 1 spec. (EMEC): Waikohu River at Hwy. 2, just S Rakauroa, -38.41521, 177.56088, 21.ii.2016, C. B. Barr lgt. **Wanganui:** 3 ♀♀ (NZAC, EMEC): Bulls, 40°11.17'S 175°23.47'E, 9.ii.2016, 33 m, pools near river, William D. Shepard. lgt., WDS-A-1988A.

**Additional material examined. Larvae.** 1 third instar larva (NMPC): Putorino, nr. On Route 2, Waikiri River, 39.12945°S, 176.9974°E, 36 m, 20.i.2017, water collecting, Leschen & Maier lgt.

**Description of adults** [characters identical to *B. pallidipennis* description are not repeated]. Body length 4.4–5.4 mm (holotype: body length: 4.7 mm; humeral width: 1.8 mm). Shape elongate ellipsoid (Figs 2C, G).

**Coloration.** Pronotum with yellowish ground color and dark metallic central spot which is narrowly rectangular in anterior half and widely semicircular posteriorly. Maxillary palpi with palpomere 4 darkened in apical fourth. Legs with black trochanters, remaining parts testaceous.

**Dorsum.** Pronotal surface with long pale decumbent setae. Surface of elytra smooth in males, with mesh-like microsculpture in females. Elytral apices divergent and pointed in males, divergent and rounded in females, in both sexes leaving a wide gap between apices when elytra are closed.

**Ventrum.** Mesoventrite with low pubescent median ridge not projecting into a process posteriorly. Abdominal ventrite 5 with a narrow very shallow notch in males, and a wide and slightly deeper apical notch in females.

**Legs.** Male protarsus with adhesive soles on tarsomere 1, which is ca. three-times as thick as following tarsomeres; tarsomere 4 slightly longer than tarsomeres 1–3 combined.

**Male genitalia.** Total length 2.13 mm. Parameres long, narrow, gradually acuminate, apical half straight and pointing ventrally in lateral view. In dorsal view the parameres curving in towards each other, apices pointed. Median lobe much shorter than parameres, very narrow.

**Larval morphology** (Figs 1I–J). Larva corresponds to the larvae of other species of *Berosus* in the main characteristics (head with large left and minute right epistomal lobe, mandibles of the 'Berosus-type', labium reduced in size, ligula absent, abdomen with one pair of tubular spiracular gills on sides of segments I–VIII, spiracular system closed, spiracular atrium absent; MINOSHIMA & HAYASHI 2015, FIKÁČEK et al. 2018). In contrast to the known larvae, the body is very wide and robust, with large laterodorsal tubercles above the bases of tracheal gills. The head differs from all known *Berosus* larvae in the absence of a nasale: anteromedian margin of head is completely smooth (Fig. 1J).

**Differential diagnosis.** *Berosus muellerorum* sp. nov. differs from *B. pallidipennis* and *B. maru* sp. nov. by the pronotal spot narrowing anteriorly; in this character it resembles *B. halasi* sp. nov. from which it differs by the male genitalia and a wider and shallower emargination of the abdominal apex in females.

**Etymology.** The species is named after Swiss naturalist Roland A. Müller (see obituary by HÄMÄLÄINEN & TOL 2017) and his wife Anna-Maija Müller Kaltula (St. Gallen, Switzerland). The name is a noun in genitive plural case.

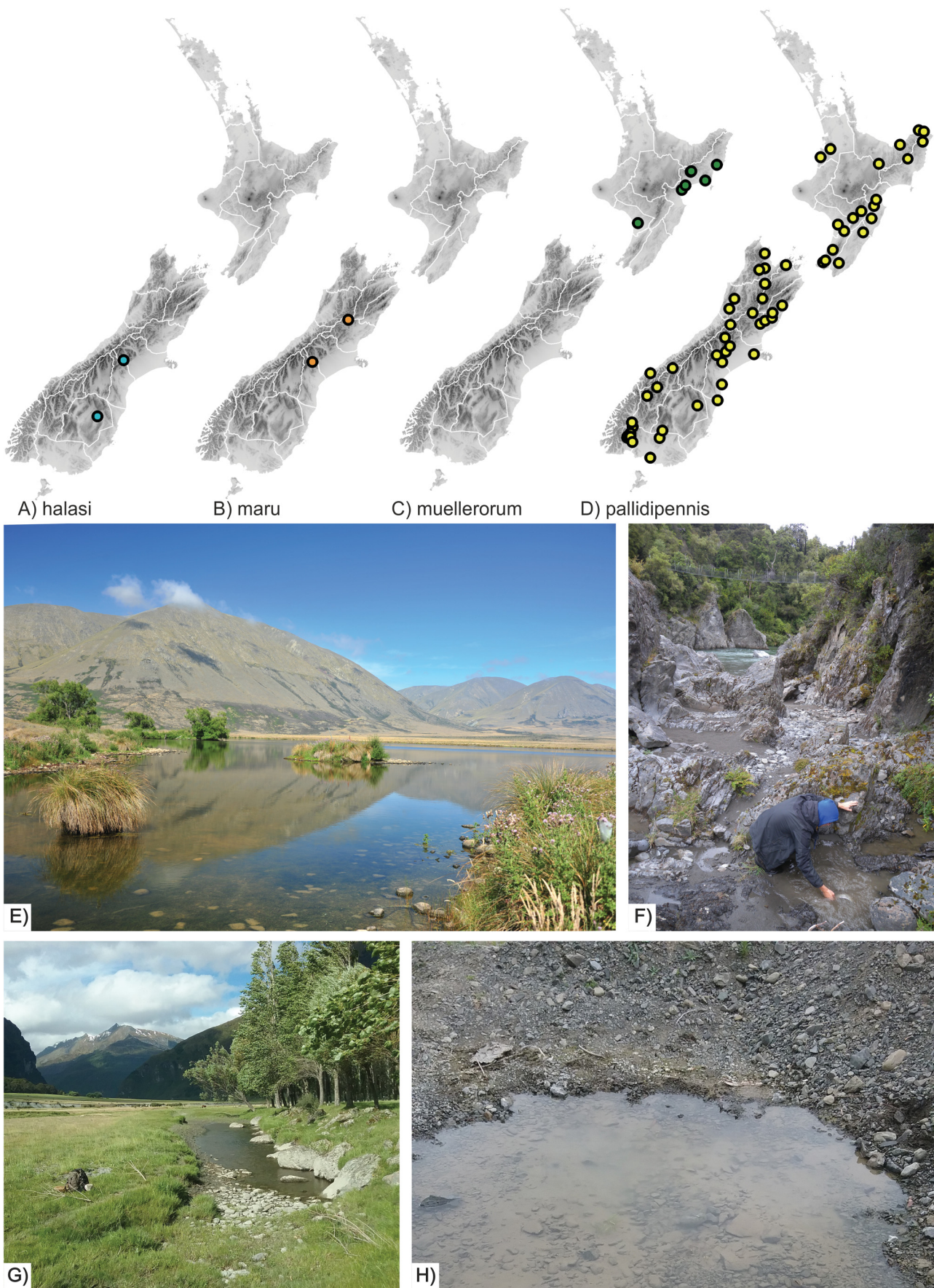


Fig. 3. Distribution and habitats of *Berosus* in New Zealand. A–D. Maps of examined specimens. E–H. Habitat photos of collection sites. E – shore of Lake Roundabout in Mid Canterbury, type locality of *B. halasi* sp. nov.; F – isolated rocky pools along Boyle River at Windy Point in North Canterbury, type locality of *B. maru* sp. nov.; G – pool at Wanaka Mount Aspiring Road in Otago Lakes, locality of *B. pallidipennis* (Sharp, 1884); H – exposed puddles in riverbed of Kahutara River at Inland Kaikoura Road in Kaikoura, locality of *B. pallidipennis*.



**Habitat.** This species was collected in pools along rivers and streams as well on temporary pools on roads in open landscape.

**Distribution** (Fig. 3C). Southern and eastern part of North Island (Wanganui, Gisborne, Hawkes Bay).

### Key to adults of the New Zealand species of *Berosus*

See also Table 1 for the summary of diagnostic characters and their comparison among species.

- 1 Pronotum with large rectangular dark spot covering nearly whole surface, basal half of femora black, elytral apices simple and closing tightly, small species (3.5–4.8 mm). ..... 2
- Pronotum with large rectangular dark spot narrowing anteriorly, basal half of femora yellow, elytral apices expanded and leaving a gap, large species (4.4–6.0 mm). ..... 3
- 2 Aedeagus small, with straight parameres in lateral view, median lobe wide and nearly reaching parameral apices. Female with apical abdominal emargination rectangular. .... *B. pallidipennis* (Sharp, 1884)
- Aedeagus medium-sized, with slightly bent parameres in lateral view, median lobe narrow and much shorter than parameres. Female with apical abdominal emargination semicircular. .... *B. maru* sp. nov.
- 3 Aedeagus medium-sized, with strongly bent parameres in lateral view, median lobe narrow and much shorter than parameres. Female with apical abdominal emargination semicircular. .... *B. halasi* sp. nov.
- Aedeagus large, with straight parameres in lateral view, median lobe narrow and much shorter than parameres. Female with apical abdominal emargination rectangular. .... *B. muellerorum* sp. nov.

### Discussion

Until recently, New Zealand *Berosus* was thought to contain a single widespread species, *B. pallidipennis*. Our study identified three additional species and the phylogenetic study performed by SEIDEL et al. (2021) revealed that all four species are closely related, forming a monophyletic New Zealand lineage of a rather ancient origin. Despite being originally overlooked and identified as *B. pallidipennis*, the species actually differ in characters showing species-specific morphologies also in other groups of *Berosus*, i.e., male genital morphology and size (Figs 2E–I), shape of the apical emargination of abdominal ventrite 5 in males and females (Figs 2A–D), coloration of meso- and metafemora (Figs 2A–D), pronotal color pattern (Figs 1A–H) and shape of elytral apices (Figs 1K–L). While all the other species are single island endemics, *B. pallidipennis* is distributed in the North Island, and South Island. We did not find morphological differences among all examined specimens to suggest this species consisted of multiple cryptic species. Across the distribution range specimens are identical in external characters and male genitalia (Figs 1A, E; 2A, E–F) supporting a single species

only, as supported by genetic data (SEIDEL et al. 2021). Characters of male genitalia and of the abdominal apex suggest sister group relationships between *B. maru* + *B. halasi* and *B. muellerorum* + *B. pallidipennis*. In contrast, external characters (pronotum pattern, body size, coloration of meso- and metafemora, shape of elytral apices, presence/absence of mesh-like elytral microsculpture in females) are similar in *B. muellerorum* + *B. halasi* and identical in *B. pallidipennis* + *B. maru*, and suggest opposite sister groupings.

*Berosus pallidipennis* was originally described in the monotypic genus *Phelerosus* (SHARP 1884). *Phelerosus* was later downgraded to monotypic subgenus (KNISCH 1924) (HANSEN 1999). The three species described here are closely related to *B. pallidipennis* and hence could be also assigned to *Phelerosus*. However, the status of *Phelerosus* needs to be clarified in the context of the world-wide fauna of *Berosus* (B. Clarkson, in prep.), and is not addressed here.

*Berosus maru* and *B. halasi* are presently known from two collections each from areas east of the Southern Alps, an area heavily modified through intense agricultural practices. Both species should be listed as threatened (GRAINGER et al. 2018), and as Data Deficient due to the paucity of specimens and localities (TOWNSEND 2008). Focussed survey work is highly recommended, especially in areas like the Moniototo plains where three specimens of *B. halasi* were collected, probably in the early 1900's when it's collector, J. S. Lewis, was active (e.g., LEWIS 1902).

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