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Monograph

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Revision of the New Zealand cave wētā genus *Isoplectron* Hutton (Orthoptera: Rhaphidophoridae), with synonymy of *Petrotettix* Richards and *Setascutum* Richards, and the description of a new genus

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Abstract. The New Zealand cave wētā genus *Isoplectron* was first described by Hutton (1896) and included two species, *Isoplectron armatum* and *I. calcaratum*. Two more species, *I. cochleatum* and *I. aciculatum*, were described by Karny in 1935 and in 1937, respectively. The species *I. cochleatum* was later moved to the genus *Pharmacus* Pictet & de Saussure, 1893. Here we clarify the status and appearance of all known species of *Isoplectron*, and of other closely related cave wētā. Based on morphology and mtDNA sequences we determine that the genera *Petrotettix* Richards, 1972 and *Setascutum* Richards, 1972, belong in *Isoplectron*, and are thus synonymised with the latter. We also infer that *Isoplectron aciculatum* Karny, 1937 does not hold species rank, and that it should be considered a subspecies of *Isoplectron armatum* instead. The male of *Isoplectron pallidum* (Richards, 1972) comb. nov. and the female of *Isoplectron armatum aciculatum* Karny, 1937 are described here for the first time. Using molecular data, we also establish that two new species that are morphologically similar to *Isoplectron* are in fact more closely related to *Pharmacus*. These species are assigned to a new genus, *Praecantrix* gen. nov. We describe seven new species and two new subspecies of New Zealand raphidophorids belonging to the genera *Isoplectron* Hutton, 1896 and *Praecantrix*: *Isoplectron bicolor* sp. nov., *I. maculatum* sp. nov., *I. virgatum* sp. nov., *I. ferratum* sp. nov., *I. parallelum* sp. nov., *Praecantrix silvatica silvatica* gen., sp. et subsp. nov., *P. silvatica lutea* gen., sp. et subsp. nov. and *P. saxicola* gen. et sp. nov. Species demoted to subspecies rank: *Isoplectron aciculatum* Karny, 1937 becomes *Isoplectron armatum aciculatum* Karny, 1937. New combinations: *Setascutum pallidum* Richards, 1972 becomes *Isoplectron pallidum* (Richards, 1972) comb. nov.; *Petrotettix serratus* Richards, 1972 becomes *Isoplectron serratum* (Richards, 1972) comb. nov. New synonyms: *Isoplectron calcaratum* Hutton, 1896 = *Isoplectron armatum* Hutton, 1896 syn. nov.; *Setascutum ohauensis* Richards, 1972 = *Isoplectron armatum* Hutton, 1896 syn. nov.; *Petrotettix spinosus* Richards, 1972 = *Isoplectron serratum* (Richards, 1972) syn. nov.; *Petrotettix cupolaensis* Richards, 1972 = *Isoplectron serratum* (Richards, 1972) syn. nov.; *Petrotettix nigripes* Richards, 1972 = *Isoplectron serratum* (Richards, 1972) syn. nov.

Keywords. Cave cricket, *Isoplectron*, *Praecantrix*, Rhaphidophoridae, New Zealand, systematics.

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Introduction

New Zealand has a rich and diverse fauna of Rhaphidophoridae Walker, 1869, locally known as cave wētā, with 20 genera endemic to the archipelago out of 93 genera recognised worldwide (Cigliano *et al.* 2024). Despite the high taxonomic diversification, cave wētā show a remarkable level of morphological uniformity, with several broad traits including size, overall shape and surface patterning being plesiomorphic (Hubbell & Norton 1978; Ward 1997; Johns & Cook 2013; Allegrucci & Sbordoni 2019). The limited number of accessible and diagnostically informative morphological characters makes identification difficult even at genus level (Cook *et al.* 2010; Hegg *et al.* 2019). The identification of New Zealand Rhaphidophoridae is further complicated at species level by the fact that several descriptions are brief and incomplete, or only available in German or French (Cook *et al.* 2010; Hegg *et al.* 2022).

The cave wētā genus *Isoplectron* was established by Hutton (1896) and originally included two species, the type species *Isoplectron armatum*, and *I. calcaratum*. The description of *I. armatum* relied on the examination of a single adult male specimen from Dunedin, whereas *I. calcaratum* was described based on a juvenile male collected in Wellington and an adult female from Canterbury (Hutton 1896). The location of the type material for these two species was not recorded but in 2021 we were able to find all specimens in the Canterbury Museum in Christchurch, New Zealand (CMNZ).

Two more species were later added to *Isoplectron* by Karny; these were *Isoplectron cochleatum* Karny, 1935 and *I. aciculatum* Karny, 1937. *Isoplectron cochleatum* was described from two adult males and two females that have since been shown to belong to two different genera; the species has been moved to the genus *Pharmacus* Pictet & de Saussure, 1893 after examination of the holotype (Hegg *et al.* 2022). *Isoplectron aciculatum* was described from one adult male specimen, collected at an unknown locality in New Zealand. The original description is in German and is devoid of any illustrations. As a result, the species *Isoplectron aciculatum* has remained virtually unknown until the present, as shown by its near complete absence in the literature on New Zealand Rhaphidophoridae. A faithful translation of the original description by Karny is published in this paper (Supp. file 1: Appendix A).

During a period spanning two decades starting in 1954, entomologist Aola Richards published a comprehensive series of manuscripts in which she described or re-described most of the New Zealand raphidophorid fauna. She revised the genera *Macropathus* Walker, 1869 (Richards 1954, 1958b), *Pachyrhamma* Brunner von Wattenwyl, 1888 (Richards 1958c, 1959a, 1959c, 1960), *Pleioplectron* Hutton, 1896 and *Miotopus* Hutton, 1898 (Richards 1959b), *Turbottoplectron* Salmon, 1948 (Richards 1961a), *Gymnoplectron* Hutton, 1897 (Richards 1961b, 1961c, 1962), *Pharmacus* (Richards 1972) and *Ischyroplectron* Hutton, 1896 (Richards 1974), and she established the new genera *Novoplectron* Richards, 1958, *Pallidoplectron* Richards, 1958, *Dendroplectron* Richards, 1964, *Notoplectron* Richards, 1964, *Insulanoplectron* Richards, 1970, *Petrotettix* Richards, 1972 and *Setascutum* Richards, 1972 (Richards 1958a, 1958c, 1964, 1970, 1972). Richards never revised the smaller mainland cave wētā in the genera *Isoplectron* and *Neonetus* von Wattenwyl, 1888, nor did she examine the island endemic *Paraneonetus* Salmon, 1948; she did, however, include all of these in her early taxonomic keys (Richards 1958c, 1961d). This means that *Isoplectron* has not had a formal revision since its original description in the nineteenth century, and has had no species added to it since 1937.

The genus *Isoplectron* therefore currently comprises three species, *Isoplectron armatum*, *I. calcaratum* and *I. aciculatum*, with the latter two species being virtually unknown.

Richard's omission of the genera *Isoplectron* and *Neonetus* from her taxonomic work implies that we cannot exclude synonymy of one or more of her new genera with previously described taxa. The genera *Petrotettix* and *Setascutum* are especially of interest in the context of this study, since they have several traits in common with *Isoplectron*, namely spination at the apex of the fore and mid femora, the green colour of the eyes and the serrated upper valve of the ovipositor (Hutton 1896; Richards 1972). Johns & Cook (2013) already observed that "*Setascutum* is almost certainly a synonym of *Isoplectron*".

The genera *Setascutum* and *Petrotettix* present several additional problems in their species descriptions. The species *Setascutum pallidum* Richards, 1972 was described from one adult female only. Likewise, *Petrotettix cupolaensis* Richards, 1972 was described from one female, and *Petrotettix spinosus* Richards, 1972 was described from two females. The male remains unknown in all three taxa. And while a handful of male and female specimens were examined in the description of *Petrotettix serratus* Richards, 1972, the criteria used to differentiate this from other species in the genus *Petrotettix* are highly dubious, resting almost entirely on the number of dorsal and apical spines on the insect's legs.

Photographs of the type specimens for all extant species in the genera *Isoplectron*, *Petrotettix* and *Setascutum* are in this paper (Supp. file 1: Appendix B).

Here, we review the status of the cave wētā genera *Isoplectron*, *Petrotettix* and *Setascutum* using morphological and genetic data from a large sample. After examination of the type material, we resolve the species *Isoplectron calcaratum* and *Isoplectron aciculatum* and we revise their taxonomic status. We identify male *Setascutum pallidum* for the first time, since no males were included in the original description. Likewise, we identify female *Isoplectron aciculatum* for the first time, since no females were included in the original description. We use a combination of dense sampling throughout New Zealand, morphological traits and mtDNA sequence data to test the taxonomic status of putative *Isoplectron*, *Petrotettix* and *Setascutum* taxa. We use morphological traits to identify five hitherto undescribed species within the genus *Isoplectron*, and two new species and subspecies that according to whole mtDNA sequence data belong to a closely related new genus. We also provide a new description for the genus *Isoplectron*, which now encompasses a larger number of species, and for any previously known species in this genus, to account for new synonymies and for the variability of traits in specimens we have collected over a much wider geographical range compared to previous studies.

Material and methods

Collection and morphological methods

Cave wētā were collected opportunistically around New Zealand, including at the holotype location of all known species, using day and night searching of forests, parks and urban gardens, mountain ridges and cliffs, rock tors, caves and occasional pitfall trapping. More than 5600 specimens have been catalogued; many have been examined in detail and sampled for DNA sequence comparison, among these 405 specimens of *Isoplectron* (including the genera *Petrotettix* and *Setascutum*) and 59 specimens belonging to a morphologically similar and hitherto undescribed genus. Specimens are held in the Phoenix Lab collection at Massey University (MPN), except for type material, which is lodged at Museum of New Zealand Te Papa Tongarewa (NMNZ). *Isoplectron* specimens were identified based on the descriptions by Hutton (1896) and Karny (1937), and by comparison with type material held at Canterbury (CMNZ) and Oxford University (OUMNH) museums. *Petrotettix* and *Setascutum* specimens were identified based on the descriptions by Richards (1972), and by comparison with type material held at the Canterbury (CMNZ) and Otago (OMNZ) museums and at the New Zealand Arthropod Collection (NZAC).

Specimens were examined and photographed using a DSLR camera (Nikon D800, Nikon D850 or Sony α 7RII) attached to a Nikon Plan 4/0.13 microscope tip and Nikon PB-6 bellows, mounted on a Cognisys Stackshot 3 \times automated rail. Focus stacks were generated using the software Helicon Focus 8.2.2 Pro (RRID:SCR_014462). Adults were distinguished from immature individuals by darker, sclerotised bodies and fully formed external genital structures. In particular, the pigmentation, shape and sharpness of ovipositors, subgenital plates and cerci were informative about developmental stage (Fig. 1). We looked for the presence/absence of each of 22 apical leg spines (Fitness *et al.* 2015) (Supp. file 1: Fig. S1), as well as the combinations and numbers of linear spines on the legs, and the shape of the subgenital and suranal plates. The nomenclature used in this paper is shown in Fig. 2.

Measurements of key body parts were obtained using digital callipers (Table 1). For each species, all linear measurements and count data were tested for sexual dimorphism in JASP ver. 0.17.1 (RRID:SCR_015823; JASP Team 2023), using Bayesian Linear Mixed Models with measurement as the response variable, sex as fixed factor and geographical location as random factor, and Bayesian Linear Regression Models with measurement as the response variable, sex as fixed factor and elevation (meters above sea level), easting and northing (New Zealand Geodetic Datum 2000 map grid) as covariates. Where sexual dimorphism is detected and is statistically significant, or where it is apparent but not statistically significant due to small sample size, measurements are reported separately for males and females; otherwise the measurements for both sexes are pooled. Some traits included in Table 1 are invariable among the taxa examined in this paper – they are included nonetheless, since they are useful

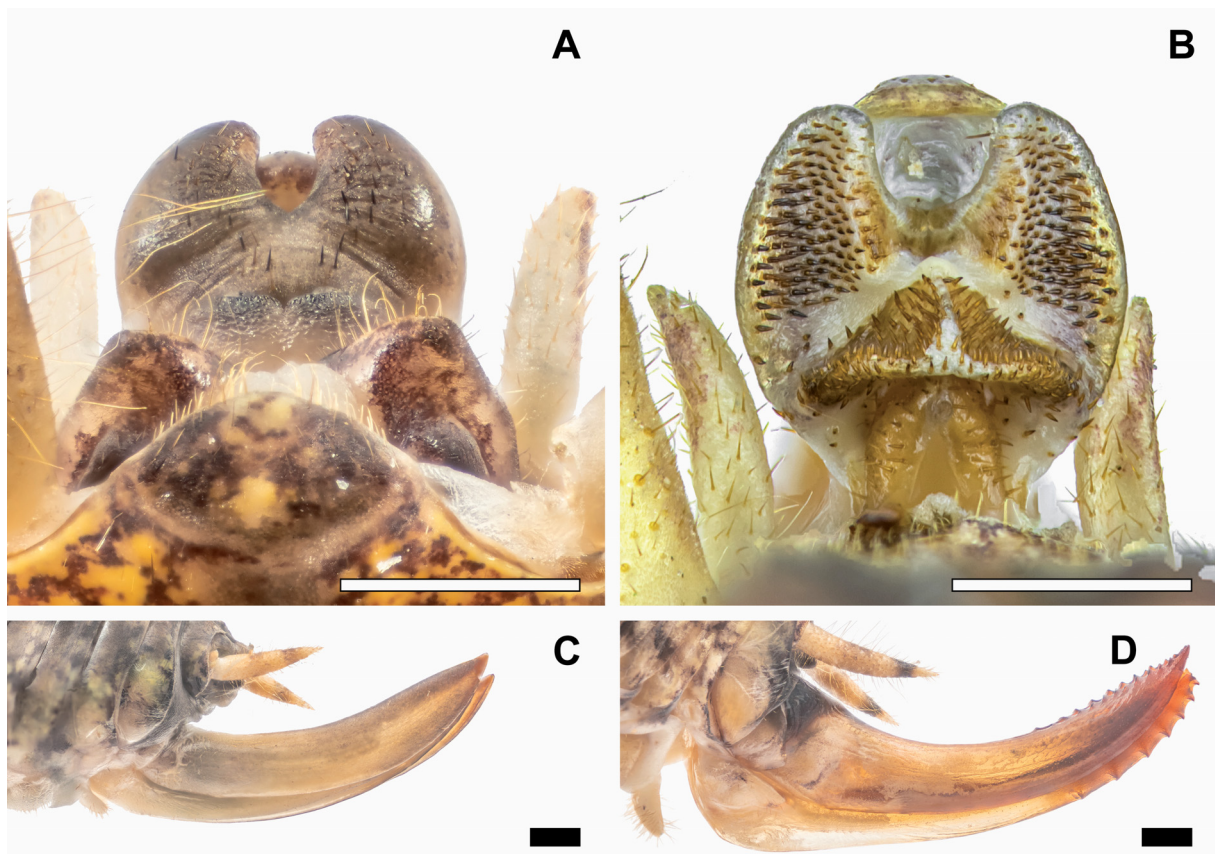


Fig. 1. Comparison of raphidophorid terminalia in nymphs and adults. **A–B.** *Isoplectron pallidum* (Richards, 1972) comb. nov., ♂. Crown Range Road, Central Otago. **A.** Nymph, final instar (MPN CW5561). **B.** Adult (MPN CW5601). **C–D.** *Praecantrix silvatica* gen. et sp. nov., ♀. Catlins Forest, Southland. **C.** Nymph, final instar (MPN CW4951). **D.** Adult (MPN CW4946). Scale bars: 500 μ m.

for comparison with other genera of NZ Rhaphidophoridae (see for example Fitness *et al.* 2018: table 1; Hegg *et al.* 2019, 2022).

Collection acronyms

CMNZ	=	Canterbury Museum, Christchurch, New Zealand
iNaturalist	=	Available from iNaturalist.org [accessed 12 May 2023]
MPN	=	Phoenix Lab, Massey University, Palmerston North, New Zealand
NMNZ	=	Museum of New Zealand Te Papa Tongarewa, Wellington, New Zealand
NZAC	=	New Zealand Arthropod Collection, Auckland, New Zealand
OMNZ	=	Otago Museum, Dunedin, New Zealand
OUMNH	=	Oxford University Museum of Natural History, United Kingdom

Two-letter codes in the ‘Material examined’ sections below refer to the New Zealand entomological regions (Crosby *et al.* 1998) (Fig. 3B).

Molecular phylogenetic analysis

We identified adult specimens to species level based on morphology, and used mitochondrial DNA sequences to confirm association of males and females within each taxon and to identify nymphs, which are often too difficult to identify to species based on morphology alone. Ultimately, we were seeking concordance between phylogenetic clades and morphologically identified taxa. The correlation of morphological and genetic clusters is expected from distinct evolutionary lineages that are consistent with their treatment as distinct taxonomic units (Mallet 1995, 2013b). We note that large stable populations observed in New Zealand insect species tend to yield distributions of pairwise mtDNA differences that deviate from the expected exponential distribution owing to their common history (Slatkin & Hudson 1991; Morgan-Richards *et al.* 2017), which can mislead species delimitation tools that rely on this single non-recombining locus (Dellicour & Flot 2015). In addition, lack of lineage sorting, selection on morphology and hybridisation can all result in gene trees that may differ from species trees; therefore, our focus is to illustrate the concordance between haplotypes and phenotype.

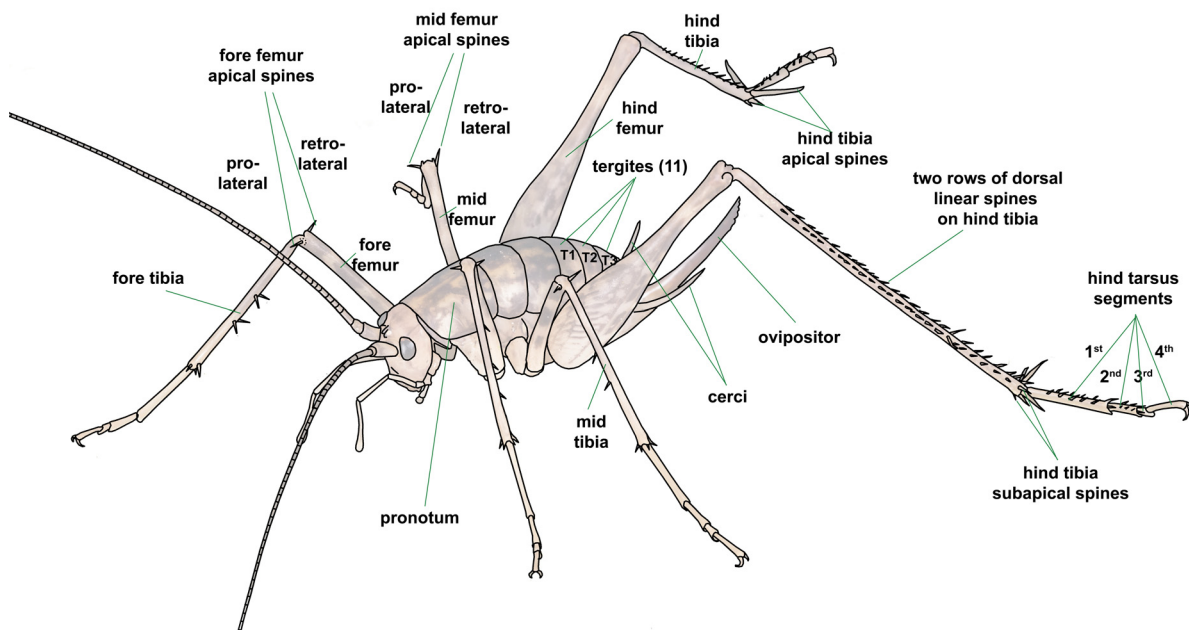


Fig. 2. Rhaphidophorid body plan (adult female), labelled with nomenclature used throughout this paper.

Genomic DNA was extracted from leg tissue of specimens representing each morphotype, using a salting-out protocol (Trewick & Morgan-Richards 2005). The cytochrome *c* oxidase I (COI) gene of the mitochondrial genome was amplified using polymerase chain reaction (PCR), either as a single fragment spanning ~1500 base pairs (bp) using the invertebrate primers LCO1490 (Folmer *et al.* 1994) and L2-N-3014 (Simon *et al.* 1994), or as two fragments of ~800 bp amplified using primer pairs LCO1490 with C1-N-2191 and C1-J-2195 with L2-N-3014 (Simon *et al.* 1994). Amplified DNA fragments were sequenced with Bigdye chemistry on an ABI 3730 Genetic Analyser (Applied Biosystems Inc., Carlsbad, CA).

Nucleotide sequences were aligned using the Geneious alignment tool in Geneious Prime 2020.2.2 (<https://www.geneious.com>; Kearse *et al.* 2012). No insertions/deletions were detected and sequences were translated to confirm that there were no stop codons or frame shifts that would indicate the presence of nuclear paralogs. A selection of 108 sequences was submitted to GenBank; accession numbers (PP155078–PP155185) are listed in the Material examined section.

Phylogenetic relationships were inferred using mtDNA sequences from 108 putative *Isoplectron* specimens to illustrate the concordance between morphologically distinct taxa and unique haplotypes. We examined the relationships of putative taxa of *Isoplectron* by phylogenetic reconstruction using maximum likelihood criteria. We applied a GTR evolutionary model with a gamma-distributed rate variation across DNA sites and a proportion of invariable sites. This was implemented with the PhyML plugin (Guindon *et al.* 2010) in Geneious Prime. Representative, homologous mtDNA sequences from other New Zealand cave wētā, *Talitropsis sedilloti* Bolívar, 1882 (MPN CW1830), *Pharmacus senex* Hegg *et al.*, 2022 (CW285) and *Notoplectron brewsterense* (Richards, 1964) (CW2625), were used for comparison; *Macropathus filifer* Walker, 1869 (CW226B) was included as an outgroup based on available phylogenetic information (Allegrucci *et al.* 2010; Fitness *et al.* 2018; Hegg *et al.* 2019) and unpublished analyses. Due to lack of monophyly of the initial sampling we divided our dataset and analysed the two lineages separately (see below).

To test for monophyly of putative *Isoplectron* we assembled whole mitochondrial genome sequence data for eight representative specimens using a ‘skim-sequencing’ approach with iterative mapping of short-read sequences (details in Koot *et al.* 2020; Dowle *et al.* 2024). Genomic DNA samples were paired-end sequenced with high-throughput sequencing on an Illumina HiSeq 2500 (BGI) following fragmentation and indexing using the Illumina TruSeq Nano DNA kit. Resulting 150 bp paired-end reads were demultiplexed, from which we assembled DNA sequences for the whole mitochondrial genomes using Geneious Prime. Paired reads were iteratively mapped to a reference sequence in Geneious generating a novel consensus sequence, which was then used as a reference to remap the raw sequence reads. This process was repeated until all alignment gaps were filled by extension with the new sequence data and ambiguities resolved. Sequences were uploaded as raw FASTA files to MITOS (Bernt *et al.* 2013) for initial identification of protein coding regions, rDNAs and tRNAs. Annotations were transferred and individually cross-checked by comparison of reading frames, amino acid translation and RNA structure. All 13 protein coding genes were extracted and concatenated to create the alignment for phylogenetic analyses. Phylogenetic relationships within the sampled taxa were inferred using a bootstrapped ML phylogeny estimated using IQ-TREE ver. 2.2.2.2 (Minh *et al.* 2020). A best-fit substitution model for each gene was estimated using ModelFinder (Kalyanamoorthy *et al.* 2017) and the MERGE function within IQ-TREE, and node support was assessed with 1000 ultrafast bootstrap replicates using the resulting model (Hoang *et al.* 2018).

Results

Identity of previously described species

We were able to resolve all known species of *Isoplectron*, *Petrotettix* and *Setascutum*, after comparing cave wētā collected at each species’ holotype location with the type specimens held in museums, and by matching our material examined with the descriptions provided by Hutton (1896), Karny (1937) and Richards (1972).

Hutton's (1896) descriptions of *Isoplectron armatum* and of *I. calcaratum* are very succinct. *Isoplectron armatum* is, however, readily identified by few key traits, namely the very pronounced, recurved spine on the inferior inner edge of the hind femur in adult males, which gives the species its name (Fig. 4A–C); the male subgenital plate with an elongated central lobe (Fig. 4D–F); the female subgenital plate with two small, rounded lobes, separated by a small gap and not touching at the vertex (Fig. 4G–I); and the lack of dorsal linear spines on the first and second segments of the hind tarsi. The species is both very common and widespread. It accounts for 171 out of 405 specimens of *Isoplectron* examined in this work (42%) and is found throughout the eastern and central regions of New Zealand's South Island between Invercargill and Blenheim, and as far north as Gisborne in North Island's eastern regions (see map in Fig. 10A). It is therefore unsurprising that it could have been encountered multiple times by early taxonomists and not recognised as a previously described species.

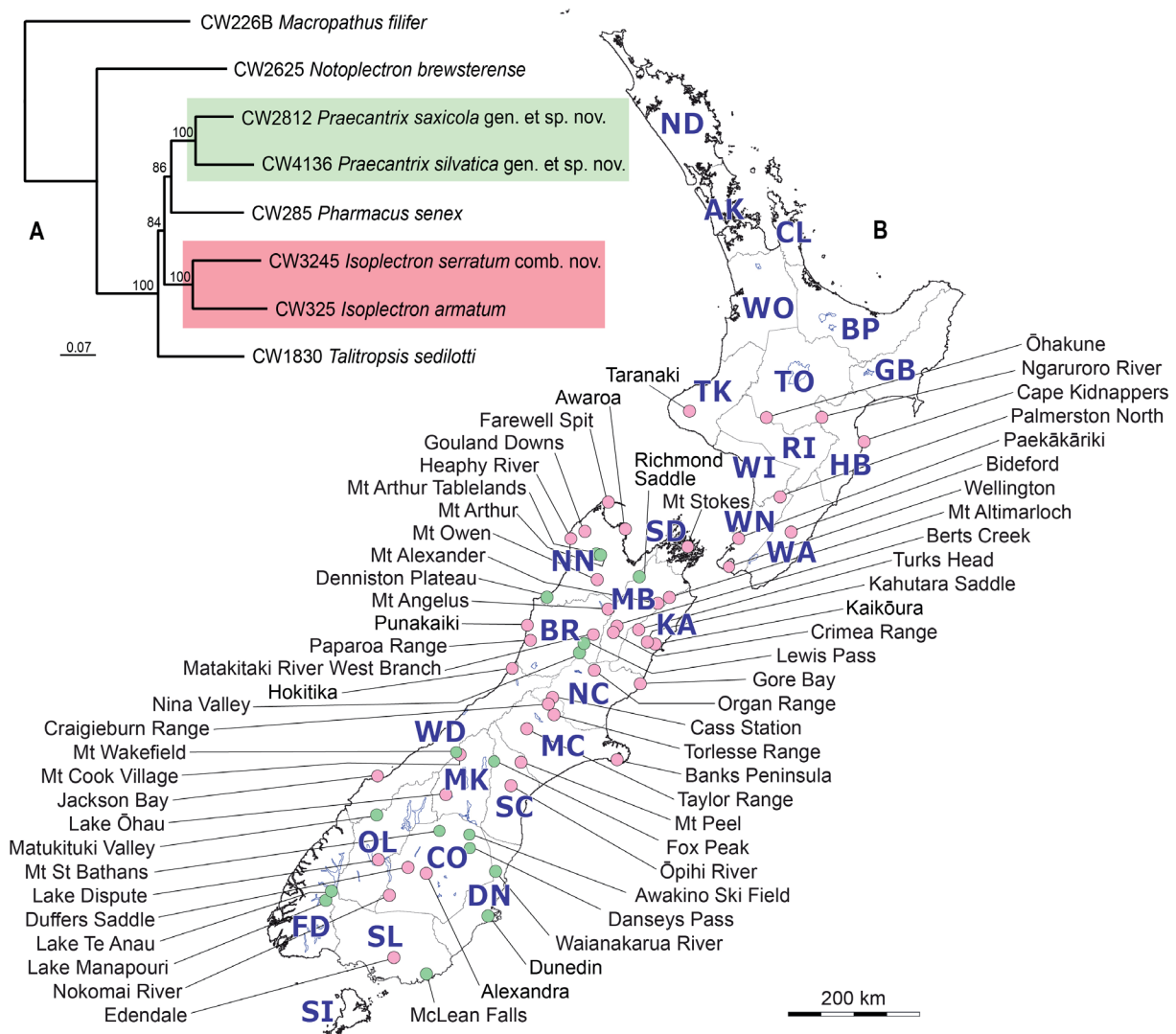


Fig. 3. A. Phylogenetic relationships of six genera of New Zealand Rhaphidophoridae Walker, 1869 inferred from whole mitochondrial genome sequences using Maximum Likelihood approach and 1000 bootstraps. B. Map of New Zealand, showing locations of specimens of *Isoplectron* Hutton, 1896 and *Praecantrix* gen. nov. used in phylogenetic analyses (Figs 6–7). Colours correspond to different genera: red = *Isoplectron*; green = *Praecantrix*. Two letter codes indicate the New Zealand entomological regions (Crosby *et al.* 1998). These codes are reported in the Material examined section for each species.

A recurved spine on the inferior inner edge of the hind femur is also found in female *Isoplectron armatum*, but it is smaller and not as pronounced (see Supp. file 1: Fig. S3). This may explain why Hutton (1896) did not recognize his holotype specimen of *Isoplectron calcaratum* as being the female of *I. armatum*. All other morphological traits (except for the genitalia), however, are the same in both sexes. Having analysed the mtDNA from a large number of males and females across the country, we have no doubt about *I. calcaratum* being a junior synonym of *I. armatum* (compare Fig. 4G–H).

After microscope examination of 28 adult male specimens of *Isoplectron armatum* from several localities throughout New Zealand, we found that males from North Island have paraprocts much wider compared to males from South Island (compare Fig. 14A, D). This observation is corroborated by our analysis of mitochondrial DNA sequences (sample size N = 31), which shows that *Isoplectron armatum* from South Island of New Zealand form a distinct cluster (Fig. 8). The difference between haplotypes, however, is small (P distance between clusters is approximately 1.2%) and comparable to within-species variation, suggesting that the two morphotypes could be considered two different subspecies. Since the holotype of *Isoplectron armatum* was collected in Dunedin, the trinomial *Isoplectron armatum armatum* Hutton, 1896 is assigned to the South Island subspecies.

Karny's (1937) description of *Isoplectron aciculatum* was written in a footnote; it is rather scant and insufficient in itself to positively identify the species (see the English translation in the Supp. file 1: Appendix A in this paper). To make things worse, the type locality was not recorded and remains unknown. The holotype, however, and adult male held in the OUMNH collections is in very good condition (Fig. 5B–C). The prominent spine on the inner edge of the hind femora, the shape of the terminalia, the dorsal spines on the hind tibiae and the lack of dorsal spines on the hind tarsi are all consistent with *Isoplectron armatum*. The holotype's wide paraprocts suggest that the specimen originates from North Island (compare Fig. 5A–B). Additionally, Karny's (1937) species description states that "the inner edge [of the hind femur] is armed with three longer spines, the one in the middle approximately twice as long as the remaining two". We have found three spines on the inner edge of the hind femur in 11 out of 13 specimens of *I. armatum* we examined from North Island, and only in 4 out of 46 specimens from South Island (see Table 1). Furthermore, the code '20e' on the holotype's labels (Fig. 5C) has been identified by Dr Robert Hoare of Landcare Research as originating from George V. Hudson's (1867–1946) entomology collections. An examination of the collection's catalogues held at NMNZ (Supp. file 1: Fig. S4B) places this specimen in a batch of small raphidophorids collected by Hudson in Wellington, North Island, in the early 1900s. Based on this evidence, we conclude that *I. aciculatum* is the same as the North Island subspecies of *I. armatum*, and is thus reassigned to *Isoplectron armatum aciculatum* Karny, 1937.

Richard's (1972) description of *Setascutum ohauensis* is detailed, accurate, and accompanied by good illustrations. It includes male and female specimens. The fact that Richards did not recognise this species as being the same as *Isoplectron armatum* suggests that she overlooked the genus *Isoplectron* in her work. Richards' descriptions and type material (Supp. file 1: Fig. S5) match with *Isoplectron armatum* (see Fig. 4C, F, I). Since *Setascutum ohauensis* is the type species of the genus *Setascutum* by designation (Richards 1972), the synonymy of *S. ohauensis* with *I. armatum* dictates that the genus *Setascutum*, Richards is also a junior synonym of *Isoplectron*, as per article 61.3.3 in the International Code of Zoological Nomenclature (ICZN 1999).

Setascutum pallidum was originally described from a single adult female. Similar to *Isoplectron armatum* in size and appearance, it can be recognised by the female subgenital plate having two small lobes at an angle, touching at the vertex (Fig. 6), the larger number of dorsal linear spines on the hind tibiae (see Table 1) and the presence of dorsal linear spines on the first and second segments of the hind tarsi (Richards 1972). Our phylogenetic analysis of mtDNA sequences nests *Setascutum pallidum* within the genetic diversity of the genus *Isoplectron* (Fig. 8).

We also found Richard's (1972) description of *Petrotettix serratus* to be detailed, accurate and accompanied by good illustrations. It includes both male and female specimens. The species is readily

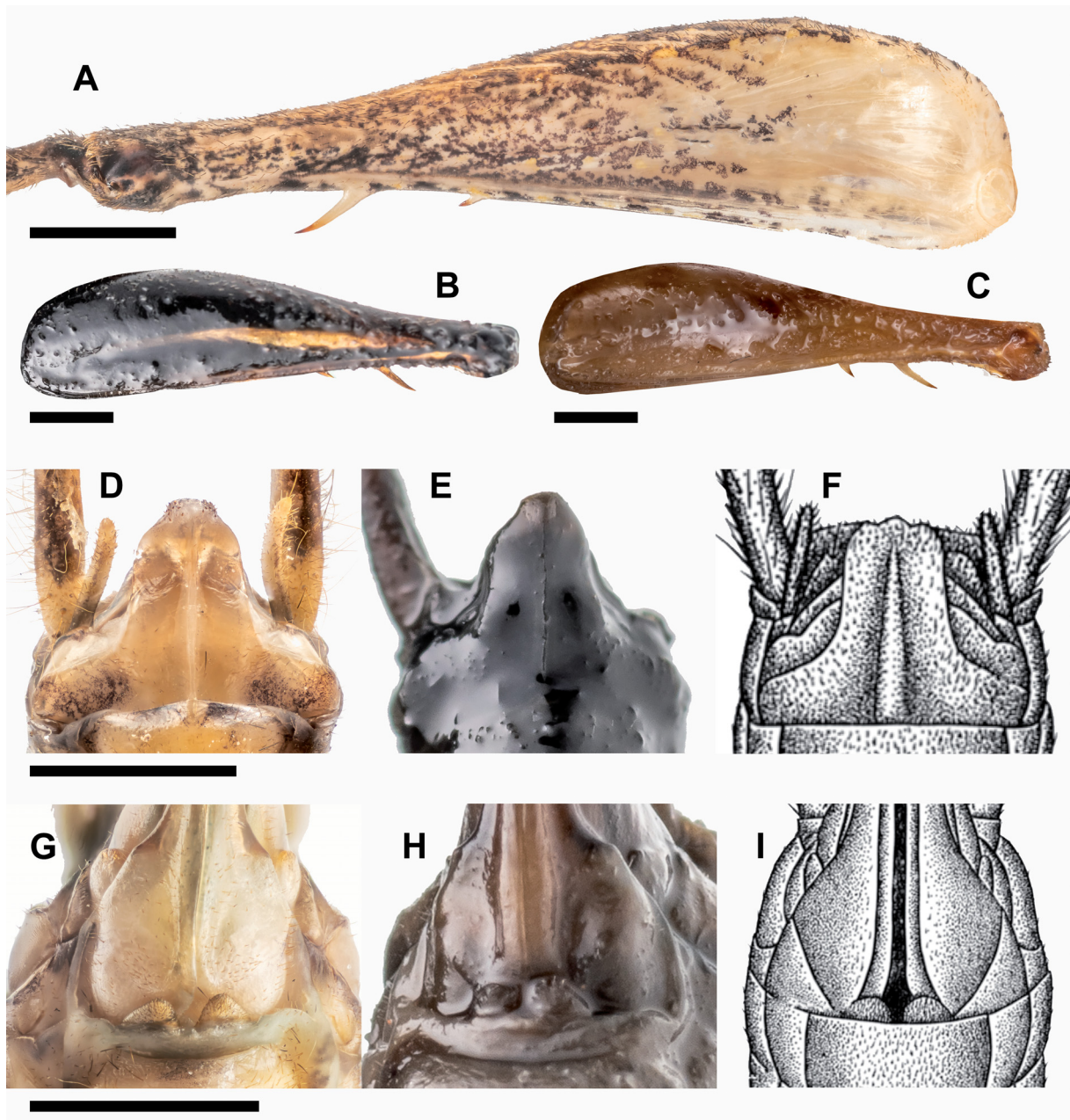


Fig. 4. A–C. Hind femur in adult ♂. **A.** *Isoplectron armatum armatum* Hutton, 1896, Hinau Track, Kaikōura (MPN CW4934). **B.** *Isoplectron armatum armatum*, holotype, Dunedin (CMNZ 2021.17.3). **C.** *Setascutum ohauensis* Richards, 1972, holotype, Lake Ōhau (OMNZ IV7928). **D–F.** Adult ♂ subgenital plate. **D.** *Isoplectron armatum armatum*, Kaiterau Trail, Kaikōura (MPN CW4938). **E.** *Isoplectron armatum armatum*, holotype, Dunedin (CMNZ 2021.17.3). **F.** *Setascutum ohauensis*, holotype, Lake Ōhau (OMNZ IV7928); original drawing by Richards (1972). **G–I.** Adult ♀ subgenital plate. **G.** *Isoplectron armatum armatum*, South Mavora Lake (MPN CW4928). **H.** *Isoplectron calcaratum* Hutton, 1896, holotype (CMNZ 2021.17.6). **I.** *Setascutum ohauensis*, allotype, Lake Ōhau (OMNZ IV7929); original drawing by Richards (1972). Scale bars: 2 mm.

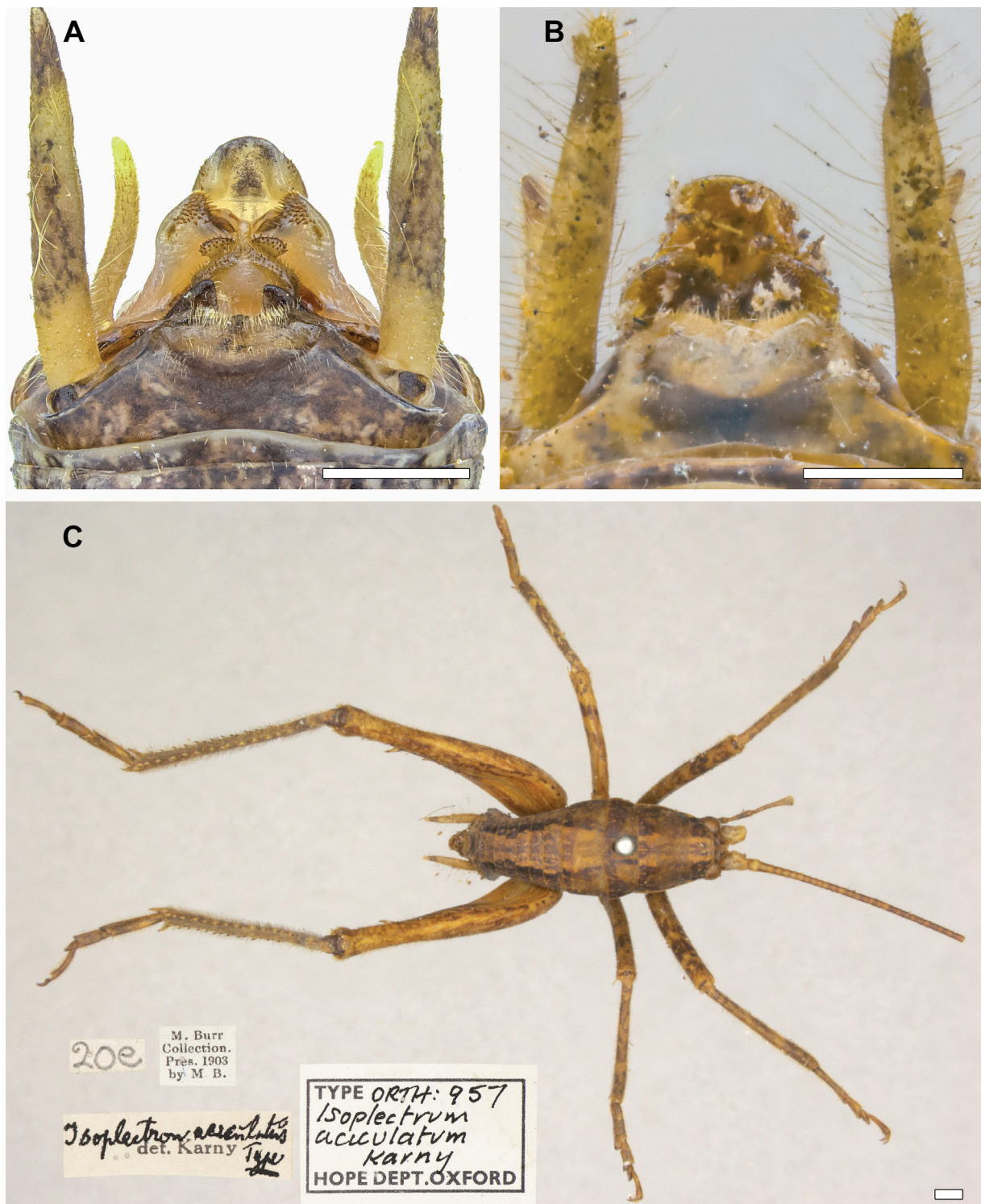


Fig. 5. *Isoplectron armatum aciculatum* Karny, 1937. **A–B.** Adult male terminalia. **A.** Ngaruroro River terrace, Hawke's Bay (MPN CW2657). **B.** Holotype, New Zealand (OUMNH ENT-ORTH097). **C.** Dorsal view of insect. Holotype, New Zealand (OUMNH ENT-ORTH097). Scale bars: 1 mm. Images B–C ©Oxford University Museum of Natural History, published with permission.

identified by its relatively large size and slender, long legs; in males, the strongly chitinised, trapezoidal suranal plate with a serrated posterior edge (Fig. 7A–C) and a prominent median lobe at the apex of the subgenital plate; in females, a subgenital plate with two small, rounded lobes, separated by a gap larger than they are wide (Fig. 7D–F). Our phylogenetic analysis of mtDNA COI sequences places *Petrotettix serratus* within the *Isoplectron* clade, sister to a new taxon from Mt Peel, and together these two taxa are sister to *Isoplectron pallidum* (Richards, 1972) comb. nov. (Fig. 8). Since *Petrotettix serratus* is the type

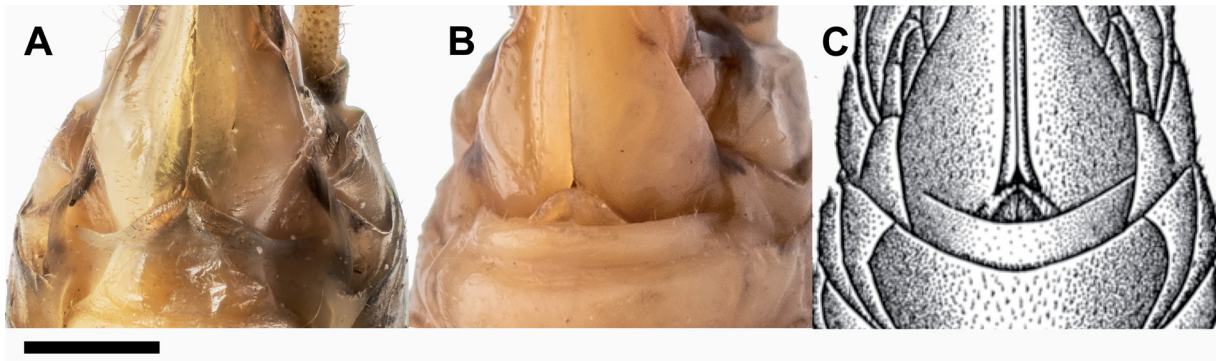


Fig. 6. *Isoplectron pallidum* (Richards, 1972) comb. nov. Adult ♀, subgenital plate. Duffers Saddle, Old Woman Range. A. MPN CW5387. B–C. Holotype (NZAC 03015582). B. Photograph of museum specimen. C. Original drawing by Richards (1972). Scale bar: 1 mm.

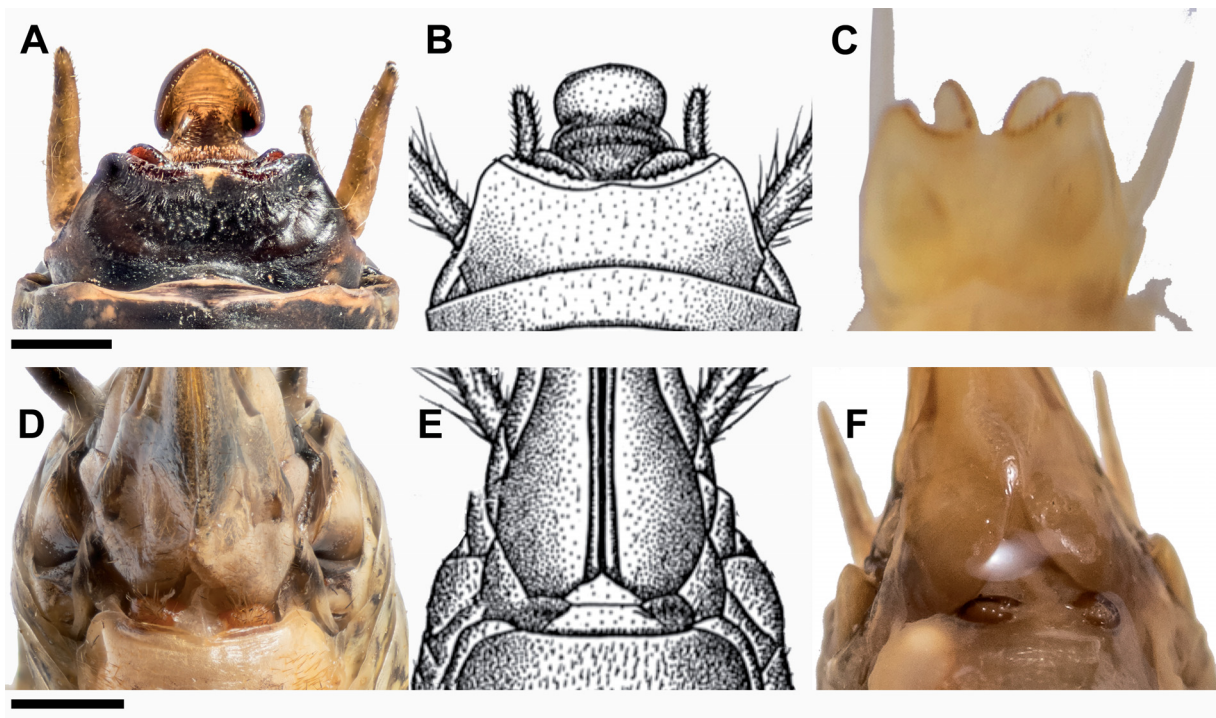


Fig. 7. *Isoplectron serratum* (Richards, 1972) comb. nov. A–C. Adult ♂, dorsal view of terminalia. A. The Gap, Torlesse Range (MPN CW3182). B–C. Holotype, Mt Binser, Canterbury (CMNZ 000223). B. Original drawing by Richards (1972). C. Photograph of museum specimen, with subgenital plate removed. D–F. Adult ♀, subgenital plate. D. Mt Altimarloch, Black Birch Range (MPN CW5587). E–F. Paratype, Mt St Patrick, St James Range (CMNZ 000223). E. Original drawing by Richards (1972). F. Photograph of museum specimen. Scale bars: 1 mm.

species of the genus *Petrotettix* by designation (Richards 1972), the genus *Petrotettix* is also a junior synonym of *Isoplectron*.

Petrotettix serratus is both common and widespread in the drier alpine regions east of the Southern Alps, from the Rangitata River north to the Kaikōura and Richmond Ranges (see map in Fig. 10F), a geographical region that encompasses the distribution range of all four species of *Petrotettix* described by Richards (1972).

Richard's (1972) key to *Petrotettix* was derived from the examination of very few specimens and relies on the presence/absence of a retrolateral apical spine on the mid femur, the number of dorsal spines on the first and second segments of the hind tarsi and the number of ventral spines on the hind femora. The unsuitability of this latter trait in taxonomic keys to New Zealand Rhabdiphoridae was already highlighted elsewhere (Fitness *et al.* 2015; Hegg *et al.* 2019, 2022). Examination of additional specimens causes Richard's key to the species *Petrotettix serratus*, *P. spinosus* and *P. cupolaensis* to fall apart entirely. The differences between putative species highlighted by Richards are simply explained by individual variation within a species. The one exception is the species *Petrotettix nigripes* Richards, 1972, which is distinguished from other species of *Petrotettix* by the absence of a retrolateral apical spine on the mid femur. We found this trait to be consistent in the population from the type locality of *P. nigripes* on Mt Altimarloch. The male and female genitalia are the same as in *P. serratus*. MtDNA sequence analysis shows little variation within Richard's *Petrotettix* across its whole range and does not distinguish samples from Mt Altimarloch (see Fig. 8). We therefore infer just one species in *Petrotettix* and as this genus is a junior synonym of *Isoplectron* we have the combination *Isoplectron serratum* (Richards, 1972) comb. nov.

New species

Eighty-two specimens in our material examined fit Hutton's (1896) description of *Isoplectron* but do not fit into any of the species discussed above. Using the morphology of terminalia in adult specimens, measurements of body parts, spine counts, colour pattern and ecology, we identified five other related and as yet undescribed species. We thus designate the new species *Isoplectron bicolor* sp. nov., *I. ferratum* sp. nov., *I. parallelum* sp. nov., *I. maculatum* sp. nov. and *I. virgatum* sp. nov. Four of the five new species identified by morphology were each found to correspond to a distinct mtDNA lineage within the monophyletic *Isoplectron* clade (Fig. 8). Specimens from the lower North Island (*I. parallelum*) are morphologically and ecologically very similar to the southern species *I. virgatum*, but have mtDNA haplotypes that nest within the diversity of *I. ferratum*. Possible explanations for this incongruence are put forward in this paper's discussion.

Additionally, we identified 59 specimens that fit Hutton's (1896) description of *Isoplectron*, but which fall into a morphologically and genetically distinct clade that lies outside of *Isoplectron*, and is sister to *Pharmacus* (Fig. 3A). Phylogenetic analysis with whole mitochondrial genome data (>15000 bp) provides strong evidence for this new lineage, which has not previously been sampled (Dowle *et al.* 2024). We thus designate a new genus, *Praecantrix* gen. nov., and two new species, *Praecantrix saxicola* gen. et sp. nov. and *Praecantrix silvatica* gen. et sp. nov. The latter species is divided into two geographically and genetically distinct clusters (Fig. 9), but specimens from the two groups have identical male and female terminalia and can only be differentiated by the colour of the abdomen. We suggest that the concordance of geographical separation and clustering of mtDNA haplotypes warrants these two populations being assigned to different subspecies (Cronin *et al.* 1996; Miller *et al.* 2011). We thus designate two subspecies, *Praecantrix silvatica silvatica* gen., sp. et subsp. nov. from the western regions of South Island, and *P. silvatica lutea* gen., sp. et subsp. nov. from the eastern regions of South Island, from the lower North Island, and from Rakiura/Stewart Island.

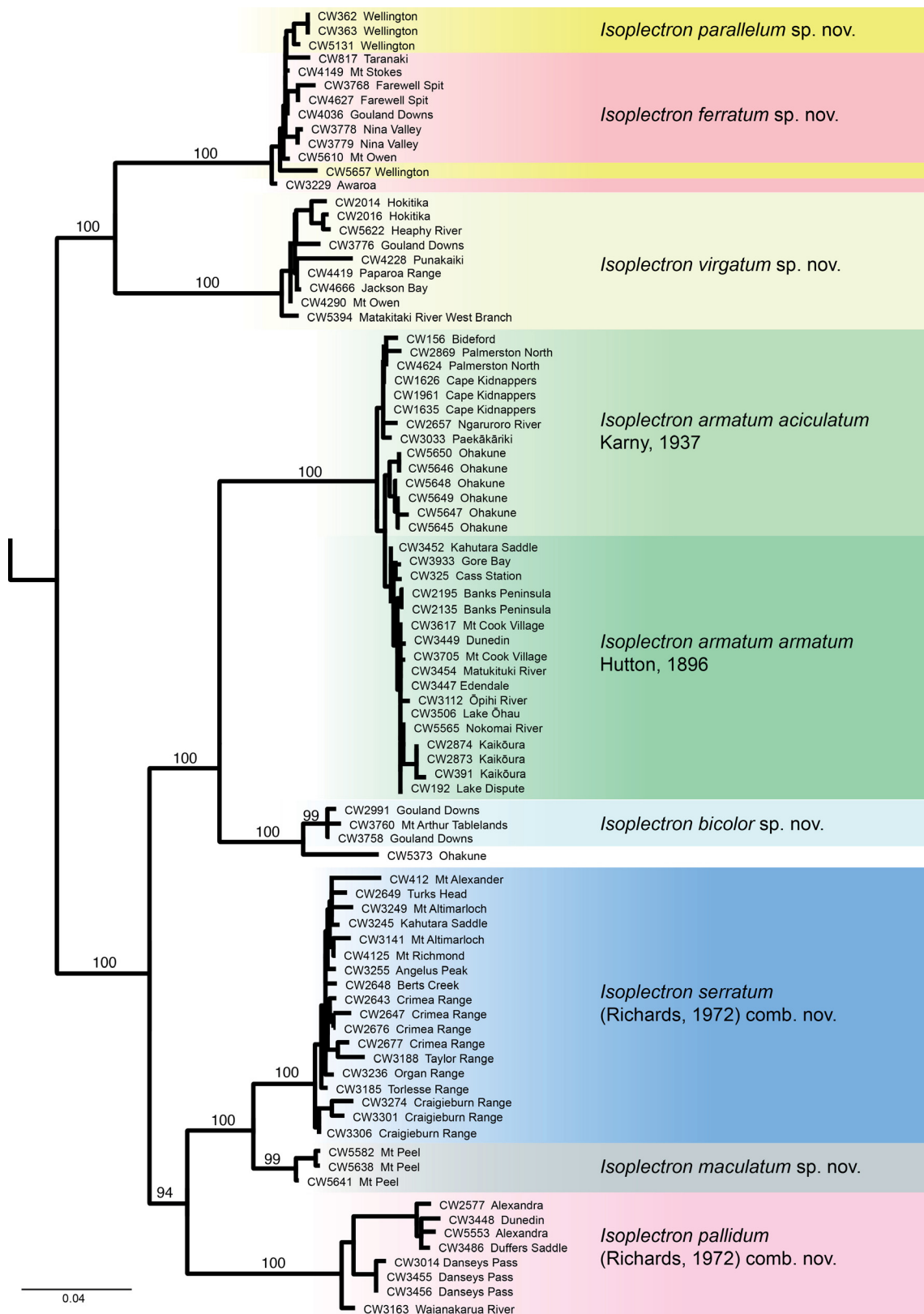


Fig. 8. Gene tree for the eight morphologically identified species of *Isoplectron* Hutton, 1896 using Maximum Likelihood analysis of ~850 bp of mtDNA (COI) from 86 specimens. Node support labels are the result of 1000 ML bootstrap replicates.

Measurements and spine counts

The measurements and spine counts for 191 adult *Isoplectron* and *Praecantrix* gen. nov. specimens are reported in Table 1.

Bayesian linear mixed models with body length and length of hind tibia as measurement, sex and species as fixed factors and location as random factor indicate that any sexual dimorphism is species specific. Models therefore need to be run separately for each species. The model results for all species and the associated posterior exclusion probabilities are summarised in Table 2.

There appears to be no significant difference in body size between adult males and females in *Isoplectron armatum*, in *I. pallidum* or in *I. ferratum* sp. nov. In four other species, *I. serratum*, *I. parallelum* sp. nov., *Praecantrix silvatica* gen. et sp. nov. and *P. saxicola* gen et sp. nov., the female is larger than the male. This appears to be the case in *Isoplectron bicolor* sp. nov. also, although our sample size is too small for a statistical analysis.

We have found significant sexual dimorphism in the length of the hind tibiae in all species except in *Isoplectron ferratum* sp. nov. In three species, *I. armatum*, *I. pallidum* and *I. serratum*, the hind tibiae are longer in the male than they are in the female. This seems to be the case in *Isoplectron bicolor* sp. nov. also, although our sample size is too small for a statistical analysis. In another three species, *Isoplectron parallelum* sp. nov., *Praecantrix silvatica* gen. et sp. nov. and *P. saxicola* gen et sp. nov., the hind tibiae are longer in the female than they are in the male.

In *Isoplectron pallidum* insects are larger in the south and at the higher elevations. The insect's hind tibiae are also longer at the higher elevations (see Table 2).

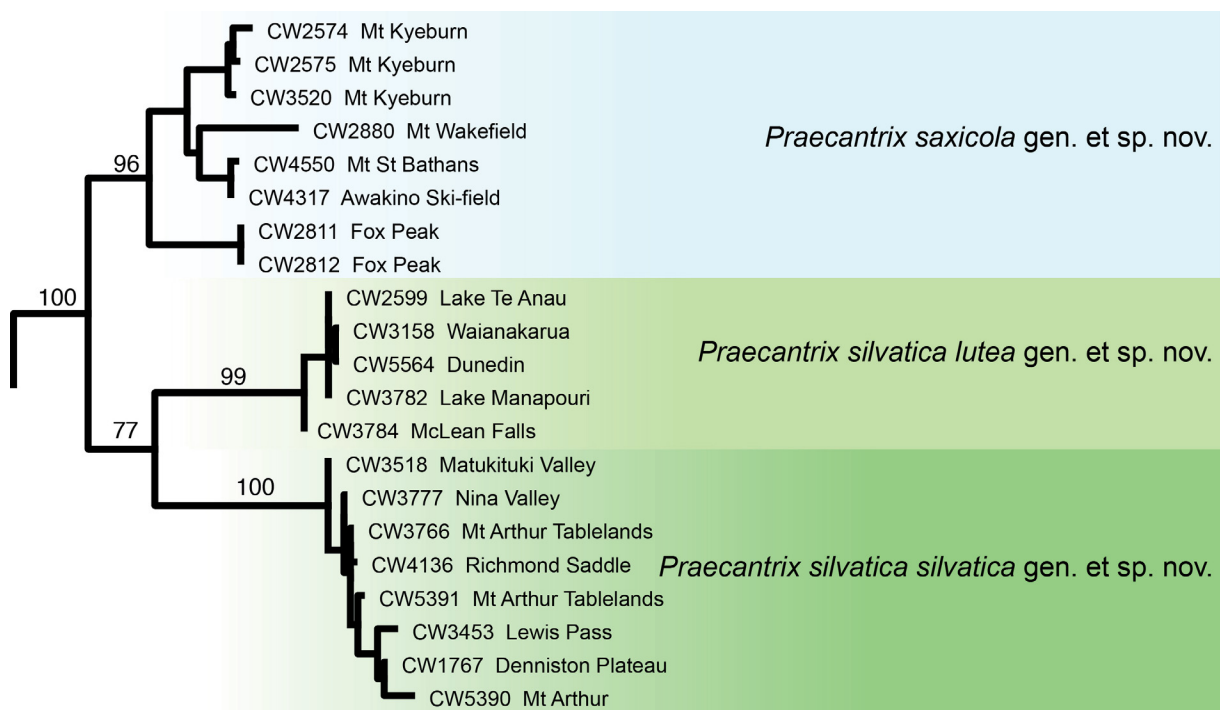


Fig. 9. Gene tree for the two morphologically identified species of *Praecantrix* gen. nov. using Maximum Likelihood analysis of ~850 bp of mtDNA (COI) from 22 specimens. Node support labels are the result of 1000 ML bootstrap replicates.

Table 1 (continued on next three pages). Dimensions and spine count of *Isoplectron* Hutton, 1896 and *Praecantrix* gen. nov.

		<i>Isoplectron armatum armatum</i> Hutton, 1896	<i>Isoplectron armatum aciculatum</i> Karny, 1937	<i>Isoplectron bicolor</i> sp. nov.
Sample size		46 (25 ♀♀, 21 ♂♂)	13 (6 ♀♀, 7 ♂♂)	6 (1 ♀, 5 ♂♂)
Apical spines fore, mid and hind femora ¹		0 0, 0 1, 0 0 2 ♀♀, 1 ♂: 0 0, 0 0, 0 0	0 0, 0 1, 0 0	0 0, 0 1, 0 0
Apical spines fore, mid and hind tibiae		2-3-8 1 ♀, 2 ♂♂: 2-3-7	2-3-8 1 ♀, 1 ♂: 3-3-8	2-3-8
Body length (mm) ²		11.3 (8.6–13.8)	12.7 (9.9–16.8)	♀ 17.7 ♂ 13.4 (11.8–16.0)
Pronotum length (mm)		2.9 (2.1–4.0)	♀ 3.2 (2.8–3.4) ♂ 3.4 (3.2–3.5)	4.1 (3.8–4.3)
Eye colour		green	green	green
Ovipositor length (mm)		8.4 (6.7–9.7)	8.8 (6.7–9.5)	13.7
Ratio ovipositor to body length		0.75 (0.62–0.87)	0.70 (0.64–0.77)	0.77
Teeth: ventral valve of ovipositor		7 (6–8)	7 (6–8)	6
Dorsal valve of ovipositor		serrated	serrated	serrated
Length of hind tibia (mm)		♀ 9.8 (7.5–12.4) ♂ 11.7 (10.5–15.2)	♀ 11.8 (10.4–12.7) ♂ 15.4 (13.7–16.5)	♀ 17.7 ♂ 19.5 (14.6–20.9)
Ratio hind tibia to body length		♀ 0.89 (0.73–1.10) ♂ 1.06 (0.94–1.23)	♀ 0.95 (0.80–1.15) ♂ 1.15 (0.98–1.29)	♀ 1.00 ♂ 1.36 (1.24–1.56)
Superior spines on hind tibia	prolateral	14 (11–20)	18 (15–20)	13.5 (13–16)
	retrolateral	15 (12–19)	17 (14–19)	13.5 (12–16)
Spine density on hind tibia (count/mm)	prolateral	♀ 1.46 (0.97–1.98)	♀ 1.45 (1.32–1.73)	♀ 0.73
		♂ 1.26 (0.85–1.70)	♂ 1.14 (0.94–1.39)	♂ 0.77 (0.72–0.89)
	retrolateral	♀ 1.55 (1.13–2.00)	♀ 1.37 (1.23–1.50)	♀ 0.79
		♂ 1.28 (0.92–1.70)	♂ 1.14 (0.95–1.39)	♂ 0.73 (0.57–0.96)
Pairs of longer spines on hind tibia		0	0	0
Superior spines on 1 st tarsus segment		0	0	0.5 (0–2)
Superior spines on 2 nd tarsus segment		0	0	0
Fore tibia, inferior spines	prolateral	2 (1–3)	2 (1–2)	2 (2–2)
	retrolateral	2 (1–2)	2 (1–2)	2 (2–2)
Fore tibia, superior spines		0	0	0
Mid tibia, inferior spines	prolateral	2 (1–2)	2 (0–2)	2 (2–2)
	retrolateral	1 (0–2)	1 (0–2)	2 (2–2)
Mid tibia, superior spines	prolateral	0	0	0
	retrolateral	0 (0–2)	0	0
Fore femur, inferior spines	prolateral	0	0	0
	retrolateral	0	0	0
Mid femur, inferior spines	prolateral	0	0	0
	retrolateral	0	0	0
Hind femur, inferior spines	prolateral	0 (0–2)	2 (1–2)	13.5 (9–17)
	retrolateral	2 (1–3)	3 (2–3)	5.5 (4–8)

Table 1 (continued). Dimensions and spine count of *Isoplectron* Hutton, 1896 and *Praecantrix* gen. nov.

		<i>Isoplectron pallidum</i> (Richards, 1972)	<i>Isoplectron serratum</i> (Richards, 1972)	<i>Isoplectron maculatum</i> sp. nov.	
Sample size		23 (8 ♀♀, 15 ♂♂)	27 (14 ♀♀, 13 ♂♂)	8 (4 ♀♀, 4 ♂♂)	
Apical spines fore, mid and hind femora ¹		0 0, 0 1, 0 0	0 0, 0 1, 0 0 0 0, 0 0, 0 0	0 0, 0 1, 0 0 0 0, 0 0, 0 0	
Apical spines fore, mid and hind tibiae		2-3-8 1 ♀, 1 ♂: 3-3-8	4-4-8 1 ♀: 3-4-8	4-4-8 1 ♀: 4-2-8, 1 ♂: 4-3-8	
Body length (mm) ²		9.3 (8.2–13.2)	♀ 13.1 (11.3–16.2) ♂ 13.5 (9.6–15.5)	♀ 12.8 (12.4–14.3) ♂ 11.4 (10.2–11.8)	
Pronotum length (mm)		2.6 (1.9–3.3)	♀ 3.6 (2.7–4.5) ♂ 3.4 (2.5–4.1)	♀ 3.35 (3.0–3.7) ♂ 3.1 (3.0–3.3)	
Eye colour		green	green	green	
Ovipositor length (mm)		7.4 (6.4–8.9)	8.9 (8.2–10.5)	8.7 (8.3–9.2)	
Ratio ovipositor to body length		0.79 (0.67–0.87)	0.67 (0.59–0.82)	0.65 (0.64–0.72)	
Teeth: ventral valve of ovipositor		6 (5–7)	6 (5–7)	6 (6–7)	
Dorsal valve of ovipositor		serrated	strongly serrated	strongly serrated	
Length of hind tibia (mm)		♀ 9.5 (8.5–11.8) ♂ 10.6 (9.4–15.4)	♀ 14.2 (12.1–18.7) ♂ 17.0 (14.2–23.3)	♀ 14.3 (13.2–14.7) ♂ 18.0 (17.5–20.9)	
Ratio hind tibia to body length		♀ 1.01 (0.89–1.20) ♂ 1.13 (0.82–1.47)	♀ 1.10 (0.94–1.27) ♂ 1.51 (1.10–1.70)	♀ 1.08 (1.03–1.13) ♂ 1.66 (1.53–1.81)	
Superior spines on hind tibia	prolateral	24 (15–34)	26.5 (21–37)	27 (23–36)	
	retrolateral	21 (13–31)	24 (19–30)	25 (17–33)	
Spine density on hind tibia (count/ mm)	prolateral	♀ 2.38 (1.79–2.50) ♂ 2.36 (1.60–3.47)	♀ 1.81 (1.42–2.23) ♂ 1.57 (1.11–1.92)	♀ 1.84 (1.64–2.18) ♂ 1.62 (1.20–1.95)	
		retrolateral	♀ 2.02 (1.44–2.39) ♂ 2.02 (1.38–2.74)	♀ 1.57 (1.32–2.15) ♂ 1.39 (0.92–1.69)	♀ 1.50 (1.21–1.89) ♂ 1.54 (1.42–1.78)
	Pairs of longer spines on hind tibia		0	0	0
	Superior spines on 1 st tarsus segment		13 (8–20)	9.5 (4–18)	11 (7–18)
Superior spines on 2 nd tarsus segment		6 (3–11)	4 (1–8)	3.5 (0–6)	
Fore tibia, inferior spines	prolateral	2 (2–3)	2 (2–3)	2 (2–3)	
	retrolateral	2 (1–2)	2 (0–3)	2 (2–2)	
Fore tibia, superior spines		0	0	0	
Mid tibia, inferior spines	prolateral	2 (0–3)	2 (1–4)	2 (2–2)	
	retrolateral	2 (0–3)	2 (0–3)	2 (2–2)	
Mid tibia, superior spines	prolateral	0	0	0	
	retrolateral	0	0	0	
Fore femur, inferior spines	prolateral	0	0	0 (0–1)	
	retrolateral	0	0	0	
Mid femur, inferior spines	prolateral	0	0 (0–1)	0	
	retrolateral	0	0	0	
Hind femur, inferior spines	prolateral	2 (0–3)	5.5 (1–12)	8 (2–10)	
	retrolateral	2 (1–3)	5 (2–12)	6 (5–7)	

Table 1 (continued). Dimensions and spine count of *Isoplectron* Hutton, 1896 and *Praecantrix* gen. nov.

		<i>Isoplectron virgatum</i> sp. nov.	<i>Isoplectron ferratum</i> sp. nov.	<i>Isoplectron parallellum</i> sp. nov.
Sample size		8 (4 ♀♀, 4 ♂♂)	18 (9 ♀♀, 9 ♂♂)	9 (4 ♀♀, 5 ♂♂)
Apical spines fore, mid and hind femora ¹		0 0, 0 0, 0 0 1 ♂: 0 0, 0 1, 0 0	0 0, 0 1, 0 0	0 0, 0 1, 0 0
Apical spines fore, mid and hind tibiae		3 ♀♀, 1 ♂: 2-3-6 1 ♀, 3 ♂♂: 3-3-6	2-3-6 3 ♀♀: 3-3-6	3-3-6 1 ♀, 1 ♂: 2-3-6
Body length (mm) ²		♀ 11.1 (9.0–15.2) ♂ 10.7 (8.0–13.4)	10.95 (9.0–12.8)	♀ 11.2 (10.3–12.4) ♂ 9.3 (8.8–11.5)
Pronotum length (mm)		♀ 3.2 (2.4–3.7) ♂ 2.6 (2.1–3.0)	2.85 (2.0–3.3)	♀ 2.9 (2.7–3.3) ♂ 2.6 (2.2–2.9)
Eye colour		green	green	green
Ovipositor length (mm)		8.45 (7.8–8.7)	7.5 (7.1 – 8.7)	6.5 (6.1–6.8)
Ratio ovipositor to body length		0.77 (0.56–0.87)	0.71 (0.56 – 0.84)	0.57 (0.54–0.62)
Teeth: ventral valve of ovipositor		9.5 (8–10)	8 (6 – 9)	9 (7–11)
Dorsal valve of ovipositor		serrated	serrated	serrated
Length of hind tibia (mm)		10.5 (7.7–12.0)	10.1 (8.7 – 11.7)	♀ 10.7 (9.7–11.9) ♂ 9.0 (8.9–10.5)
Ratio hind tibia to body length		♀ 0.94 (0.76–1.02) ♂ 0.97 (0.89–1.00)	0.90 (0.82 – 1.15)	♀ 0.98 (0.86–1.02) ♂ 0.96 (0.90–1.03)
Superior spines on hind tibia	prolateral retrolateral	19.5 (16–24) 18 (17–19)	13.5 (11 – 16) 14 (12 – 15)	17 (15–21) 17 (14–22)
Spine density on hind tibia (count/mm)	prolateral retrolateral	1.92 (1.42–2.60) 1.64 (1.50–2.47)	1.31 (0.94–1.72) 1.42 (1.09–1.56)	♀ 1.73 (1.65–1.76) ♂ 1.80 (1.43–2.14) ♀ 1.76 (1.62–2.02) ♂ 1.71 (1.57–1.89)
Pairs of longer spines on hind tibia		0	0	0
Superior spines on 1 st tarsus segment		0	0	0
Superior spines on 2 nd tarsus segment		0	0	0
Fore tibia, inferior spines	prolateral retrolateral	2 (1–2) 2 (2–2)	2 (1–3) 2 (1–2)	2 (2–2) 2 (2–2)
Fore tibia, superior spines		0	0	0
Mid tibia, inferior spines	prolateral retrolateral	2 (2–2) 2 (1–3)	2 (1–2) 2 (1–2)	2 (2–2) 2 (1–2)
Mid tibia, superior spines	prolateral retrolateral	0 0	0 0	0 0
Fore femur, inferior spines	prolateral retrolateral	0 0	0 0	0 0
Mid femur, inferior spines	prolateral retrolateral	0 0	0 0	0 0
Hind femur, inferior spines	prolateral retrolateral	2 (1–2) 2 (2–3)	2 (0–3) 1.5 (1–4)	2 (1–2) 2 (0–2)

Table 1 (continued). Dimensions and spine count of *Isoplectron* Hutton, 1896 and *Praecantrix* gen. nov.

		<i>Praecantrix silvatica</i> gen., sp. et subsp. nov.	<i>Praecantrix silvatica</i> <i>lutea</i> gen., sp. et subsp. nov.	<i>Praecantrix saxicola</i> gen. et sp. nov.
Sample size		13 (8 ♀♀, 5 ♂♂)	10 (4 ♀♀, 6 ♂♂)	10 (6 ♀♀, 4 ♂♂)
Apical spines fore, mid and hind femora ¹		0 0, 0 1, 0 0	0 0, 0 1, 0 0	0 0, 0 1, 0 0
Apical spines fore, mid and hind tibiae		2-3-6 1 ♀: 3-3-6	2-3-6	4-4-8 1 ♀: 3-4-8; 1 ♀: 4-4-7
Body length (mm) ²		♀ 10.4 (8.7–11.5) ♂ 8.9 (8.4–9.3)	♀ 9.6 (9.0–10.0) ♂ 9.2 (6.5–9.9)	♀ 12.4 (11.6–13.6) ♂ 10.0 (8.9–10.7)
Pronotum length (mm)		♀ 2.8 (2.1–3.0) ♂ 2.5 (2.3–3.0)	2.5 (1.8–3.2)	3.4 (3.2–4.0)
Eye colour		black	black	grey / white
Ovipositor length (mm)		6.8 (5.1–7.7)	5.1 (4.3–5.3)	8.8 (7.3–9.8)
Ratio ovipositor to body length		0.64 (0.52–0.74)	0.51 (0.48–0.58)	0.70 (0.62–0.82)
Teeth: ventral valve of ovipositor		5 (5–7)	7 (6–7)	6 (5–7)
Dorsal valve of ovipositor		strongly serrated	strongly serrated	serrated
Length of hind tibia (mm)		♀ 8.1 (7.7–9.9) ♂ 7.2 (6.6–7.3)	♀ 8.2 (6.0–8.7) ♂ 7.6 (6.6–8.3)	♀ 13.0 (10.8–14.4) ♂ 11.0 (10.3–11.7)
Ratio hind tibia to body length		♀ 0.77 (0.73–1.02) ♂ 0.81 (0.71–0.86)	♀ 0.85 (0.67–0.88) ♂ 0.82 (0.74–1.23)	♀ 1.02 (0.93–1.17) ♂ 1.10 (1.04–1.24)
Superior spines on hind tibia	prolateral	9 (7–12)	13.5 (11–14)	27.5 (23–33)
	retrolateral	11 (10–13)	13 (11–16)	25.5 (22–30)
Spine density on hind tibia (count/mm)	prolateral	♀ 1.07 (0.81–1.43) ♂ 1.51 (0.97–1.67)	♀ 1.64 (1.39–2.33) ♂ 1.70 (1.45–1.94)	♀ 2.34 (2.02–2.50) ♂ 2.39 (2.09–2.48)
	retrolateral	♀ 1.27 (1.01–1.43) ♂ 1.64 (1.39–1.81)	♀ 1.78 (1.61–2.17) ♂ 1.71 (1.32–1.97)	♀ 2.06 (1.87–2.32) ♂ 2.19 (2.00–2.72)
Pairs of longer spines on hind tibia		0	0	0
Superior spines on 1 st tarsus segment		0	0	3 (2–7)
Superior spines on 2 nd tarsus segment		0	0	0 (0–1)
Fore tibia, inferior spines	prolateral	2 (1–2)	2 (1–2)	2 (1–2)
	retrolateral	1 (1–2)	1.5 (1–2)	2 (1–2)
Fore tibia, superior spines		0	0	0
Mid tibia, inferior spines	prolateral	2 (1–2)	1.5 (1–2)	2 (2–3)
	retrolateral	1 (1–2)	1 (1–2)	2 (1–2)
Mid tibia, superior spines	prolateral	0	0	0
	retrolateral	0	0	0
Fore femur, inferior spines	prolateral	0	0	0
	retrolateral	0	0	0
Mid femur, inferior spines	prolateral	0	0	0
	retrolateral	0	0	0
Hind femur, inferior spines	prolateral	1 (0–1)	2 (0–2)	0 (0–1)
	retrolateral	1 (1–2)	1 (1–2)	2 (1–3)

¹ The six numbers are, in order from left to right: fore femur prolateral and retrolateral, mid femur prolateral and retrolateral, hind femur prolateral and retrolateral. ‘1’ means that an apical spine is present, ‘0’ means that an apical spine is absent.

² Body length is measured from the apex of the fastigium to the posterior margin of the suranal plate.

Taxonomy

Class Insecta Linnaeus, 1758
Order Orthoptera Latreille, 1793
Superfamily Rhaphidophoroidea Walker, 1869
Family Rhaphidophoridae Walker, 1869
Subfamily Macropathinae Karny, 1930
Tribe Macropathini Karny, 1930

Genus *Isoplectron* Hutton, 1896

Isoplectron Hutton, 1896: 237.

Setascutum Richards, 1972: 163. **Syn. nov.**

Petrotettix Richards, 1972: 166. **Syn. nov.**

Isoplectron – Karny 1937: 229–230, pl. 6 fig. 5. — Ward 1997: 13–15. — Johns & Cook 2013: 1. — Hegg *et al.* 2022: 51–52.

Setascutum – Ward 1997: 13–15. — Johns & Cook 2013: 1.

Petrotettix – Ward 1997: 13–16. — Johns & Cook 2013: 1. — Hegg *et al.* 2022: 51.

Type species

Isoplectron armatum Hutton, 1896.

Diagnosis

A genus of small to mid-sized Rhaphidophoridae (adult body length typically between 9 and 13 mm; up to 18 mm in the larger species), with hind tibiae armed above with two rows of linear spines that are very similar in size. These spines are fused to the shaft of the tibia and are never socketed or articulated. Fore femora always without apical spines; mid femora usually armed with one retrolateral spine at the apex. Male subgenital plate broadly speaking triangular, with an elongated central lobe; female subgenital plate bilobed. Upper valve of the ovipositor always serrated above.

While some species of *Isoplectron* are morphologically very similar and are easily mistaken for one another, other species are morphologically and ecologically quite distinct. This makes it somewhat difficult to characterise the genus, yet some traits are common to all species. A detailed description of these common traits follows; individual species descriptions focus on those traits that differ among species.

Etymology

Not explained by Hutton. From the Greek ‘*Isos*’ = ‘equal’, ‘*plectron*’ = ‘plectrum’ (probably referring to the dorsal spines on the hind tibiae, which are shaped like a plectrum). The hind tibiae are armed with spines that are equal in shape and size. *Isoplectron* is neuter gender.

Description

Adult

MESUREMENTS. See Table 1. Sexual dimorphism in body length, with females being larger than males by up to 10% in most but not all species.

HEAD (Fig. 11A–B). Oval in shape. Eyes rounded, but with a straight inner edge facing the scapes of the antennae. Eye colour green, wholly or partially, in all species. Fastigium divided by a deep median groove; shaped like an isosceles triangle with a rounded pale patch in the middle when seen from the

side. No visible sexual dimorphism in scapes of antennae or any other head-part. Labial and maxillary palps pale, of varying length, with moderately dense covering of hair.

THORAX. Pronotum, mesonotum and metanotum all covered in dense, fine tomentum. A pale, thin median dorsal line is generally inconspicuous or absent (see Fig. 12A–I). Lateral edges of pronotum with a pronounced rim. In dorsal view, the pronotum is up to 80% wider at the posterior end than at the anterior end (Fig. 12A–I).

LEGS. Moderately long. Hind femora slender; sexual dimorphism evident, with all leg segments longer in males than in females in most but not all species. Coxae and trochanters generally of uniform pale colour. Fore and mid femora and tibiae may be uniform pale or variegated; hind legs variegated. Fore coxae with a pronounced lateral anterior spine. Fore tibiae approximately half of body length, and 10% longer in males than in females in most species; on average 5% longer than fore femora in both males and females. Fore femora without linear spines above or below, and always without apical spines. Fore tibiae armed below, generally with two linear spines on both anterior and posterior edge in all species. The number of apical spines on the fore tibiae varies by species. Mid legs 2% to 5% shorter than fore legs, otherwise with the same proportions in male and females. Mid femora without linear spines above or below, but usually armed with one retrolateral spine at the apex. A prolateral spine at the apex of the mid femur is always absent. Mid tibiae armed below, generally with two linear spines on both anterior and posterior edge in all species. Dorsal linear spines on the mid tibiae are rare but possible. The number of apical spines on the mid tibiae varies by species. Hind tibiae approximately of same length as body in females, up to 50% longer in males in most but not all species. Hind femora approximately 10% shorter than hind tibiae. Hind femora generally armed with few but at times very conspicuous linear spines below on both anterior and posterior edges. Hind tibiae armed with anything between 11 and 37 linear spines above (number varies both within and between species), of similar size, on both anterior and posterior edges (Fig. 13A–I). The spines are fused to the shaft of the tibia and are never socketed or articulated. The number of apical spines on the hind tibiae varies by species. Hind tarsi with four segments; first and second segments with a pair of spines on distal end. First and second tarsal segment may be armed or unarmed above, depending on species.

ABDOMEN. Tergites always covered in dense, fine tomentum. Colour of tergites varies by species; a pale, thin median dorsal line is generally inconspicuous or absent (see Fig. 12A–I). In some species, the seventh and eighth sternites are equipped with 3 to 5 very conspicuous protuberances, in females only (see Fig. 18G, J and Fig. 19A).

MALE TERMINALIA. Cerci between 10% and 25% of body length depending on species; pointed at apex, variable in colour, clothed in setae. The subgenital plate looks somewhat similar in all species, with an elongated median lobe; it is at least twice as long at centre as on the sides. Paraprocts armed with strong, stout spinules in most species. The difference in male terminalia between species is pronounced enough to provide one of the strongest characters for species level identification (see Figs 14–16).

FEMALE TERMINALIA. Subgenital plate consists of two small, rounded lobes, separated by a gap in the middle. Ovipositor reddish-brown, moderately to strongly curved upwards at apex, terminating in a sharp point; approximately three quarters of body length in most species. Upper valve always serrated above, strongly so in some species; lower valve with 5 to 10 strong teeth at apex on ventral edge (Figs 17–19).

Nymph

Generally look similar to adults. Due to the small size of the insects and the lack of developed terminalia, nymphs may be next to impossible to differentiate from their equivalents in *Praecantrix* gen. nov. or *Neonetus*.

Table 2. *Isoplectron* Hutton, 1896 and *Praecantrix* gen. nov. Summary of Bayesian model results for length of insect body and of hind tibia as a function of sex, geographical coordinates (easting, northing in New Zealand Geodetic Datum 2000 map grid) and elevation (m a.s.l.). All models run in JASP ver. 0.17.1. Species for which sample size is too small for statistics are omitted. CI stands for credible intervals; for covariates these are only reported where they are significant.

Species	Measurements (mm)	Sample size ¹	Bayesian Linear Mixed Model Fixed factor: Sex Random factor: Location	Bayesian Linear Regression Factor: Sex Covariates: Easting, Northing, Elevation
<i>Isoplectron armatum armatum</i> Hutton, 1896	Body	46	No sexual dimorphism 95% CI: -0.34–0.93 mm	No effect of covariates
	Hind tibia	46	+2.5mm in ♂ 95% CI: 1.59–3.20 mm	No effect of covariates
<i>Isoplectron armatum aciculatum</i> Karny, 1937	Body	13	No sexual dimorphism 95% CI: -1.09–0.99 mm	No effect of covariates
	Hind tibia	13	+3.2mm in ♂ 95% CI: 1.01–5.35 mm	No effect of covariates
<i>Isoplectron pallidum</i> Richards, 1972	Body	23	No sexual dimorphism 95% CI: -1.54–1.40 mm	+0.13 mm per 100 m elevation 95% CI: 0.00 mm–0.60 mm +0.99mm per 100 km south 95% CI: 0.00 mm–2.96 mm
	Hind tibia	23	+1.2 mm in ♂ 95% CI: -0.01–2.35 mm	+0.15 mm per 100 m elevation 95% CI: 0.00 mm–0.60mm
<i>Isoplectron serratum</i> Richards, 1972	Body	27	+1.2 mm in ♀ 95% CI: 0.1–2.37 mm	No effect of covariates
	Hind tibia	27	+3.7 mm in ♂ 95% CI: 1.84–5.89 mm	No effect of covariates
<i>Isoplectron ferratum</i> sp. nov.	Body	18	No sexual dimorphism 95% CI: -1.1–2.06 mm	No effect of covariates
	Hind tibia	18	No sexual dimorphism 95% CI: -0.27–1.23 mm	No effect of covariates
<i>Praecantrix silvatica</i> gen. et sp. nov.	Body	23	+1.2 mm in ♀ 95% CI: 0.3–1.97 mm	No effect of covariates
	Hind tibia	23	+0.8 mm in ♀ 95% CI: 0.12–1.43 mm	No effect of covariates
<i>Praecantrix saxicola</i> gen. et sp. nov.	Body	10	+2.8 mm in ♀ 95% CI: 1.56–4.09 mm	Sample size too small
	Hind tibia	10	+1.8 mm in ♀ 95% CI: 0.06–3.42 mm	Sample size too small

¹ For the number of males and females in each sample, refer to Table 1.

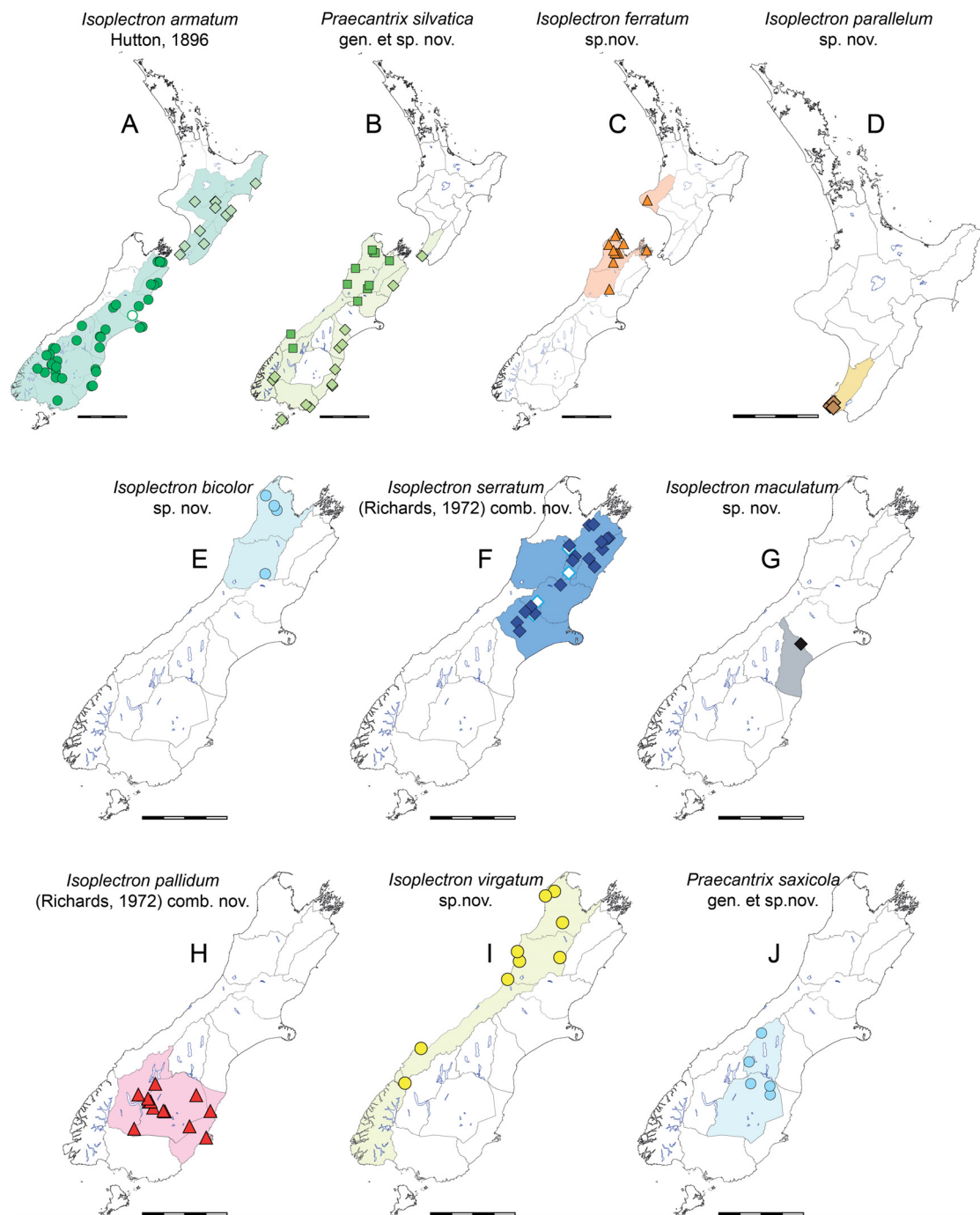


Fig. 10. Known distribution of cave wētā in the genera *Isoplectron* Hutton, 1896 and *Praecantrix* gen. nov. **A–C.** All of New Zealand. **A.** *Isoplectron armatum* Hutton, 1896. Solid shapes indicate material collected as part of this study; empty circles indicate additional locations of material examined by Hutton (1896). Shapes represent different subspecies: circle = *Isoplectron armatum armatum* Hutton, 1896; diamond = *Isoplectron armatum aciculatum* Karny, 1937. **B.** *Praecantrix silvatica* gen. et sp. nov. Shapes represent different subspecies: dark green square = *Praecantrix silvatica silvatica* gen., sp. et subsp. nov.; light green diamond = *Praecantrix silvatica lutea* gen., sp. et subsp. nov. **D.** Map of North Island. **E–J.** Map of South Island. **F.** *Isoplectron serratum* (Richards, 1972) comb. nov. Solid shapes indicate material collected as part of this study; empty diamonds indicate additional locations of material examined by Richards (1972). Scale bars: 200 km.

Distribution

New Zealand, all of South Island; limited to southern regions in North Island (Fig. 3).

Isoplectron armatum Hutton, 1896

A small arboreal cave wētā, widespread throughout New Zealand's eastern regions between Invercargill and Gisborne (Fig. 10A), this is by far the most common species in the genus *Isoplectron*. Based on examination of the adult male terminalia and on DNA analysis we recognize two subspecies, geographically separated by Cook Strait: *Isoplectron armatum armatum* in South Island and *Isoplectron armatum aciculatum* in North Island.

Isoplectron armatum armatum Hutton, 1896

Figs 3–4, 8, 10A, 11A–B, 12A, 13A, 14A–C, 17A–C, 21A–C

Isoplectron armatum Hutton, 1896: 237–238, pl. XIII fig. 18–18b.

Isoplectron calcaratum Hutton, 1896: 238, pl. XIII fig. 19, 19b. **Syn. nov.**

Setascutum ohauensis Richards, 1972: 163–165, fig. 5.1–5.6. **Syn. nov.**

Isoplectron armatum – Karny 1937: 230. — Johns & Cook 2013: 17.

Isoplectron calcaratum – Karny 1937: 230. — Johns 1977: 316, 318.

Isoplectron aciculatum – Bowie *et al.* 2006: 263–264, 267.

Diagnosis

A small to medium-sized raphidophorid with a body length between 9 and 14 mm, the hind tibiae about the same length as the body in males, approx. 10% shorter in females.

The most typical coloration is a mottled dark brown that blends in well with the bark of many New Zealand native trees, with pale spots on the mesonotum and/or the metanotum (Figs 12A, 21A), or on the first tergite. Colour morphs with a pale diamond on the back (Fig. 21B) or a pale longitudinal band (Fig. 21C) are also commonly encountered. The most characteristic trait of this species is a very conspicuous, weakly curved spine on the retrolateral inferior edge of the hind femur in adult males (Fig. 4A–C).

Isoplectron armatum armatum can only be differentiated from the other subspecies, *I. armatum aciculatum*, by examination of the adult male terminalia. The two subspecies, however, are allopatric, *I. a. armatum* being confined to New Zealand's South Island, whereas *I. a. aciculatum* is only found in New Zealand's North Island.

Isoplectron a. armatum can easily be confused with *I. pallidum* in Otago, where the two species are sympatric. *Isoplectron pallidum*, however, always has first and second hind tarsal segments armed with dorsal linear spines, whereas *I. armatum* always has first and second hind tarsal segments unarmed above. Adults of the species *I. ferratum* sp. nov. and nymphs of *I. bicolor* sp. nov. are also morphologically very similar to *I. a. armatum*. These two species, however, are only found in the north-west of New Zealand's South Island, outside of the distribution range of *I. armatum* (compare Fig. 10A, C, E).

Etymology

'*Armātus*' (adj.) is Latin for 'armed' – with a very conspicuous spine on the retrolateral inferior edge of the hind femur in adult males.

Material examined (see also Supp. file 1: Table S1 and Figs S2–S5)

Holotype

NEW ZEALAND • ♂, adult; Dunedin (DN), Dunedin; 45.9° S, 170.5° E; 1896 or earlier; F.W. Hutton leg.; CMNZ 2021.17.3.

Other material

NEW ZEALAND – **Southland (SL)** • 1 ♂; Kāmahī Reserve, Edendale; 46.32143° S, 168.73513° E; 60 m a.s.l.; 13 Nov. 2016; D. Hegg leg.; on tree trunk in native forest; night search + insect net; GenBank: PP155178; MPN CW3447. – **Fiordland (FD)** • 1 nymph; Eglinton River mouth; 45.16355° S, 167.82449° E; 200 m a.s.l.; 24 Dec. 2018; D. Hegg leg.; on tree trunk in native forest; casual find; MPN CW4283. – **Dunedin (DN)** • 1 ♀; Brockville, Dunedin; 45.8705° S, 170.4615° E; 250 m a.s.l.; 21 Jun. 1998; S. Trewick leg.; on footpath; casual find; MPN CW168 • 1 ♂; same data as for preceding; 13 Apr. 2007; B. Trewick leg.; inside house; casual find; MPN CW1920 • 1 ♂; Frasers Gully, Dunedin; 45.861° S, 170.461° E; 200 m a.s.l.; 17 Apr. 2017; S. Trewick and M. Morgan-Richards leg.; MPN CW3470 • 1 ♀; same data as for preceding; MPN CW3471 • 1 ♀; Ōpoho, Dunedin; 45.85431° S, 170.53385° E; 130 m a.s.l.; 30 Nov. 2016; D. Hegg leg.; on tree trunk in garden; night search + insect net; GenBank: PP155176; MPN CW3449 • 2 ♂♂; Duncan Rd, near Hampden; 45.36689° S, 170.72316° E; 460 m a.s.l.; 1 Oct. 2016; M. Morgan-Richards leg.; on clay bank; MPN CW3128, CW3130 • 1 nymph; same data as for preceding; MPN CW3127 • 1 ♂; Staircase Hut track, Waianakarua; 45.28210° S, 170.69724° E; 420 m a.s.l.; 3 Sep. 2016; D. Hegg leg.; on tree trunk in native forest; night search + insect net; MPN CW3159 • 5 ♀♀; same data as for preceding; MPN CW3161, CW3165, CW3166, CW3168, CW4923 • 1 nymph; same data as for preceding; MPN CW3167. – **Central Otago (CO)** • 3 nymphs; Wye Creek; 45.1384° S, 168.7623° E; 400 m a.s.l.; Nov. 2009; M. McDonald leg.; in native forest; night search; MPN CW1027, CW1029, CW1030 • 1 ♀; Piano Flat, Waikaia Forest; 45.55472° S, 169.02195° E; 220 m a.s.l.; 5 Mar. 2020; D. Hegg leg.; on tree trunk in native forest; night search + insect net; MPN CW4962 • 1 nymph; Nokomai River; 45.5148° S, 168.7091° E; 300 m a.s.l.; 12 Nov. 2022; D. Hegg leg.; on willow tree next to river; night search + insect net; GenBank: PP155185; MPN CW5565. – **Otago Lakes (OL)** • 1 spec. (hind leg only); Lake Dispute, Wakatipu; 45.050° S, 168.544° E; 450 m a.s.l.; Nov. 2004; P. Johns leg.; GenBank: PP155182; MPN CW192 • 2 specs (hind legs only); same data as for preceding; MPN CW193, CW194 • 2 ♂♂; same data as for preceding; M. Francis leg.; MPN CW251, CW252 • 4 nymphs; Sam Summers Walking Track; 45.0540° S, 168.5305° E; 450 m a.s.l.; Nov. 2009; M. McDonald leg.; in native forest; night search; MPN CW1024, CW1025, CW1031, CW1032 • 1 ♂; Bush Creek Track, Arrowtown; 44.9365° S, 168.8189° E; 400 m a.s.l.; Nov. 2009; M. McDonald leg.; in native forest; night search; MPN CW1033 • 1 nymph; Te Kere Haka Track, Kingston; 45.3247° S, 168.7157° E; 300 m a.s.l.; Nov. 2009; M. McDonald leg.; in native forest; night search; MPN CW1034 • 2 nymphs; Lake Sylvan; 44.7219° S, 168.3151° E; 400 m a.s.l.; Nov. 2009; M. McDonald leg.; in native forest; night search; MPN CW1026, CW1028 • 2 ♂♂; OBHS Lodge, Matukituki River; 44.49654° S, 168.77397° E; 400 m a.s.l.; 5 May 2017; D. Hegg leg.; on tree trunk in native forest; night search + insect net; MPN CW4932, CW4933 • 1 ♀; same data as for preceding; MPN CW4949 • 3 nymphs; same data as for preceding; MPN CW3444 to CW3446 • 1 ♀; Aspiring Hut track, Matukituki River; 44.50131° S, 168.68372° E; 400 m a.s.l.; 5 May 2017; D. Hegg leg.; on large rock; night search + insect net; MPN CW3771 • 1 ♂; Aspiring Hut, Matukituki River; 44.47580° S, 168.65914° E; 460 m a.s.l.; 6 May 2017; D. Hegg leg.; on beech tree branch; night search + insect net; GenBank: PP155181; MPN CW3454 • 1 ♂; same data as for preceding; MPN CW3999 • 3 ♀♀; South Mavora Lake; 45.31441° S, 168.17702° E; 630 m a.s.l.; 14 Mar. 2018; D. Hegg leg.; on tree trunk in native forest; night search + insect net; CW3802, CW4927, CW4928 • 2 ♀♀; South Mavora Lake; 45.29922° S, 168.17931° E; 630 m a.s.l.; 25 Jun. 2020; D. Hegg leg.; on tree trunk in native forest; night search + insect net; MPN CW4929, CW4930 • 1 nymph; Muddy Creek, Rees River; 44.69636° S, 168.46955° E; 520 m a.s.l.; 6 Sep. 2018; D. Hegg leg.; on tree trunk in native forest; night search + insect net; MPN CW4083. – **Mackenzie (MK)** • 1 ♂, holotype of *Setascutum ohauensis*; Lake Ōhau; 44.2° S, 169.8° E;

500 m a.s.l.; May 1958; OUSSA Otago University Science Students Association leg.; OMNZ IV7928 • 1 ♀, allotype of *Setascutum ohauensis*; same data as for preceding; OMNZ IV7929 • 1 ♂; Parsons Bush, Lake Ōhau; 44.24971° S, 169.81942° E; 540 m a.s.l.; 14 May 2017; D. Hegg leg.; on tree trunk in native forest; night search + insect net; GenBank: PP155184; MPN CW3506 • 6 ♂♂; same data as for preceding; MPN CW3503 to CW3505, CW5123 to CW5125 • 5 ♀♀; same data as for preceding; MPN CW3507, CW3508, CW5120 to CW5122 • 1 ♂; Governors Bush, Mt Cook Village; 43.73758° S, 170.09640° E; 750 m a.s.l.; 20 Oct 2017; D. Hegg leg.; on twig in native forest; night search + insect net; GenBank:

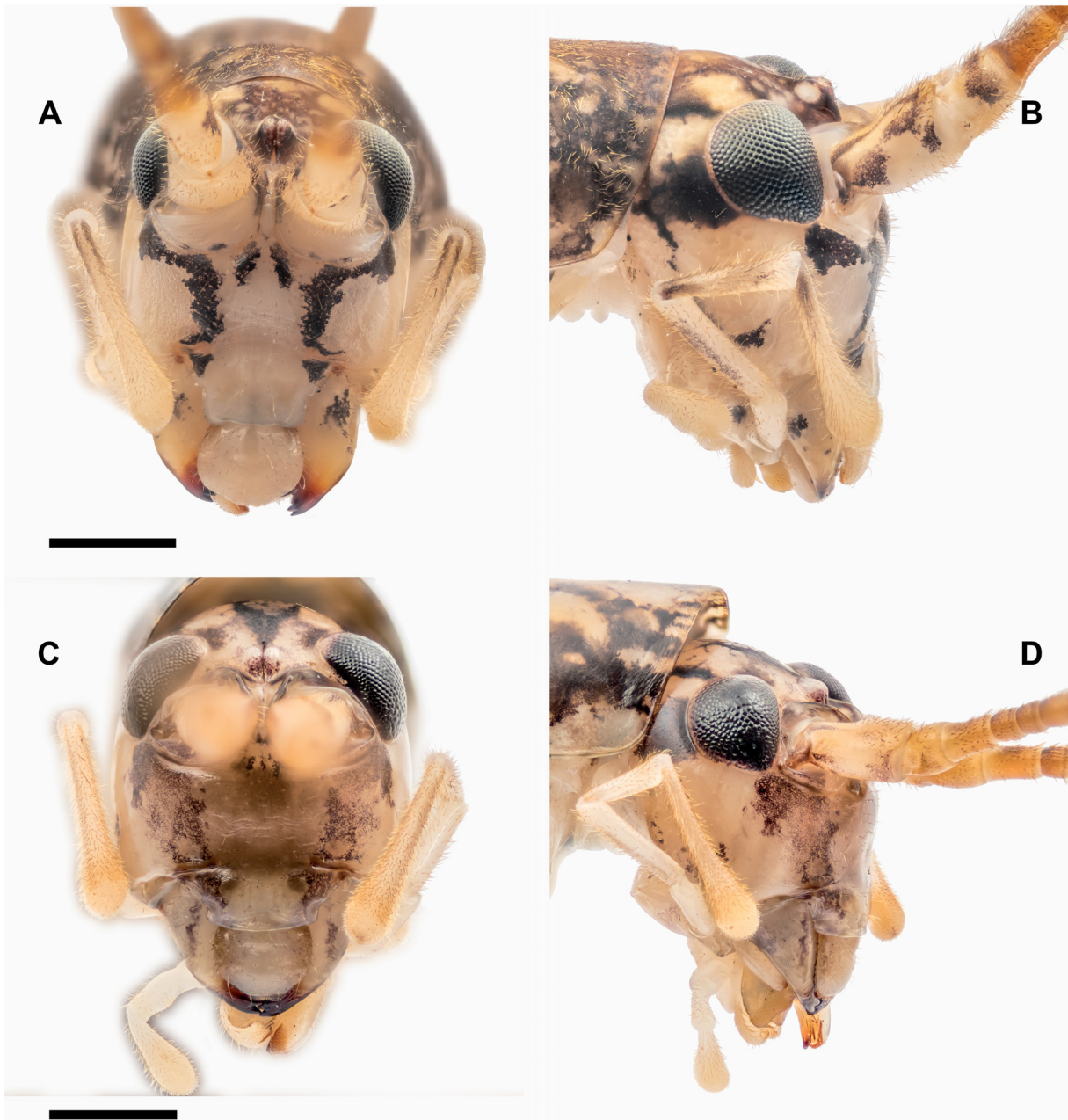


Fig. 11. Head of cave wētā in the genera *Isoplectron* Hutton, 1896 and *Praecantrix* gen. nov., frontal and lateral views. **A–B.** *Isoplectron armatum* Hutton, 1896, adult ♂. Parsons Bush, Lake Ōhau (MPN CW5123). **C–D.** *Praecantrix silvatica* gen. et sp. nov., adult ♀. Mt Arthur Tablelands, Kahurangi National Park (MPN CW4000). Scale bars: 1 mm.

PP155177; MPN CW3617 • 1 ♀; same data as for preceding; GenBank: PP155180; MPN CW3705 • 1 ♂; same data as for preceding; CW4960 • 1 ♂; same data as for preceding; 15 May 2018; D. Hegg leg.; MPN CW4961. – **South Canterbury (SC)** • 1 ♂; Raincliff Reserve, Ōpihi River; 44.16157° S, 170.99234° E; 150 m a.s.l.; 2 Jul. 2016; D. Hegg leg.; on *Griselinia littoralis* tree trunk; night search + insect net; GenBank: PP155175; MPN CW3112 • 1 ♂, 1 ♀; same data as for preceding; MPN CW3113, CW3114 • 1 ♂; Pioneer Park, Ōpihi River; 44.14562° S, 170.95329° E; 240 m a.s.l.; 27 Nov. 2022; D. Hegg leg.; on tree trunk in native forest; night search + insect net; MPN CW5554 • 4 ♂♂; Otaio Gorge; 44.52335° S, 170.92860° E; 330 m a.s.l.; 18 Mar. 2018; D. Hegg leg.; on tree trunk in native forest; night search + insect net; MPN CW5116 to 5119 • 2 ♀♀; same data as for preceding; MPN CW5114, CW5115 • 1 nymph; same data as for preceding; MPN CW3938 • 2 ♂♂; Peel Forest; 43.89631° S, 171.23491° E; 460 m a.s.l.; 2 Oct. 2020; D. Hegg leg.; on tree trunk in native forest; night search + insect net; MPN CW4965, CW4966 • 2 ♀♀; same data as for preceding; MPN CW4964, CW4967 • 5 ♂♂; Peel Forest; 43.899° S, 171.238° E; 400 m a.s.l.; 24 Feb. 2022; S. Trewick, M. Morgan-Richards and T. Trewick leg.; MPN CW5417, CW5418, CW5421, CW5422, CW5424 • 2 ♀♀; same data as for preceding; MPN CW5419, CW5423 • 1 nymph; same data as for preceding; MPN CW5420. – **Mid Canterbury (MC)** • 1 ♀; Cass Station; 43.033° S, 171.762° E; 600 m a.s.l.; 26 Feb. 2006; J. Whitfield leg.; GenBank: PP155172; MPN CW325 • 1 ♀; same data as for preceding; MPN CW326 • 1 ♀, 1 nymph; Wainui, Banks Peninsula; 43.817° S, 172.903° E; 20 m a.s.l.; 30 Nov. 2012; B. Taylor-Smith and M. Morgan-Richards leg.; night search; GenBank: PP155173, PP155174; MPN CW2135, CW2195 • 1 ♀; Hinewai Reserve, Banks Peninsula; 43.81489° S, 173.02740° E; 300 m a.s.l.; 22 Sep. 2018; D. Hegg leg.; on tree branch in native forest; night search + insect net; MPN CW4924 • 1 ♂; Hamilton Hut, Harper River; 43.12903° S, 171.62762° E; 800 m a.s.l.; 12 Sep. 2020; D. Hegg leg.; on tree trunk in native forest; night search + insect net; MPN CW4963. – **North Canterbury (NC)** • 1 ♀, holotype of *I. calcaratum*; Eyreton, Canterbury; 43.4° S, 172.5° E; 50 m a.s.l.; 1896 or earlier; F.W. Hutton leg.; CMNZ 2021.17.6 • 2 ♀♀; Tiromoana Bush Walk, Waipara; 43.09185° S, 172.85077° E; 220 m a.s.l.; 27 Sep. 2018; D. Hegg leg.; on clay bank on side of track; night search + insect net; MPN CW4925, CW4926 • 1 ♀; Tweedies Gully, Gore Bay; 42.86225° S, 173.30737° E; 20 m a.s.l.; 7 Apr. 2018; D. Hegg leg.; in blackberry shrub; night search + insect net; GenBank: PP155183; MPN CW3933. – **Kaikōura (KA)** • 1 ♂; Mt Fyffe Track, Kaikōura; 42.349° S, 173.571° E; 300 m a.s.l.; 17 Jan. 2006; J. Goldberg leg.; GenBank: PP155169; MPN CW391 • 1 ♀; same data as for preceding; MPN CW390 • 1 ♂; Hinau Track, Kaikōura; 42.34977° S, 173.56725° E; 200 m a.s.l.; 28 Mar. 2016; D. Hegg leg.; on tree trunk in native forest; night search + insect net; GenBank: PP155171; MPN CW2874 • 1 ♀; same data as for preceding; GenBank: PP155170; MPN CW2873 • 3 ♂♂; same data as for preceding; MPN CW2875 to CW2877 • 1 ♀; same data as for preceding; MPN CW2878 • 1 nymph; same data as for preceding; Jan. 2017; MPN CW3451 • 1 ♂; same data as for preceding; 3 Jul. 2020; MPN CW4934 • 2 ♀♀; same data as for preceding; MPN CW4939, CW4940 • 1 ♂; Kaiterau Trail, Kaikōura; 42.34121° S, 173.56832° E; 560 m a.s.l.; 4 Jul. 2020; D. Hegg leg.; on tree trunk in native forest; night search + insect net; MPN CW4938 • 3 ♀♀; same data as for preceding; MPN CW4935 to CW4937 • 1 ♂; Puhī Puhī Bush, Kaikōura; 42.27014° S, 173.73771° E; 160 m a.s.l.; 15 Oct. 2020; D. Hegg leg.; on tree trunk in native forest; night search + insect net; MPN CW5156 • 1 nymph; Kahutara Saddle, Seaward Kaikōura Range; 42.32241° S, 173.42870° E; 1200 m a.s.l.; 1 Apr. 2017; D. Hegg leg.; on clay bank on side of track; night search + insect net; GenBank: PP155179; MPN CW3452. – **Marlborough (MB)** • 1 ♂; Renwick, Wairau Valley; 41.52725° S, 173.84760° E; 50 m a.s.l.; 28 Sep. 2018; D. Hegg leg.; on tree trunk near river; night search + insect net; MPN CW4942 • 1 ♀; same data as for preceding; MPN CW4943 • 1 ♂; Renwick, Wairau Valley; 41.51304° S, 173.83856° E; 50 m a.s.l.; 5 Oct. 2018; S. Trewick and M. Morgan-Richards leg.; MPN CW4296 • 1 ♀; same data as for preceding; MPN CW4297 • 7 ♂♂; Southerland Stream Track, Blenheim; 41.54806° S, 173.96524° E; 60 m a.s.l.; 5 Oct. 2018; S. Trewick and M. Morgan-Richards leg.; MPN CW4298, CW4299, CW4301 to CW4303, CW4308, CW4309 • 5 ♀♀; same data as for preceding; MPN CW4300, CW4304 to CW4307 • 1 ♂; Waihopai River, Wairau

Valley; 41.52456° S, 173.73504° E; 80 m a.s.l.; 19 Oct. 2018; D. Hegg leg.; on tree trunk near river; night search + insect net; MPN CW4941.

Description

MEASUREMENTS. See Table 1. No sexual dimorphism in body length.

HEAD. As per generic description. Vertex mottled brown with pale patches. Black streaks run from the posterior margin of each eye to the pronotum, resembling the temples in a pair of sun-glasses. Frons pale, with dark vertical stripes below the scapes of the antennae. Scapes and pedicels of antennae pale with thin brown streaks. All other segments of the antennae are reddish (Fig. 11A–B).

THORAX. As per generic description. The most typical coloration is a mottled dark brown with pale patches on the mesonotum and/or the metanotum (Figs 12A, 21A). A narrow pale dorsal stripe (Fig. 21B) or a broad pale dorsal band (Fig. 21C) running across all three thoracic segments is also commonly seen.

LEGS. Fore and mid femora approximately half as long as body. Hind tibiae same length as body in males, 15% shorter in females. Fore femora always unarmed at the apex. Mid femora armed with one retrolateral spine at the apex; prolateral apical spine absent. Hind femora armed with one to three retrolateral ventral linear spines; one of these very conspicuous, weakly curved (Fig. 4A–C). This spine is present in both males and females, but is much larger and more pronounced in males. Up to two prolateral ventral linear spines are present on occasion but are much smaller. Fore tibiae armed with two pairs of ventral linear spines, and with one pair of ventral apical spines. Mid tibiae armed with two pairs of ventral linear spines, one pair of ventral spines and one retrolateral dorsal spine at the apex. A prolateral dorsal spine at the apex of the mid tibia is always absent. Up to two retrolateral dorsal linear spines on the mid tibiae may be present but only rarely. Hind tibiae armed with about 15 dorsal linear spines (min 11, max 20) on both the anterior and the posterior edge (Fig. 13A). Hind tibiae armed at the apex with two ventral sub-apical spines, two ventral apical spines, two dorsal apical spines and two dorsal sub-apical spines. The dorsal apical spines are always largest, whereas the ventral sub-apical spines are smallest. First and second segments in hind tarsi always unarmed except at the apex.

ABDOMEN. Typically mottled dark brown (Figs 12A, 21A), occasionally with pale dorsal spots on the sides of the first tergite. Colour morphs with a pale diamond on the back (Fig. 21B) or a pale longitudinal band (Fig. 21C) are also commonly encountered.

MALE TERMINALIA. Subgenital plate with central lobe three times as long as lateral lobes, covered with sparse, short setae at the apex, and with a visible keel at the centre (Fig. 4D–F). The subgenital plate's central lobe is visibly folded upwards on the sides near the apex (Fig. 14A). Cerci on average one quarter of body length, covered in long hairs; tapering gradually along their whole length and ending with a blunt tip at the apex. Styli slender, covered in sparse setae, reaching to the apex of the subgenital plate. Paraprocts covered in dense, stout spinules at the apex; short and always contained entirely within the perimeter of the subgenital plate both in length and in width (Fig. 14A). The paraprocts are therefore never visible from below (Fig. 14B).

FEMALE TERMINALIA. Subgenital plate consists of two small, rounded, asymmetrical lobes, covered by sparse hair at the apex; the two lobes separated by a small gap and not touching at the vertex (Figs 4G–I, 17A). Ovipositor on average three quarters of body length, relatively straight in the basal half, tapering and moderately recurved upwards in the apical half. Lower valve of ovipositor with 6 to 8 teeth below at the apex. Dorsal surface of upper valve finely serrated in distal half (Fig. 17B–C).

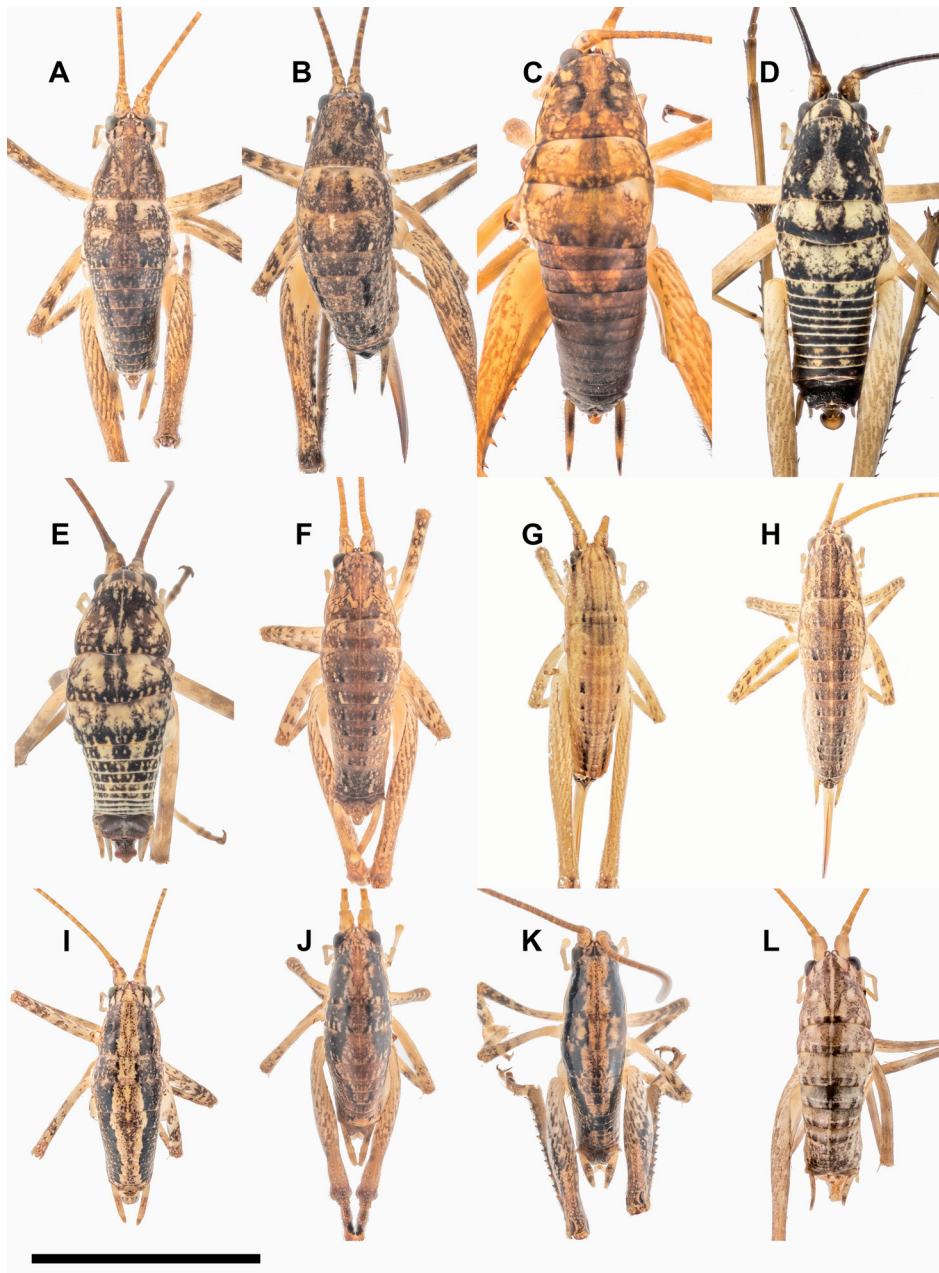


Fig. 12. Dorsal view of cave wētā in the genera *Isoplectron* Hutton, 1896 and *Praecantrix* gen. nov. **A–I.** *Isoplectron*. **A.** *I. armatum armatum* Hutton, 1896, adult ♂. Parsons Bush, Lake Ōhau (MPN CW5123). **B.** *I. armatum aciculatum* Karny, 1937, adult ♀. Ohakune (MPN CW5644). **C.** *I. bicolor* sp. nov., adult ♂. Mt Arthur Tablelands (MPN CW3760). **D.** *I. serratum* (Richards, 1972) comb. nov., adult ♂. The Gap, Torlesse Range (MPN CW3182). **E.** *I. maculatum* sp. nov., holotype, adult ♂. Middle Mt Peel, South Canterbury (NMNZ AI.071892). **F.** *I. ferratum* sp. nov., holotype, adult ♂. Cave Brook, Goulund Downs (NMNZ AI.071896). **G.** *I. virgatum* sp. nov., adult ♀. Cave Brook, Goulund Downs (MPN CW3794). **H.** *I. parallellum* sp. nov., adult ♀. Ahumairangi Town Belt, Wellington (MPN CW5598). **I.** *I. pallidum* (Richards, 1972) comb. nov., adult ♂. Mt Kyeburn, Danseys Pass (MPN CW3456). **J–L.** *Praecantrix*. **J.** *P. silvatica silvatica* gen., sp. et subsp. nov., adult ♂. Mt Arthur Hut (MPN CW5390). **K.** *P. silvatica lutea* gen., sp. et subsp. nov., adult ♂. Peel Forest (MPN CW4968). **L.** *P. saxicola* gen et sp. nov., holotype, adult ♂. Mt Wakefield (NMNZ AI.071904). Scale bar: 10 mm.

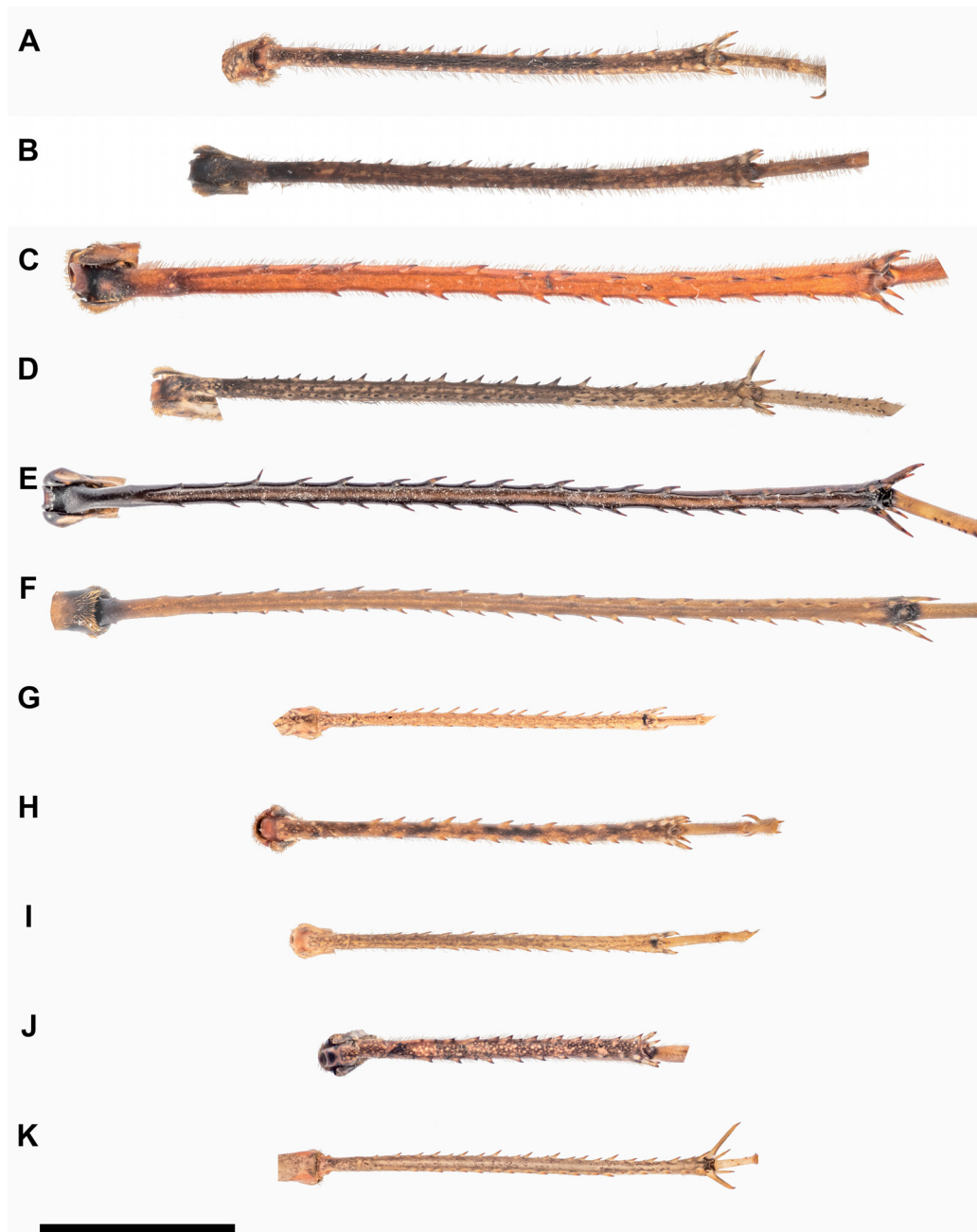


Fig. 13. Left hind tibia of cave wētā in the genera *Isoplectron* Hutton, 1896 and *Praecantrix* gen. nov., adult ♂, dorsal view. **A–I.** *Isoplectron*. **A.** *I. armatum armatum* Hutton, 1896. Parsons Bush, Lake Ōhau (MPN CW5123). **B.** *I. armatum aciculatum* Karny, 1937. Ohakune (MPN CW 5646). **C.** *I. bicolor* sp. nov., holotype. Cave Brook, Gouland Downs (NMNZ AI.071889). **D.** *I. pallidum* (Richards, 1972) comb. nov. Duffers Saddle, Old Woman Range (MPN CW5385). **E.** *I. serratum* (Richards, 1972) comb. nov. The Gap, Torlesse Range (MPN CW3182). **F.** *I. maculatum* sp. nov., holotype. Middle Mt Peel, South Canterbury (NMNZ AI.071892). **G.** *I. virgatum* sp. nov. Cave Brook, Gouland Downs (MPN CW3776). **H.** *I. ferratum* sp. nov., holotype. Cave Brook, Gouland Downs (NMNZ AI.071896). **I.** *I. parallelum* sp. nov. Ahumairangi Town Belt, Wellington (MPN CW5569). **J–K.** *Praecantrix* **J.** *P. silvatica lutea* gen., sp. et subsp. nov. McLean Falls, Catlins Forest (MPN CW3901). **K.** *P. saxicola* gen et sp. nov., holotype. Mt Wakefield (NMNZ AI.071904). Scale bar: 5 mm.

Distribution and habitat

Isoplectron armatum is an arboreal cave wētā, common and widespread in dry forests in New Zealand's South Island from Southland to the Marlborough Sounds (Fig. 10A). It is frequently encountered in urban parks and gardens. It is most easily found hiding under bark on tree trunks, often in groups of up to ten individuals; also in artificial wētā motels (Bowie *et al.* 2006; pers. obs.).

Isoplectron armatum aciculatum Karny, 1937
Figs 3, 5, 8, 10A, 12B, 13B, 14D–F, 17D–F, 21D

Isoplectron aciculatum Karny, 1937: 230.

Isoplectron calcaratum – Hutton 1896: pl. XIII fig. 19a.

Diagnosis

Morphologically very similar to *Isoplectron armatum armatum*, it can only be differentiated from the latter by examination of the adult male terminalia or by DNA analysis. Other minor differences between the two subspecies are a larger body size and longer legs in *I. a. aciculatum* (see Table 1), and frequently (but not always) an additional spine on both the prolateral and retrolateral inferior edges of the hind femur in the northern subspecies. The two subspecies, however, are allopatric, *I. a. aciculatum* being confined to the southern regions of New Zealand's North Island, between Wellington, Tongariro and Gisborne, whereas *I. a. armatum* is only found in South Island.

Isoplectron armatum aciculatum could be confused with several species in the genus *Neonetus*; it is most easily differentiated from these by the slender, elongated shape of the hind femora, which are armed with a prominent spine underneath, and by the absence of a prolateral spine at the apex of the fore and mid femora.

Etymology

The Latin word '*ācīcūla*' translates as 'hair pin'. Named after the shape of the conspicuous spine on the retrolateral inferior edge of the hind femur in adult males.

Material examined (see also Supp. file 1: Table S2)

Holotype

NEW ZEALAND • ♂, adult; Wellington (WN), Wellington; 41.3° S, 174.8° E; 1903 or earlier; G.V. Hudson leg.; OUMNH ENT-ORTH097.

Representative female

NEW ZEALAND • ♀, adult; Hawke's Bay (HB), Mohi Bush Reserve; 39.85485° S, 176.89542° E; 450 m a.s.l.; 10 May 2023; D. Hegg leg.; on tree trunk in native forest; night search + insect net; NMNZ AI.071888.

Other material

NEW ZEALAND – **Wellington (WN)** • 1 ♂ subadult, paratype of *I. calcaratum*; Wellington; 41.3° S, 174.8° E; 1896 or earlier; F.W. Hutton leg.; CMNZ 2021.17.7 • 1 ♀; Ahumairangi Town Belt, Wellington; 41.26896° S, 174.76929° E; 250 m a.s.l.; 9 Apr. 2022; D. Hegg leg.; in *Veronica* shrub; night search + insect net; MPN CW5606 • 1 ♀; Queen Elizabeth II Park, Paekākāriki; 40.96758° S, 174.97745° E; 40 m a.s.l.; 10 Jul. 2016; J. Nisbet leg.; in wētā motel on tree trunk; Genbank: PP155156; MPN CW3033 • 1 ♂; same data as for preceding; MPN CW3034 • 2 ♀♀; same data as for preceding; MPN CW3029, CW3030 • 2 nymphs; same data as for preceding; MPN CW3031, CW3032 • 1 ♂; Turitea Road, Palmerston North; 40.41496° S, 175.66401° E; 120 m a.s.l.; 28 Aug. 2004; S. Trewick leg.; on

the ground; casual find; MPN CW139 • 1 ♂; same data as for preceding; 3 Apr. 2016; S. Trewick and M. Morgan-Richards leg.; in wētā motel on tree trunk; GenBank: PP155155; MPN CW2869 • 1 ♂; same data as for preceding; MPN CW2868 • 1 ♂; same data as for preceding; 19 Mar. 2017; GenBank: PP155154; MPN CW4625 • 1 ♀; same data as for preceding; GenBank: PP155162; MPN CW4624. – **Wairarapa (WA)** • 1 ♀; Bideford; 40.86653° S, 175.86795° E; 150 m a.s.l.; 18 Sep. 2004; S. Trewick and M. Morgan-Richards leg.; on rotting log; GenBank: PP155159; MPN CW156 • 1 ♂; same data as for preceding; MPN CW154 • 1 ♀; same data as for preceding; MPN CW155. – **Rangitikei (RI)** • 1 ♀; Big Hill Stream Track, Ruahine Range; 39.58789° S, 176.33173° E; 500 m a.s.l.; 2011; M. Lusk leg.; MPN CW1634. – **Hawke's Bay (HB)** • 1 ♂; Cape Sanctuary, Cape Kidnappers; 39.66073° S, 177.04288° E; 160 m a.s.l.; 14 Mar. 2011; M. Lusk leg.; in rifleman nest box; GenBank: PP155161; MPN CW1626 • 1 ♂; same data as for preceding; 16 May 2011; M. Lusk leg.; under kānuka bark; GenBank: PP155158; MPN CW1635 • 1 ♂; same data as for preceding; 14 Jun. 2011; GenBank: PP155157; MPN CW1961 • 2 ♀♀; same data as for preceding; Sep. 2011; MPN CW1809A, CW1809B • 1 ♂; Kuripapango Track, Kaweka Range; 39.380° S, 176.334° E; 500 m a.s.l.; 27 Feb. 2012; M. Lusk leg.; MPN CW1884 • 1 ♀; Lorenbrey, Kahurānaki Rd; 39.8200° S, 176.8465° E; 160 m a.s.l.; Sep. 2011; M. Lusk leg.; MPN CW2075 • 1 ♂; Ngaruroro River terrace; 39.36934° S, 176.32052° E; 520 m a.s.l.; 11 Mar. 2014; M. Lusk leg.; in mānuka/kānuka forest; GenBank: PP155160; MPN CW2657. – **Gisborne (GB)** • 1 ♂; Okitu Bush Scenic Reserve; 38.66506° S, 178.09982° E; 50 m a.s.l.; 9 Mar. 2023; R. Kleinpaste leg.; photograph only; iNaturalist 150680236. – **Taupō (TO)** • 1 ♀; Marshalls Road, Ohakune; 39.39469° S, 175.39605° E; 580 m a.s.l.; 5 Apr. 2023; D. Hegg leg.; on tree trunk on road side; night search + insect net; MPN CW5644 • 1 gynandromorph; same data as for preceding; 7 May 2023; GenBank: PP155165; MPN CW5645 • 1 ♂; same data as for holotype; 12–14 May 2023; in wētā motel; GenBank: PP155167; MPN CW5647 • 1 ♀; same data as for preceding; GenBank: PP155166; MPN CW5648 • 1 ♀; same data as for preceding; GenBank: PP155168; MPN CW5649 • 1 ♀; same data as for preceding; GenBank: PP155164; MPN CW5650 • 1 ♂; Marshalls Road, Ohakune; 39.39518° S, 175.39726° E; 580 m a.s.l.; 13 May 2023; D. Hegg leg.; on tree trunk on road side; night search + insect net; GenBank: PP155163; MPN CW5646.

Description

MEASUREMENTS. See Table 1. No sexual dimorphism in body length.

HEAD. Same as in *Isoplectron a. armatum*.

THORAX. Same as in *Isoplectron a. armatum* (Fig. 12B).

LEGS. Same as in *Isoplectron a. armatum*, only longer (see Table 1). Hind femora most frequently armed with three retrolateral ventral linear spines; one of these very conspicuous, weakly curved. This spine is present in both males and females, but is much larger and more pronounced in males. Two prolateral ventral linear spines are generally also present but are much smaller.

ABDOMEN. Mottled dark brown, with pale dorsal spots on the sides of the first tergite (Figs 12B, 21D). Colour morphs with a pale diamond on the back or a pale longitudinal band are also commonly encountered.

MALE TERMINALIA. Subgenital plate similar to that in *Isoplectron a. armatum*, but glabrous at apex, and with a much wider keel (Fig. 14E); also shallower and not as strongly folded upwards at the edges, meaning that from the sides one can see through the gap between the subgenital plate and the paraprocts (Fig. 14F). Cerci one quarter of body length, covered in long hairs; tapering gradually along their whole length and ending with a blunt tip at the apex. Styli slender, covered in sparse setae, reaching to the apex of the subgenital plate. Paraprocts covered in dense, stout spinules at the apex; short but wide and



Fig. 14. Adult male terminalia of cave wētā in the genus *Isoplectron* Hutton, 1896. Left column: dorsal view; central column: ventral view (subgenital plate); right column: lateral view. **A–C.** *I. armatum armatum* Hutton, 1896. **A–B.** Kaiterau Trail, Kaikōura (MPN CW4938). **C.** Pioneer Park, Ōpihi River (MPN CW5554). **D–F.** *I. armatum aciculatum* Karny, 1937. Ohakune. **D.** MPN CW5647. **E–F.** MPN CW5646. **G–I.** *I. bicolor* sp. nov., Cave Brook, Goulund Downs. **G–H.** Holotype (NMNZ AI.071889). **I.** MPN CW3758. **J–L.** *I. pallidum* (Richards, 1972) comb. nov. **J, L.** Staircase Hut track, Waianakarua River (NMNZ AI.071891). **K.** Mt Kyeburn, Danseys Pass (MPN CW3455). Scale bars: 1 mm.

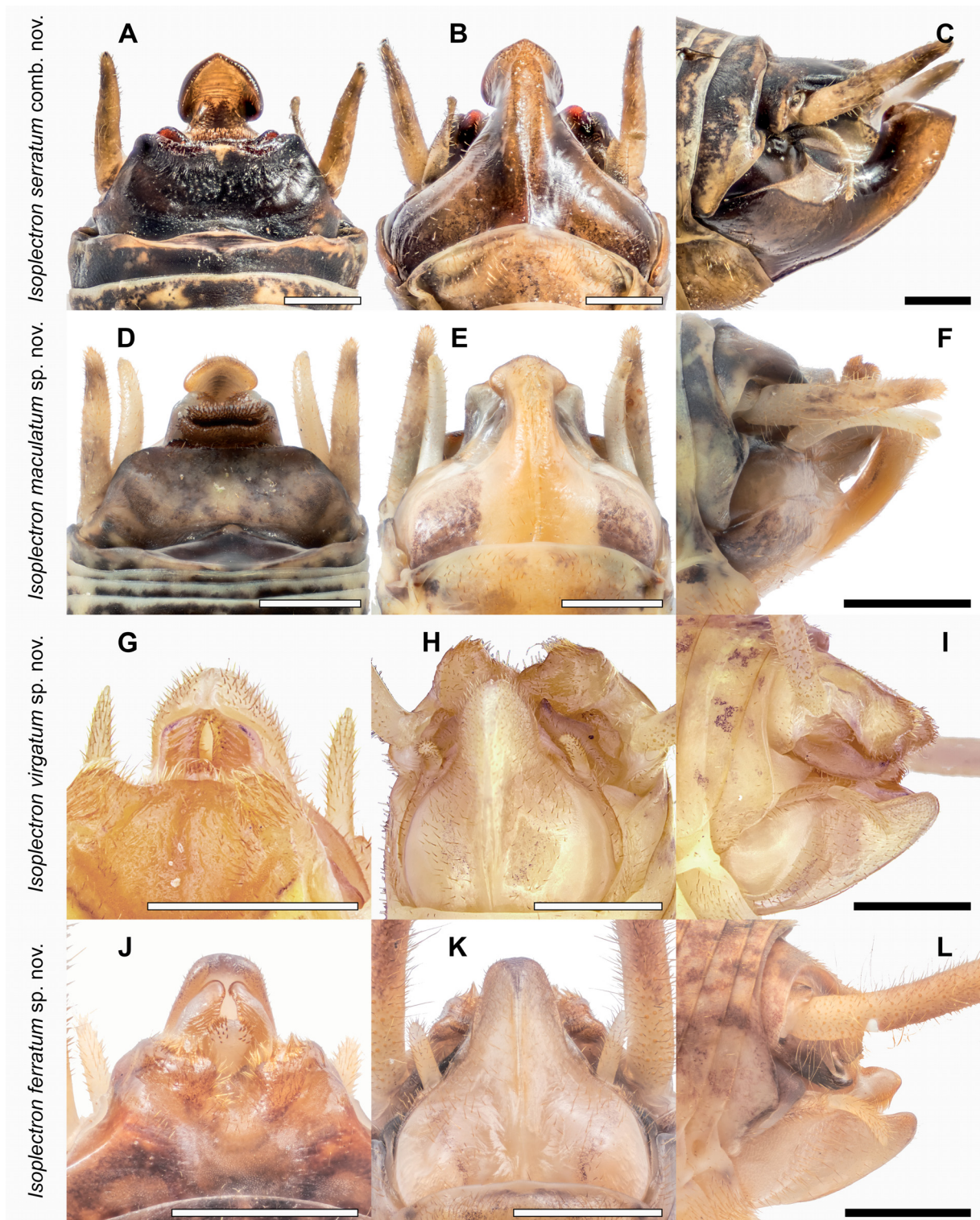


Fig. 15. Adult male terminalia of cave wētā in the genus *Isoplectron* Hutton, 1896. Left column: dorsal view; central column: ventral view (subgenital plate); right column: lateral view. **A–C.** *I. serratum* (Richards, 1972) comb. nov. The Gap, Torlesse Range (MPN CW3182). **D–F.** *I. maculatum* sp. nov., Middle Mount Peel, South Canterbury. **D–E.** MPN CW5638. **F.** MPN CW5640. **G–I.** *I. virgatum* sp. nov., Heaphy River, Kahurangi NP (MPN CW5622). **J–L.** *I. ferratum* sp. nov., Cave Brook, Goulund Downs, Kahurangi NP. **J–K.** Holotype (NMNZ AI.071896). **L.** MPN CW4953. Scale bars: 1 mm.

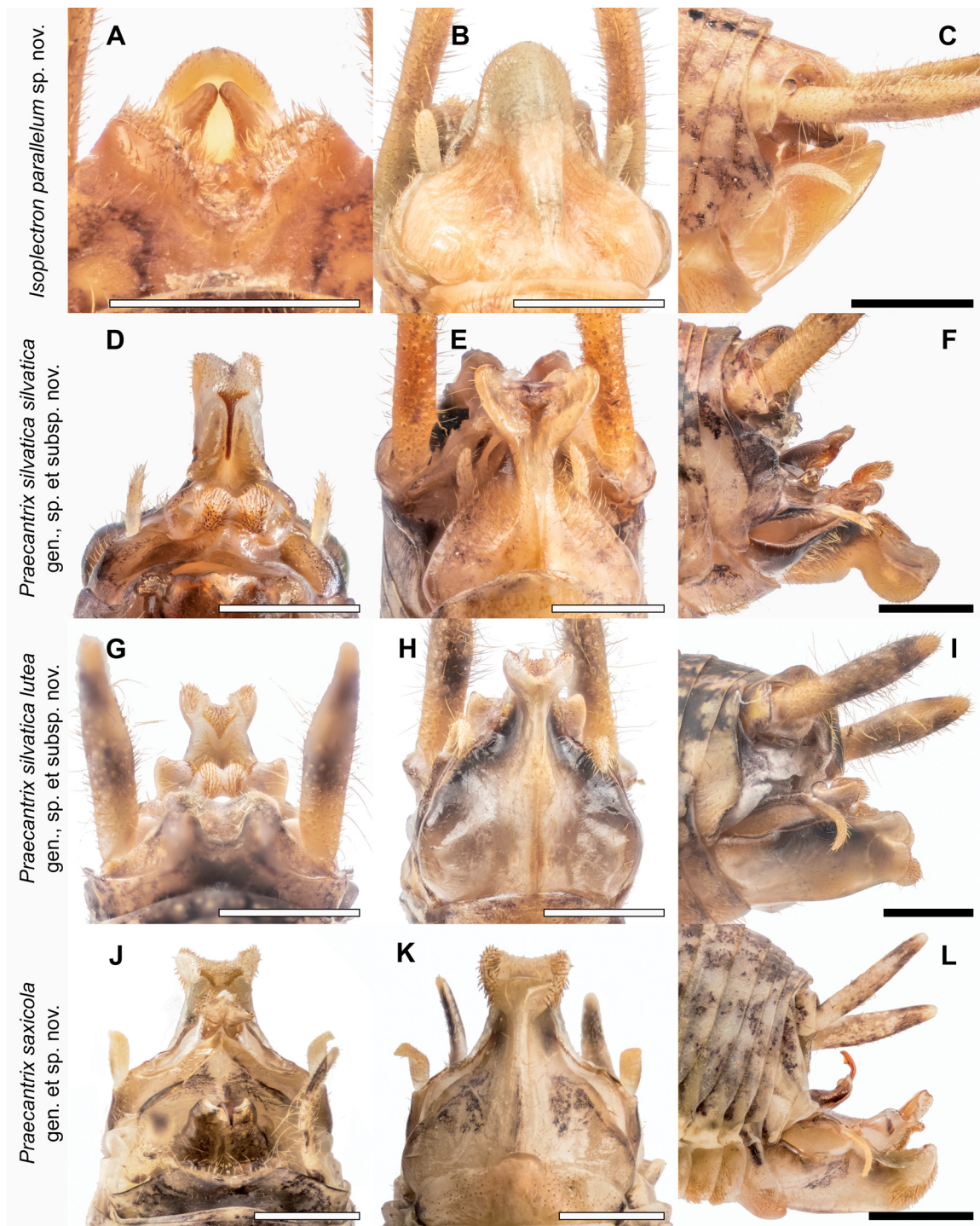


Fig. 16. Adult male terminalia of cave wētā in the genera *Isoplectron* Hutton, 1896 and *Praecantrix* gen. nov. Left column: dorsal view; central column: ventral view (subgenital plate); right column: lateral view. **A–C.** *Isoplectron parallelum* sp. nov., holotype. Ahumairangi Town Belt, Wellington (NMNZ AI.071898). **D–F.** *Praecantrix silvatica silvatica* gen., sp. et subsp. nov. **D, F.** Holotype. Mt Arthur Tablelands, Kahurangi NP (NMNZ AI.071900). **E.** Richmond Saddle, Marlborough (MPN CW4136). **G–I.** *Praecantrix silvatica lutea* gen., sp. et subsp. nov., holotype. McLean Falls, Catlins Forest (NMNZ AI.071902). **J–L.** *Praecantrix saxicola* gen. et sp. nov., holotype. Mt Wakefield, Aoraki/Mt Cook NP (NMNZ AI.071904). Scale bars: 1 mm.

protruding beyond the perimeter of the subgenital plate on the sides (Fig. 14D), visible from below (Fig. 14E).

FEMALE TERMINALIA. Subgenital plate consists of two small, rounded, asymmetrical lobes, covered by sparse hair at the apex; the two lobes separated by a small gap and not touching at the vertex (Figs 17D). Ovipositor same as in *Isoplectron a. armatum* (Fig. 17E–F).

Isoplectron bicolor sp. nov.

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Figs 3, 8, 10E, 12C, 13C, 14G–I, 17G–I, 21E–F

Diagnosis

The largest species in the genus *Isoplectron*; in the adult form, it is unmistakable due to its characteristic coloration, with tawny head, thorax, fore and mid legs and hind femora, which contrast with the near black abdomen and hind tibiae (Fig. 21E). Nymphs could be easily mistaken for those of *I. ferratum* sp. nov., with which it is sympatric, and with *I. armatum*. The latter species however is not found within the distribution range of *I. bicolor* sp. nov.

Etymology

‘*Bīcōlor*’ (adj.) is Latin for ‘two-coloured’ – because of the unique contrasting coloration, tawny in the front and black in the back.

Material examined (see also Supp. file 1: Table S3)

Holotype

NEW ZEALAND • ♂, adult; Nelson (NN), Cave Brook, Goulund Downs; 40.89153° S, 172.35449° E; 620 m a.s.l.; 4 Feb. 2018; D. Hegg leg.; on tree trunk; night search + insect net; NMNZ AI.071889.

Paratype

NEW ZEALAND • 1 ♀, adult; Nelson (NN), Chaffey Hut, Cobb River; 41.09600° S, 172.57535° E; 880 m a.s.l.; 26 Dec. 2020; D. Hegg leg.; on tree trunk; night search + insect net; NMNZ AI.071890.

Other material

NEW ZEALAND – **Buller (BR)** • 1 ♀; Nina Hut, Nina Valley; 42.46573° S, 172.32202° E; 760 m a.s.l.; 15 Mar 2015; in sink outside hut; photograph only; iNaturalist 1909084. – **Nelson (NN)** • 1 nymph; same data as for holotype; 20 Apr. 2016; GenBank: PP155151; MPN CW2991 • 1 ♂; same data as for holotype; GenBank: PP155152; MPN CW3758 • 1 ♂; Mt Arthur Tablelands; 41.18500° S, 172.64370° E; 1180 m a.s.l.; 8 Feb. 2018; D. Hegg leg.; in beech tree canopy; night search + insect net; GenBank: PP155153; MPN CW3760 • 1 ♂; same data as for preceding; 24 Dec. 2020; MPN CW5346 • 3 nymphs; same data as for paratype; MPN CW5195, CW5197, CW5198 • 1 ♂; same data as for paratype; 5 Jan. 2022; MPN CW5357.

Description

MEASUREMENTS. See Table 1. The only female collected has a body longer than any of the examined males by two to six millimetres.

HEAD. As per generic description. Vertex tawny with dark streaks. A dark patch extends behind the posterior margin of the eye. Frons pale, with dark vertical stripes below the scapes of the antennae. Scapes of antennae tawny. All other segments of the antennae are reddish.

THORAX. Pronotum, mesonotum and metanotum tawny with complex dark pattern (Fig. 12C).

LEGS. All leg segments are tawny, except for the hind tibiae, which are near black in adults. Hind tibiae of same length as body in females, up to 50% longer than body in males. Fore femora always unarmed at the apex. Mid femora armed with one retrolateral spine at the apex; prolateral apical spine absent. Hind femora armed with nine to seventeen prolateral ventral linear spines, very small, and four to eight strong retrolateral ventral linear spines. Fore tibiae armed with two pairs of ventral linear spines, and with one pair of ventral apical spines. Mid tibiae armed with two pairs of ventral linear spines, one pair of ventral spines and one retrolateral dorsal spine at the apex. A prolateral dorsal spine at the apex of

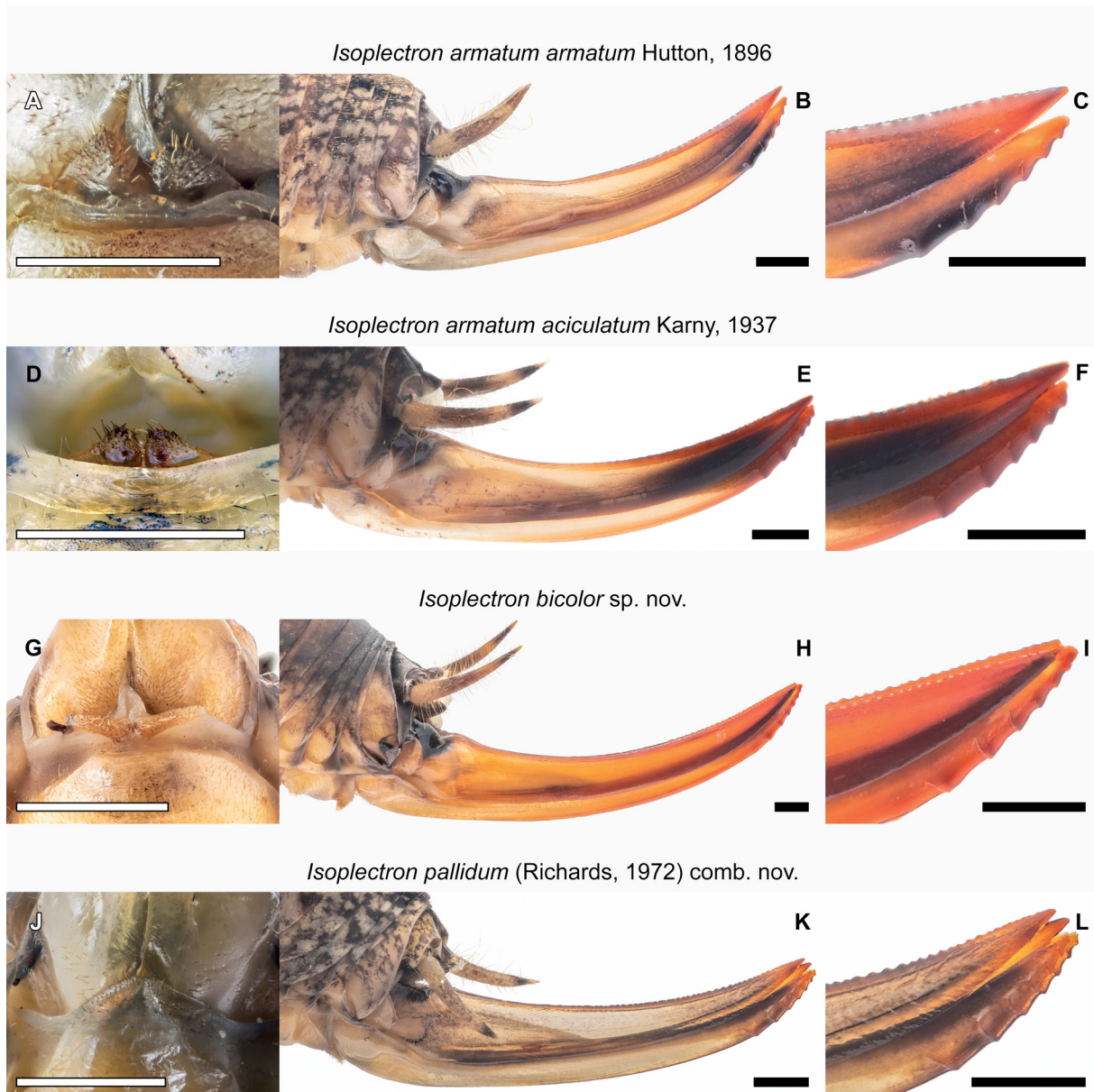


Fig. 17. Adult female terminalia of cave wētā in the genus *Isoplectron* Hutton, 1896. Left column: subgenital plate; central and right columns: ovipositor. A–C. *Isoplectron armatum armatum* Hutton, 1896. South Mavora Lake (MPN CW4927). D–F. *I. armatum aciculatum* Karny, 1937. Ohakune. D. MPN CW5648. E–F. MPN CW5650. G–I. *I. bicolor* sp. nov., paratype (NMNZ AI.071890). Chaffey Hut, Cobb River. J–L. *I. pallidum* (Richards, 1972) comb. nov. Duffers Saddle, Old Woman Range (MPN CW5387). Scale bars: 1 mm.

the mid tibia is always absent. Hind tibiae armed with 12 to 16 dorsal linear spines on both the anterior and the posterior edge (Fig. 13C). Hind tibiae armed at the apex with two ventral sub-apical spines, two ventral apical spines, two dorsal apical spines and two dorsal sub-apical spines. The dorsal apical spines are always largest, whereas the ventral sub-apical spines are smallest. First hind tarsal segment occasionally armed with a few dorsal linear spines. Second tarsal segment unarmed except at the apex.

ABDOMEN. Typically dark, near black in adults, although a tawny diamond may extend from the thorax into the first few tergites (Figs 12C, 21E). Nymphs often have a diamond pattern on the back (Fig. 21F).

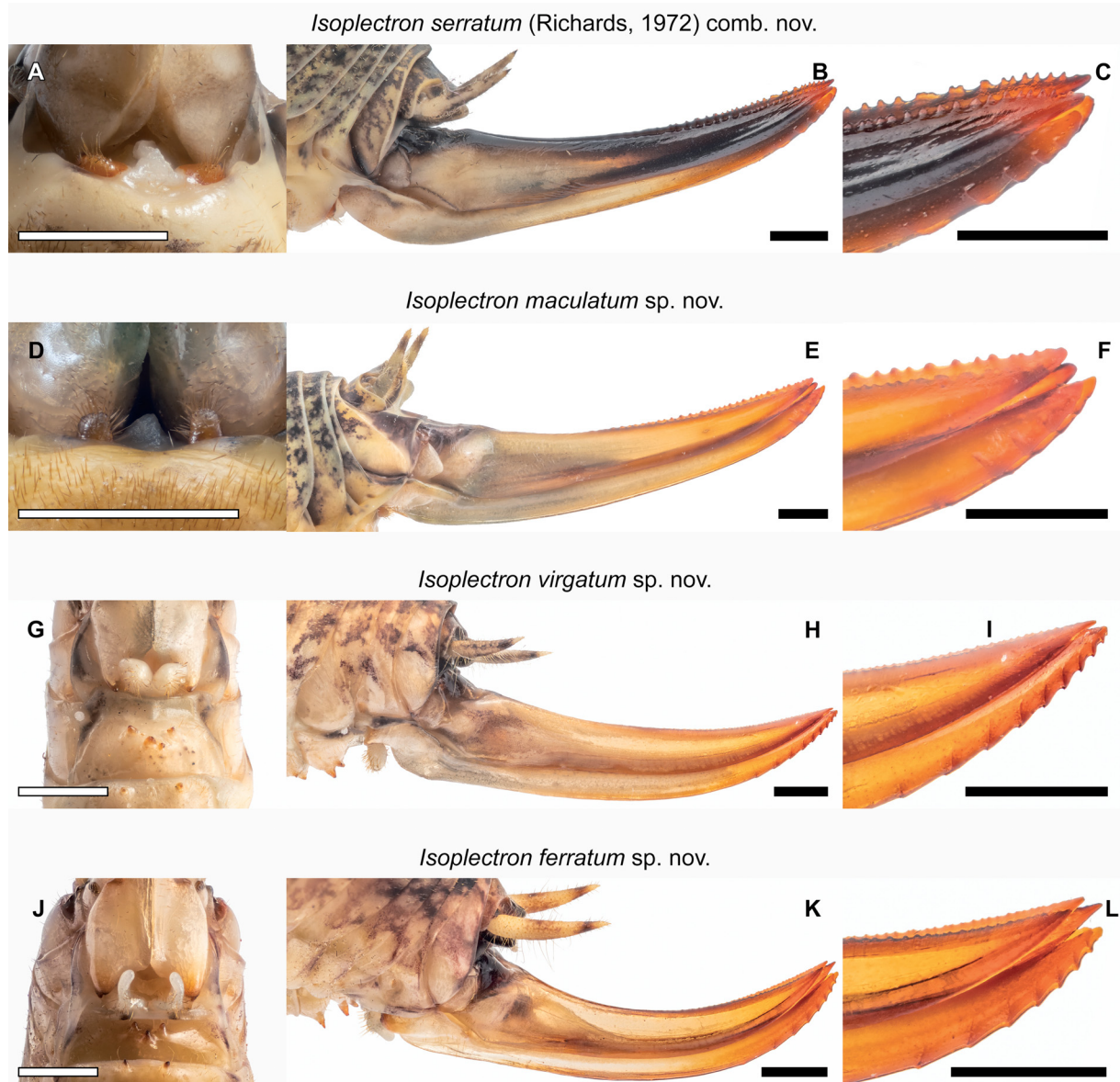


Fig. 18. Adult female terminalia of cave wētā in the genus *Isoplectron* Hutton, 1896. Left column: subgenital plate; central and right columns: ovipositor. **A–C.** *Isoplectron serratum* (Richards, 1972). Kahutara Saddle, Seaward Kaikōura Range (MPN CW5555). **D–F.** *I. maculatum* sp. nov. Middle Mount Peel, South Canterbury (MPN CW5642). **G–I.** *I. virgatum* sp. nov., paratype. Ces Clarke Hut, Papanoa Range (NMNZ AI.071895). **J–L.** *I. ferratum* sp. nov., paratype. Mt Stokes, Marlborough Sounds (NMNZ AI.071897). Scale bars: 1 mm.

MALE TERMINALIA. Subgenital plate with central lobe at least twice as long as lateral lobes, glabrous, with visible keel at centre (Fig. 14H). Cerci with alternating tawny and dark bands; on average one quarter of body length; covered in long hairs; tapering gradually along their whole length and ending with a blunt tip at the apex. Styli slender, covered in sparse setae, extending beyond the apex of the subgenital plate. Paraprocts with pronounced lateral lobes at the apex, which is covered in dense, stout spinules

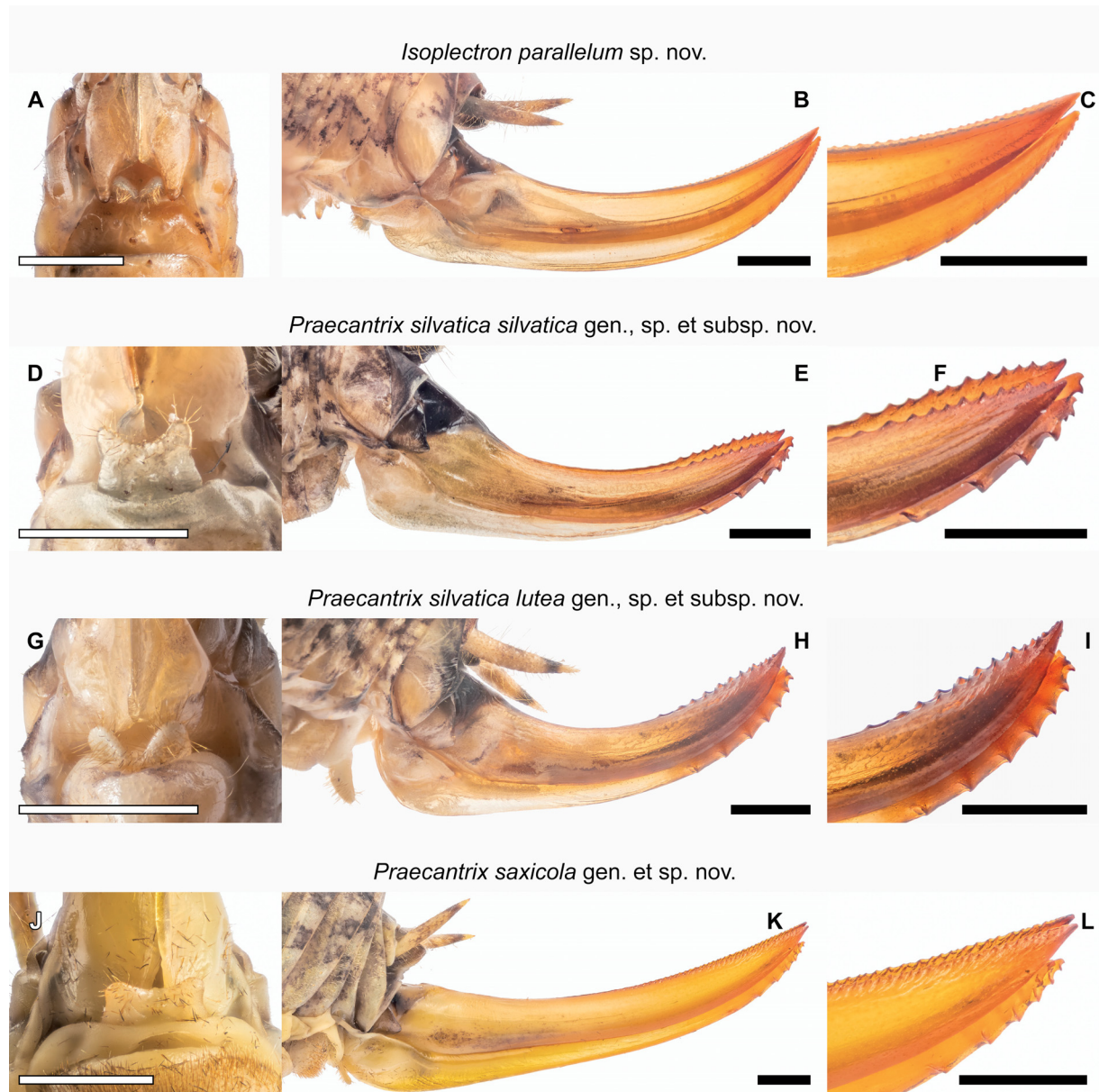


Fig. 19. Adult female terminalia of cave wētā in the genera *Isoplectron* Hutton, 1896 and *Praecantrix* gen. nov. Left column: subgenital plate; central and right columns: ovipositor. **A–C.** *Isoplectron parallelum* sp. nov., paratype. Ahumairangi Town Belt, Wellington (NMNZ AI.071899). **D–F.** *Praecantrix silvatica silvatica* gen., sp. et subsp. nov. **D.** Paratype. Smoothwater Bay, South Westland (NMNZ AI.071901). **E–F.** Aspiring Hut, Mt Aspiring NP (MPN CW3518). **G–I.** *Praecantrix silvatica lutea* gen., sp. et subsp. nov. **G.** Paratype. Ōpoho, Dunedin (NMNZ AI.071903). **H–I.** McLean Falls, Catlins (MPN CW4946). **J–L.** *Praecantrix saxicola* gen. et sp. nov., paratype. Mt St Bathans, Central Otago (NMNZ AI.071905). Scale bars: 1 mm.

(Fig. 14G). The paraprocts project beyond the apex of the subgenital plate and are therefore visible from below (Fig. 14H).

FEMALE TERMINALIA. Subgenital plate consists of two large, elongated lobes, flat at the vertex, which is covered in short hair (Fig. 17G). Ovipositor three quarters of body length, tapering and curving upwards gradually along its whole length. Lower valve of ovipositor with 6 teeth below at the apex. Dorsal surface of upper valve finely serrated in distal half (Fig. 17H–I).

Distribution and habitat

A cryptic, arboreal insect, confined to the north-west regions of New Zealand's South Island between Lewis Pass and Kahurangi National Park (Fig. 10E). It is believed to live primarily in the tree canopy in native forests.

Isoplectron pallidum (Richards, 1972) comb. nov.
Figs 1A–B, 3, 6, 8, 10H, 12I, 13D, 14J–L, 17J–L, 20A–B, 22A

Setascutum pallidum Richards, 1972: 165–166, fig. 6.1–6.3.

Setascutum pallidum – Hegg *et al.* 2022: 4, fig. 1A.

Diagnosis

The smallest species in the genus *Isoplectron*, *I. pallidum* has a body length between 8 and 13 mm, the hind tibiae slightly longer than the body in males.

Throughout its distribution range, *I. pallidum* is sympatric with *I. armatum* and with *Praecantrix silvatica* gen. et sp. nov.; indeed, we have found all three species on the same tree trunk. Similar in its look to *I. armatum*, *I. pallidum* is most reliably differentiated from the two species listed above by the presence of dorsal linear spines on the first and second hind tarsal segments.

In the Kakanui Mountains and in the St Marys Range in North Otago, *I. pallidum* is also sympatric with *Praecantrix saxicola* gen. et sp. nov. In spite of what the name might suggest, the latter species is in fact the one that is reliably identified by its pale colour. The two species also tend to occupy different microhabitats, with *I. pallidum* most commonly found on rock bluffs, *P. saxicola* among scree. We have, however, found the two species on the same bluff.

Etymology

'*Pallidus*' (adj.) is Latin for 'pale'. Named by Richards (1972) because of the pale coloration of the single specimen she examined. The name is somewhat misleading within this genus.

Material examined (see also Supp. file 1: Table S4 and Fig. S6)

Holotype

NEW ZEALAND • ♀, adult; Central Otago (CO), Duffers Saddle, Old Woman Range; 45.1689° S, 169.0757° E; 1250 m a.s.l.; 12 Sep. 1968; J.S. Dugdale leg.; in crevice on rock tor; NZAC 03015582.

Representative male

NEW ZEALAND • ♂, adult; Dunedin (DN), Staircase Hut track, Waianakarua River; 45.28210° S, 170.69724° E; 400 m a.s.l.; 3 Sep. 2016; D. Hegg leg.; on tree trunk; night search; NMNZ AI.071891.

Other material

NEW ZEALAND – Dunedin (DN) • 1 ♀; same data as for representative male; GenBank: PP155125; MPN CW3163 • 1 ♀; Mt Cargill, Dunedin; 45.81242° S, 170.55488° E; 620 m a.s.l.; 22 Nov. 2016;

D. Hegg leg.; on rocky outcrop; night search; GenBank: PP155123; MPN CW3448 • 1 ♂; same data as for preceding; MPN CW5605 • 1 ♀; same data as for preceding; MPN CW5604. – **Central Otago (CO)** • 1 ♂; same data as for holotype; 26 Nov. 2016; D. Hegg leg.; in crevice on rock tor; night search + insect net; GenBank: PP155122; MPN CW3486 • 1 ♂; same data as for holotype; MPN CW3488 • 1 ♀; same data as for preceding; MPN CW3487 • 2 nymphs; same data as for preceding; MPN CW3458, CW3485 • 4 ♂♂; same data as for preceding; 7 May 2017; MPN CW5384 to CW5387 • 3 ♀♀; same data as for preceding; MPN CW3439 to CW3441 • 1 nymph; same data as for preceding; MPN CW3442 • 1 ♂; Nevis Road; 45.16186° S, 169.10122° E; 1120 m a.s.l.; 26 Nov. 2016; D. Hegg leg.; in crevice on rock tor; night search + insect net; MPN CW5383 • 1 ♀; same data as for preceding; MPN CW5382 • 1 nymph; Mt Rosa Track, Queenstown; 45.045° S, 168.963° E; 30 Nov. 2006; L. Cook and P. Johns leg.; in wētā motel; MPN CW703 • 2 nymphs; Nevis Bluff; 45.042° S, 169.012° E; 400 m a.s.l.; Nov. 2009; M. McDonald leg.; MPN CW1040, CW1042 • 1 ♂; Alexandra; 45.256° S, 169.404° E; 250 m a.s.l.; Dec. 2013; T. Jewell leg.; on rock tor; GenBank: PP155121; MPN CW2577 • 1 ♂; same data as for preceding; MPN CW2578 • 1 ♀; same data as for preceding; MPN CW2579 • 1 nymph; Earnsclough Tailings Reserve, Alexandra; 45.24230° S, 169.36039° E; 130 m a.s.l.; 18 Nov. 2022; D. Hegg leg.; on willow tree next to river; night search + insect net; GenBank: PP155124; MPN CW5553 • 1 ♂; Sutton Salt Lake, Middlemarch; 45.57555° S, 170.08818° E; 250 m a.s.l.; 23 Feb. 2021; D. Hegg leg.; on rock tor; night search + insect net; MPN CW5603 • 1 ♀; same data as for preceding; MPN CW5602 • 2 nymphs; same data as for preceding; MPN CW5209, CW5210 • 1 ♀; Danseys Pass Road; 44.96188° S, 170.32864° E; 650 m a.s.l.; 7 May 2016; D. Hegg leg.; on rock slabs at edge of river; night search + insect net; GenBank: PP155127; MPN CW3014 • 2 nymphs; same data as for preceding; MPN CW3015, CW3016 • 1 ♂; Mt Kyeburn, Danseys Pass; 44.95412° S, 170.31028° E; 1160 m a.s.l.; 16 Jan. 2017; D. Hegg leg.; on rock bluffs; night search + insect net; GenBank: PP155128; MPN CW3456 • 2 ♀♀; same data as for preceding; MPN CW4231, CW4245 • 1 ♀; Mt Kyeburn, Danseys Pass; 44.95466° S, 170.31002° E; 1120 m a.s.l.; 16 Apr. 2017; D. Hegg leg.; on rock bluffs; night search + insect net; GenBank: PP155126; MPN CW3455 • 1 ♂, 1 ♀; same data as for preceding; MPN CW4246, CW4247 • 5 ♂♂; Crown Range Road; 44.98128° S, 168.94333° E; 980 m a.s.l.; 14 Nov. 2020; D. Hegg leg.; on rock tor; night search + insect net; MPN CW5560 to CW5563, CW5601 • 1 ♂; Bendigo; 44.96156° S, 169.28727° E; 330 m a.s.l.; 4 Jun. 2023; D. van der Westhuizen leg.; sparse rocks; casual find; MPN CW5637. – **Central Otago/Otago Lakes (CO/OL)** • 1 ♂; Jollies Hill Pass; 45.57260° S, 168.50332° E; 400 m a.s.l.; 28 Aug. 2020; D. Hegg leg.; on pine tree trunk in highway rest area; casual find; MPN CW5113. – **Otago Lakes (OL)** • 2 nymphs; Skippers Canyon; 44.892° S, 168.676° E; Nov. 2009; M. McDonald leg.; MPN CW1041, CW1043 • 1 ♂; Mt Iron, Wānaka; 44.69332° S, 169.16855° E; 320 m a.s.l.; 12 Oct. 2018; D. Hegg leg.; on tree trunk; night search + insect net; MPN CW4975 • 1 ♀; same data as for preceding; MPN CW4974.

Description

MEASUREMENTS. See Table 1. No sexual dimorphism in body length.

HEAD. As per generic description. Vertex mottled dark brown with pale patches. Black streaks run from the posterior margin of each eye to the pronotum, resembling the temples in a pair of sun-glasses. Frons pale, with broad, irregular, dark vertical stripes below the scapes of the antennae. Scapes and pedicels of antennae pale mottled cream and brown. All other segments of the antennae are reddish.

THORAX. As per generic description. The pronotum, mesonotum and metanotum are typically coloured brown to dark brown, with elaborate patterns and pale patches on the two posterior segments (Fig. 22A). A pale colour band running through the whole length of the body is also common (Fig. 12I).

LEGS. Fore and mid femora approximately half as long as body. Hind tibiae same length as body in females, on average 15% longer than body in males. Fore femora always unarmed at the apex. Mid femora armed with one retrolateral spine at the apex; prolateral apical spine absent. Hind femora armed

with one to three retrolateral ventral linear spines, and up to three proteral ventral linear spines. A conspicuous spine on the posterior lower margin of the hind femur is often present, but is never as large as in adult male *I. armatum*. Fore tibiae armed with two pairs of ventral linear spines, and with one pair of ventral apical spines. A retrolateral dorsal spine at the apex of the fore tibia is rarely present. Mid tibiae armed with two pairs of ventral linear spines, one pair of ventral spines and one retrolateral dorsal spine at the apex. A proteral dorsal spine at the apex of the mid tibia is always absent. Hind tibiae armed with about 25 dorsal linear spines (min 13, max 34) on both the anterior and the posterior edge (Fig. 13D). Hind tibiae armed at the apex with two ventral sub-apical spines, two ventral apical spines, two dorsal apical spines and two dorsal sub-apical spines. The dorsal apical spines are always largest, whereas the ventral sub-apical spines are smallest. First hind tarsal segment armed with eight to twenty dorsal linear spines; second hind tarsal segment armed with three to eleven dorsal linear spines.

ABDOMEN. Typically mottled brown (Fig. 22A). Dark colour morphs with a pale longitudinal band (Fig. 12I) are also commonly encountered.

MALE TERMINALIA. Subgenital plate triangular, very narrow at apex, lacking a keel but with a visible median suture (Fig. 14K). Cerci on average 20% of body length, covered in long hairs; tapering gradually along their whole length and ending with a blunt tip at the apex. Styli slender and tapering, generally shorter than subgenital plate. Paraprocts form a horseshoe covered in dense, stout spinules; two triangular lobes rising vertically at the base of the paraprocts are also covered in spinules (Fig. 14J, L). Under the suranal plate there is a retractable cover which presumably protects the genitalia when not in use (Fig. 20A–B; compare with Fig. 14J).

FEMALE TERMINALIA. Subgenital plate consists of two small lobes at an angle, touching at the vertex (Figs 6, 17J). Ovipositor on average 80% of body length, relatively straight in the basal half, tapering and moderately recurved upwards only near the apex. Lower valve of ovipositor with 5 to 7 teeth below at the apex. Dorsal surface of upper valve more heavily serrated in distal half than in *I. armatum* (Fig. 17K–L).

Distribution and habitat

Isoplectron pallidum is only known from the Otago Region in New Zealand's South Island, between the east coast and Lakes Wānaka and Wakatipu, at elevations ranging from 250 m to 1250 m a.s.l. It occupies a range of habitats including montane forests, rock tors and bluffs. Populations may be locally dense, with several specimens hiding in cracks in the rock or under bark on tree trunks.

Isoplectron serratum (Richards, 1972) comb. nov.
Figs 3, 7–8, 10F, 12D, 13E, 15A–C, 18A–C, 20C, 22C–F

Petrotettix serratus Richards, 1972: 166–169, fig. 7.1–7.6, table 4.

Petrotettix spinosus Richards, 1972: 169–170, fig. 8.1–8.3. **Syn. nov.**

Petrotettix cupolaensis Richards, 1972: 170–171, fig. 9.1–9.3. **Syn. nov.**

Petrotettix nigripes Richards, 1972: 171–174, fig. 10.1–10.6, table 5. **Syn. nov.**

Petrotettix serratus – Johns 1977: 325. — Hegg *et al.* 2019: 42; 2022: 21.

Petrotettix spinosus – Johns 1977: 325.

Diagnosis

A relatively large insect with very long legs in males and variable coloration in adults, ranging from chequered yellow/black to mottled grey/brown. Nymphs are a dull, dark green.

Isoplectron serratum is closely related to *I. maculatum* sp. nov., from which it can only be differentiated by examination of the male terminalia. The two species, however, are allopatric, their distribution ranges being separated by the Rangitata River.

In the western part of its distribution range, *I. serratum* shares the habitat with *Pharmacus montanus* Pictet & de Saussure, 1893. It is most easily differentiated from the latter by the long, slender legs, the presence of dorsal linear spines on the first two segments of the hind tarsi and the serrated upper valve of the ovipositor.

In the Kaikōura Ranges and in North Canterbury, *I. serratum* is sympatric with *Pleioplectron rodmorrisi* Hegg *et al.*, 2019. The latter species, however, is unmistakable with its red-orange legs and antennae, purple-black back and a bold dorsal yellow median line.

Etymology

‘*Serrātus*’ (adj.) is Latin for ‘serrated’, ‘toothed like a saw’. While Richards (1972) did not explain her choice for the name, it seems most likely that it refers to the upper valve of the ovipositor, which is strongly serrated in the distal half.

The genus name *Petrotettix* is gender masculine (Richards, 1972). The insect was thus originally named *Petrotettix serratus*. *Isoplectron* however is gender neuter. The declension of the species name therefore becomes *serratum*, as per article 34.2 in the International Code of Zoological Nomenclature (ICZN 1999).

Material examined (see also Supp. file 1: Table S5 and Figs S7–S10)

Holotype

NEW ZEALAND • ♂, adult; North Canterbury (NC), Mt Binser, Cass; 43.038° S, 171.857° E; 1000–1200 m a.s.l.; 24 Feb. 1963; P. Johns leg.; among scree; CMNZ 000223.

Paratype

NEW ZEALAND • 1 ♀, adult; Marlborough (MB), Mt St Patrick, St James Range; 42.439° S, 172.748° E; 1200 m a.s.l.; 30 Oct. 1962; P. Johns leg.; among scree; CMNZ 000224.

Other material

NEW ZEALAND – **Mid Canterbury (MC)** • 1 ♀, holotype of *Petrotettix spinosus*; Hamilton Peak, Craigieburn Range; 43.123° S, 171.690° E; 1500–1800 m a.s.l.; 15 Dec. 1968; R. Watson leg.; on rocky ridge; CMNZ 000219 • 2 ♂♂; Mt Somers; 43.60777° S, 171.36341° E; 1300 m a.s.l.; 12 Dec. 2020; D. Hegg leg.; on rock bluffs; night search + insect net; MPN CW5583, CW5584 • 1 ♀; same data as for preceding; MPN CW5585 • 1 ♂; Round Hill Creek, Taylor Range; 43.43186° S, 171.29781° E; 1450 m a.s.l.; 4 Dec. 2016; D. Hegg leg.; on rock bluffs; night search + insect net; GenBank: PP155132; MPN CW3188 • 3 ♂♂; same data as for preceding; MPN CW3189, CW3190, CW3193 • 2 ♀♀; same data as for preceding; MPN CW3191, CW3192 • 1 ♂; Mount Ida; 43.22° S, 171.53° E; 1500 m a.s.l.; 3 Dec. 1999; collector unknown; MPN CW178B • 1 ♀; same data as for preceding; MPN CW178A • 1 ♂; Hamilton Peak, Craigieburn Range; 43.11746° S, 171.68554° E; 1750 m a.s.l.; 12 Feb. 2017; D. Hegg leg.; on rocky ridge; night search + insect net; GenBank: PP155143; MPN CW3301 • 1 ♀; same data as for preceding; GenBank: PP155141; MPN CW3306 • 1 nymph; same data as for preceding; GenBank: PP155142; MPN CW3274 • 9 nymphs; same data as for preceding; MPN CW3267 to CW3273, CW3275, CW3276 • 1 ♀; The Gap, Torlesse Range; 43.25649° S, 171.78426° E; 1440 m a.s.l.; 20 Nov. 2016; D. Hegg leg.; on rocky outcrop; night search + insect net; GenBank: PP155144; MPN CW3185 • 2 ♂♂; same data as for preceding; MPN CW3182, CW3186 • 3 ♀♀; same data as for preceding; MPN CW3183, CW3184, CW3187 • 1 ♂; Mid Hill, Black Range; 43.06201° S, 171.58003° E; 1660 m a.s.l.; 18 Dec. 2021; D. Hegg leg.; on rocky ridge; night search + insect net; MPN CW5363 • 1 ♀; same data as

for preceding; MPN CW5362. – **North Canterbury (NC)** • 1 ♀; Spider Web, Organ Range; 42.68837° S, 172.502947° E; 1670 m a.s.l.; 20 Dec. 2016; D. Hegg leg.; on rocky outcrop; night search + insect net; GenBank: PP155145; MPN CW3236 • 4 ♂♂; same data as for preceding; MPN CW3238 to CW3241 • 1 ♀; same data as for preceding; MPN CW3237. – **Buller (BR)** • 1 ♀, holotype of *Petrotettix cupolaensis*; Cupola Basin, Travers Range; 41.980° S, 172.720° E; 1860 m a.s.l.; Dec. 1965; C.L. Batchelor; NZAC 03016359 • 1 nymph; Angelus Peak, Travers Range; 41.89771° S, 172.74426° E; 1650 m a.s.l.; 7 Jan. 2017; D. Hegg leg.; on rock bluffs; night search + insect net; GenBank: PP155139; MPN CW3255 • 2 ♂♂; same data as for preceding; MPN CW3253, CW3254 • 1 ♀; same data as for preceding; MPN CW3252 • 2 nymphs; same data as for preceding; MPN CW3256, CW3257. – **Marlborough (MB)** • 1 ♂, holotype of *Petrotettix nigripes*; Mt Altimarloch, Black Birch Range; 41.744° S, 173.806° E; 1360 m a.s.l.; 6 Feb. 1970; J.S. Dugdale leg.; NZAC 03016360, 03015544 • 1 ♀, allotype of *Petrotettix nigripes*; same data as for preceding; NZAC 03015510 • 1 ♀; Inkerman Ridge, Crimea Range; 42.1990° S, 172.8328° E; 2000 m a.s.l.; 24 Jan. 2012; T. Watson leg.; on ridge-top; GenBank: PP155148; MPN CW2643 • 1 ♀; Crimea Creek, Crimea Range; 42.2001° S, 172.8356° E; 1880 m a.s.l.; 24 Jan. 2012; I. Millar leg.; GenBank: PP155149; MPN CW2647 • 1 ♂; Crimea Creek, Crimea Range; 42.2020° S, 172.8340° E; 1870 m a.s.l.; 24 Jan. 2012; T. Watson leg.; GenBank: PP155147; MPN CW2676 • 1 nymph; same data as for preceding; GenBank: PP155135; MPN CW2677 • 2 nymphs; same data as for preceding; MPN CW2674, CW2675 • 1 ♀; Berts Creek; 42.1180° S, 172.8999° E; 1100 m a.s.l.; 20 Dec. 2011; T. Watson leg.; GenBank: PP155146; MPN CW2648 • 1 ♂; Mt Alexander; 41.8219° S, 173.6059° E; 1340 m a.s.l.; 27 Apr. 2006; I. Millar leg.; GenBank: PP155134; MPN CW412 • 2 nymphs; Mt Harkness, Black Birch Range; 41.76021° S, 173.75181° E; 1640 m a.s.l.; 22 Oct. 2016; D. Hegg leg.; on summit rocks; night search + insect net; MPN CW3514, CW3515 • 1 nymph; Mt Altimarloch, Black Birch Range; 41.74389° S, 173.80445° E; 1360 m a.s.l.; 23 Oct. 2016; D. Hegg leg.; on rocky outcrop; night search + insect net; GenBank: PP155137; MPN CW3141 • 3 nymphs; same data as for preceding; MPN CW3142 to CW3144 • 1 ♀; same data as for preceding; 6 Jan. 2017; GenBank: PP155140; MPN CW3249 • 2 ♂♂; same data as for preceding; MPN CW3250, CW3251 • 4 ♂♂; same data as for preceding; 29 Jan. 2018; MPN CW5588, CW5590 to CW5592 • 3 ♀♀; same data as for preceding; MPN CW5586, CW5587, CW5589 • 1 nymph; Mt Richmond, Richmond Range; 41.47298° S, 173.39135° E; 1600 m a.s.l.; 21 Oct. 2018; D. Hegg leg.; on rock bluffs; night search + insect net; GenBank: PP155138; MPN CW4125 • 1 ♂; same data as for preceding; MPN CW5577 • 1 ♀; same data as for preceding; MPN CW5578 • 1 nymph; same data as for preceding; MPN CW4124 • 1 ♂; Slaty Peak, Richmond Range; 41.48759° S, 173.27426° E; 1520 m a.s.l.; 28 Dec. 2021; D. Hegg leg.; on ridge top; night search + insect net; MPN CW5361 • 1 ♀; same data as for preceding; MPN CW5360. – **Kaikōura (KA)** • 1 ♀; Turks Head; 42.1629° S, 173.2752° E; 1630 m a.s.l.; 18 Jan. 2012; T. Watson leg.; among scree; GenBank: PP155133; MPN CW2649 • 1 ♂; Hodder Huts, Awatere River; 41.96950° S, 173.63789° E; 1380 m a.s.l.; 4 Apr. 2018; D. Hegg leg.; on rock bluffs; night search + insect net; MPN CW5579 • 1 ♂; Kahutara Saddle; 42.32217° S, 173.42933° E; 1200m a.s.l.; 1 Apr. 2017; D. Hegg leg.; on rock bluffs; night search + insect net; GenBank: PP155136; MPN CW3245 • 5 ♂♂; same data as for preceding; MPN CW3389, CW3407 to CW3410 • 6 ♀♀; same data as for preceding; MPN CW3388, CW5555 to CW5559 • 7 nymphs; same data as for preceding; MPN CW3242 to CW3244, CW3246 to CW3248, CW3387.

Description

MEASUREMENTS. See Table 1. Body longer by 1.2 mm (10%) in females (Table 2).

HEAD. As per generic description. Vertex pale with four thin black lines running perpendicularly to the pronotum, two above the eyes and two near the centre. The lower extremity of the vertex is black, including the fastigium. Frons and labrum mottled grey/black; clypeus pale. Scapes variegated pale and black. Pedicels and all other segments of the antennae black.

THORAX. In adults, the pronotum, mesonotum and metanotum are either chequered yellow/black (Figs 12D, 22C) or mostly dark (Fig. 22D–E). In nymphs, the whole thorax tends to be coloured a dull grey/green (Fig. 22F).

LEGS. Longer than in any other species of *Isoplectron* in both sexes, with pronounced sexual dimorphism. The hind tibiae are on average 10% longer than the body in females, 50% longer than the body in males (max 70%). Fore femora always unarmed at the apex. Mid femora armed with one retrolateral spine at the apex; prolateral apical spine absent. Hind femora armed with up to 12 retrolateral and prolateral ventral linear spines, the retrolateral ones being larger. Fore and mid tibiae armed with one to three pairs of ventral linear spines, with one pair of ventral apical spines, and with one pair of dorsal apical spines. Hind tibiae armed with about 25 dorsal linear spines (min 19, max 37) on both the anterior and the posterior edge (Fig. 13E). Hind tibiae armed at the apex with two ventral sub-apical spines, two ventral apical spines, two dorsal apical spines and two dorsal sub-apical spines. The dorsal apical spines are always largest, whereas the ventral sub-apical spines are smallest. First hind tarsal segment armed with up to 18 dorsal linear spines; second hind tarsal segment armed with up to 8 dorsal linear spines.

ABDOMEN. Predominantly dark, almost black, or chequered yellow/black (Figs 12D, 22C–E). In nymphs, the whole body tends to be coloured a dull grey/green (Fig. 22F).

MALE TERMINALIA. Suranal plate trapezoidal and heavily sclerotised (Fig. 15A). Subgenital plate triangular; heavily sclerotised; enlarged and folded upwards like a scoop-shaped trowel at the apex; with a pronounced double keel along its whole length (Fig. 15B). Cerci short, on average 13% of body length, covered in sparse, mostly short hair; tapering gradually along their whole length and ending with a blunt tip at the apex. Styli slender, shorter than subgenital plate. Paraprocts small and covered in dense, stout spinules on the inward-facing side; they are entirely contained within the perimeter of the subgenital plate and are not visible from below (Figs 7A–C, 15A). Under the suranal plate there is a retractable cover which presumably protects the genitalia when not in use (Fig. 20C; compare with Fig. 15A).

FEMALE TERMINALIA. Subgenital plate consists of two small, rounded lobes, covered in sparse hair; separated by a gap at least as wide as the lobe themselves (Figs 7D–F, 18A). Ovipositor on average two thirds of body length; relatively straight and only lightly recurved upwards near the apex; heavily sclerotised and black in the distal half. Lower valve of ovipositor with 5 to 7 teeth below at the apex. Dorsal surface of upper valve heavily serrated in distal half (Fig. 18B–C).

Distribution and habitat

Widespread in the drier alpine regions of New Zealand's South Island north of the Rangitata River and east of the Main Divide of the Southern Alps. Found almost exclusively on rock well above the tree-line. It feeds on lichen and camouflages well with its background.

Isoplectron maculatum sp. nov.

urn:lsid:zoobank.org:act:D7BC8F91-27ED-42D8-9E63-CE84613D39E3

Figs 3, 8, 10G, 12E, 13F, 15D–F, 18D–F, 20D, 22B

Diagnosis

Slightly smaller than the closely related *I. serratum*, it can only be differentiated from the latter species by examination of the male terminalia. The two species, however, are allopatric. *I. maculatum* sp. nov. has a chequered yellow/black coloration in adults.

The distribution range of *I. maculatum* sp. nov. may overlap with *Pharmacus montanus*. *Isoplectron maculatum* is most easily differentiated from the latter species by the long, slender legs, the presence

of dorsal linear spines on the first two segments of the hind tarsi and the serrated upper valve of the ovipositor.

Etymology

‘*Mācūlātus*’ (adj.) is Latin for ‘speckled’, after the insect’s colour pattern.

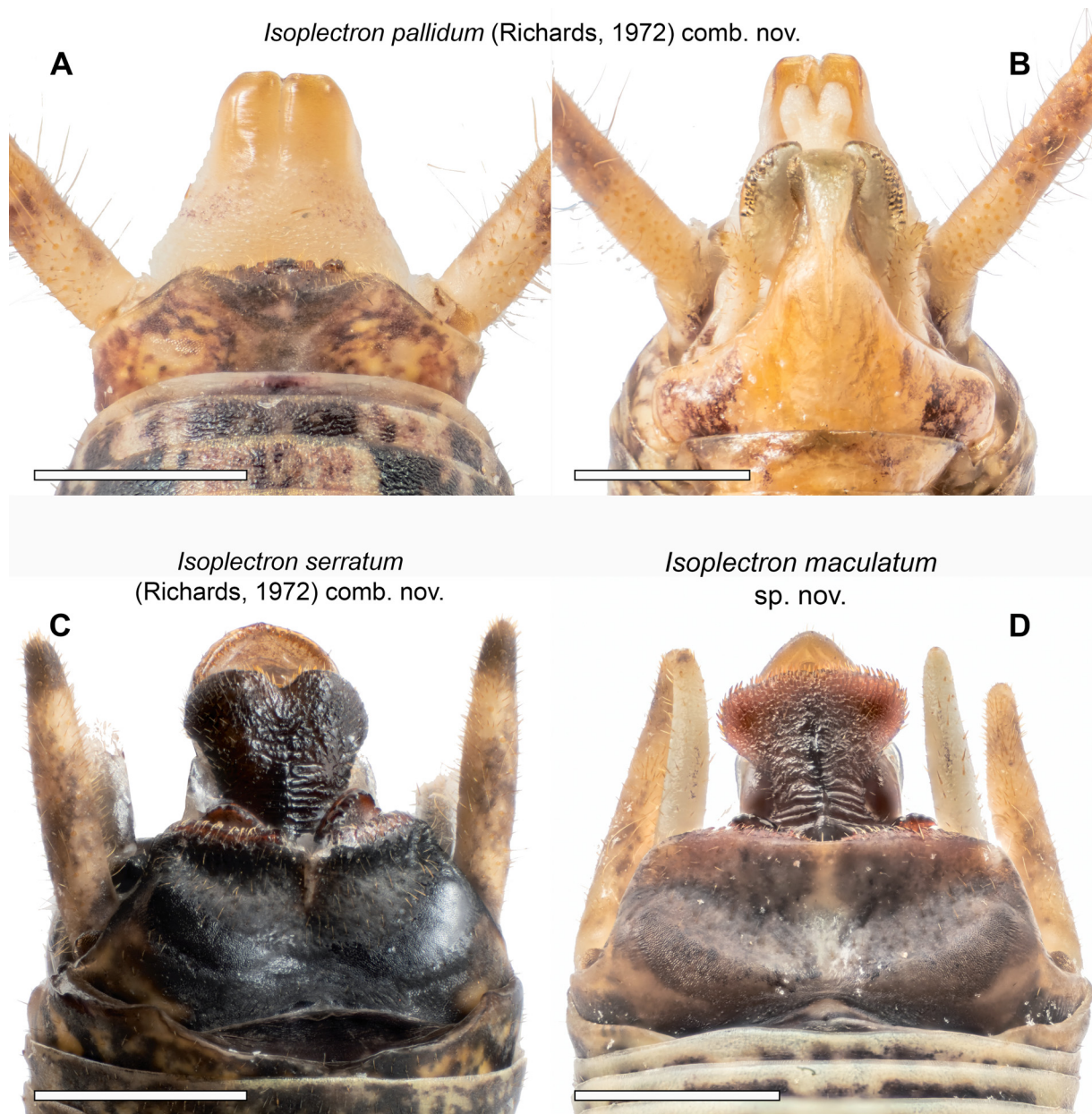


Fig. 20. Retractable cover in adult male terminalia of cave wētā in the genus *Isoplectron* Hutton, 1896. **A–B.** *I. pallidum* (Richards, 1972) comb. nov. Crown Range Road (MPN CW5560). **A.** Dorsal view of retractable cover. **B.** Ventral view of subgenital plate and apex of retractable cover. **C.** *I. serratum* (Richards, 1972) comb. nov., dorsal view. Mt Altimarloch, Black Birch Range (MPN CW5588). **D.** *I. maculatum* sp. nov., holotype, dorsal view. Middle Mt Peel, South Canterbury (NMNZ AI.071892). Scale bars: 1 mm.

Material examined (see also Supp. file 1: Table S6)

Holotype

NEW ZEALAND • ♂, adult; South Canterbury (SC), Middle Mt Peel; 43.86312° S, 171.18167° E; 1350 m a.s.l.; 19 Apr. 2019; D. Hegg leg.; on rocky outcrop on ridgeline; night search + insect net; GenBank: PP155130; NMNZ AI.071892.

Paratype

NEW ZEALAND • 1 ♀, adult; same data as for holotype; NMNZ AI.071893.

Other material

NEW ZEALAND – **South Canterbury (SC)** • 1 ♀; same data as for holotype; MPN CW5581 • 1 ♂; same data as for holotype; 27 May 2023; GenBank: PP155129; MPN CW5641 • 1 ♀; same data as for preceding; GenBank: PP155131; MPN CW5638 • 1 ♂; same data as for preceding; MPN CW5642 • 2 ♀♀; same data as for preceding; MPN CW5639, CW5640.

Description

MEASUREMENTS. See Table 1. Body longer by 1.4 mm (12%) in females.

HEAD. Very similar to *I. serratum*. Like in the latter species, the lower extremity of the vertex is black, but with two conspicuous pale spots between the fastigium and the eyes. Frons and clypeus pale, with vertical dark streaks below the eyes. Labrum pale. Scapes and pedicels variegated pale and grey; all other segments of the antennae brown.

THORAX. In adults, the pronotum, mesonotum and metanotum are chequered yellow/black (Figs 12E, 22B).

LEGS. Same as *I. serratum*.

ABDOMEN. Chequered yellow/black (Figs 12E, 22B). In nymphs, the whole body tends to be coloured a dull grey/green.

MALE TERMINALIA. Suranal plate trapezoidal, not as heavily sclerotised as in *I. serratum* (Fig. 15D). Subgenital plate same as in *I. serratum*; not as heavily sclerotised; with a double keel only in the distal half (Fig. 15E). Cerci short, on average 13% of body length, covered in sparse, mostly short hair; tapering gradually along their whole length and ending with a blunt tip at the apex. Styli slender, longer than subgenital plate. Paraprocts covered in dense, stout spinules on the inward-facing side; they are wider than the subgenital plate and are visible from below (Fig. 15E). Under the suranal plate there is a retractable cover which presumably protects the genitalia when not in use (Fig. 20D; compare with Fig. 15D).

FEMALE TERMINALIA. Subgenital plate consists of two narrow, rounded lobes, covered in sparse hair; separated by a gap at least twice as wide as the lobe themselves (Fig. 18D). Ovipositor on average two thirds of body length; relatively straight and only lightly recurved upwards near the apex. Lower valve of ovipositor with 6 to 7 teeth below at the apex. Dorsal surface of upper valve heavily serrated in distal half (Fig. 18E–F).

Distribution and habitat

Isoplectron maculatum sp. nov. is currently only known from the alpine regions on Mt Peel in South Canterbury. It is most likely more widely distributed in the mountain ranges south of the Rangitata River, possibly as far west as the Two Thumb Range. Found almost exclusively on rock, where it feeds on lichen, it camouflages well with its background.

Isoplectron virgatum sp. nov.

urn:lsid:zoobank.org:act:CF2E5537-FF7B-4C16-9236-6A00D079407A

Figs 3, 8, 10I, 12G, 13G, 15G–I, 18G–I, 23A

Diagnosis

A small insect, pale throughout, with six to eight longitudinal stripes on the back. A retrolateral spine at the apex of the mid femur is usually absent.

Very similar to *I. parallelum* sp. nov. and to *Talitropsis poduroides* (Walker, 1871) in morphology and habitat use, but geographically separated from these two species, which are confined to North Island. It can be mistaken for striped morphs of *I. ferratum* sp. nov., although the latter species is arboreal and is always armed with a retro-lateral spine at the apex of the mid femur, a trait that is generally absent in *I. virgatum* sp. nov.

Isoplectron virgatum sp. nov. could be confused with a small, undescribed species in the genus *Notoplectron*, which inhabits the southern regions of the South Island's West Coast. This species, however, appears to prefer grasslands in the low alpine zone, whereas *I. virgatum* is mainly a low elevation species. *Notoplectron* also has a smooth upper valve of the ovipositor and macroscopically different male terminalia.

Etymology

'*Virgātus*' (adj.) is Latin for 'striped'.

Material examined (see also Supp. file 1: Table S7)

Holotype

NEW ZEALAND • ♂, adult; Buller (BR), Ces Clarke Hut, Paparoa Range; 42.29007° S, 171.39307° E; 900 m a.s.l.; 6 Apr. 2019; D. Hegg leg.; on *Phormium* leaf; night search + insect net; NMNZ AI.071894.

Paratype

NEW ZEALAND • 1 ♀, adult; same data as for holotype; GenBank: PP155107; NMNZ AI.071895.

Other material

NEW ZEALAND – **Fiordland (FD)** • 1 ♀; Cleft Creek, Hollyford Valley; 44.64813° S, 168.10538° E; 100 m a.s.l.; 9 Jan. 2023; J. Jack leg.; in native forest; photograph only; iNaturalist 146558750. – **Westland (WD)** • 1 ♀; Jackson Bay; 43.97° S, 168.61° E; 80 m a.s.l.; 1 Nov. 2019; D. Hegg leg.; on tree fern; night search + insect net; GenBank: PP155105; MPN CW4666 • 1 ♂; Awatuna, Hokitika; 42.64905° S, 171.06228° E; 40 m a.s.l.; May 2012; B. Taylor-Smith leg.; GenBank: PP155104; MPN CW2014 • 1 ♂; same data as for preceding; GenBank: PP155102; MPN CW2016 • 1 ♂; same data as for preceding; MPN CW2009 • 1 nymph; same data as for preceding; MPN CW2013. – **Buller (BR)** • 1 ♂; Bob's Hut, Matakītaki River West Branch; 42.22528° S, 172.48754° E; 840 m a.s.l.; 6 Jan. 2021; D. Hegg leg.; on *Astelia* leaf; night search + insect net; GenBank: PP155101; MPN CW5394 • 1 ♀; same data as for preceding; MPN CW5395 • 1 ♀; same data as for holotype; MPN CW4420 • 1 nymph; Truman Track, Punakaiki; 42.09430° S, 171.34349° E; 50 m a.s.l.; 6 Dec. 2018; D. Hegg leg.; on *Astelia* leaf; night search + insect net; GenBank: PP155100; MPN CW4228. – **Nelson (NN)** • 1 nymph; Granity Pass, Mt Owen; 41.52327° S, 172.56349° E; 1200 m a.s.l.; 9 Jan. 2019; D. Hegg leg.; on *Aciphylla* flower; night search + insect net; GenBank: PP155106; MPN CW4290 • 1 ♀, 1 nymph; same data as for preceding; MPN CW4289, CW4291 • 1 ♂; Cave Brook, Goulund Downs; 40.89153° S, 172.35449° E; 630 m a.s.l.; 4 Feb. 2018; D. Hegg leg.; on *Astelia* leaf; night search + insect net; GenBank: PP155099; MPN CW3776 • 1 ♀; same data as for preceding; MPN CW3794 • 1 nymph; same data as for preceding; MPN CW3775 • 1 ♂; Heaphy River, Kahurangi NP; 40.983° S, 172.114° E; 20 m a.s.l.; 20 Feb. 2023; D. Hegg leg.; on *Coprosma* shrub; night search + insect net; GenBank: PP155103; MPN CW5622.

Description

MEASUREMENTS. See Table 1. Body length approximately 11 mm in both males and females.

HEAD. Vertex pale with four brown lines running from the fastigium to the anterior margin of the pronotum, two above the eyes and two near the centre. Dark streaks run from the posterior margin of each eye to the pronotum, resembling the temples in a pair of sun-glasses. Frons, clypeus and labrum pale, with two faint, vertical dark stripes below the scapes of the antennae. Scapes and pedicels variegated; all other segments of the antennae pale.

THORAX. Pale with brown dorsal lines running along the length of the thorax and continuing into the abdomen (Fig. 12G).

LEGS. Relatively short, without sexual dimorphism. The hind tibiae are on average 95% of body length in both males and females. Fore and mid femora unarmed at the apex, although a retro-lateral apical spine on the mid femur may be present on rare occasion. Hind femora armed with one to three retrolateral and pro-lateral ventral linear spines, the retrolateral ones being larger. Fore tibiae armed with two pairs of ventral linear spines, and with one pair of ventral apical spines. A retrolateral dorsal spine at the apex of the fore tibia is present in 50% of examined specimens. Mid tibiae armed with two pairs of ventral linear spines, one pair of ventral spines and one retrolateral dorsal spine at the apex. A pro-lateral dorsal spine at the apex of the mid tibia is always absent. Hind tibiae armed with about 20 dorsal linear spines (min 16, max 24) on both the anterior and the posterior edge (Fig. 13G). Hind tibiae armed at the apex with two ventral apical spines, two dorsal apical spines and two dorsal sub-apical spines; the dorsal apical spines are largest. Ventral sub-apical spines are always absent. First and second segments in hind tarsi always unarmed except at the apex.

ABDOMEN. Tergites pale, with dorsal brown stripes running longitudinally along the whole length of the insect from the pronotum to the terminalia (Figs 12G and 23A). In females only, the seventh sternite is equipped with two ventral protuberances; the eighth sternite with three ventral protuberances (Fig. 18G).

MALE TERMINALIA. Suranal plate trapezoidal with conspicuous hair tufts on the two posterior corners. The posterior margin can be either straight (Fig. 15G) or deeply notched. Subgenital plate pear-shaped; covered in sparse, thin tomentum except near the base on the sides, which are glabrous; with a pronounced keel along its whole length (Fig. 15H). Cerci on average 20% of body length, covered in sparse, mostly short hair; tapering gradually along their whole length and ending with a blunt tip at the apex. Styli tapering and not reaching to the apex of the subgenital plate. Paraprocts with parallel sides, tapering to a sharp tip only near the apex; glabrous except for a single row of spinules near the interior margin (Fig. 15G).

FEMALE TERMINALIA. Subgenital plate consists of two bulging, rounded lobes, joined at the base and diverging at the apex; glabrous on the inner surface, covered in stout hair on the outer surface (Fig. 18G). Ovipositor on average three quarters of body length; curving gently upwards from the base to the apex; lower valve with 8 to 10 teeth below at the apex; dorsal surface of upper valve serrated in distal third (Fig. 18H–I).

Distribution and habitat

Isoplectron virgatum sp. nov. is mainly found on the elongated leaves of shrubs in the genera *Phormium* J.R.Forst. & G.Forst. and *Astelia* Banks & Sol. ex R.Br., where the insect's habitus blends in with the leaf's longitudinal nervature. Distributed along the West Coast of South Island from Fiordland to Kahurangi (Fig. 10I).

Isoplectron ferratum sp. nov.

urn:lsid:zoobank.org:act:81140EE2-3572-4274-869C-A617DBF74D68

Figs 3, 8, 10C, 12F, 13H, 15J–L, 18J–L, 23B

Diagnosis

A small insect (body length 9 to 13 mm), most commonly of uniform rusty colour (Figs 12F, 23B). Longitudinally striped morphs are encountered on occasion and could be mistaken for *I. virgatum*



Fig. 21. Live *Isoplectron* Hutton, 1896 in their natural habitats. A–C. *I. armatum armatum* Hutton, 1896. A. Adult ♂ showing the most common habitus, dark brown back with two pale patches on the metanotum. Raincliff Reserve, Ōpihi River, South Canterbury. B. Adult ♂ with diamond-shaped dorsal pattern. Hinau Track, Kaikōura. C. Adult ♀ with broad longitudinal dorsal band. Pioneer Park, Ōpihi River, South Canterbury. D. *I. armatum aciculatum* Karny, 1937, adult ♀. Ohakune. E–F. *I. bicolor* sp. nov. E. Adult ♂. Mt Arthur Tablelands, Kahurangi NP. F. Male nymph. Chaffey Hut, Cobb River.

sp. nov. Striped morphs of *I. ferratum* sp. nov. have fewer, broader stripes than *I. virgatum* and are darker overall. *Isoplectron virgatum* also occupies a different micro-habitat and generally lacks the retro-lateral spine at the apex of the mid femur.

Isoplectron ferratum sp. nov. could be mistaken for *I. armatum*. The two species are allopatric but have adjacent ranges. *Isoplectrum ferratum* has shorter legs than *I. armatum*, has lighter colour with rusty/red tones and lacks the prominent ventral spine on the posterior edge of the hind femur.



Fig. 22. Live *Isoplectron* Hutton, 1896 in their natural habitats. **A.** *I. pallidum* (Richards, 1972) comb. nov., adult ♀. Staircase Hut Track, Waianakarua. **B.** *I. maculatum* sp. nov., adult ♂. Middle Mt Peel, South Canterbury. **C–F.** *I. serratum* (Richards, 1972) comb. nov. **C.** Adult ♀. The Gap, Torlesse Range. **D.** Adult ♂. Mt Richmond, Richmond Range. **E.** Mating pair. Mt Altimarloch, Black Birch Range. **F.** Female nymph. Mt Altimarloch, Black Birch Range.

Isoplectron ferratum sp. nov. is sympatric with *I. bicolor* sp. nov. throughout its distribution range and could be mistaken for a nymph of the latter species. The state of development of terminalia or ovipositor will show whether a specimen is an adult of the smaller *I. ferratum* or a nymph of the larger *I. bicolor*.



Fig. 23. Live *Isoplectron* Hutton, 1896 and *Praecantrix* gen. nov. in their natural habitats. **A.** *Isoplectron virgatum* sp. nov., adult ♀ on *Astelia* Banks & Sol. ex R.Br. leaf. Bob's Hut, Matakītaki River. **B.** *Isoplectron ferratum* sp. nov. in black beech *Fuscospora solandri* (Hook.f.) Heenan & Smitsen tree canopy. Cave Brook, Goulānd Downs, Kahurangi NP. **C.** *Isoplectron parallelum* sp. nov., adult ♀ on flax *Phormium tenax* J.R.Forst. & G.Forst. flower. Wellington. **D.** *Praecantrix saxicola* sp. nov., adult ♀. Mt St Bathans, Central Otago. **E.** *Praecantrix silvatica silvatica* gen., sp. et subsp. nov. adult ♀. Mt Arthur Tablelands, Kahurangi NP. **F.** *Praecantrix silvatica lutea* gen., sp. et subsp. nov. adult ♀. Hināu Track, Kaikōura.

On Taranaki, *I. ferratum* sp. nov. could be confused with several species in the genus *Neonetus*. While insects in the latter genus generally have prolateral and retrolateral spines at the apex of fore and mid femora, an examination of the male terminalia or of the female posterior sternites is advised for a correct identification of these smaller species of cave wētā.

Etymology

‘*Ferrum*’ is the Latin word for ‘horseshoe’ (among other meanings). ‘*Ferrātus*’ (adj.) means ‘fitted with a horseshoe’, after the shape of the female subgenital plate (see Fig. 18J).

Material examined (see also Supp. file 1: Table S8)

Holotype

NEW ZEALAND • ♂, adult; Nelson (NN), Cave Brook, Goulund Downs; 40.89153° S, 172.35449° E; 630 m a.s.l.; 4 Feb. 2018; D. Hegg leg.; in beech tree canopy; night search + insect net; NMNZ AI.071896.

Paratype

NEW ZEALAND • 1 ♀, adult; Marlborough Sounds (SD), Mt Stokes; 41.08747° S, 174.10983° E; 1000 m a.s.l.; 17 Nov. 2018; D. Hegg leg.; on beech tree; night search + insect net; GenBank: PP155117; NMNZ AI.071897.

Other material

NEW ZEALAND – **Buller (BR)** • 1 nymph; Nina Valley; 42.45974° S, 172.36472° E; 650 m a.s.l.; 26 Jan. 2018; D. Hegg leg.; on large rock in forest; night search + insect net; GenBank: PP155112; MPN CW3778 • 1 nymph; same data as for preceding; GenBank: PP155113; MPN CW3779 • 2 ♂♂; same data as for preceding; MPN CW5607, CW5608 • 1 ♀; same data as for preceding; MPN CW5609. – **Nelson (NN)** • 1 ♀; Blue Creek, Mt Owen; 41.51561° S, 172.56022° E; 1100 m a.s.l.; 11 Jan. 2019; D. Hegg leg.; on tree trunk; night search + insect net; GenBank: PP155114; MPN CW5610 • 1 ♀; Graham River North Branch; 41.19414° S, 172.80776° E; 170 m a.s.l.; 19 Dec. 2011; S. Trewick leg.; MPN CW1800 • 1 ♂; Mt Arthur Track, Mt Arthur; 41.19966° S, 172.72180° E; 1180 m a.s.l.; 21 Dec. 2020; D. Hegg leg.; on tree trunk; night search + insect net; MPN CW5575 • 1 ♂; Salisbury Lodge, Mt Arthur; 41.18465° S, 172.64217° E; 1200 m a.s.l.; 24 Dec. 2020; D. Hegg leg.; on tree trunk; night search + insect net; MPN CW5576 • 2 ♂♂; Chaffey Hut, Cobb River; 41.09531° S, 172.57310° E; 900 m a.s.l.; 26 Dec. 2020; D. Hegg leg.; on tree trunk; night search + insect net; MPN CW5573, CW5574 • 3 ♀♀; same data as for preceding; MPN CW5570 to CW5572 • 1 ♂; Goulund Downs Hut, Heaphy Track; 40.89060° S, 172.35334° E; 630 m a.s.l.; 16 Sep. 2005; M. Ogle leg.; between sheets of plywood; casual find; MPN CW343 • 1 ♀; same data as for preceding; MPN CW342 • 1 ♀; same data as for holotype; 26 Dec. 2016; GenBank: PP155116; MPN CW4036 • 1 ♂, 1 ♀; same data as for holotype; MPN CW3774, CW4953 • 2 ♂♂; Awaroa, Abel Tasman NP; 40.863° S, 173.043° E; 10 m a.s.l.; Jan. 2011; M. Morgan-Richards and S. Trewick leg.; MPN CW1953, CW1954 • 1 ♀; same data as for preceding; 18 Jan. 2017; S. Trewick leg.; in sink outside hut; casual find; GenBank: PP155110; MPN CW3229 • 1 ♂; Pakawau Bush Rd, Collingwood; 40.583° S, 172.657° E; 20 m a.s.l.; 27 Jan. 2010; M. Morgan-Richards and S. Trewick leg.; MPN CW1907 • 1 ♀; same data as for preceding; MPN CW1906 • 1 nymph; Farewell Spit; 40.51417° S, 172.75389° E; 10 m a.s.l.; 5 Feb. 2018; D. Hegg leg.; on tree trunk; night search + insect net; GenBank: PP155111; MPN CW3768 • 1 ♂; same data as for preceding; MPN CW5599 • 1 ♀; same data as for preceding; MPN CW5600 • 1 ♀; Cape Farewell; 40.50490° S, 172.70925° E; 100 m a.s.l.; 1 Dec. 2019; E. Trewick leg.; under rimu bark; GenBank: PP155115; MPN CW4627. – **Taranaki (TK)** • 1 ♂; Dawson Falls, Taranaki Mouna; 39.330° S, 174.110° E; 800 m a.s.l.; 1 Jun. 2008; M. Morgan-Richards and S. Trewick leg.; GenBank: PP155109; MPN CW817.

Description

MEASUREMENTS. See Table 1. Body length approximately 11 mm in both males and females; no sexual dimorphism in body or leg length.

HEAD. Vertex variegated with a complex pattern of pale patches and thin dark stripes. Dark streaks run from the posterior margin of each eye to the pronotum, resembling the temples in a pair of sun-glasses. Frons, clypeus and labrum pale, with two dark patches under the scapes of the antennae, two dark patches under the eyes and another two smaller dark patches near the median line on each of frons and clypeus. Scapes of antennae pale, criss-crossed by a pattern of thin, dark stripes; pedicels pale; all other segments of the antennae reddish-brown.

THORAX. Most commonly rusty red/brown (Fig. 12F).

LEGS. Relatively short, without sexual dimorphism. The hind tibiae are on average 90% of body length in both males and females. Fore femora always unarmed at the apex. Mid femora armed with one retrolateral spine at the apex; prolateral apical spine absent. Hind femora armed with one to four retrolateral and prolateral ventral linear spines, the retrolateral ones being larger. Fore tibiae armed with two pairs of ventral linear spines, and with one pair of ventral apical spines. A retrolateral dorsal spine at the apex of the fore tibia is present on rare occasion. Mid tibiae armed with two pairs of ventral linear spines, one pair of ventral spines and one retrolateral dorsal spine at the apex. A prolateral dorsal spine at the apex of the mid tibia is always absent. Hind tibiae armed with about 14 dorsal linear spines (min 11, max 16) on both the anterior and the posterior edge (Fig. 13H). Hind tibiae armed at the apex with two ventral apical spines, two dorsal apical spines and two dorsal sub-apical spines; the dorsal apical spines are largest. Ventral sub-apical spines are always absent. First and second segments in hind tarsi always unarmed except at the apex.

ABDOMEN. Tergites usually rusty red/brown throughout (Figs 12F, 23B). Specimens we have examined from Mt Stokes and Farewell Spit have a pale diamond or a longitudinal band on the back, bordering two dark brown bands either side. In females only, the seventh sternite is equipped with two ventral protuberances; the eighth sternite with three ventral protuberances (Fig. 18J).

MALE TERMINALIA. Suranal plate trapezoidal with conspicuous hair tufts on the two posterior corners; the posterior margin has a deep, narrow indentation in the middle (Fig. 15J). Subgenital plate pear-shaped; covered in very sparse, thin tomentum except near the base on the sides, which are glabrous; with a thin keel along its whole length (Fig. 15K). Cerci on average 20% of body length, covered in sparse, mostly short hairs; tapering gradually along their whole length and ending with a blunt tip at the apex. Styli short and stumpy, not reaching to the apex of the subgenital plate. Paraprocts narrow, tapering right from the base to a blunt tip at the apex; glabrous (Fig. 15J).

FEMALE TERMINALIA. Subgenital plate consists of two elongated, rounded lobes in the shape of a horseshoe (Fig. 18J). Ovipositor on average 70% of body length; moderately recurved upwards from the base to the apex; lower valve with 6 to 9 teeth below at the apex; dorsal surface of upper valve serrated in distal third (Fig. 18K–L).

Distribution and habitat

An arboreal insect confined to the regions in the north-west of South Island from Lewis Pass to Farewell Spit and to the Marlborough Sounds, and to Taranaki Mouna in North Island (Fig. 10C).

Isoplectron parallelum sp. nov.

urn:lsid:zoobank.org:act:577A6714-3C40-4422-A145-4A299C18B287

Figs 3, 8, 10D, 12H, 13I, 16A–C, 19A–C, 23C, 24A–C

Diagnosis

A small raphidophorid (body length 9 to 12 mm) characterised by the presence of six to eight longitudinal stripes on the back. Very similar to *Talitropsis poduroides* in morphology and habitat use, it can only

be differentiated from this species by examination of the male terminalia or of the female sternites and sub-genital plate (Fig. 24). While *Talitropsis poduroides* is widely distributed in North Island, the two species appear to be allopatric.

Isoplectron parallelum sp. nov. is also very similar to *I. virgatum* sp. nov. in morphology and habitat use and can only be differentiated from the latter species by examination of the male terminalia, or by the number of ventral protuberances on the female sternites (compare Figs 15G and 16A, Figs 18G and 19A). *Isoplectron parallelum* also always has a retrolateral spine at the apex of the mid femur, a trait that is usually absent in *I. virgatum*. The latter species, however, is confined to South Island, which makes confusion between the two species unlikely.

Etymology

‘*Pārrallēlus*’ (adj.) is Latin for ‘parallel’, because of the longitudinal parallel stripes on the insect’s back.

Material examined (see also Supp. file 1: Table S9)

Holotype

NEW ZEALAND • ♂, adult; Wellington (WN), Ahumairangi Town Belt, Wellington; 41.26896° S, 174.76929° E; 250 m a.s.l.; 9 Apr. 2022; D. Hegg leg.; in *Veronica* shrub; night search + insect net; NMNZ AI.071898.

Paratype

NEW ZEALAND • 1 ♀, adult; same data as for holotype; NMNZ AI.071899.

Other material

NEW ZEALAND – **Wellington (WN)** • 1 ♂; Newlands, Wellington; 41.233° S, 174.827° E; 150 m a.s.l.; 16 Apr. 2006; S. Trewick leg.; on *Eucalyptus* tree; casual find; GenBank: PP155119; MPN CW362 • 1 ♂; same data as for preceding; GenBank: PP155120; MPN CW363 • 1 ♀; Zealandia Ecosanctuary, Wellington; 41.30554° S, 174.73678° E; 250 m a.s.l.; 8 May 2006; R. Goudswaard leg.; MPN CW410 • 1 ♀; Rangitautau Reserve, Wellington; 41.33716° S, 174.82203° E; 60 m a.s.l.; 16 Oct. 2020; D. Hegg leg.; on *Phormium tenax* flower; night search + insect net; GenBank: PP155118; MPN CW5131 • 4 ♂♂; same data as for holotype; MPN CW5566 to CW5569 • 2 ♀♀; same data as for holotype; MPN CW5596, CW5598 • 1 ♀; Days Bay, Wellington; 41.27566° S, 174.90748° E; 100 m a.s.l.; 2 Oct. 2023; S. Trewick leg.; on *Melicytus ramiflorus* leaves; night search; GenBank: PP155108; MPN CW5657.

Description

MEASUREMENTS. See Table 1. Sexual dimorphism in body length, with females being larger by 1.4 mm (15%).

HEAD. Vertex pale with four brown lines running from the fastigium to the anterior margin of the pronotum, two above the eyes and two near the centre. Dark streaks run from the posterior margin of each eye to the pronotum, resembling the temples in a pair of sun-glasses. Frons, clypeus and labrum pale, with two vertical dark stripes below the scapes of the antennae. Scapes and pedicels variegated; all other segments of the antennae pale.

THORAX. Pale with brown dorsal lines running along the length of the thorax and continuing into the abdomen (Fig. 12H).

LEGS. Sexual dimorphism present. The hind tibiae are about the same length as the body in both males and females. Since females are larger than males, their hind tibiae are also longer, by approximately the same amount. Fore femora always unarmed at the apex. Mid femora armed with one retrolateral spine at the apex; prolateral apical spine absent. Hind femora armed with one or two retrolateral and prolateral

ventral linear spines, the retrolateral ones being larger. Fore tibiae armed with two pairs of ventral linear spines, and with one pair of ventral apical spines. A retrolateral dorsal spine at the apex of the fore tibia is usually present. Mid tibiae armed with two pairs of ventral linear spines, one pair of ventral spines and one retrolateral dorsal spine at the apex. A prolateral dorsal spine at the apex of the mid tibia is always absent. Hind tibiae armed with about 17 dorsal linear spines (min 14, max 22) on both the anterior and the posterior edge (Fig. 13I). Hind tibiae armed at the apex with two ventral apical spines, two dorsal apical spines and two dorsal sub-apical spines; the dorsal apical spines are largest. Ventral sub-apical spines are always absent. First and second segments in hind tarsi always unarmed except at the apex.

ABDOMEN. Tergites pale, with dorsal brown stripes running longitudinally along the whole length of the insect from the pronotum to the terminalia (Figs 12H, 23C). In females only, the seventh sternite is equipped with two ventral protuberances; the eighth sternite with one ventral protuberance (Fig. 19A).

MALE TERMINALIA. Suranal plate trapezoidal with conspicuous hair tufts on the two posterior corners; the posterior margin is bent inwards in a V-shape (Fig. 16A). Subgenital plate pear-shaped; covered in very sparse, thin tomentum except near the base on the sides, which are glabrous; with a double keel in the basal half, turning into a single keel in the distal half (Fig. 16B). Cerci on average 20% of body length, covered in sparse, mostly short hair; tapering gradually along their whole length and ending with



Fig. 24. Comparison of terminalia in two otherwise very similar species of cave wētā from the North Island of New Zealand. **A–C.** *Isoplectron parallelum* sp. nov., Ahumairangi Town Belt, Wellington. **A–B.** Dorsal and lateral view of adult ♂ terminalia (holotype, NMNZ AI.071898). **C.** Ventral view of adult ♀ terminalia (paratype, NMNZ AI.071899). **D–F.** *Talitropsis poduroides* (Walker, 1871). **D–E.** Dorsal and lateral view of adult ♂ terminalia. Lake Westmere, Whanganui (MPN CW5375). **F.** Ventral view of adult ♀ terminalia. Waipu Caves Track, Northland (MPN CW4972). Scale bars: 1 mm.

a blunt tip at the apex. Styli short and stumpy, not reaching to the apex of the subgenital plate. Paraprocts narrow, tapering right from the base to a blunt tip at the apex; glabrous (Fig. 16A).

FEMALE TERMINALIA. Subgenital plate consists of two bulging, rounded lobes, joined at the base and diverging at the apex; glabrous on the inner surface, covered in stout hair on the outer surface (Fig. 19A). Ovipositor short, 55% to 60% of body length; moderately recurved upwards from the base to the apex; lower valve with 7 to 11 teeth below at the apex; dorsal surface of upper valve serrated in distal third (Fig. 19B–C).

Distribution and habitat

Only known from Wellington and surrounds (North Island). *Isoplectron parallelum* sp. nov. is mainly found on the elongated leaves of shrubs in the genera *Phormium* and *Astelia*, where the insect's habitus blends in with the leaf's longitudinal nervature.

Genus *Praecantrix* gen. nov.

urn:lsid:zoobank.org:act:38A9C3BD-9229-4AD5-9540-537D83249989

Type species

Praecantrix silvatica gen. et sp. nov.

Diagnosis

A genus of small Rhabdophoridae (adult body length typically between 8 and 13 mm), comprising two species. The genus strongly resembles *Isoplectron* in its morphology, except in the terminalia. The male subgenital plate, which terminates in a single, rounded lobe at the apex in all species of *Isoplectron*, forks into two lobes at the apex in *Praecantrix* gen. nov. The female subgenital plate, which consists of two separate lobes in all species of *Isoplectron*, is a square extending into two small lobes in the distal corners in both species of *Praecantrix*.

Etymology

'*Praecantrix*' is Latin for 'enchantress', 'sorceress'. We chose this name because the genus is sister to *Pharmacus* ('sorcerer'). *Praecantrix* is feminine gender.

Description

Adult

MEASUREMENTS. See Table 1. Sexual dimorphism in body length, with females being larger than males by 15% to 20% in both species.

HEAD (Fig. 11C–D). Rounded in the upper half, constricted at the clypeus. Eyes with a straight inner edge facing the scapes of the antennae. Eye colour varies by species. Fastigium divided by a deep median groove; not as prominent above the vertex as in *Isoplectron*. No visible sexual dimorphism in scapes of antennae or any other head-part. Labial and maxillary palps pale, of varying length, with moderately dense covering of hair.

THORAX. Pronotum an inverted U in cross-section; lateral edges with a pronounced rim. In dorsal view, the pronotum is wider at the posterior end than at the anterior end (Fig. 12J–L).

LEGS. Sexual dimorphism present, with all leg segments longer in females than in males in both species. The ratio of leg length over body length, however, is slightly larger in males than in females. Coxae and trochanters generally of uniform pale colour. Fore and mid femora and tibiae may be uniform pale or variegated; hind legs variegated. Fore coxae with a pronounced lateral anterior spine. Fore tibiae less

than half of body length; on average 5% longer than fore femora in both males and females. Fore femora without linear spines above or below, and always without apical spines. Fore tibiae armed below, with one or two linear spines on both anterior and posterior edge in both species. The number of apical spines on the fore tibiae varies by species. Mid legs approximately 5% shorter than fore legs, otherwise with the same proportions in male and females. Mid femora without linear spines above or below; always armed with one retrolateral spine at the apex. A prolateral spine at the apex of the mid femur is always absent. Mid tibiae armed below, with one or two linear spines on both anterior and posterior edge in both species. The number of apical spines on the mid tibiae varies by species. Hind tibiae shorter than or equal to body length, depending on species. Hind femora of same length as hind tibiae. Hind femora generally armed with one to two small linear spines below on both anterior and posterior edges. Hind tibiae armed with anything between 7 and 33 linear spines above (number varies both within and between species), of similar size, on both anterior and posterior edges (Fig. 13J–K). The spines are fused to the shaft of the tibia and are never socketed or articulated. The number of apical spines on the hind tibiae varies by species. Hind tarsi with four segments; first and second segments with a pair of spines on distal end. First and second tarsal segment may be armed or unarmed above, depending on species.

ABDOMEN. Colour and tomentum vary by species.

MALE TERMINALIA. Cerci between 15% and 20% of body length depending on species; rounded at apex, variable in colour, clothed in setae. The subgenital plate looks very similar in both species, roughly pear-shaped, bilobed and widened at apex (see Fig 16).

FEMALE TERMINALIA. Subgenital plate square with rounded lobes protruding at distal corners. Ovipositor pale or reddish-brown, moderately to strongly curved upwards at apex, terminating in a sharp point; between 50% and 70% of body length depending on species. Upper valve always serrated above, strongly so in some species; lower valve with 5 and 7 strong teeth at apex on ventral edge (Fig. 19).

Nymphs

Generally look similar to adults. Due to the small size of the insects and the lack of developed terminalia, nymphs may be impossible to differentiate from their equivalents in *Isoplectron*.

Distribution

New Zealand: South Island, Stewart Island/Rakiura, and one record from the Wellington Region in North Island.

Praecantrix silvatica gen. et sp. nov.

Exclusively a forest dweller, widespread throughout New Zealand's South Island, with known observations from Stewart Island/Rakiura and the southern end of North Island (Fig. 10B), it may be encountered both in leaf litter on the forest floor and on tree trunks or in foliage, but appears to be primarily an arboreal species. With a body length under 10mm, this is the smallest species treated in this paper. Based on DNA analysis we recognize two subspecies, very similar in their overall habitus and nearly identical in the terminalia, but allopatric in their distribution. *Praecantrix silvatica silvatica* gen., sp. et subsp. nov. is found in the western regions of New Zealand's South Island from Jackson Bay to Kahurangi National Park and the Marlborough Sounds, whereas *Praecantrix silvatica lutea* gen., sp. et subsp. nov. is found along the east coast from Stewart Island/Rakiura to Wellington (Fig. 10B).

Praecantrix silvatica gen. et sp. nov. is most easily identified by its shiny look conferred by the glabrous body, by the clear, crisp line delimiting the white body under-parts and the black sides of the thoracic dorsal segments and of the abdominal tergites (Fig. 23E), and by the small number of dorsal linear spines on the hind tibiae (generally less than 15 pairs).

Praecantrix silvatica gen. et sp. nov. adults are most easily confused with nymphs of the larger *Talitropsis sedilloti*, another glabrous, shiny arboreal cave wētā with which it is sympatric. *Talitropsis sedilloti*, however, is rarely black on the dorsum and lacks the lateral black/white line. Furthermore, an examination of the terminalia will quickly reveal if a specimen at hand is an adult of the smaller species or a nymph of a larger species – and *Talitropsis sedilloti* adults are nearly twice as large as those of *Praecantrix silvatica* gen. et sp. nov.

Praecantrix silvatica silvatica gen., sp. et subsp. nov.

urn:lsid:zoobank.org:act:94CE2C17-C99C-4E92-8870-F3494E224A98

Figs 3, 9, 10B, 11C–D, 12J, 16D–F, 19D–F, 23E

Diagnosis

Praecantrix silvatica silvatica gen., sp. et subsp. nov. is very similar to the sister subspecies *Praecantrix s. lutea* gen., sp. et subsp. nov., from which it is only differentiated by the overall darker coloration of the tergites, and by the longer ovipositor. The two subspecies are allopatric.

Etymology

The Latin adjective ‘*silvātīcus*’ means ‘of or belonging to a wood or to trees’. The insect is exclusively a forest dweller.

Material examined (see also Supp. file 1: Table S10)

Holotype

NEW ZEALAND • ♂, adult; Nelson (NN), Mt Arthur Tablelands; 41.18506° S, 172.64476° E; 1170 m a.s.l.; 24 Dec. 2020; D. Hegg leg.; on tree trunk in native forest; night search + insect net; NMNZ AI.071900.

Paratype

NEW ZEALAND • 1 ♀, adult; Westland (WD), Smoothwater Bay; 43.97494° S, 168.59452° E; 0 m a.s.l.; 14 Oct. 2018; D. Hegg leg.; on tree trunk in native forest; night search + insect net; NMNZ AI.071901.

Other material

NEW ZEALAND – **Otago Lakes (OL)** • 1 ♀; Aspiring Hut, Matukituki Valley; 44.47580° S, 168.65914° E; 460 m a.s.l.; 6 May 2017; D. Hegg leg.; on tree trunk in native forest; night search + insect net; GenBank: PP155094; MPN CW3518. – **North Canterbury (NC)** • 1 ♀; Casey Hut, Poulter River; 42.89625° S, 171.87076° E; 600 m a.s.l.; 1 Oct. 2021; D. Hegg leg.; on tree trunk in native forest; night search + insect net; MPN CW5388. – **Buller (BR)** • 1 ♀; Nina Valley, Lewis Pass; 42.46093° S, 172.34196° E; 680 m a.s.l.; 26 Jan. 2018; D. Hegg leg.; leaf litter in beech forest; night search + insect net; GenBank: PP155095; MPN CW3777 • 1 ♂; Cannibal Gorge, Lewis Pass; 42.33964° S, 172.42218° E; 820 m a.s.l.; 25 Apr. 2017; D. Hegg leg.; in native forest; night search + insect net; GenBank: PP155091; MPN CW3453 • 1 ♀; Ces Clarke Hut, Paparoa Range; 42.29007° S, 171.39307° E; 900 m a.s.l.; 6 Apr. 2019; D. Hegg leg.; on tree trunk in native forest; night search + insect net; MPN CW4945. – **Nelson (NN)** • 1 ♂; Denniston Plateau; 41.73792° S, 171.78861° E; 570 m a.s.l.; 8 Jul. 2012; M. Morgan-Richards and S. Trewick leg.; bioblitz; GenBank: PP155092; MPN CW1767 • 1 ♂; Mt Arthur Hut; 41.19771° S, 172.71606° E; 1280 m a.s.l.; 21 Dec. 2020; D. Hegg leg.; on tree trunk in native forest; night search + insect net; GenBank: PP155093; MPN CW5390 • 1 ♂; Mt Arthur Tablelands; 41.18500° S, 172.64370° E; 1170 m a.s.l.; 9 Feb. 2018; D. Hegg leg.; on tree branch in native forest; night search + insect net; GenBank: PP155096; MPN CW3766 • 1 ♀; same data as for preceding; MPN CW4000 • 1 ♀; same data as for holotype; GenBank: PP155097; MPN CW5391 • 1 ♀; same data as for holotype; CW5392 • 1 ♂; Chaffey Hut, Cobb River; 41.09600° S, 172.57535° E; 880 m a.s.l.; 27 Dec. 2020; D. Hegg leg.; on tree trunk in native forest; night search + insect net; MPN CW5389. – **Marlborough**

(MB) • 1 ♂; Richmond Saddle; 41.47924° S, 173.38111° E; 1200 m a.s.l.; 20 Oct. 2018; D. Hegg leg.; hopping on forest floor; night search + insect net; GenBank: PP155098; MPN CW4136.

Description

MEASUREMENTS. See Table 1. Sexual dimorphism in body length, with females being larger by 1.5 mm (15%).

HEAD (Fig. 11C–D). Vertex pale with an elongated black patch in the middle and four dark stripes running from the eyes to the anterior margin of the pronotum, the two external stripes being thicker. Eyes black. Frons, clypeus and labrum pale, with two faint vertical dark stripes below the scapes of the antennae. Scapes and pedicels pale; flagellum variegated reddish-brown.

THORAX. Pronotum, mesonotum and metanotum glabrous and shiny, black on the sides, reddish-brown in the middle (Fig. 12J). Crisp line delimitating the dark upper parts from the white sternites.

LEGS. Rather short in both sexes. Sexual dimorphism present. The hind tibiae are about three quarters of body length in both males and females. Since females are larger than males, their hind tibiae are also longer, by approximately the same amount. Fore femora always unarmed at the apex. Mid femora armed with one retrolateral spine at the apex; prolateral apical spine absent. Hind femora armed with up to one prolateral and up to two retrolateral ventral linear spines, the retrolateral ones being larger. Fore tibiae armed with one or two pairs of ventral linear spines, and with one pair of ventral apical spines. A retrolateral dorsal spine at the apex of the fore tibia is usually absent. Mid tibiae armed with one or two pairs of ventral linear spines, one pair of ventral spines and one retrolateral dorsal spine at the apex. A prolateral dorsal spine at the apex of the mid tibia is always absent. Hind tibiae armed with about 10 dorsal linear spines (min 7, max 13) on both the anterior and the posterior edge. Hind tibiae armed at the apex with two ventral apical spines, two dorsal apical spines and two dorsal sub-apical spines; the dorsal apical spines are largest. Ventral sub-apical spines are always absent. First and second segments in hind tarsi always unarmed except at the apex.

ABDOMEN. All tergites glabrous and shiny, black on the sides, reddish-brown in the middle (Fig. 12J). Sternites pale.

MALE TERMINALIA. Suranal plate trapezoidal, the posterior, shorter side concave (Fig. 16D). Subgenital plate pear-shaped; covered in sparse, thin tomentum on the sides only; with two obvious lobes at the apex, covered with short, stout bristles on the upper side (Fig. 16E). Cerci on average 20% of body length, covered in sparse, mostly short hair; conical in the basal half, tapering to a blunt tip in the distal half. Styli short and stumpy.

FEMALE TERMINALIA. Subgenital plate square, with two rounded lobes on the distal corners, covered with sparse hair at the apex (Fig. 19D). Ovipositor approximately 65% of body length; moderately recurved upwards from the base to the apex; lower valve with 5 to 7 teeth below at the apex; dorsal surface of upper valve heavily serrated with strong teeth in distal third (Fig. 19E–F).

Distribution and habitat

Exclusively a forest insect, common and widespread in the western regions of New Zealand's South Island, on both sides of the Main Divide of the Southern Alps, from Jackson Bay to Kahurangi National Park and to the Richmond Ranges (Fig. 10B).

Praecantrix silvatica lutea gen., sp. et subsp. nov.

urn:lsid:zoobank.org:act:31C70239-046B-4818-8497-BD3359457C25

Figs 1C–D, 3, 9, 10B, 12K, 13J, 16G–I, 19G–I, 23F

Diagnosis

Praecantrix silvatica lutea gen., sp. et subsp. nov. is very similar to the sister subspecies *Praecantrix s. silvatica*, from which it is only differentiated by the overall lighter coloration of the dorsum, and by the shorter, strongly recurved ovipositor. The two subspecies are allopatric.

Etymology

The Latin adjective ‘*lūtēus*’ means ‘yellow’ or ‘orange’, after the predominant colour on the insect’s dorsum.

Material examined (see also Supp. file 1: Table S11)

Holotype

NEW ZEALAND • ♂, adult; Southland (SL), McLean Falls, Catlins Forest; 46.57093° S, 169.34823° E; 60 m a.s.l.; 4 Aug. 2017; D. Hegg leg.; on tree trunk in native forest; night search + insect net; NMNZ AI.071902.

Paratype

NEW ZEALAND • 1 ♀, adult; Dunedin (DN), Ōpoho, Dunedin; 45.85440° S, 170.53380° E; 130 m a.s.l.; 18 Jun. 2022; D. Hegg leg.; on tree trunk; night search + insect net; GenBank: PP155081; NMNZ AI.071903.

Other material

NEW ZEALAND – **Stewart Island (SI)** • 1 ♀; Rakeahua River estuary; 46.97496° S, 167.90398° E; 0 m a.s.l.; 10 Mar. 2021; J. Tweed leg.; underneath rotting log; photograph only; iNaturalist 73903375. – **Fiordland (FD)** • 1 ♂; Surprise Bay, Lake Manapouri; 45.55036° S, 167.56380° E; 180 m a.s.l.; 18 Nov. 2017; D. Hegg leg.; on tree trunk in native forest; night search + insect net; GenBank: PP155078; MPN CW3782 • 1 ♂; same data as for preceding; MPN CW4944 • 1 ♀; Dock Bay, Lake Te Anau; 45.43580° S, 167.67849° E; 240 m a.s.l.; Jan. 2014; T. Jewell leg.; on tree trunk in native forest; GenBank: PP155080; MPN CW2599. – **Southland (SL)** • 1 nymph; same data as for holotype; GenBank: PP155090; MPN CW3784 • 1 ♂; same data as for holotype; MPN CW3901 • 1 ♀; same data as for holotype; MPN CW4946 • 1 ♀; McLennan Range, Catlins Forest; 46.48570° S, 169.16642° E; 400 m a.s.l.; 1 Dec. 2018; D. Hegg leg.; on tree trunk in native forest; night search + insect net; MPN CW4951. – **Dunedin (DN)** • 1 ♀; Sullivans Dam, Dunedin; 45.80771° S, 170.52375° E; 300 m a.s.l.; 15 Aug. 2019; D. Hegg leg.; on tree trunk in native forest; night search + insect net; MPN CW4451 • 1 ♀; Staircase Hut track, Waianakarua; 45.28210° S, 170.69724° E; 420 m a.s.l.; 3 Sep. 2016; D. Hegg leg.; on tree trunk in native forest; night search + insect net; GenBank: PP155079; MPN CW3158 • 1 ♀; same data as for preceding; MPN CW3160. – **South Canterbury (SC)** • 1 ♂; Otaio Gorge; 44.52335° S, 170.92860° E; 230 m a.s.l.; 18 Mar. 2018; D. Hegg leg.; on tree trunk in native forest; night search + insect net; MPN CW4931 • 1 ♂; Claremont Bush Reserve; 44.41214° S, 171.08438° E; 150 m a.s.l.; 21 Sep. 2018; D. Hegg leg.; on tree trunk in native forest; night search + insect net; MPN CW4950 • 1 ♂; Peel Forest; 43.89657° S, 171.23457° E; 460 m a.s.l.; 3 Oct. 2020; D. Hegg leg.; on tree trunk in native forest; night search + insect net; MPN CW4968 • 1 ♀; same data as for preceding; MPN CW4969. – **Kaikōura (KA)** • 1 ♀; Hinau Walk, Kaikōura; 42.35082° S, 173.56802° E; 200 m a.s.l.; 22 Oct. 2016; D. Hegg leg.; on tree trunk in native forest; photograph only; iNaturalist 4438856. – **Wellington (WN)** • 1 ♀; Butterfly Creek, Eastbourne; 41.298° S, 174.905° E; 100 m a.s.l.; Apr. 2006; M. Morgan-Richards and S. Trewick leg.; MPN CW366.

Description

MEASUREMENTS. See Table 1. Sexual dimorphism in body length, with females being slightly larger than males.

HEAD. Same as in *P. s. silvatica*.

THORAX. Pronotum, mesonotum and metanotum glabrous and shiny, dark on the sides, red-orange in the middle (Fig. 12K). Crisp line delimitating the dark upper parts from the white sternites.

LEGS. Same as in *P. s. silvatica*, but with the number of dorsal linear spines on the hind tibiae varying between 11 and 16 on each side.

ABDOMEN. All tergites glabrous and shiny, dark on the sides, red-orange in the middle (Fig. 12K). Sternites pale.

MALE TERMINALIA. Same as in *P. s. silvatica* (see Fig. 16 G-I).

FEMALE TERMINALIA. Subgenital plate square, with two rounded lobes on the distal corners, covered with sparse hair at the apex (Fig. 19G). Ovipositor approximately 50% of body length; strongly recurved upwards from the base to the apex; lower valve with 6 to 7 teeth below at the apex; dorsal surface of upper valve heavily serrated with strong teeth in distal third (Fig. 19H-I).

Distribution and habitat

Exclusively a forest insect, common and widespread in the southern and eastern regions of New Zealand's South Island, mainly near the coast; also found on Stewart Island/Rakiura and in the Wellington Region in North Island (Fig. 10B).

Praecantrix saxicola gen. et sp. nov.

urn:lsid:zoobank.org:act:7888A528-5ABC-4CBA-AA33-4641DAA7CB26

Figs 3, 9, 10J, 12L, 13K, 16J-L, 19J-L, 23D

Diagnosis

The largest of the two species in the genus *Praecantrix* gen. nov. (body length 9 to 14 mm), it is characterised by sexual dimorphism, the females being larger than males, a pale grey colour throughout and a dense tomentum covering the whole insect. This is in contrast to *Praecantrix silvatica* gen. et sp. nov., which is glabrous and shiny, and has a clear, crisp line delimiting the white body under-parts from the dark dorsal regions.

In the western part of its distribution range, *P. saxicola* gen. et sp. nov. is sympatric with species of *Pharmacus* and with *Notoplectron brewsterense*. It is most easily differentiated from *Pharmacus* by its lighter coloration, smaller size and micro-habitat preferences, with *Pharmacus* being more often found in cracks in solid rock. *Notoplectron brewsterense* is stockier, with shorter legs, has articulated linear spines on the hind tibiae and is glabrous, whereas *P. saxicola* is covered in fine tomentum. Additionally, female *Pharmacus* and *Notoplectron* have a smooth upper valve of the ovipositor, whereas *P. saxicola* has an ovipositor serrated above in the distal third (Fig. 19K-L).

In Otago, *P. saxicola* gen. et sp. nov. is sympatric with *Isoplectron pallidum*. The latter species, however, prefers cracks or small pockets in solid rock, and (in spite of the name) has a darker body colour.

Etymology

The Latin noun ‘*saxum*’ means ‘stone’, ‘rock’; in the plural also ‘stony place’. The insect is a dweller of stony places.

Material examined (see also Supp. file 1: Table S12)

Holotype

NEW ZEALAND • ♂, adult; Mackenzie (MK), Mt Wakefield, Aoraki/Mt Cook NP; 43.71987° S, 170.12763° E; 1450 m a.s.l.; 13 May 2017; D. Hegg leg.; broken rocks on ridgeline; night search + insect net; NMNZ AI.071904.

Paratype

NEW ZEALAND • 1 ♀, adult; Central Otago (CO), Mt St. Bathans; 44.71826° S, 169.77104° E; 1650 m a.s.l.; 9 Mar. 2019; D. Hegg leg.; on rock bluffs; night search + insect net; GenBank: PP155085; NMNZ AI.071905.

Other material

NEW ZEALAND – **Central Otago (CO)** • 1 ♂, 1 ♀; Mt Kyeburn, Danseys Pass; 44.95471° S, 170.30851° E; 1100 m a.s.l.; Dec. 2013; T. Jewell leg.; in scree among bluffs; GenBank: PP155088, PP155089; MPN CW2574, CW2575 • 3 ♂♂; same data as for preceding; MPN CW2572, CW2573, CW2576 • 1 ♀; same data as for preceding; 16 Jan. 2017; D. Hegg leg.; night search + insect net; GenBank: PP155087; MPN CW3520 • 1 ♀; Awakino Ski-field, St Marys Range; 44.78° S, 170.31° E; 1800 m a.s.l.; 20 Apr. 1998; B. Sinclair leg.; in scree; MPN CW173 • 1 ♂; same data as for paratype; GenBank: PP155086; MPN CW4317 • 2 ♀♀; same data as for paratype; MPN CW4551, CW4552 • 3 nymphs; same data as for paratype; MPN CW4318 to CW4320. – **Mackenzie (MK)** • 1 ♂; Ahuriri River East Branch; 44.27917° S, 169.74279° E; 1720 m a.s.l.; 30 Apr. 2022; D. Hegg leg.; in scree among bluffs; night search + insect net; MPN CW5611 • 1 ♀; same data as for preceding; MPN CW5612 • 1 ♀; Mt Wakefield, Aoraki/Mt Cook NP; 43.70548° S, 170.12192° E; 1680 m a.s.l.; 12 Mar. 2016; D. Hegg leg.; on sparsely vegetated ground; night search; GenBank: PP155084; MPN CW2880 • 1 ♂; Mt Wakefield, Aoraki / Mt Cook NP; 43.71063° S, 170.12445° E; 1750 m a.s.l.; 18 Mar. 2017; D. Hegg leg.; broken rocks on ridgeline; night search + insect net; MPN CW3540 • 1 nymph; same data as for preceding; MPN CW3332 • 1 ♀; same data as for preceding; 17 Apr. 2017; MPN CW3946 • 1 nymph; same data as for preceding; MPN CW3947 • 1 ♀; Mt Wakefield, Aoraki/Mt Cook NP; 43.71798° S, 170.12875° E; 1540 m a.s.l.; 13 May 2017; D. Hegg leg.; broken rocks on ridgeline; night search + insect net; MPN CW3517. – **South Canterbury (SC)** • 1 ♂; Fox Peak; 43.84° S, 170.79° E; 2000 m a.s.l.; 22 Feb. 2015; S. Trewick leg.; GenBank: PP155082; MPN CW2811 • 1 ♀; same data as for preceding; GenBank: PP155083; MPN CW2812.

Description

MEASUREMENTS. See Table 1. Sexual dimorphism in body length, with females being nearly 25% larger than males.

HEAD. Vertex pale with four brown lines running from the fastigium to the anterior margin of the pronotum, two above the eyes and two near the centre. Grey patches behind the eyes. Eyes grey-green. Frons, clypeus and labrum pale, with two faint dark patches below the scapes of the antennae. Labial and maxillary palps pale. Scapes and pedicels pale; flagellum reddish-brown.

THORAX. Pronotum, mesonotum and metanotum grey with a pale median line, covered in fine tomentum (Fig. 12L).

LEGS. Sexual dimorphism present. The hind tibiae are about the same length as the body in females, 10% longer than the body in males. Since females are larger than males by approx. 25%, females have longer legs. Fore femora always unarmed at the apex. Mid femora armed with one retrolateral spine at the apex; proteral apical spine absent. Hind femora armed with up to one proteral and one to three retrolateral ventral linear spines, the retrolateral ones being larger. Fore and mid tibiae armed with two pairs of ventral linear spines, one pair of ventral apical spines and one pair of dorsal apical spines. Hind tibiae armed with about 26 dorsal linear spines (min 22, max 33) on both the anterior and the posterior edge. Hind tibiae armed at the apex with two ventral sub-apical spines, two ventral apical spines, two dorsal apical spines and two dorsal sub-apical spines; the dorsal apical spines are largest. First hind tarsal segment armed with two to seven dorsal linear spines; second hind tarsal segment occasionally armed with one dorsal linear spine.

ABDOMEN. All tergites covered in fine tomentum; grey with a pale median line running along the whole length of the body (Fig. 12L). Sternites pale.

MALE TERMINALIA. Same as in *Praecantrix silvatica* gen. et sp. nov., but with longer bristles on the two lobes at the apex of the subgenital plate (Fig. 16J–L). Cerci on average 15% of body length, covered in sparse, mostly short hair; conical in the basal half, tapering to a blunt tip in the distal half. Styli short and stumpy.

FEMALE TERMINALIA. Subgenital plate square, with two rounded lobes on the distal corners, not as pronounced as in *Praecantrix silvatica* gen. et sp. nov., covered with sparse hair at the apex (Fig. 19J). Ovipositor approximately 70% of body length; nearly straight and only weakly recurved upwards near the apex; lower valve with 5 to 7 teeth below at the apex; dorsal surface of upper valve finely serrated in distal third (Fig. 19K–L).

Distribution and habitat

A small alpine raphidophorid that inhabits the dry alpine regions east of the Southern Alps, in Central Otago and in the Mackenzie Country (Fig. 10J). It is predominantly found on scree slopes or boulder fields and is most easily recognised by the light grey or grey-brown body colour and grey-green eye colour. When disturbed, it jumps erratically up and down until it falls into a hole between rocks.

Unresolved taxa

We have one specimen (Fig. 8) from old-growth forest in Ohakune (Taupō Region, North Island), which we have been unable to resolve (specimen code MPN CW5373; GenBank: PP155150; iNaturalist 73080453). This is a male nymph belonging to a taxon that appears to be sister to *Isoplectron bicolor* sp. nov. based on DNA analysis and on the numerous ventral linear spines on the hind femora. We have spent in excess of 20 nights searching for more specimens, in all four seasons, without any luck. Most likely, we are dealing with a cryptic tree canopy species, like *I. bicolor*. The latter is the taxon for which we have obtained the smallest sample size in this study; the one adult female we have been able to collect also took in excess of ten person nights searching.

It is likely that a dedicated tree canopy sampling approach will be required to capture this elusive insect. Methods that have been employed in similar forest habitats include fogging and branch clipping (Ozanne 2005), even tree felling (Otte & Alexander 1983: 397). We do not favour any of these methods since they are destructive and they are better suited to generic biodiversity monitoring than to targeting a specific insect, especially one that cannot even be located by sound. More realistic approaches may be liaising with road maintenance crews, who occasionally need to fell trees close to the road verge, or building a structure to access the canopy, e.g. a crane or a suspended walkway (Ozanne 2005).

Discussion

Relationships between species, with notes about habitat and distribution

The genus *Isoplectron* is monophyletic comprising eight species, all endemic to New Zealand, with a distribution spanning the whole country except for Rakiura/Stewart Island and the northern regions of North Island. While these eight species share several common traits – long, slender legs, green eyes, a serrated upper valve of the ovipositor, bilobed subgenital plate in females and pear-shaped subgenital plate in males – they are otherwise quite different from one another in size, habitus and ecology. Most species are small, with a body length of just over 10 mm; *Isoplectron serratum* and *Isoplectron bicolor* sp. nov., however, may reach a body length up to 18mm. Several species are forest dwellers, some are high alpine specialists. And since most species blend in well with their surrounds, forest species tend to be predominantly brown, alpine species the colour of rock lichen, while species that live on herbaceous perennial plants have parallel longitudinal stripes.

The eight species in the genus *Isoplectron* fit into three distinct clades, each with its own unique morphological and ecological traits (Fig. 8). One group consists of two species, *Isoplectron armatum*, and *I. bicolor* sp. nov. Both species are strictly arboreal. *I. armatum* is the most common and frequently encountered species in the genus *Isoplectron* and is widespread throughout the eastern regions in both main islands of New Zealand (Fig. 10A). It reaches the highest densities in the cooler climates in southern and central South Island, and seems to become less abundant further north. *Isoplectron armatum* lives predominantly in forest, both native and exotic, including plantation forest, and most frequently hides behind flakes of loose bark or in longitudinal cracks in tree trunks during the day. However, it is also common in urban parks and gardens, and uses artificial hides (e.g., wētā motels – see Bowie *et al.* 2006); it can be also found on isolated trees. While we know it is abundant in a forest's lower storeys, we do not know if it also utilizes the tree canopy. The newly discovered species *I. bicolor*, on the other hand, is a cryptic insect that appears to be restricted to the tree canopy in unmodified forest habitats, which explains how such a large insect could have eluded collection until now. It is only known from the north-west of South Island, and its distribution range is not known to overlap with that of *I. armatum*. Nymphs of the larger *Isoplectron bicolor* resemble adult *Isoplectron armatum* in size and habitus. This might reflect maturity at different instars, which are known to vary among Rhabdiphoridae (Richards 1961e; Hubbell & Norton 1978).

A second group within the genus *Isoplectron* consists of three species, *Isoplectron pallidum*, *I. serratum* and *I. maculatum* sp. nov. These three species are unique in the genus *Isoplectron* for having distinctive dorsal linear spines on the first two hind tarsal segments, and for occupying montane or alpine habitats. They inhabit the drier mountain ranges east of the Southern Alps where they occur in a parapatric sequence with *I. pallidum* in Otago, *I. maculatum* in South Canterbury south of the Rangitata River and *I. serratum* from Mid Canterbury north to Marlborough (Fig. 10F–H). *Isoplectron pallidum* lives in montane forests in Central Otago down to 200 m a.s.l. and on rock tors above the tree line up to 1200 m a.s.l. At higher elevations it is replaced by alpine rhabdiphorids in the genus *Pharmacus*. The adult body length of *I. pallidum* (N = 23) increases with elevation (+0.13 mm per 100 m of elevation) and latitude (+0.88 mm per 100 km south) (Table 2), as would be expected according to the 'temperature – size rule' for ectotherms. In this scenario an insect's development rate is positively correlated with temperature more than growth rate, so that at higher temperatures the adult stage is reached at a smaller body size (Atkinson 1994; Klok & Harrison 2013; Brehm *et al.* 2019).

The larger species *Isoplectron serratum* and *I. maculatum* sp. nov. are both alpine specialists, found exclusively in rocky habitats above the tree line up to 2500 m a.s.l. Their distribution ranges appear to be separated by the Rangitata River, which drains the mountains immediately to the east of Aoraki/Mt Cook. The geographic divide north and south of the Aoraki/Mt Cook region and the corresponding

phylogenetic split are consistent with the pattern seen in several alpine birds and insects (Weston & Robertson 2015; Wallis *et al.* 2016; Hegg *et al.* 2022) and are attributed to Pleistocene glaciation (Wallis *et al.* 2016). As in the species *I. armatum* and *I. bicolor* sp. nov., the nymphs of the larger species *I. serratum* and of *I. maculatum* resemble adult *I. pallidum* in size and habitus.

A third clade in the genus *Isoplectron* also consists of three species, *I. ferratum* sp. nov., *I. virgatum* sp. nov. and *I. parallelum* sp. nov. All three species are forest dwellers and are found from sea level to the tree-line in New Zealand's western, wetter regions (Fig. 10C–D, I). Adult females have three to five protuberances on the seventh and eighth sternites which are likely to be involved in mating as secondary copulatory devices (Gwynne 2005) (Figs 18G, J, 19A), whereas males have similar terminalia with the paraprocts converging and touching at the apex (Figs 15G, J, 16A). *Isoplectron ferratum* is an arboreal species, common in South Island forests north of Lewis Pass, and present on Taranaki in North Island (Fig. 10C) – a distribution that spans Cook Strait and is also seen in another raphidophorid, *Miotopus richardsae* (Fitness *et al.* 2018). *Isoplectron virgatum* and *I. parallelum* are deceptively similar species, with parallel longitudinal stripes on the back, and are most often found on herbaceous perennials including the monocots *Phormium* and *Astelia*. *Isoplectron virgatum* is distributed along the west coast of South Island from the Hollyford River to Kahurangi National Park (Fig. 10I) and is sympatric with *I. ferratum* north of Lewis Pass, whereas *I. parallelum* is only known from the Wellington region at the southern extremity of North Island (Fig. 10D). While *I. parallelum* closely resembles *I. virgatum* in its morphology and ecology, genetically it cannot be differentiated from *I. ferratum* using partial mitochondrial DNA sequences (COI gene) (Fig. 8). It is not uncommon for mtDNA (DNA barcoding) to be unable to discriminate recently diverged lineages due to incomplete lineage sorting or subsequent hybridization, and there is a similar instance in *Pharmacus* (Hegg *et al.* 2022).

It is also worth noting how *I. parallelum* sp. nov. is confined to the very southern extremity of the North Island (Fig. 10D), being replaced further north by another ecologically and phenotypically similar species, *Talitropsis poduroides*. The latter species actually belongs to the genus *Neonetus* (unpubl. data), a genus that, although common, is only found in North Island. While the scenario of southern lineages extending north of Cook Strait but stopping at the southern extremity of North Island is relatively common (see Rogers 1989), there are relatively few endemic invertebrate species found only in the Wellington region (Taylor-Smith *et al.* 2020). In a scenario of warming climate it seems likely that *Isoplectron parallelum* could be displaced by *Talitropsis poduroides* expanding its range southward, thus reducing orthopteran diversity. While this is speculation not supported by data, there is good evidence for a similar range shift in the case of the Wellington tree wētā *Hemideina crassidens* (Blanchard, 1851) being displaced by the expanding range of the Auckland tree wētā *Hemideina thoracica* (White, 1846) (Bulgarella *et al.* 2014).

Species vs subspecies

In this study we recognize two species, *Isoplectron armatum* and *Praecantrix silvatica* gen. et sp. nov., as each being further subdivided into two subspecies. We use concordance of genetic and morphological clusters to form our hypothesis of distinct taxonomic units (Mallet 1995, 2013b), which is expected to result from reproductively isolated group of individuals (Mayr 1942). We consider a subspecies as a population that inhabits a clearly distinct and separated part of a species' range and is morphologically and/or genetically notably different from other subspecies (Monroe 1982; Mallet 2013a, 2013b). In both of the above species, *Isoplectron armatum* and *Praecantrix silvatica*, the two subspecies are geographically separated, can be differentiated morphologically and form genetically distinct clades. The morphological differences, however, are subtle (the width of the paraprocts in male *Isoplectron armatum*; the length and curvature of the ovipositor and the colour of the tergites in *Praecantrix silvatica*), and the genetic distance is small and comparable to within-species variation.

Having said this, we have to admit that we did not actually prove that the populations we have assigned to different subspecies aren't reproductively isolated, and that they therefore do not belong to separate species. We are really taking an educated guess, based on the available evidence and consider all taxonomic designations as hypotheses that can be tested. Scientific literature abounds with debates about whether two geographically and morphologically distinct populations should be considered different species or subspecies due to the dynamic nature of species boundaries as populations evolve (Mallet 2013a; Huang & Knowles 2016). Some recent examples include langurs in Asia (Ang *et al.* 2020), the European robin in the Canary Islands (Sangster *et al.* 2022) and the gray wolf in North America (Khidas 2023; Vilaça *et al.* 2023). We accept that in the future what we have designated as a subspecies could be elevated to species level, or vice versa. It is our belief that this uncertainty does not detract in any way from the validity of our study. We are confident that all taxa we have identified and resolved are valid, irrespective of where they are placed in the taxonomical hierarchy.

Our current knowledge suggests that both subspecies pairs are allopatric, making the use of nuclear loci to detect gene flow between subspecies in the wild impractical. Future work could focus on dense sampling at the boundaries to identify any regions where two subspecies might meet or overlap, combined with the use of molecular methods to investigate gene flow. Alternatively, it might be possible to cross-breed captive populations of *Isoplectron armatum armatum* with *I. a. aciculatum*, and of *Praecantrix silvatica silvatica* with *P. s. lutea* gen., sp. et subsp. nov., and then test the fertility of any offspring. Females obviously need to enter the experiment as nymphs to make sure they have not yet been fertilized. To our knowledge, *Isoplectron* or *Praecantrix* have not been reared in captivity before. Successful growth and reproduction in captivity need to be attained before it is possible to proceed with cross-breeding experiments.

Life history and biology of *Isoplectron* and *Praecantrix* gen. nov.

Cave wētā in the genera *Isoplectron* and *Praecantrix* gen. nov. have never been studied before; therefore, next to nothing is known about their life history. Given the differences in habitat use and ecology between species in these two genera, we should expect their life histories to be equally diverse.

Like all rhabdophorids, *Isoplectron* and *Praecantrix* gen. nov. are nocturnal insects. From opportunistic observations, we know that the activity pattern during the night varies between species and between genera. *Isoplectron* are first to leave their hides after sunset and are often spotted on tree trunks or on rock tors at dusk, well before complete darkness sets in. In karst areas, we have never found *Isoplectron* or *Praecantrix* inside a cave. At Goulard Downs for instance, in Kahurangi National Park, caves are numerous and are inhabited by several rhabdophorids including *Miotopus richardsae*, *Pachyrhamma edwardsii* (Scudder, 1869), *P. delli* (Richards, 1954) and *Macropathus filifer*. In forest we have collected *Isoplectron ferratum* sp. nov., *I. virgatum* sp. nov., *I. bicolor* sp. nov. and *Praecantrix silvatica* gen. et sp. nov. – but not once have we seen one of these species inside a cave. In Central Otago, where there are numerous abandoned mining tunnels, we have regularly found *Pleioplectron thomsoni* (Chopard, 1923) inside the tunnels, but never *Isoplectron pallidum*, even though both species are found sharing the same habitat outside. Given that the diurnal hides of *Isoplectron* are quite shallow under flakes of bark or in cracks in rock, it would seem that *Isoplectron* are among the most light-tolerant rhabdophorids. The common name 'cave wētā' is certainly a misnomer for these insects.

Like other rhabdophorids, *Isoplectron* and *Praecantrix* gen. nov. are likely omnivores, feeding on lichen, fungi and vegetable matter, occasionally scavenging or preying on other insects. Direct observations of their feeding habits, however, are scarce. Lichen seems to be a common food source for most species, since we have observed *Isoplectron armatum* and *Praecantrix silvatica* gen. et sp. nov. foraging on lichen on tree trunks, and *I. serratum*, *I. maculatum* sp. nov. and *I. pallidum* are most commonly associated with rock lichen.

The longevity and the number of life stages in species of *Isoplectron* and *Praecantrix* gen. nov. are unknown and studies of the life history of New Zealand raphidophorids are few. *Pachyrhamma cavernae* (Hutton, 1900) takes over two years to complete its life cycle (Richards 1961e). *Pachyrhamma edwardsii* has ten instars in males and eight in females (Richards 1961e), whereas *Insulanoplectron spinosum* Richards, 1970 has nine instars in males, ten in females (Butts 1983). These species are, however, larger than most *Isoplectron* and *Praecantrix*; since growth (in size) can only occur during molt, it is reasonable to assume the number of life stages in the genera *Isoplectron* and *Praecantrix* to be smaller. Tweed *et al.* (2023) suggested that *Maotoweta virescens* Johns & Cook, 2013 has a one-year life cycle with eggs hatching in spring and adults maturing in late summer/autumn, laying eggs before winter. *Maotoweta virescens* is a small forest raphidophorid, more similar in size and ecology to many of the species treated in this study; it is smaller than any species of *Isoplectron*, one or two millimeters smaller than *Praecantrix silvatica* gen. et sp. nov.

All evidence we have gathered during this study points to a seasonal one-year life cycle as the norm in *Isoplectron* and *Praecantrix* gen. nov., but remaining responsive to New Zealand's variable environmental conditions. The vast majority of populations we have sampled consist mainly of nymphs in spring and early summer, and predominantly of adults in late summer/autumn and going into winter. And yet, adults are occasionally encountered in spring, suggesting that they have survived winter, and some nymphs are seen in autumn. This suggests that by and large *Isoplectron* and *Praecantrix* overwinter in the egg stage and hatch in spring to reach maturity in mid to late summer, but exceptions are possible, and individuals can likely survive winter as subadults or adults and possibly also as nymphs. The situation is more complicated in *Isoplectron serratum*, an alpine species and one of the largest insects in the genus *Isoplectron*. In the Seaward Kaikōura Ranges, near the northern end of the species' range and in one of New Zealand's sunniest regions, the life cycle of *Isoplectron serratum* seems to be strongly synchronized univoltine, with large cohorts of same-sized nymphs in spring and populations of adults in autumn. Moving south and west towards the Main Divide of the Southern Alps, where snow cover lasts longer and the growth season is shorter, populations are a mix of nymphs and adults in summer and autumn. The summer season here may be too short for the insect to complete its life cycle, meaning that an individual may have to overwinter at least once. This is the norm for *Pharmacus*, which live at high elevation in the Southern Alps and regularly survive winter at any life stage (Hegg *et al.* 2022). Conversely *I. bicolor* sp. nov., the largest species of *Isoplectron*, lives in a mild northern region of South Island where it may experience a growth season long enough for it to complete its life cycle in a year. Alternatively, insects may be active at any time of the year, whenever environmental conditions allow, and may take longer than a year to reach maturity. The cryptic nature of this arboreal species means it is rarely encountered, so population age structure is unknown.

The 'Isoplectron pose'

Identification of cave wētā in the field is often difficult and requires attention to detail. *Isoplectron* are immediately recognizable whenever they take a posture where they fully stretch their body longitudinally, the sternum in contact with the substrate, the anterior legs extended in line with the body forwards, the mid and hind legs on the same line but in the opposite direction (Fig. 23A). In *Isoplectron armatum* this can be observed when several (up to a dozen) individuals share a roost, their bodies in full contact, forming a bundle. *Isoplectron virgatum* sp. nov. and *I. parallelum* sp. nov. align their bodies on the longitudinal nervatures of flax leaves and other herbaceous perennials in a way that may emphasise camouflage. *Isoplectron pallidum*, *I. serratum* and *I. maculatum* sp. nov. are often encountered in the same fully extended position in a dihedral corner in the rock, where they become almost invisible. With the exception of *Talitropsis poduroides*, which also extends its body longitudinally on herbaceous plants, this posture is not seen in any other New Zealand raphidophorids.

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Fig. S1. Apical spine numbering, terminology and position in Rhabdophoridae, after Fitness *et al.* (2015). Dorsal view, showing cross-sectional relationship of each potential spine on femora and tibiae. Positions are indicated as prolateral (anterior facing), retrolateral (posterior facing), inferior (ventral facing) and superior (dorsal facing).

Appendix A. English translation of the original description of *Isoplectron aciculatum* Karny, 1937 from the German language.

Appendix B. Museum specimens of *Isoplectron* Hutton, 1896.

Fig. S2. *Isoplectron armatum* Hutton, 1896, adult ♂. Holotype. Dunedin, New Zealand (CMNZ 2021.17.3). **A.** Lateral view of insect. **B.** Ventral view of terminalia (sub-genital plate). **C.** Dorsal view of terminalia. 1 mm scale bars.

Fig. S3. *Isoplectron calcaratum* Hutton, 1896, adult ♀. Holotype. Eyreton, Canterbury, New Zealand (CMNZ 2021.17.6). **A.** Lateral view of insect. **B.** Dorsal view of left hind tibia. **C.** Sub-genital plate. **D.** Lateral view of ovipositor. 1 mm scale bars.

Fig. S4. **A.** *Isoplectron aciculatum* Karny, 1937, adult ♂. Holotype. New Zealand (OUMNH ORTH097). Image © Oxford University Museum of Natural History, published with permission. 5 mm scale bar. **B.** Extract from the Hudson Collection's Orthoptera catalogue. Museum of New Zealand Te Papa Tongarewa (NMNZ), Wellington.

Fig. S5. *Setascutum ohauensis* Richards, 1972, type specimens. **A–C.** Adult ♂. Holotype. Lake Ōhau, New Zealand (OMNZ IV7928). **A.** Lateral view of insect. **B.** Ventral view of terminalia. **C.** Dorsal view of terminalia. **D–E.** Adult ♀. Allotype. Lake Ōhau, New Zealand (OMNZ IV7929). **D.** Subgenital plate. **E.** Lateral view of ovipositor. 1 mm scale bars.

Fig. S6. *Setascutum pallidum* Richards, 1972, adult ♀. Holotype. Duffers Saddle, Old Woman Range, Otago (NZAC 03015582). **A.** Lateral view of insect. **B.** Hind legs. **C.** Subgenital plate. 1 mm scale bars.

Fig. S7. *Petrotettix serratus* Richards, 1972, type specimens. **A–B.** Adult ♂. Holotype. Mt Binsler, Cass (CMNZ 000223). **A.** Lateral view of insect. **B.** Dorsal view of terminalia. **C–D.** Adult ♀. Paratype. Mt St Patrick, St James Range (CMNZ 000224). **C.** Subgenital plate. **D.** Lateral view of insect, and hind leg. 2 mm scale bars.

Fig. S8. *Petrotettix spinosus* Richards, 1972, adult ♀. Holotype. Hamilton Peak, Craigieburn Range (CMNZ 000219). **A.** Lateral view of insect. **B.** Subgenital plate. 2 mm scale bars.

Fig. S9. *Petrotettix cupolaensis* Richards, 1972, adult ♀. Holotype. Cupola Basin, Travers Range (NZAC 03016359). **A.** Lateral view of insect. **B.** Subgenital plate. 2 mm scale bars.

Fig. S10. *Petrotettix nigripes* Richards, 1972, type specimens. Mt Altimarloch, Marlborough. **A–B.** Adult ♂. Holotype. **A.** Dorsal view of insect, with legs detached (NZAC 03016360). **B.** Subgenital plate (NZAC 03015544). **C–D.** Adult ♀. Allotype (NZAC 03015510). **C.** Lateral view of insect, with leg detached. **D.** Subgenital plate. 2 mm scale bars.

Table S1. Material examined of *Isoplectron armatum armatum* Hutton, 1896. All specimens collected in New Zealand. Collector abbreviations: BT = Bianca Trewick, BTS = Briar Taylor-Smith, DH = Danilo Hegg, EXMT = Edward (Ted) Trewick, FWH = Frederick Wollaston Hutton, JG = Julia Goldberg, JW = Jim Whitfield, MF = M. Francis, MMD = Marie McDonald, MMR = Mary Morgan-Richards, OUSSA = Otago University Science Students Association, PMJ = Peter Johns, SAT = Steve Trewick.

- Table S2. Material examined of *Isoplectron armatum aciculatum* Karny, 1937. All specimens collected in New Zealand. Collector abbreviations: DH = Danilo Hegg, FWH = Frederick Wollaston Hutton, GVH = George Vernon Hudson, JN = Jan Nisbet, ML = Mike Lusk, MMR = Mary Morgan-Richards, RK = Ruud Kleinpaste, SAT = Steve Trewick.
- Table S3. Material examined of *Isoplectron bicolor* sp. nov. All specimens collected in New Zealand. Collector abbreviations: DH = Danilo Hegg, M = Miriam ?.
- Table S4. Material examined of *Isoplectron pallidum* (Richards, 1972) comb. nov. All specimens collected in New Zealand. Collector abbreviations: DH = Danilo Hegg, DvW = Donald van der Westhuizen, JSD = John Stewart Dugdale, LC = Lorraine Cook, MMD = Marie McDonald, PMJ = Peter Johns, TJ = Tony Jewell.
- Table S5. Material examined of *Isoplectron serratum* (Richards, 1972) comb. nov. All specimens collected in New Zealand. Collector abbreviations: CLB = C.L. Batchelor, DH = Danilo Hegg, IM = Ian Millar, JSD = John Stewart Dugdale, PMJ = Peter Johns, RW = R. Watson, TR = Troy Watson.
- Table S6. Material examined of *Isoplectron maculatum* sp. nov. All specimens collected in New Zealand. Collector abbreviations: DH = Danilo Hegg.
- Table S7. Material examined of *Isoplectron virgatum* sp. nov. All specimens collected in New Zealand. Collector abbreviations: BTS = Briar Taylor-Smith, DH = Danilo Hegg, JJ = Jean Jack.
- Table S8. Material examined of *Isoplectron ferratum* sp. nov. All specimens collected in New Zealand. Collector abbreviations: DH = Danilo Hegg, EXMT = Edward (Ted) Trewick, MMR = Mary Morgan-Richards, MO = Mike Ogle, SAT = Steve Trewick.
- Table S9. Material examined of *Isoplectron parallelum* sp. nov. All specimens collected in New Zealand. Collector abbreviations: DH = Danilo Hegg, MMR = Mary Morgan-Richards, RG = Ron Goudswaard, SAT = Steve Trewick.
- Table S10. Material examined of *Praecantrix silvatica silvatica* gen., sp. et subsp. nov. All specimens collected in New Zealand. Collector abbreviations: DH = Danilo Hegg, MMR = Mary Morgan-Richards, SAT = Steve Trewick.
- Table S11. Material examined of *Praecantrix silvatica lutea* gen., sp. et subsp. nov. All specimens collected in New Zealand. Collector abbreviations: DH = Danilo Hegg, JT = James Tweed, MMR = Mary Morgan-Richards, SAT = Steve Trewick, TJ = Tony Jewell.
- Table S12. Material examined of *Praecantrix saxicola* gen. et sp. nov. All specimens collected in New Zealand. Collector abbreviations: BS = Brent Sinclair, DH = Danilo Hegg, SAT = Steve Trewick, TJ = Tony Jewell.