



<http://dx.doi.org/10.11646/zootaxa.3955.2.4>

<http://zoobank.org/urn:lsid:zoobank.org:pub:828A05F3-D367-498A-ABDB-70E1126EAE47>

## ***Zemacrosaldula*, a new genus of Saldidae (Hemiptera: Heteroptera) from New Zealand: taxonomy, geographic distribution, and biology**

MARIE-CLAUDE LARIVIÈRE & ANDRÉ LAROCHELLE

*New Zealand Arthropod Collection, Landcare Research, Private Bag 92170, Auckland 1142, New Zealand.*

*E-mail: LariviereM@landcareresearch.co.nz; LarochelleAndre@hotmail.com*

### **Abstract**

*Zemacrosaldula*, new genus, is described with *Salda australis* White, 1876, as type species, resulting in the following new combination *Zemacrosaldula australis* (White, 1876). Three new species are described: *Zemacrosaldula kapekape* new species, *Z. whakarunga* new species, *Z. pangare* new species. A revision of the taxonomy of all taxa is presented. Species are keyed. Morphological descriptions are provided together with illustrations emphasising the most significant diagnostic features of external morphology and male genitalia. Information is given on synonymy, type specimens, material examined, geographic distribution and biology.

**Key words:** shore bugs, revision, systematics, biodiversity

### **Introduction**

Relatively little is known about the shore bugs (Hemiptera: Saldidae) of New Zealand. Seven endemic species so far placed in the genus *Saldula* Van Duzee, 1914, have been described from this country (Larivière & Larochelle 2004; 2014). No taxonomic revision or identification key has ever been published for this fauna.

In addition to original species descriptions, the most useful contributions to the taxonomy and general understanding of the New Zealand Saldidae have been made by Cobben (1961; 1980a), Polhemus (1985a), and Schuh & Polhemus (2009). Cobben (1961) published descriptions for three species, doubling the number of New Zealand species assigned to *Saldula*. Cobben's descriptions were accompanied by useful illustrations but no identification key; an informative discussion on the composition of the fauna was however provided. Cobben's (1980a) revision of Hawaiian *Saldula* was also insightful especially in terms of dealing with "taxonomic complications" caused by character polymorphism (e.g., variation in hemelytral pigmentation or in degree of development of hindwings) which, as he put it, can hardly be resolved using single specimens or the small samples found in most museums. Polhemus (1985a) published the most comprehensive world overview of the family Saldidae, including a preliminary generic-level phylogeny. Consequently his work yielded the most exhaustive framework to consider regional faunas. Without the broad perspective offered by Polhemus (1985a) it would have been extremely difficult to undertake this New Zealand study mainly because the Southern Hemisphere fauna in general and the Australian fauna in particular, remain largely unresolved taxonomically. Schuh & Polhemus's (2009) revision and phylogenetic analysis of the South American and Andean genus *Pseudosaldula* contributed further useful contextual information for the New Zealand revision, especially with respect to morphological character analysis, saldid phylogeny, and austral biogeography.

The Australian Saldidae (three genera, ten species) are only partially known taxonomically and the most relevant literature on the subject (Rimes 1951; Cobben 1980b; Polhemus 1991; Cassis & Gross 1995) so far does not suggest a particularly close affinity with the New Zealand fauna.

The proposition that the New Zealand saldids described to date are not congeneric with *Saldula*, is not new (Polhemus 1985a–b; Lindsog & Polhemus 1992; Schuh & Polhemus 2009) but little could be done until now to revise this classification for lack of sufficient and well-documented material. Extensive fieldwork by the authors

since 1992 has yielded large amount of new saldid material, including long series of specimens from several populations and a wealth of new information on geographic distribution and biology. This provided solid bases upon which to conduct the current study.

The genus *Saldula* (*sensu lato*) is a large, nearly worldwide, polyphyletic taxon that has often served as a ‘wastebasket genus’ to classify species that could not readily fit elsewhere. Lindskog & Polhemus (1992) estimated that nearly half of known Saldidae were contained in *Saldula* and that nearly half of *Saldula* species could eventually be transferred to other genera. These authors were the first to suggest a more restricted taxonomic definition and description of *Saldula* (*sensu stricto*), using a monophyletic concept based on two synapomorphies (median cell of corium with eye spot; median endosomal sclerite of male with anteromedial laminar projections).

The taxa revised here do not fit Lindskog & Polhemus’s definition of *Saldula* or the taxonomic concept of other described saldid genera. Consequently a new genus, *Zemacrosaldula* (Saldidae: Saldinae: Saldoidini), is erected to accommodate *Salda australis* White, 1876 (formerly placed in *Saldula*) as well as three new species (*Z. kapekape*, *Z. whakarunga*, *Z. pangare*). This brings the total number of known saldid taxa for New Zealand to two genera, *Zemacrosaldula* and *Saldula* (*sensu lato*), containing four and six species respectively.

*Zemacrosaldula* species are easily recognised in the field. They are the largest of the New Zealand Saldidae. Their overall body colour is blackish with variously shaped pale dorsal hemelytral markings and speckles. They are generally heliophilous, showing peak activity during intense sunlight periods, and mostly saxicolous, living on stones, gravel and other rocky formations arising from or located near freshwater. They live along riverbanks—including the long braided rivers of the South Island—and on the shores of lakes. This is typically a group of inland species that can at times be found in estuaries near the mouths of mainly large rivers as long as suitable riparian habitat is available and upstream populations are well established. *Zemacrosaldula* species are macropterous, with well-developed hindwings, and able to fly at least short distances.

The authors hope that their efforts to clarify the alpha-taxonomy of species in this genus and to publish extensive biological and distributional information can address some of the limitations to advancing knowledge on New Zealand saldids as well as provide a foundation for more detailed systematics and evolutionary studies.

## Materials and methods

This study is based on the examination of over 1,100 specimens (mostly adults) from more than 130 New Zealand localities. Most of this material (c. 85%) was collected by the authors from 1992 to 2014 and is deposited in the New Zealand Arthropod Collection (NZAC), Auckland.

Other specimens were kindly provided by the following New Zealand institutions: Auckland Institute and Museum, Auckland (AMNZ); BMNH (The Natural History Museum, London, U.K.; formerly British Museum of Natural History); Canterbury Museum, Christchurch—P.M. Johns specimens (CMNZ); Entomology Research Museum, Lincoln University, Lincoln (LUNZ); Museum of New Zealand Te Papa Tongarewa, Wellington (MONZ).

The NZAC specimens used in this study received unique barcode labels and were databased. Once this paper is published, specimen records will be made available through Landcare Research’s Systematics Collections Database portal (<http://scd.landcareresearch.co.nz/>).

Terms particular to Saldidae morphology mostly follow Schuh & Polhemus (2009), the most notable exceptions are as follows: preocellar furrow(s), “sillons antéocellaires” of Péricart (1990); preocular spot(s), adopted here to denote the rather smooth area of cuticle near the point of insertion of each of a pair of trichobothrium-like setae near the preocellar furrow; acetabulum (acetabula) of Cobben (1961), the area of the sternum forming each thoracic cavity into which a leg is inserted, numbered I, II and III (pro-, meso-, metathoracic acetabulum); inner membrane of parandria, adopted here instead of medial membrane. For the male aedeagus, the expression anterolateral sclerites refers to the apicolateral sclerites of Polhemus (1985a).

The adjective pruinose is used to qualify dull hemelytral surfaces that appear ‘frosted’ or ‘covered by a powdery layer.’ Schuh & Polhemus (2009) showed these pruinose or dull surfaces to bear dense mats of microtrichia and non-pruinose or shiny surfaces to be devoid of them.

The male genitalia of representatives of as many populations as possible were dissected in the following manner. Dry-mounted specimens were warmed for 15 minutes in hot soapy water; softened specimens were

transferred to a watch glass containing some of the hot water used for softening (e.g., square 4 cm watch glass or equivalent). For each specimen, the genital capsule was separated from the abdomen using fine forceps and a microscalpel (e.g., needle tip from a 1.0 ml disposable hypodermic syringe or other fine needle); parameres and aedeagus were detached and extracted from the genital capsule using the same tools; dissected genitalia were transferred to smaller individual watch glasses (e.g., 1 dram glass vials cut in half) containing glycerol and a thin film of 75% ethanol to assist transfer of structures from water to glycerol; the small watch glasses were then stored in 24 wells sorting trays for further examination. At the end of the study dissected genitalia were transferred to plastic microvials containing glycerol, and subsequently mounted on the pin below relevant specimens.

Descriptions are based on adults. Measurements included in the descriptions, were taken as follows: *body length*, in dorsal view, from visible apex of head to apex of hemelytron; *antennal segment length*, from base to apex of segment; *antenna length*, the sum of individual segment lengths; *leg segment length*, from base to apex of segment; *pronotum* or *scutellum length*, along midline, from base to apex. Cells in the membrane of the hemelytron are numbered from 1 to 4, from most anterior cell (near costal margin) to most posterior cell (near apex of clavus).

The eunomy or eunomic series—the range of variation in hemelytral pigmentation arranged in a sequence from light to dark according to a more or less stable gradation pattern for a given species—is an important taxonomic character used in saldid taxonomy. The eunomic series in this revision represent the general pattern that best fits variations observed among populations of a species.

Type data, when provided, are listed in this order: type status followed by sex, acronym of entomological collection or museum serving as repository, and original label data with a forward slash (/) separating data from different labels.

The taxonomic arrangement of species and illustrations follows the order of taxa in the identification key.

Photographs were taken using Leica stereomicroscopes (MZ16 or M205A), digital cameras (Leica DFC450 or Nikon DSRi1), and the image stacking applications Helicon Focus or Zerene Stacker. Further photo-processing was done using Adobe Photoshop, CorelDRAW graphics suite, and Adobe Lightroom. Black and white illustrations were prepared and laid out using CorelDRAW graphics suite. The distribution map was digitally traced from a draft map generated from georeferenced locality data using internet-based GIS technology.

The two-letter abbreviation codes of Crosby *et al.* (1976; 1998) for areas of New Zealand, were used to record localities. North Island: AK, Auckland; BP, Bay of Plenty; CL, Coromandel; GB, Gisborne; HB, Hawke's Bay; ND, Northland; RI, Rangitikei; TK, Taranaki; TO, Taupo; WA, Wairarapa; WI, Wanganui; WN, Wellington; WO, Waikato. South Island: BR, Buller; CO, Central Otago; DN, Dunedin; FD, Fiordland; KA, Kaikoura; MB, Marlborough; MC, Mid Canterbury; MK, Mackenzie; NC, North Canterbury; NN, Nelson; OL, Otago Lakes; SC, South Canterbury; SD, Marlborough Sounds; SL, Southland; WD, Westland. Stewart Island: SI. For each species areas codes are listed from north to south and west to east. Table 1 provides geographical coordinates of collecting localities in decimal degrees.

Biological notes are based on an analysis and synthesis of specimen label data and field observations by the authors.

## Taxonomy, geographic distribution, and biology

### *Zemacrosaldula* new genus

**Type species.** *Salda australis* White, 1876, by present designation.

**Description.** Body length 4.22–6.28 (5.15) mm; elongate-ovate or broad-ovate. Dorsal colour somewhat speckled; largely blackish, with uniformly dark or, more rarely, narrowly pale lateral margins of pronotum, and a few to several, coalesced or individual pale markings on hemelytra, including a more or less defined line of three to four spots along R vein. Macropterous. **Head** not closely appressed to thorax (eyes distinctly separated from thorax), with three pairs of long trichobothrium-like setae (two dorsally on mandibular plates, two near preocellar furrows, two near preocellar spots). Frons with well-developed longitudinal furrow medially. Ocelli slightly elevated from surface of vertex, separated by the diameter of one ocellus or less, closer to each other than to eyes. Preocellar spots distinct, usually paler than surrounding area, subtriangular to crescent-shaped, narrowly to broadly touching eyes (by one ocellus width or more), slightly extending or not in front of ocelli. Preocellar furrows present, about as

deep as longitudinal frontal furrow. Preocular spots indistinct, of same colour as surrounding area. Transverse swelling (postclypeus of Cobben) rather flat, slightly to moderately developed; lateral portions separated by a gap (mostly) or contiguous near facial midline. Mandibular plates rather flat, evanescent to moderately developed (not prominent or tumid). Maxillary plates slightly to moderately developed. **Antennae** largely dark; segment II completely dark or narrowly pale subapically only, at least 2.2x longer than I, clothed over entire length with very short setae (shorter than segment width), without long setae in apical half; segments III–IV not wider than apex of segment II, with short setae and a number of longer setae (subequal to segment width). **Thorax.** Pronotum: 0.51–0.62x as long as scutellum medially; subtrapezoidal; lateral margins subrectilinear to slightly convex, more rarely sinuate-concave, uniformly dark or, more rarely, narrowly pale (pale area narrower than or about as wide as antennal segment II), not explanate and not separated from disc by a longitudinal furrow; collar present, continuous (not interrupted medially), delimited posteriorly by a row of punctures; calli not strongly raised although well differentiated from disc, contiguous, forming a transverse elevation with a median pit, delimited posteriorly by a row of punctures curving forward laterally and reaching lateral margins of pronotum. Underside: xyphus 2 elongate (as long as or longer than wide), subtriangular. **Legs:** hind tibiae with subapical comb; hind tarsal segment II 1.0–1.4x as long as segment III. **Hemelytra:** without a distinct eyespot subbasally on exocorium; pubescence short, mostly semi-erect, whitish, more or less evenly distributed; clavus and corium largely pruinose or, more rarely, with pruinosity reduced on corium; costal margin slightly convex along entire length; costal fracture slightly curved forward, nearly reaching apex of R vein; embolar modification of female moderately (*Z. pangare*) to strongly developed; subapical pale spot of clavus present or absent; membrane with four well-formed cells, cell 2 about as long as cell 3, cell 4 distinctly longer than cell 3; hypocostal ridge simple; secondary hypocostal ridge absent. **Abdomen.** Venter largely black (never narrowly or broadly pale laterally) with or without posterior margin of segments narrowly pale. Paired eversible glands present; when externally visible, one gland located on each side near posterior margin of segment VII. **Male parandria** (Figs 19–20) elongate, narrowly or broadly subtriangular; tip acuminate or obtusely rounded; inner membrane present along basal quarter to basal third of inner margins. **Male paramere** (Figs 15–18) with or without distinct processus sensualis; dorsal margin bearing moderate to long setae. **Male aedeagus** containing three pairs of sclerites (Fig. 23, *Z. australis*), two larger median branched sclerites and 4 smaller simple anterolateral sclerites. **Male filum gonopori** coiled approximately 1.25 or 1.5 times (Figs 24–25). Female subgenital plate (segment VII, ventrally) with posterior margin produced caudally, truncate medially. Ovipositor with gonapophyse 1 distinctly serrate. Spermathecal pump flange present. Gynandrial gland sclerotised.

**Remarks.** The generic name *Zemacrosaldula* is derived from *Ze-* (New Zealand) and *Macrosaldula* (Greek, *makros* = large; Latin, *Saldula*, feminine gender); the name of the Northern Hemisphere genus that *Zemacrosaldula* resembles. The authors think that this is the genus tentatively identified as Genus A by Polhemus (1985a), and said to represent the closest morphological and ecological analogue of *Macrosaldula* Southwood & Leston, 1959.

The main morphological characters unifying the species of *Zemacrosaldula* are listed here, with generic level apomorphies from Polhemus (1985a) in italics: size relatively large (4.22–6.28 mm); dorsal colour somewhat speckled, largely blackish, with uniformly black or narrowly pale lateral margins of pronotum, and a few to several coalesced or individual pale markings on hemelytra, including a line of three to four spots along R vein; hemelytra lacking a distinct eyespot subbasally on exocorium; *antennal segment II long, clothed over entire length with very short setae, without long setae in apical half; frons with well-developed longitudinal furrow medially; calli of pronotum with a distinct median pit and delimited posteriorly by a row of punctures reaching lateral margins;* hemelytra and hindwings fully developed; membrane with four well-formed cells; *embolar modification of female hemelytra well developed; hind tibiae with subapical comb; male aedeagus with anterolateral sclerites; processus sensualis of male paramere distinct or indistinct; filum gonopori of male coiled 1.25 or 1.5 times.*

The male abdominal grasping plate was not studied in detail but preliminary observations in *Z. australis* indicate that it bears about 24 spines in the following configuration: an outer row of roughly 12 moderately long spines and an inner group of roughly 12 longer spines.

*Zemacrosaldula* species exhibit a high level of eunomic variability. Divergence from the ‘standard’ eunomy is common even within populations, and although it is possible to ‘perceive’ the identity of a species based on hemelytral pigmentation patterns, further confirmation is required from other morphological characters, including male genitalia. By the same token study material used for character analysis must consist of long series of specimens from any given population so as to sufficiently cover the range of morphological variations.

Cobben (1980a), in his study of Hawaiian *Saldula*, noted that environmental factors exert an influence on the

proportion of colour morphs at the population level, e.g., high temperatures and/or lower humidity shift the eunomic series towards the light side of the sequence while cooler temperatures and/or higher humidity generally produce darker morphs. The authors have noted similar trends for *Zemacrosaldula* species, each occupying a distribution range encompassing broad and complex climatic conditions mainly caused by extensive topographical variation (e.g., from coastal lowlands to high mountains), wide-ranging temperatures (e.g., warm or cool temperate to severely cold) and precipitations (e.g., annual rainfalls of 600–4000 mm, and snow in the mountains). The authors have also observed that the pigmentation of newly emerged adults and females in general, tends towards the pale side of pigmentation spectrum.

### Key to species of *Zemacrosaldula*

**Remark.** Additionally helpful but not necessarily exclusive characters are provided between square brackets.

- 1 Body elongate-ovate (Figs 1–2). Dorsum mostly dull in appearance, with rather evenly distributed, short whitish pubescence. Lateral margins of pronotum uniformly dark or narrowly pale. Hemelytra with several individual or coalesced whitish markings (Figs 1–2, 11–12). Face pubescent (Figs 5–8). Male genitalia: parandria narrowly subtriangular, acuminate at tip, with evenly curved inner margins (Fig. 19); paramere without distinct processus sensualis (Figs 15–16); apical half of aedeagus with subelongate and bent anterolateral sclerite (Fig. 21); filum gonopori coiled 1.5 times (Fig. 24). . . . . 2
  - Body broad-ovate (stocky) (Figs 3–4). Dorsum shinier in appearance (at least head and pronotum contrastingly shiny), with sparser, less evenly distributed or reduced, short to very short whitish pubescence. Lateral margins of pronotum uniformly dark. Hemelytra with few individual (not coalesced) whitish markings (Figs 3–4, 13–14). Face pubescent (Fig. 9) or glabrous (Fig. 10). Male genitalia: parandria broadly subtriangular, obtusely rounded at tip, with angular inner margins (Fig. 20); paramere with distinct processus sensualis (Figs 17–18); apical half of aedeagus with Y-shaped anterolateral sclerite (Fig. 22); filum gonopori coiled 1.25 times (Fig. 25) . . . . . 3
  
- 2 Antennae: segment II at least 2.4x longer than segment I. Pronotum: lateral margins uniformly dark or narrowly pale. Hemelytra with several, often coalesced, whitish markings (Figs 1, 11). Male paramere: processus hamatus acuminate and slightly upturned at tip (Fig. 15). [Distribution: North Island and northeastern South Island.] . . . . . *Z. australis* (White)
  - Antennae: segment II at most 2.2x longer than segment I. Pronotum: lateral margins uniformly dark. Hemelytra with several individual (not coalesced) whitish markings (Figs 2, 12). Male paramere: processus hamatus narrowly rounded and subrectilinear at tip (Fig. 16). [Distribution: southernmost areas and west coast of the South Island.] . . . . . *Z. kapekape* new species
  
- 3 Face pubescent (Fig. 9); slightly to moderately contrasted in colour (with partially pale transverse swelling, maxillary plates, anteclypeus). Dorsum (Fig. 3) moderately shiny (especially head, pronotum, scutellum), with short, somewhat sparse and unevenly distributed whitish pubescence. Hemelytra with clavus and corium largely pruinose. Underside of thorax mostly pubescent. Male paramere (Fig. 17): processus sensualis well developed; processus hamatus narrowly rounded at tip. [Hemelytra (Fig. 13): corium frequently with a pair of semilunate marks in basal third and a subquadrate medial mark at about midlength. Distribution: South Island, excluding southernmost areas and the west coast.] . . . . . *Z. whakarunga* new species
  - Face glabrous (Fig. 10); not contrasted in colour (entirely black or at most with transverse swelling slightly paler near sides or facial midline). Dorsum (Fig. 4) very shiny overall, with very short, very sparse (reduced) and quite unevenly distributed whitish pubescence. Hemelytra with clavus largely pruinose; corium partially pruinose (inner endocorium, subbasal exocorium). Underside of thorax mostly glabrous. Male paramere (Fig. 18): processus sensualis slightly developed; processus hamatus broadly rounded at tip. [Hemelytra (Fig. 14): corium largely immaculate, frequently with a subquadrate medial mark subapically. Distribution: South Island west coast, in the vicinity of the Fox and Franz Josef glaciers.] . . . . . *Z. pangare* new species

### *Zemacrosaldula australis* (White, 1876) new combination

*Salda australis* White, 1876: 106. Holotype male (BMNH; seen by Larivière & Laroche 2004); New Zealand.

*Acanthia australis*: Kirkaldy, 1909: 27.

*Saldula australis*: Drake & Hoberlandt, 1950: 7.

**Description.** Body length 4.22–5.89 (4.91) mm; elongate-ovate (Fig. 1). Dorsal colour largely black, with uniformly dark or narrowly pale lateral margins of pronotum and several whitish markings on hemelytra; frequently with irregular coalesced marks on exocorium. Facial colour (Figs 5–7) slightly to moderately contrasted. Head, pronotum and scutellum slightly shiny, contrasting slightly against mostly dull hemelytra. Dorsal pubescence short, reclined to semi-erect, whitish, more or less evenly distributed. Dorsal microsculpture rugulose on head, pronotum and scutellum. **Head** black. Face (Figs 5–7) pubescent. Transverse swelling whitish yellow to pale brown; lateral portions separated by a narrow to rather wide dark gap or, rarely, almost contiguous (nearly touching) near facial midline. Mandibular plates whitish yellow to pale brown or nearly black. Maxillary plates, anteclypeus and labrum whitish yellow to pale brown; anteclypeus often marked with brown basally. **Antennae** 4.07–4.33x longer than pronotum + collar medially, largely dark; segment I whitish yellow to yellowish brown, with ventral and dorsal sides dark brown to black (often striped), sometimes nearly entirely black; segment II dark brown to black, often paler in apical fourth, 2.40–2.77x longer than segment I; segments III–IV dark brown to black, sometimes slightly darker than segment II. **Thorax.** Lateral margins of pronotum subrectilinear to very slightly sinuate-concave, uniformly dark or, more rarely, narrowly pale (pale area usually narrower than, sometimes about as wide as antennal segment II). Underside black, with sharply contrasting broadly or narrowly pale acetabula I–III (acetabulum III rarely completely dark) and partially (posterior quarter to half) to almost completely pale lateral margins; pubescence rather dense, silvery, appressed (except for glabrous lateral margins). **Legs** moderately dark; fore, mid femora, and often hind femora striped with dark brown to nearly black on ventral and dorsal sides, along part or entire length, otherwise whitish yellow with some brown spots, or, nearly completely black; tibiae with dark brown to black dorsal stripe over most of length (mid and hind tibiae often infuscate only) and black subapical annulus, otherwise whitish yellow with dark spines; hind tibiae 2.70–2.76x longer than tarsal segments II+III combined; tarsal segment II darkened or not apically, otherwise whitish yellow, segment III brown in apical half (more rarely completely brown); pretarsal claws long, about half the length of tarsal segment III. Scutellum black, 1.76–1.91x longer than pronotum + collar medially. **Hemelytra:** corium (Fig. 11) largely black with several irregular, often coalesced, whitish markings; endocorium with a line of four pale spots along R vein, a few additional spots subapically along membrane, and sometimes a longitudinal mark about middle; exocorium frequently with rather large irregular coalesced markings on basal third to three-quarters and an irregularly shaped medial mark subapically; colour pattern in female consistent with that of male but often paler overall with broader markings; pale markings in darker individuals not coalesced, reduced in size and numbers, with line of four spots still visible but reduced to diminutive spots or speckles; corium in darkest individuals almost entirely black with only a few speckles; corium and clavus largely pruinose; basal pale spot of clavus present or absent; subapical pale spot of clavus present or, more rarely, absent; membrane dark brown to black basally with a pale mark near tip of clavus, brown medially within cells, pale elsewhere, and with dark brown to black veins. **Abdomen.** Venter black, with or without posterior margin of most segments narrowly pale (generally more broadly pale in female). Pubescence rather dense, silvery, appressed in both sexes. **Male parandria** (Fig. 19) narrowly subtriangular, acuminate at tip; inner margins evenly curved; basal margin slightly sinuate. **Male paramere** (Fig. 15) without distinct processus sensualis; instead, with flat cuticular surface bearing less than 10 setae; processus hamatus acuminate and slightly upturned at tip. Apical half of **male aedeagus** (Fig. 21), in lateral view, with 3 main visible sclerites (elongate median sclerite; subelongate, bent anterolateral sclerite; small, often subtriangular anterolateral sclerite). Male aedeagal sclerites, in ventral view, as in Fig. 23. **Male filum gonopori** (Fig. 24) coiled 1.5 times. Female subgenital plate (segment VII, ventrally) black with apical half pale or plate largely pale. *Other characters as in generic description.*

**Geographic distribution** (Fig. 26). North Island and northeastern South Island.

**Material examined.** A total of 621 specimens including holotype, from the following localities. **North Island.** **BP**—Kaimai Range, Dickey Flat Road end (NZAC); Papatea, Waiti Stream (NZAC); Urewera National Park, Waimana River Valley, Pohatu Track, 3.2 km E Tauwhare (NZAC); Waioeka Gorge, N of Oponae and S of Opotiki (AMNZ). **CL**—Coromandel Range, Stony Bay (NZAC); Coromandel Range, West of Kirikiri Saddle (NZAC); Coromandel Range, Tapu River Valley (AMNZ). **GB**—Karakatuwhero River Valley, by upper ford (NZAC); Mangatuna (NZAC); Morere (AMNZ); Te Awha Stream, Rangitukia Road (NZAC); Urewera National Park, Aniwanuiwa (NZAC); Urewera National Park, Te Taita a Makaro (NZAC). **HB**—Kaweka Forest Park, Lawrence Road access, Tutaekuri River (NZAC); Tangoio (near) (AMNZ); Tukituki River, Pourerere Road, 10km E of Waipawa (NZAC); Wakarara, upper Waipawa River (NZAC). **RI**—Kawhata River, Junction of Toetoe & Potaka Roads (NZAC); Mangaweka, Rangitikei River bridge (AMNZ); Vinegar Hill, Junction of Vinegar Hill Road &

Rangitikei River (NZAC). **TK**—Inglewood, Manganui River (AMNZ); Mangorei (AMNZ); Mount Egmont (N side) (AMNZ). **TO**—Lake Taupo (AMNZ); Mount Ruapehu (Whakapapanui Stream above Chateau (AMNZ); Whakapapanui Stream, dam (AMNZ)); Owhango, Whakapapa River (AMNZ); Taupo (NZAC); Whakapapanui Stream, Junction of Mahuia Rapid & Highway 47 (NZAC). **WA**—Dannevirke, Manawatu River, Aerodrome Road end (NZAC); Makaretu River, 2 km N of Takapau (NZAC); Mangatowainui River, Junction with Gundry Road (NZAC). **WI**—Whangaehu River, 5km N of Mangamahu (NZAC). **WN**—Kimberley Scenic Reserve (S of Levin), Ohau River (NZAC); Ngatiawa River (NZAC); Otaki (6 km S (NZAC); 6 km SE (NZAC)); Otaki Forks (AMNZ). **WO**—Mangaotaki River, S of Pio Pio (AMNZ). **South Island. BR**—Buller River, Gowan River Bridge (NZAC); Maruia River, Maruia Falls (NZAC); Rotokohu, Inangahua River (NZAC); Inangahua area, White Cliffs, Buller River (AMNZ). **KA**—Clarence River mouth (NZAC); Clarence River, 12 km inland via Clarence Valley Road (NZAC); Oaro (LUNZ), Omihi Stream mouth (LUNZ). **MB**—Pelorus River, Daltons Bridge (NZAC); Wairau River (2.5 km N of Leatham Road (NZAC); Church Lane end (NZAC)). **MC**—Highway 73, 15 km W of Springfield (NZAC); Rakaia River (NZAC); Waimakariri Gorge (CMNZ), N of Waddington (NZAC); Waimakariri River (CMNZ). **NC**—Hurunui Bridge (N side) (CMNZ); Junction of Hope River & Highway 7 (NZAC); Kairaki Beach (CMNZ).

**Biology. Altitudinal range.** Lowland (mostly) to low montane, more rarely high montane (e.g., central North Island volcanic plateau). Not usually coastal; may be present in predominantly freshwater habitats located near the mouth of rivers that also harbour inland populations. **Habitat.** Occurs along stony-gravelly (or shingled) riverbanks, riverbeds or, less frequently, lakeshores; saxicolous, found mainly on gravel, stones or boulders near the water's edge, usually within 0.5 to 3 m from the waterline, as well as on stones or boulders emerging from the water; mostly in sandy environments, also in slightly silty or clayish situations; primarily near moderate to fast running water, also near calmer water (e.g., side river channels or temporary backwaters). Sometimes found on bare ground patches between stones or boulders near the waterline or, occasionally, near rocky seepages away from a main river channel. Nymphs live in the same habitat, on the ground surface between and under stones or among gravel. **Seasonality.** Adults collected from October to April; mating pairs observed in December; newly emerged adults (teneral) collected mostly in December and March; nymphs found from October to March—suggesting overwintering in the egg stage, nymphal development in the spring and emergence of a new summer generation from December, possibly with a one or two month delay in southern parts of the distribution range or at higher altitudes. **Food.** Predator or scavenger. **Behaviour.** Jumps from stone to stone, flies short distances (usually less than 2 m), dashes quickly into the space between stones or into water when disturbed. Heliophilous; hides under and between stones, in cloudy or rainy weather.

**Remarks.** *Zemacrosaldula australis* is the most widely distributed species of this genus. It is the only *Zemacrosaldula* species known from the North Island and it occurs also in northern areas of the South Island. *Zemacrosaldula australis* closely resembles the South Island endemic *Z. kapekape* and can be difficult to distinguish from it although the two species are largely allopatric. In addition to characters of the male genitalia *Z. australis* bears the following distinguishing features: hemelytra usually with larger, more coalesced pale markings; antennae with longer segment II; paramere with more acutely tipped processus hamatus. Dissection of the male genitalia is necessary to diagnose the two species with certainty, especially when dealing with darker specimens with reduced hemelytral markings or populations that occur in relatively close proximity (e.g., on the South Island west coast).

On the North Island *Z. australis* should not be confused with *Saldula trivialis* Cobben, 1961 or *Saldula maculipennis* Cobben, 1961. These two taxa may be conspecific or part of an unresolved species-complex. They superficially resemble *Z. australis* albeit in a diminutive version with highly distinctive, acutely tipped male parandria (see Fig. 30 in Cobben 1961) and broadly pale sides of the female abdominal venter.

Morphologically speaking, *Z. australis* is the most highly variable species in this genus. As a general rule this species is more darkly coloured and somewhat smaller in body size in southern parts of its range, in more mountainous or generally colder habitats (e.g., central North Island volcanic plateau) although *Z. australis* is not typically monticolous. Anomalous looking specimens of *Z. australis*, somewhat reminiscent of *Z. whakarunga*, were observed from several South Island populations, especially in the lowlands and along the coast in a Kaikoura (KA), North Canterbury (NC), and Mid Canterbury (MC). The identity of these specimens could only be confirmed when male specimens were available for genitalic dissection.

Variations in facial colour, pubescence, and degree of development of transverse swelling (Figs 5–7) encountered in this species are similarly observed in *Z. kapekape* and *Z. whakarunga*.





**FIGURES 1–4.** Dorsal views of *Zemacrosaldula* species (legs and antennae omitted). Scale bar = 1 mm. (1) *Z. australis*, (2) *Z. kapekape*, (3) *Z. whakarunga*, (4) *Z. pangare*.





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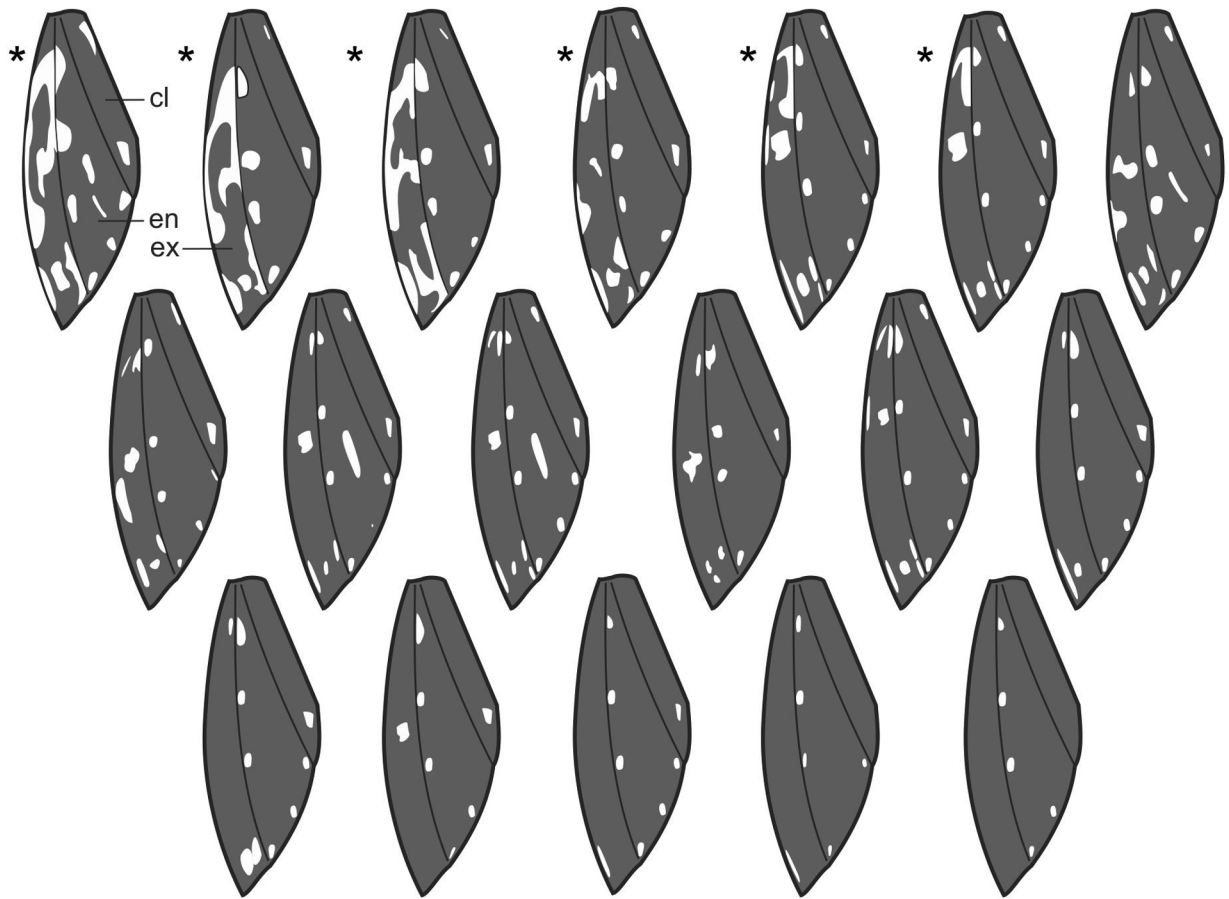


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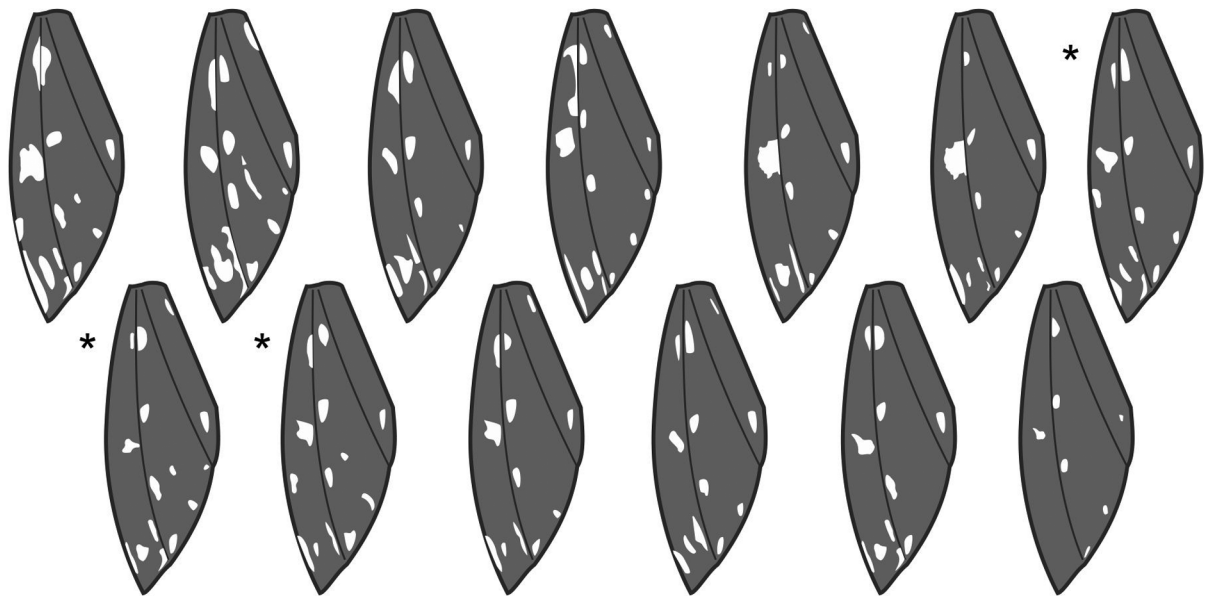


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**FIGURES 5–10.** Facial views of *Zamacrosaldula* species. (5–7) *Z. australis*, (8) *Z. kapekape*, (9) *Z. whakarunga*, (10) *Z. pangare*.

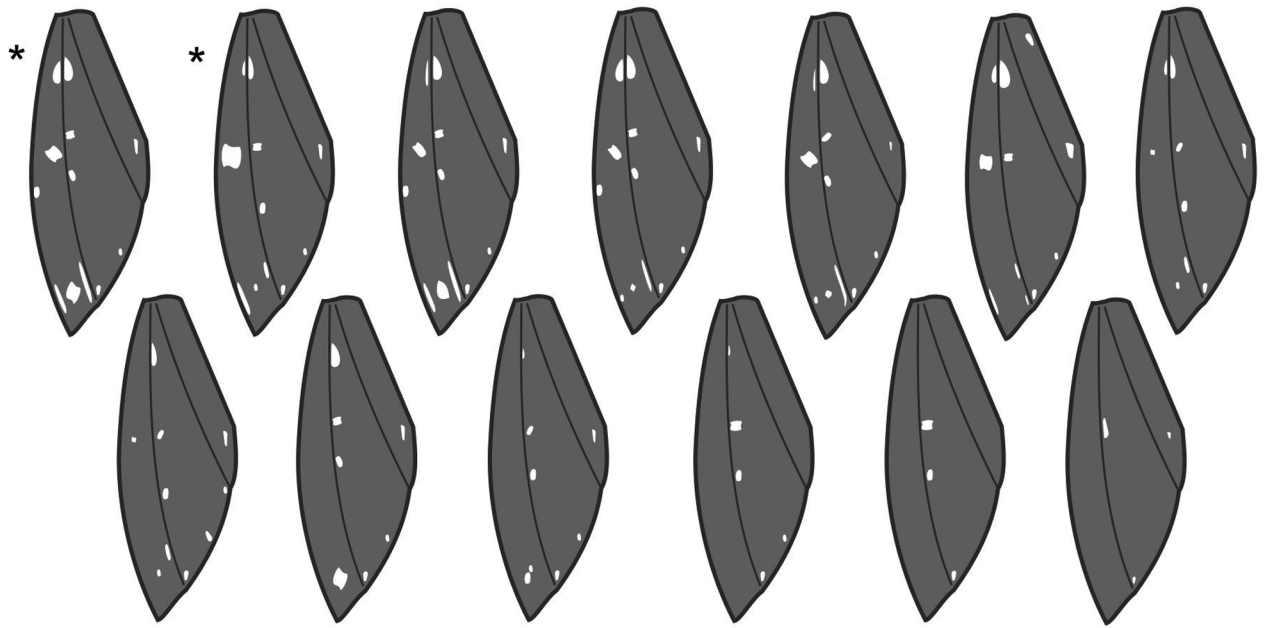


11

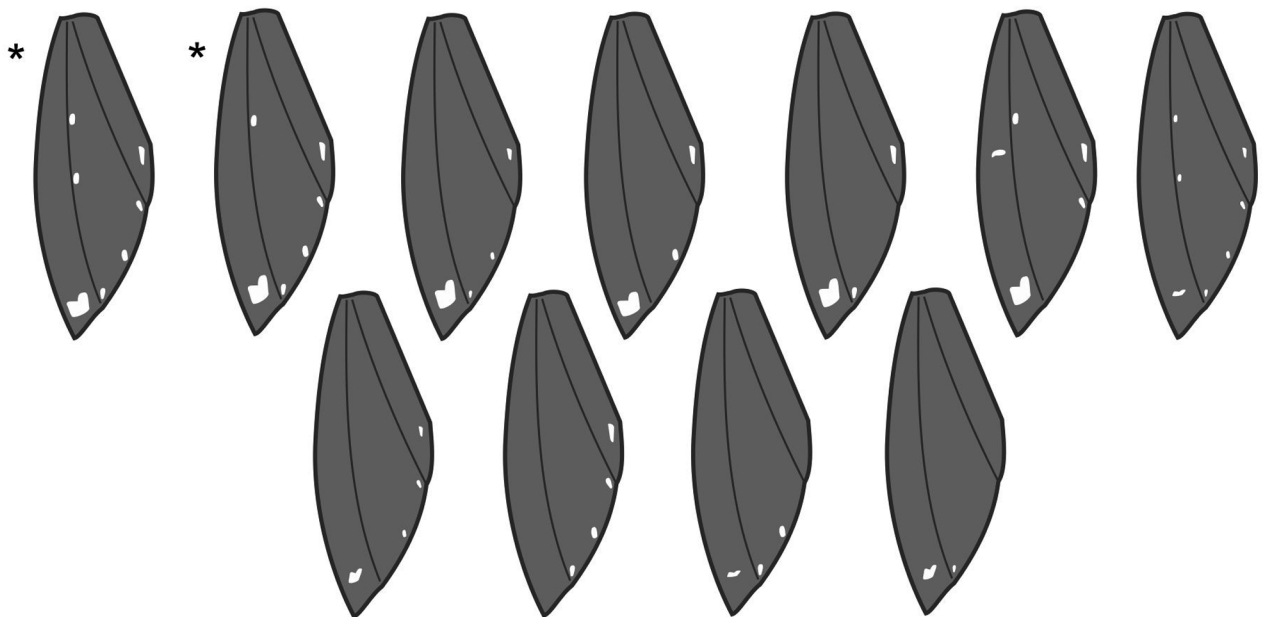


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**FIGURES 11–12.** Eunyomy (left corium), with more frequently observed pigmentation patterns indicated by an asterisk (\*). (11) *Zemacrosaldula australis* (cl = clavus, en = endocorium, ex = exocorium), (12) *Z. kapekape*.

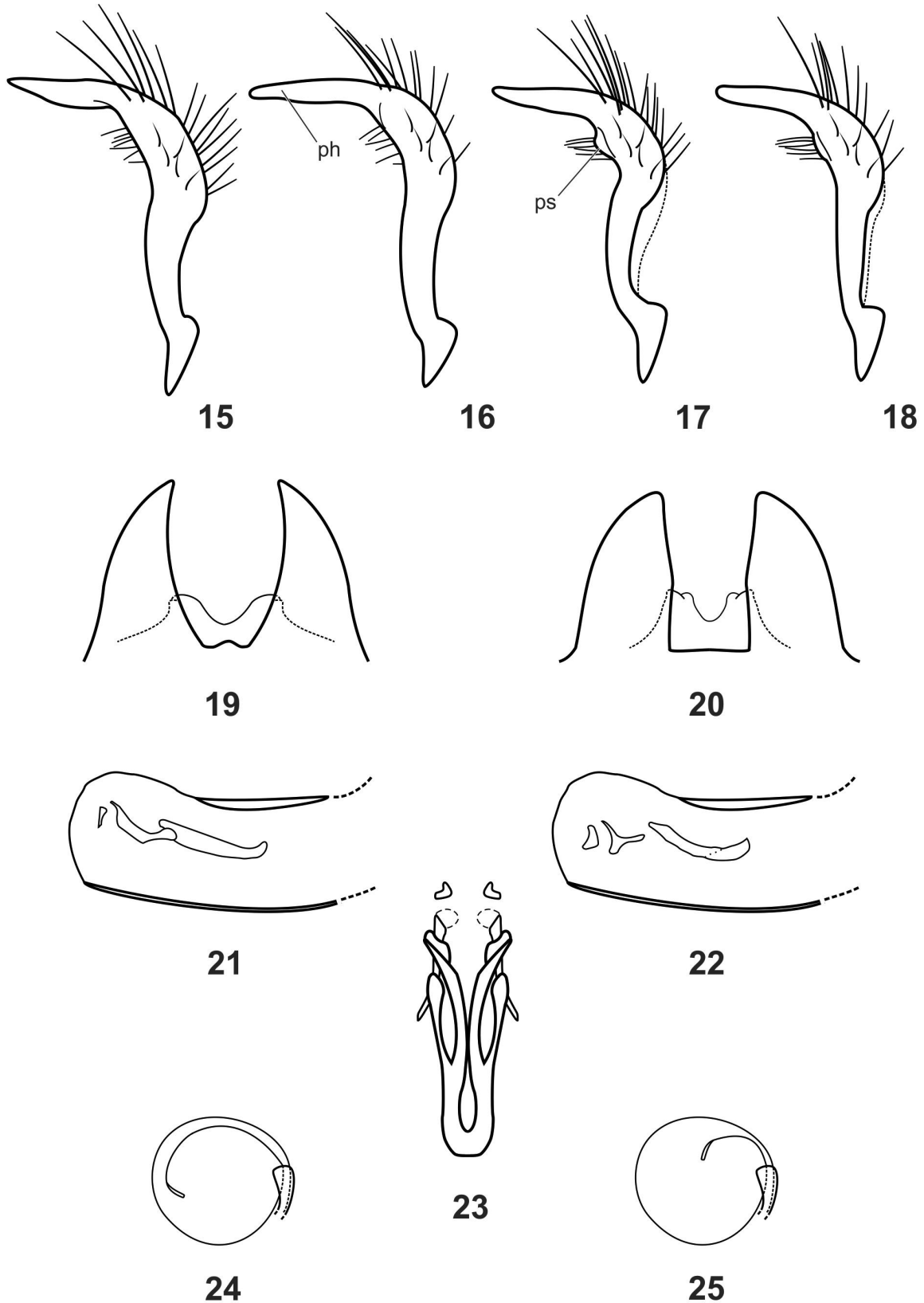


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**FIGURES 13–14.** Eunomy (left corium), with more frequently observed pigmentation patterns indicated by an asterisk (\*). (13) *Zemacrosaldula whakarunga*, (14) *Z. pangare*.



**FIGURES 15–24.** Schematic views of male genitalia. (15–18) Paramere, ventral view. (15) *Zemacrosaldula australis*, (16) *Z. kapekape* (ph = processus hamatus), (17) *Z. whakarunga* (ps = processus sensualis), (18) *Z. pangare*. (19–20) Parandria, posterior view. (19) *Z. australis*, (20) *Z. whakarunga*. (21–22) Anterior half of aedeagus, lateral view. (21) *Z. australis*, (22) *Z. whakarunga*. (23) Sclerites of aedeagus, *Z. australis*, ventral view. (24–25) Filum gonopori, lateral view. (24) *Z. australis*, (25) *Z. whakarunga*.

## *Zemacrosaldula kapekape* new species

*Zemacrosaldula kapekape* Larivière & Larochele, new species. Holotype: male (NZAC) labelled “NEW ZEALAND OL Mt [=Mount] Aspiring NP [=National Park], Cameron Flat 300m 4429S 16848E 17.III.2006 Larivière, Larochele / Stony-gravelly streambank: bare silty soil; on stones near water / HOLOTYPE [male symbol] *Zemacrosaldula kapekape* Larivière & Larochele, 2015 (red label). Paratypes: 7 males (1 CMNZ, 1 LUNZ, 1 MONZ, 4 NZAC) and 8 females (1 CMNZ, 1 LUNZ, 1 MONZ, 5 NZAC) with same data as holotype, bearing blue paratype labels.

**Description.** Body length 4.51–5.53 (5.04) mm; elongate-ovate (Fig. 2). Dorsal colour largely black, with uniformly dark lateral margins of pronotum and several individual (not coalesced) whitish markings on hemelytra; frequently with a combination of a pair of semilunate or irregularly shaped marks in basal third of corium and moderate to large irregularly shaped medial mark at about midlength on exocorium. Facial colour (Fig. 8) slightly to moderately contrasted. Head, pronotum and scutellum moderately shiny, contrasting moderately against mostly dull hemelytra. Dorsal pubescence short, reclined to semi-erect, whitish, sometimes more sparse than in *Z. australis* but still rather evenly distributed. Dorsal microsculpture rugulose on head, pronotum and scutellum. **Head** black. Face (Fig. 8) pubescent. Transverse swelling whitish yellow to yellowish brown; lateral portions separated by a narrow to rather wide dark gap or, sometimes, almost contiguous (nearly touching) near facial midline. Mandibular plates whitish yellow to yellowish brown. Maxillary plates whitish yellow. Anteclypeus and labrum whitish yellow to yellowish brown; anteclypeus often marked with brown basally and dark brown to black along margins; labrum often margined with dark brown to black. **Antennae** 4.07–4.33x longer than pronotum + collar medially, largely dark; segment I whitish yellow to yellowish brown, with ventral and dorsal sides dark brown to black (usually striped); segment II dark brown to black, often shortly paler subapically, 2.16–2.17x longer than segment I; segments III–IV dark brown to black. **Thorax.** Lateral margins of pronotum subrectilinear to very slightly convex, uniformly dark. Underside black, with sharply contrasting broadly pale acetabula I–II (acetabulum II sometimes narrowly pale), acetabulum III narrowly to very narrowly pale (rarely completely dark), and partially pale (posterior half) to almost completely pale lateral margins; pubescence rather dense, silvery, appressed (except for glabrous lateral margins). **Legs** moderately dark; fore femora striped with dark brown to nearly black on ventral and dorsal sides, along part or entire length; mid and hind femora thickly marked with brown on ventral and lateral sides, otherwise whitish yellow with some brown spots, or, nearly completely black; tibiae with dark brown to black dorsal stripe over most of length and black subapical annulus, otherwise whitish yellow with dark spines; hind tibiae 2.71–2.87x longer than tarsal segments II+III combined; tarsal segment II slightly darkened or not apically, otherwise yellowish brown, segment III completely dark brown to black (often paler in basal half of hind tarsus); pretarsal claws rather short, about a third of the length of tarsal segment III. Scutellum black, 1.82–1.96x longer than pronotum + collar medially. **Hemelytra:** corium (Fig. 12) largely black with several irregular, individual (not coalesced), whitish markings; endocorium with a line of four pale spots along R vein, a few additional spots subapically along membrane, sometimes with a spot about middle (rarely an irregular longitudinal mark); exocorium without coalesced irregular markings on basal third to three-quarters (as opposed to *Z. australis*), with a number of individual markings, a moderate to large irregularly shaped medial mark at about midlength, and usually a smaller irregular medial mark subapically; colour pattern in female consistent with that of male but often paler overall with broader markings; pale markings in darker individuals reduced in size but hardly in numbers, with line of four visible spots not significantly reduced in size; corium in darkest individuals never almost entirely black with a few speckles; corium and clavus largely pruinose; basal pale spot of clavus present or absent; subapical pale spot of clavus present; membrane dark brown to black basally with a pale mark near tip of clavus, brown medially within cells and along margin, pale within cells on each side of brown medial mark, and with dark brown to black veins. **Abdomen.** Venter black, with posterior margin of some or most segments narrowly pale (generally more broadly pale in female). Pubescence rather dense, silvery, appressed in both sexes. **Male parandria** as in *Z. australis* (see Fig. 19). **Male paramere** (Fig. 16) without distinct processus sensualis; instead, with flat cuticular surface bearing less than 10 setae; processus hamatus narrowly rounded and subrectilinear at tip. Apical half of **male aedeagus**, in lateral view, with 3 main visible sclerites as in *Z. australis* (see Fig. 21). **Male filum gonopori** coiled 1.5 times as in *Z. australis* (see Fig. 24). Female subgenital plate (segment VII, ventrally) black with apical half pale or plate largely pale. *Other characters as in generic description.*

**Geographic distribution** (Fig. 26). Southernmost areas and west coast of the South Island.

**Material examined.** A total of 223 specimens including types, from the following localities. **South Island.**

**CO**—Clutha River (LUNZ); Clutha River, junction with Highway 8A, 9 km SE of Luggate (NZAC); Danseys Pass (N of) (CMNZ); Nevis Crossing (LUNZ). **DN**—Otekaieke, Otekaieke River (NZAC). **FD**—Hunter Mountains, South Borland River (NZAC). **MK**—Lake Pukaki, Whale Stream (NZAC). **OL**—Glenorchy, Buckler Burn (NZAC); Lake Hawea (AMNZ); Mount Aspiring National Park, Cameron Flat (NZAC). **SC**—Hakataramea, Hakataramea River (NZAC); Aparima River (14 km S of Mossburn (NZAC); 4.2 km S of Wreys Bush (NZAC)); Dipton West, Oreti River (NZAC); Winton, Oreti River (NZAC). **WD**—Harihari, Wanganui River mouth (CMNZ); Junction of Wanganui River & Highway 6 (NZAC); Lake Mapourika (MONZ); Lake Moeraki (NZAC); Omoeroa River, S of Franz Josef (AMNZ); Totara River, near Moorhouse Road (NZAC).

**Biology. Altitudinal range.** Lowland (mostly) to lower montane. Not usually coastal; may be present in predominantly freshwater habitats located near the mouth of rivers that also harbour inland populations. **Habitat.** Occurs along stony-gravelly (or shingled) riverbanks, riverbeds or, less frequently, lakeshores; saxicolous, found mainly on gravel, stones or boulders near the water's edge, usually within 0.5 to 3 m from the waterline, as well as on stones or boulders emerging from the water; mostly in sandy environments, also in slightly silty or clayish situations; primarily near moderate to fast running water, also near calmer water (e.g., side river channels or temporary backwaters). Sometimes found on bare ground patches between stones or boulders near the waterline. Nymphs live in the same habitat, on the ground surface between and under stones or among gravel. **Seasonality.** Adults collected from October to March; mating pairs observed in March; newly emerged adults (teneral) and nymphs found in March. **Food.** Predator or scavenger. **Behaviour.** Jumps from stone to stone, flies short distances (usually less than 2 m), dashes quickly into the space between stones or into water when disturbed. Heliophilous; hides under and between stones, in cloudy or rainy weather.

**Remarks.** The species name is from the Maori word 'kapekape', meaning west-south-west. It refers to the South Island west coast and southernmost distribution of this species and to it being the west-south-west counterpart of *Z. australis*.

The external morphology and male genitalia of *Z. kapekape* closely resemble those of *Z. australis* from which it can be difficult to distinguish. The eunomy falls somewhere between that of *Z. whakarunga* and darker forms of *Z. australis*. The configuration of the male paramere is also reminiscent of the condition observed in *Z. australis* but differs mainly in the shape of the processus hamatus which is more bluntly rounded and straight at the tip in *Z. kapekape*. In addition, this species usually lacks the coalesced hemelytral markings seen in the basal third to three-quarters of the exocorium in *Z. australis* and it has a shorter second segment of the antenna. See also Remarks under *Z. australis*.

### *Zemacrosaldula whakarunga* new species

*Zemacrosaldula whakarunga* Larivière & Laroche, new species. Holotype: male (NZAC) labelled "NEW ZEALAND SD Carluke, Rai River 50m 4112S 17335E 27.II.2012 Larivière, Laroche / Sandy-silty gravelly riverbank; within 2m from water[line] / HOLOTYPE [male symbol] *Zemacrosaldula whakarunga* Larivière & Laroche, 2015 (red label). Paratypes: 6 males (1 LUNZ, 1 CMNZ, 1 MONZ, 3 NZAC) and 5 females (1 LUNZ, 1 MONZ, 3 NZAC) with same data as holotype, bearing blue paratype labels.

**Description.** Body length 4.31–6.28 (5.57) mm; broad-ovate (Fig. 3). Dorsal colour largely black, sometimes with a very faint maroon hue, with uniformly dark lateral margins of pronotum and a few individual (not coalesced) whitish markings on hemelytra; frequently with combination of a pair of semilunate marks in basal third of corium and a small to medium size subquadrate medial mark at about midlength on exocorium. Facial colour (Fig. 9) slightly to moderately contrasted. Head, pronotum, and scutellum strongly shiny, usually contrasting strongly against mostly dull hemelytra. Dorsal pubescence short, reclined to semi-erect, whitish, somewhat sparse and unevenly distributed. Dorsal microsculpture slightly rugulose on head, pronotum and scutellum. **Head** black. Face (Fig. 9) pubescent. Transverse swelling yellowish brown to almost entirely black; lateral portions contiguous or, sometimes, separated by a narrow to rather wide dark gap near facial midline. Mandibular plates black or, less often, yellowish brown. Maxillary plates whitish yellow to yellowish brown, rarely obscure. Anteclypeus and labrum yellowish brown to dark brown, narrowly to broadly margined with black. **Antennae** 4.24–4.85x longer than pronotum + collar medially, largely dark; segment I mostly black with partial or complete yellowish stripe on one side, sometimes entirely black; segment II black, often shortly paler subapically, 2.18–2.35x longer than



segment I; segments III–IV black. **Thorax.** Lateral margins of pronotum subrectilinear to slightly convex, uniformly black. Underside black, with moderately contrasting broadly or narrowly pale acetabulum I, broadly to very narrowly pale acetabulum II, narrowly pale to completely dark acetabulum III, and partially (posterior quarter to half) to completely dark lateral margins; rarely, if ever, with lateral margins almost completely pale; pubescence moderately dense, silvery, appressed (except for glabrous lateral margins). **Legs** largely dark; fore, mid, and often hind femora almost entirely black or thickly striped with black on ventral and often also dorsal side over most of length, otherwise whitish yellow to yellowish brown with some brown spots; tibiae with dark brown to black dorsal stripe over most of length (hind tibiae often infuscate only) and black subapical annulus, otherwise whitish yellow to yellowish brown with dark spines; hind tibiae about 2.77–2.86x longer than tarsal segments II+III combined; tarsal segment II darkened apically, otherwise whitish yellow to yellowish brown, segment III completely dark brown to black (often paler in basal half on hind tarsus); pretarsal claws rather short, about a third of the length of tarsal segment III. Scutellum black, 1.78–1.83x longer than pronotum + collar medially. **Hemelytra:** costal margin (Fig. 3) more convex and embolium generally more explanate basally than in *Z. australis* or *Z. kapekape*; corium (Fig. 13) largely black with few irregular, individual (not coalesced), whitish markings; frequently with a pair of semilunate marks in basal third, one on each side of R vein (as opposed to *Z. pangare*); endocorium with a line of four pale spots (often reduced to two or three) along R vein, a few additional speckles (often reduced) subapically along membrane; exocorium without coalesced markings, with few individual markings, a small to moderately large subquadrate medial mark at about midlength, and often a smaller irregular medial mark subapically (often reduced or absent); colour pattern in female consistent with that of male but regularly with larger subquadrate medial mark at about midlength on exocorium; pale markings in darker individuals strongly reduced in size and numbers, with line of two to four spots still visible but reduced to speckles; corium in darkest individuals almost entirely black and barely speckled; corium and clavus largely pruinose; basal and subapical pale spots of clavus present or absent; membrane brown to black basally, rarely with a pale mark near tip of clavus, brown medially within cells and around margin, pale within cells on each side of brown medial mark, and with dark brown to black veins. **Abdomen.** Venter black, with (both sexes) or without (male) posterior margin of most segments narrowly pale. Pubescence moderately dense (although sparser than in *Z. australis* or *Z. kapekape*), silvery, appressed in both sexes. **Male parandria** (Fig. 20) broadly subtriangular, obtusely rounded at tip; inner margins angular; basal margin straight. **Male paramere** (Fig. 17) with distinct, well-developed processus sensualis bearing less than 10 setae; processus hamatus narrowly rounded and often slightly upturned at tip. Apical half of **male aedeagus** (Fig. 22), in lateral view, with 3 main visible sclerites (elongate median sclerite; shorter Y-shaped anterolateral sclerite; smaller subtriangular anterolateral sclerite). **Male filum gonopori** (Fig. 25) coiled 1.25 times. Female subgenital (segment VII, ventrally) plate black with apical quarter to half pale or, sometimes, plate at most narrowly pale apically. *Other characters as in generic description.*

**Geographic distribution** (Fig. 26). South Island, excluding southernmost areas and the west coast.

**Material examined.** A total of 228 specimens including types, from the following localities. **South Island.** **BR**—Boyle River, Dans Creek Bridge, Engineers Camp (LUNZ); Fox River (Buller County) (LUNZ); Nelson Lakes National Park (Lake Rotoiti, head (LUNZ); Mount Robert (LUNZ)); Punakaiki, Bullock Creek (CMNZ). **CO**—Lowburn Valley mouth (NZAC); The Remarkables, Rastus Burn (LUNZ); Duntroon, Maerewhenua River (NZAC); Junction of Danseys Pass Road & S Branch of Maerewhenua River (NZAC); Palmerston, Shag River (NZAC). **KA**—Hundalee, Conway River (NZAC); Junction of Kowhai River & Postmans Road (NZAC); Kahutara River mouth (NZAC); Oaro Beach (LUNZ). **MC**—Banks Peninsula (Birdlings Flat (CMNZ); near Lake Ellesmere (LUNZ)); Cameron River (LUNZ); Craigieburn Forest Park, Dracophyllum Track (NZAC); Craigieburn Ski Field (LUNZ); Mount Algidus (NZAC); Porters Pass, Lake Lyndon (CMNZ, NZAC); South Highway 72, W of Staveley (NZAC); Thomas River, N branch (LUNZ). **NC**—Arthurs Pass National Park, Poulter River (NZAC); Lees Valley, Ashley River bridge (LUNZ); Napenape Scenic Reserve, Hurunui River mouth (NZAC); Okuku River, 5km W of Loburn (NZAC). **NN**—Aniseed Valley (NZAC); Iron Hill, Iron Lake (LUNZ); Karamea River mouth (LUNZ); Lake Sylvester (LUNZ); Lake Sylvester, Bushline Hut (LUNZ); Little Sylvester Lake (LUNZ); Oparara River (NZAC); Pariwhakaoho River mouth (NZAC); Pearce River Resurgence (LUNZ); Pelorus Bridge Scenic Reserve (NZAC). **OL**—Dart Hut (NZAC); Greenstone River (NZAC); Headlong Peak (NZAC), South Basin Stream (NZAC); Peak 2.5 km W of Mount Tyndall (NZAC). **SC**—Temuka, Opihi River near Waiapi (CMNZ). **SD**—Carluke, Rai River (NZAC); Opouri River, junction with Tunakino Valley Road (NZAC). **WD**—Mount Aspiring National Park (Arawata Bivouac (LUNZ); Arawata River (LUNZ)); Nelson Creek domain, beside Nelson Creek (LUNZ).

**Biology. Altitudinal range.** Montane (mostly) to subalpine, more rarely lowland. Exceptionally coastal, in predominantly freshwater habitats located near the mouth of rivers that also harbour inland populations. **Habitat.** Occurs along stony-gravelly (or shingled) riverbanks riverbeds or, less frequently, lakeshores; mostly saxicolous; found mainly on gravel, stones or boulders near the water's edge, usually within 0.5 to 3 m from the waterline, as well as on stones or boulders emerging from the water; mostly in sandy environments, also in moderately silty or clayish situations; primarily near moderate to fast running water, also near calmer water (e.g., side river channels or temporary backwaters); at higher altitudes, on wet screes and snowmelt patches. Often taken near water, on bare ground patches between stones or boulders, on bare ground with few scattered stones (e.g., silty, clayish or rather muddy flats and banks of otherwise stony-gravelly rivers and lakes), or, sparsely vegetated ground (e.g., at the margin of subalpine lakes). Occasionally collected near rocky seepages away from a main river channel. Nymphs live in the same habitat, on the ground surface between and under stones or among gravel, or, hiding at the base of plants. **Seasonality.** Adults collected from November to March; mating pairs observed in March; newly emerged adults (teneral) collected in March; nymphs found from January to March. **Food.** Predator or scavenger. **Behaviour.** Jumps from stone to stone, flies short distances (usually less than 2 m), dashes quickly into the space between stones or into water when disturbed. Heliophilous; hides under and between stones or at the base of plants, in cloudy or rainy weather.

**Remarks.** The species name 'whakarunga' is from the Maori and means south or southern. It refers to the geographic range of this species which is restricted to New Zealand's South Island where it is widely distributed.

*Zemacrosaldula whakarunga* is morphologically closer to *Z. pangare* than to other species in this genus. In addition to structural differences in the male genitalia, *Z. whakarunga* has an overall less shiny, more pubescent, more pruinose and more blackish appearance than *Z. pangare*. The hemelytral colour pattern, especially the frequent occurrence of a pair of semilunate marks in the basal third of the corium and a subquadrate medial mark at about midlength on the exocorium, is most often diagnostic for *Z. whakarunga*. See also Remarks under *Z. pangare*.

In eastern areas of the South Island, *Z. whakarunga* can be especially difficult to differentiate from darker, anomalous looking specimens of *Z. australis* (see Remarks under that species). In such cases as well as for darker forms of both species, with strongly reduced hemelytral markings, examination of the male genitalia is the only reliable identification method. Although found in lowland areas, especially along and near the mouth of large rivers originating from the Southern Alps (e.g., large South Island braided rivers), *Z. whakarunga* is habitually monticolous.

### ***Zemacrosaldula pangare* new species**

*Zemacrosaldula pangare* Larivière & Laroche, new species. Holotype: male (NZAC) labelled "NEW ZEALAND WD Jct Waikukupa Riv[er] & Hwy [=Highway] 6 200m 4326S 17004E 11.III.2007 Larivière, Laroche / Sandy-silty stream in glacial moraine entering main river: on water-logged sand with dead leaves & algae / HOLOTYPE [male symbol] *Zemacrosaldula pangare* Larivière & Laroche, 2015 (red label). Paratypes: 13 males (1 CMNZ, 1 LUNZ, 1 MONZ, 10 NZAC) and 10 females (1 CMNZ, 1 LUNZ, 1 MONZ, 7 NZAC) with same data as holotype, bearing blue paratype labels.

**Description.** Body length 4.65–5.63 (5.10) mm; broad-ovate (Fig. 4). Dorsal colour largely dark brown to black, with distinctive maroon hue, uniformly dark lateral margins of pronotum, and very few individual (not coalesced) whitish markings on hemelytra; exocorium nearly immaculate but frequently with a rather large (more rarely small) subquadrate medial mark subapically. Facial colour (Fig. 10) not contrasted. Head, pronotum and scutellum strongly shiny, contrasting moderately against mostly shiny hemelytra. Dorsal pubescence very short, reclined to semi-erect, whitish to slightly golden, very sparse (reduced) and quite unevenly distributed (more so than in *Z. whakarunga*). Dorsal microsculpture very slightly rugulose on head; similarly developed although partly lacking on pronotum and scutellum. Macropterous. **Head** black. Face (Fig. 10) glabrous (pubescent in other species). Transverse swelling black or, very rarely, more lightly coloured at sides or near facial midline (but still mostly black); lateral portions contiguous or, rarely, separated by a narrow to rather wide dark gap near facial midline. Mandibular plates, maxillary plates, anteclypeus, and labrum black; maxillary plates seldom marked with brown speckles; anteclypeus and labrum sometimes lighter brown or narrowly marked with brown apically. **Antennae** 3.98–4.00x longer than pronotum + collar medially, largely dark; segment I black or with apical fourth to half dark

yellowish brown or pale brown (not distinctly striped as in *Z. whakarunga*); segment II dark brown to black, often shortly paler subapically, 2.59–2.61x longer than segment I; segments III–IV dark brown to black. **Thorax.** Lateral margins of pronotum subrectilinear to slightly convex, uniformly black. Underside black, with barely contrasting narrowly to very narrowly pale (rarely completely dark) acetabulum I, narrowly pale to completely dark acetabulum II, completely dark (rarely very narrowly pale) acetabulum III, and completely dark lateral margins; rarely, if ever, with lateral margins narrowly pale brown near posterior edge; pubescence very sparse or evanescent (overall mostly glabrous). **Legs** largely dark; fore, mid, and usually hind femora entirely black, at most shortly tinged with dark yellowish brown or pale brown subapically; tibiae with dark brown to black dorsal stripe over most of length (hind tibiae often infuscate only) and black subapical annulus, otherwise dark yellowish brown with dark spines; hind tibiae about 2.87–2.91x longer than tarsal segments II+III combined; tarsal segment II not of barely darkened apically, otherwise yellowish brown, segment III completely dark brown to black (often paler in basal half on hind tarsus); pretarsal claws rather short, about a third of the length of tarsal segment III. Scutellum black, 1.61–1.89x longer than pronotum + collar medially. **Hemelytra:** costal margin (Fig. 4) convex and embolium basally explanate as in *Z. whakarunga*; embolar modification of female moderately developed (strongly developed in other species); corium (Fig. 14) largely black with very few irregular, rather small, individual (not coalesced) whitish markings; markings lacking in basal third on each side of R vein (as opposed to *Z. whakarunga*); endocorium with a line of three pale spots (often reduced to one or two) along R vein, with or without additional speckles subapically along membrane (as opposed to *Z. whakarunga*); exocorium without coalesced markings (as opposed to *Z. australis*) or a subquadrate mark at about midlength (as opposed to *Z. whakarunga* and *Z. kapekape*), with very few individual markings and a rather large subquadrate medial marking subapically (often reduced, sometimes absent); colour pattern in female consistent with that of male but regularly with a larger subapical medial mark on exocorium; corium in darkest individuals almost entirely black and barely speckled; clavus largely pruinose; corium partially pruinose (inner endocorium, subbasal exocorium, especially embolium); basal pale spot of clavus absent; subapical pale spot of clavus present or, more rarely, absent; membrane brown to black basally, without pale mark near tip of clavus, brown medially within cells and around margin, pale within cells on each side of brown medial mark, and with dark brown to black veins. **Abdomen.** Venter black, with or without posterior margin of at least some segments narrowly pale. Pubescence much shorter than in other *Zemacrosaldula* species, very sparse along middle, nearly lacking elsewhere, silvery, appressed in both sexes. **Male parandria** as in *Z. whakarunga* (see Fig. 20). **Male paramere** (Fig. 18) with distinct, slightly developed processus sensualis bearing less than 10 setae; processus hamatus broadly rounded at tip. Apical half of **male aedeagus**, in lateral view, with 3 main visible sclerites as in *Z. whakarunga* (see Fig. 22). **Male filum gonopori** coiled 1.25 times as in *Z. whakarunga* (see Fig. 25). Female subgenital plate (segment VII, ventrally) completely black or at most with apical half of sides pale. *Other characters as in generic description.*

**Geographic distribution** (Fig. 26). South Island west coast, in the vicinity of the Fox and Franz Josef glaciers.

**Material examined.** A total of 44 specimens including types (NZAC), from the following localities. **South Island. WD**—Junction of Clearwater River & Gillespies Beach Road (NZAC); Junction of Waikukupa River & Highway 6 (NZAC); Franz Josef (NZAC).

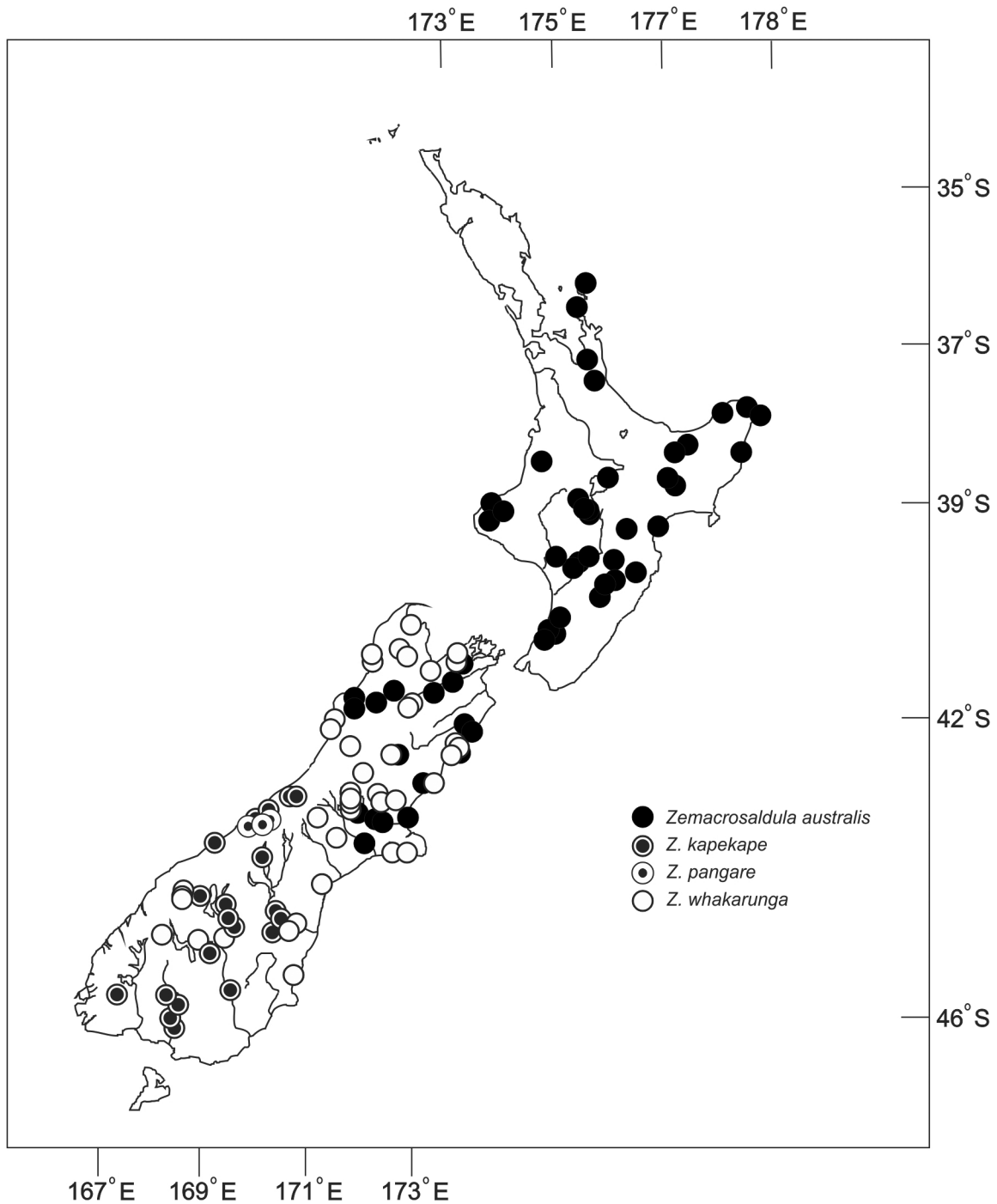
**Biology. Altitudinal range.** Lowland (50–200 m). **Habitat.** Found along a sandy silty stream in a glacial moraine entering a main river, on waterlogged sand and seepages with sparse dead leaves and algae (several specimens, Junction Waikukupa River and Highway 6); in glacial moraine, among cushion plants (one specimen, Franz Josef); on bare silty ground patch along an otherwise stony riverbank (one specimen, Junction Clearwater River and Gillespies Beach Road). Apparently not obligatory saxicolous. **Seasonality.** Adults collected in March; newly emerged adults (teneral) also found in March. **Food.** Predatory or scavenger. **Behaviour.** Sluggish, jumping for a distance of 15 cm or less, if jumping at all, when disturbed (several specimens, Junction Waikukupa River and Highway 6). Presumably heliophilous like other *Zemacrosaldula* species.

**Remarks.** The species name ‘pangare’ means beardless in Maori. It refers to the smooth, hairless face of this species and its overall shinier, more glabrous appearance, compared to other *Zemacrosaldula* species.

It is mostly the above mentioned appearance and structural differences in the male genitalia that set *Z. pangare* apart from *Z. whakarunga*. The maroon hue of the dorsum, best seen in oblique lateral view, appears mostly due to the pruinosity of the hemelytra. A similar colour hue can, to some extent, also be seen on the eyes and antennae. The following characters are also diagnostic for *Z. pangare*: face almost entirely black; hemelytra lacking markings

in the basal third of the corium on each side of R vein and bearing a subquadrate medial mark subapically on the exocorium.

While all other *Zemacrosaldula* species are primarily saxicolous and live close to the waterline of main river channels, *Z. pangare* favours waterlogged soil and ground seepages located at some distance from stony-gravelly riverbanks and riverbeds. See also Remarks under *Z. whakarunga*.



## 26

**FIGURE 26.** Collecting localities of *Zemacrosaldula* species, New Zealand.

**TABLE 1.** Geographical coordinates of localities in decimal degrees.

Locality (standard)	AreaCode	Latitude	Longitude
Aniseed Valley	NN	-41.3878	173.1608
Aparima River, 14 km S of Mossburn	SL	-45.7833	168.1833
Aparima River, 4.2 km S of Wreys Bush	SL	-46.0000	168.1333
Arthurs Pass National Park, Poulter River	NC	-42.8753	171.8611
Banks Peninsula, Birdlings Flat	MC	-43.8261	172.7078
Banks Peninsula, near Lake Ellesmere	MC	-43.7300	172.4400
Boyle River, Dans Creek Bridge, Engineers Camp	BR	-42.5647	172.3558
Buller River, Gowan River Bridge	BR	-41.7000	172.5500
Cameron River	MC	-43.4236	171.0847
Carluke, Rai River	SD	-41.2000	173.5833
Clarence River mouth	KA	-42.1667	173.9167
Clarence River, 12 km inland via Clarence Valley Road	KA	-42.1000	173.8333
Clutha River	CO	-45.6500	169.4000
Clutha River, junction with Highway 8A, 9 km SE of Luggate	CO	-44.7500	169.3333
Coromandel Range, Stony Bay	CL	-36.5167	175.4167
Coromandel Range, West of Kirikiri Saddle	CL	-37.1628	175.6136
Coromandel Range, Tapu River Valley	CL	-36.9807	175.5279
Craigieburn Forest Park, Craigieburn Ski Field	MC	-43.1175	171.7039
Craigieburn Forest Park, Dracophyllum Track	MC	-43.1594	171.7033
Dannevirke, Manawatu River, Aerodrome Road end	WA	-40.2333	176.0833
Danseys Pass	CO	-44.9478	170.3819
Dart Hut	OL	-44.5219	168.5544
Dipton West, Oreti River	SL	-45.9000	168.3833
Duntroon, Maerewhenua River	DN	-44.8500	170.6833
Fox River	BR	-42.0401	171.4080
Franz Josef	WD	-43.3887	170.1824
Glenorchy, Buckler Burn	OL	-44.8500	169.4000
Greenstone River	OL	-44.9053	168.1617
Hakataramea, Hakataramea River	SC	-44.7167	170.4833
Harihari, Wanganui River mouth	WD	-43.1411	170.5547
Headlong Peak	OL	-44.5403	168.5969
Headlong Peak, South Basin Stream	OL	-44.5581	168.6078
Highway 73, 15 km W of Springfield	MC	-43.3167	171.8000
Hundalee, Conway River	KA	-42.5833	173.4167
Hunter Mountains, South Borland River	FD	-45.7456	167.3803
Hurunui Bridge (N side)	NC	-42.8969	173.0978
Inangahua area, White Cliffs, Buller River	BR	-41.8000	171.8700
Inglewood, Manganui River	TK	-39.1581	174.2755
Iron Hill, Iron Lake	NN	-41.1056	172.6155
Junction Hope River & Highway 7	NC	-42.5833	172.4500
Junction of Clearwater River & Gillespies Beach Road	WD	-43.4500	169.9000
Junction of Danseys Pass Road & S Branch of Maerewhenua River	DN	-44.9333	170.5833
Junction of Kowhai River & Postmans Road	KA	-42.3667	173.5833

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**TABLE 1.** (Continued)

Locality (standard)	AreaCode	Latitude	Longitude
Junction of Waikukupa River & Highway 6	WD	-43.4333	170.0667
Junction of Wanganui River & Highway 6	WD	-43.1500	170.6167
Kahutara River mouth	KA	-42.4333	173.5833
Kaimai Range, Dickey Flat Road end	BP	-37.4387	175.7473
Kairaki Beach	NC	-43.3856	172.7114
Karakatuwhero River Valley, by upper ford	GB	-37.6761	178.2706
Karamea River mouth	NN	-41.2561	172.1047
Kaweka Forest Park, Lawrence Road access, Tutaekuri River	HB	-39.3667	176.3667
Kawhatau River, Junction Toetoe & Potaka Roads	RI	-39.7833	175.8833
Kimberley Scenic Reserve (S of Levin), Ohau River	WN	-40.6669	175.3133
Lake Hawea	OL	-44.6119	169.2615
Lake Mapourika	WD	-43.3167	170.2164
Lake Moeraki	WD	-43.7167	169.2667
Lake Pukaki, Whale Stream	MK	-43.9500	170.1167
Lake Sylvester	NN	-41.1065	172.6286
Lake Sylvester, bushline Hut	NN	-41.1060	172.6447
Lake Taupo	TO	-38.6900	176.0800
Lees Valley, Ashley River bridge	NC	-43.1856	172.1503
Little Sylvester Lake	NN	-41.1060	172.6447
Lowburn Valley mouth	CO	-45.0000	169.2167
Makaretu River, 2 km N of Takapau	WA	-40.0000	176.3500
Mangaotaki River, S of Pio Pio	WO	-38.5209	174.9063
Mangatewainui River, Junction with Gundry Road	WA	-40.0667	176.1667
Mangatuna	GB	-38.3019	178.2686
Mangaweka, Rangitikei River bridge	RI	-39.8247	175.7845
Mangorei	TK	-39.0893	174.1024
Maruia River, Maruia Falls	BR	-41.8600	172.2528
Morere	GB	-38.9809	177.7903
Mount Algidus	MC	-43.2386	172.2031
Mount Aspiring National Park, Arawata Bivouac	WD	-44.4136	168.6081
Mount Aspiring National Park, Arawata River	WD	-44.4064	168.5931
Mount Aspiring National Park, Cameron Flat	OL	-44.4833	168.8000
Mount Egmont (N side)	TK	-39.2600	174.0500
Mount Ruapehu, Whakapapanui Stream above Chateau	TO	-39.2097	175.5446
Mt Ruapehu, Whakapapanui Stream, dam	TO	-39.1914	175.5312
Napenape Scenic Reserve, Hurunui River mouth	NC	-42.9139	173.2744
Nelson Creek domain, beside Nelson Creek	WD	-42.5036	171.6036
Nelson Lakes National Park, Lake Rotoiti, head	BR	-41.8169	172.8372
Nelson Lakes National Park, Mount Robert	BR	-41.8325	172.8108
Nevis Crossing	CO	-45.1756	168.9958
Ngatiawa River	WN	-40.9123	175.1230
Oaro	KA	-42.5164	173.5044
Oaro Beach	KA	-42.5094	173.5081

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**TABLE 1.** (Continued)

Locality (standard)	AreaCode	Latitude	Longitude
Oaro, Omih Stream mouth	KA	-42.4944	173.5169
Okuku River, 5km W of Loburn	NC	-43.2461	172.4665
Omoeroa River, S of Franz Josef	WD	-43.4028	170.0971
Oparara River	NN	-41.2000	172.1000
Opouri River, junction with Tunakino Valley Road	SD	-41.2000	173.6167
Otaki, 6 km S/SE	WN	-40.7911	175.1486
Otaki Forks	WN	-40.8333	175.2500
Otekaieke, Otekaieke River	DN	-44.8167	170.5667
Owhango, Whakapapa River	TO	-38.9959	175.3982
Palmerston, Shag River	DN	-45.4667	170.7167
Papatea, Waiti Stream	BP	-37.6649	177.8417
Pariwhakaoho River mouth	NN	-40.7740	172.7393
Peak 2.5 km W of Mount Tyndall	OL	-44.5310	168.6179
Pearce River Resurgence	NN	-41.2106	172.7403
Pelorus Bridge Scenic Reserve	NN	-41.2994	173.5733
Pelorus River, Daltons Bridge	MB	-41.2667	173.6333
Porters Pass, Lake Lyndon	MC	-43.3033	171.7025
Porters Pass, Lake Lyndon	MC	-43.2955	171.7111
Punakaiki, Bullock Creek	BR	-42.1014	171.3650
Rakaia River	MC	-43.7397	172.0306
Rotokohu, Inangahua River	BR	-41.9667	171.8667
South Highway 72, W of Staveley	MC	-43.6524	171.4455
Tangoio, near	HB	-39.3289	176.9125
Taupo	TO	-38.6861	176.0708
Te Awha Stream, Rangitukia Road	GB	-37.7347	178.4975
Temuka, Opihi River near Waiapi	SC	-44.2606	171.2289
The Remarkables, Rastus Burn	CO	-45.0553	168.8139
Thomas River, N branch	MC	-43.2086	171.7053
Totara River, near Moorhouse Road	WD	-45.9000	168.3833
Tukituki River, Pourerere Road, 10km E of Waipawa	HB	-39.9500	176.6833
Urewera National Park, Aniwaniwa	GB	-38.7453	177.1633
Urewera National Park, Te Taita a Makaro	GB	-38.6828	177.0569
Urewera National Park, Waimana River Valley, Pohatu Track, 3.2 km E Tauwhare	BP	-38.2911	177.1004
Vinegar Hill, Junction of Vinegar Hill Road & Rangitikei River	RI	-39.9167	175.6333
Waimakariri Gorge	MC	-43.3600	172.0503
Waimakariri Gorge, N of Waddington	MC	-43.3500	172.0500
Waimakariri River	MC	-43.4039	172.1100
Waioeka Gorge, N of Oponae and S of Opotiki	BP	-38.2005	177.3008
Wairau River, 2.5 km N of Leatham Road	MB	-41.6333	173.2167
Wairau River, Church Lane end	MB	-41.5333	173.5500
Wakarara, upper Waipawa River	HB	-39.7831	176.2656
Whakapapanui Stream, Junction Mahuia Rapid & Highway 47	TO	-39.1333	175.5000
Whangaehu River, 5km N of Mangamahu	WI	-39.8000	175.3500
Winton, Oreti River	SL	-46.1333	168.2833

## Acknowledgments

For the opportunity to examine material in their care, the authors thank JW Early and D Ranatunga (Auckland Institute and Museum, Auckland), PM Johns (Canterbury Museum, Christchurch), JMW Marris (Entomology Research Museum, Lincoln University, Lincoln), RL Palma and P Sirvid (Museum of New Zealand Te Papa Tongarewa, Wellington). Thanks are also extended to BE Rhode (Landcare Research, Auckland) for assistance with digital photography and specimen databasing. This research was supported by Core funding for Crown Research Institutes from the Ministry of Business, Innovation and Employment's Science and Innovation Group, for the Characterising Land Biota research portfolio.

## References

- Cassis, G. & Gross, G.F. (1995) Hemiptera: Heteroptera (Coleorrhyncha to Cimicomorpha). *In*: Houston, W.W.K., Maynard, G.V. (Eds.), *Zoological Catalogue of Australia. Vol. 27.3A*. CSIRO, Melbourne, pp. 1–501.
- Cobben, R.H. (1961) A new genus and four new species of Saldidae (Heteroptera). *Entomologische Berichten*, 21, 96–107.
- Cobben, R.H. (1980a) The Saldidae of the Hawaiian Archipelago (Hemiptera: Heteroptera). *Pacific Insects*, 22 (1–2), 1–34.
- Cobben, R.H. (1980b) On some species of *Pentacora*, with the description of a new species from Australia (Heteroptera, Saldidae). *Zoologische Mededelingen (Leiden)*, 55, 116–126.
- Crosby, T.K., Dugdale, J.S. & Watt, J.C. (1976) Recording specimen localities in New Zealand: an arbitrary system of areas and codes defined. *New Zealand Journal of Zoology*, 3, 69. [with separate map overleaf]  
<http://dx.doi.org/10.1080/03014223.1976.9517903>
- Crosby, T.K., Dugdale, J.S. & Watt, J.C. (1998) Area codes for recording specimen localities in the New Zealand subregion. *New Zealand Journal of Zoology*, 25, 175–183.  
<http://dx.doi.org/10.1080/03014223.1998.9518148>
- Drake, C.J. & Hoberlandt, L. (1950) Catalogue of genera and species of Saldidae (Hemiptera). *Acta Entomologica Musei Nationalis Pragae*, 26 (376), 1–12.
- Kirkaldy, G.W. (1909) A list of the Hemiptera (excluding Sternorrhyncha) of the Maorian subregion, with notes on a few of the species. *Transactions of the New Zealand Institute*, 41, 22–29.
- Larivière, M.-C. & Larochele, A (2004) Heteroptera (Insecta: Hemiptera): catalogue. *Fauna of New Zealand*, 50, 1–330.
- Larivière, M.-C. & Larochele, A (2014) Checklist of the New Zealand Heteroptera (Insecta: Hemiptera): an update based on the 2004 to 2013 literature. *Zootaxa*, 3755 (4), 347–367.  
<http://dx.doi.org/10.11646/zootaxa.3755.4.2>
- Lindskog, P. & Polhemus, J.T. (1992) Taxonomy of *Saldula*: revised genus and species-group definitions, and a new species of the *pallipes* group from Tunisia. *Entomologica scandinavica*, 23 (1), 63–88.  
<http://dx.doi.org/10.1163/187631292X00038>
- Péricart, J. (1990) Hémiptères Saldidae et Leptopodidae d'Europe occidentale et du Maghreb. *Fauna de France*, 77, 1–238.
- Polhemus, J.T. (1985a) *Shore Bugs (Heteroptera Hemiptera: Saldidae). A world overview and taxonomy of Middle American forms*. The Different Drummer, Englewood, Colorado, 252 pp.
- Polhemus, J.T. (1985b) Zoogeography of Saldidae and other aquatic Hemiptera in the southern hemisphere. *National Geographic Society Research Reports*, 18 (1977 projects), 601–609.
- Polhemus, J.T. (1991) Three new species of *Salduncula* Brown from the Malay Archipelago, with a key to the known species (Heteroptera: Saldidae). *Raffles Bulletin of Zoology*, 39, 153–160.
- Rimes, G.D. (1951) Some new and little-known shore-bugs (Heteroptera: Saldidae) from the Australian region. *Transactions of the Royal Society of South Australia*, 74, 135–145.
- Schuh, R.T. & Polhemus, J.T. (2009) Revision and analysis of *Pseudosaldula* Cobben (Insecta: Hemiptera: Saldidae): A group with a classic Andean distribution. *Bulletin of the American Museum of Natural History*, 323, 102 pp.  
<http://dx.doi.org/10.1206/323.1>
- Southwood, T.R.E. & Leston, D. (1959) *Land and water bugs of the British Isles*. Warne, London, 436 pp.
- Van Duzee, E.P. (1914) Nomenclatorial and critical notes on Hemiptera. *Canadian Entomologist*, 46, 377–389.
- White, F.B. (1876) Descriptions of three new species of Hemiptera–Heteroptera from New Zealand. *Entomologist's Monthly Magazine*, 13, 105–106.