



Introduction to the taxonomy of Iulomorphidae of New Zealand, with descriptions of two new species of *Eumastigonus* Chamberlin, 1920 (Diplopoda: Spirostreptida: Epinannolenidea)

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Abstract

The single New Zealand genus, *Eumastigonus* Chamberlin, 1920, of the millipede family Iulomorphidae (Spirostreptida: Epinannolenidea) is reviewed, diagnosed, and its morphological characters are discussed. Redescription of the generotype *E. kaorinus* Chamberlin, 1920, further records of *E. distinctior* Chamberlin, 1920, and *E. hemmingseni* Mauriès, 1983, and descriptions of two new species: *E. hallelujah* sp. n. and *E. waitahae* sp. n. are given.

Key words: millipedes, diagnosis, Cambalidea

Introduction

The long, dark brown-black millipedes of the order Spirostreptida live commonly in rotten logs and are often abundant in New Zealand forests. They are important agents in the breakdown of litter in forests and native shrubland/grassland. They also occur in extreme environments, including saline conditions of coastal dune vegetation and subalpine/alpine grasslands and herbfields. Their morphological habitus and ecological function are similar to members of the Palearctic family Julidae, order Julida. The general colour pattern, head and collum shape, position of ozopores, shape of telson and paraprocts, even of the male gonopods (the presence of structures like a “promerite”, “opisthomerite” and “flagellum”) are all shared features. There are, however, important differences as well; the arrangement of the gnathochilarial plates (especially of the mentum and the lingual lamellae), body setation and striation, modification of the first legpair of males, and the specialized morphology of the male gonopods are the basis for Iulomorphidae and Julidae to be classed in different orders. The taxonomy of the Iulomorphidae, however, is embedded in confusion and controversy, ranging from the ordinal and subordinal position of the family to its included genera. We will attempt below to briefly explain the history of this situation, but resolving the various conflicts are beyond the scope of this study.

All iulomorphid species described from New Zealand are now placed in *Eumastigonus* Chamberlin, 1920. Its position has been somewhat conjectural at the familial, subordinal, or even the ordinal levels. Attems (1903, 1914, 1928), Chamberlin (1920), Verhoeff (1944) and Hoffman (1972, 1980) all place it in the order Spirostreptida, suborder Cambalidea (= Cambaloidea), and in the family Cambalidae. Mauriès (1983) shared this opinion, but he treated Cambalida as an order, and recognised two suborders: Cambalidea, with the families Cambalidae and Cambalopsidae, and the new suborder Pseudonannolenidea, comprising four families: Choctellidae, Iulomorphidae, Physiostreptidae, and Pseudonannolenidae. In 1987, however, Mauriès published a new classification, placed Cambalidea with the same component families into Julida, elevated Pseudonannolenida (with two families: Iulomorphidae and Pseudonannolenidae) to the ordinal level separate from Spirostreptida, and listed *Eumastigonus* in the Iulomorphidae Verhoeff, 1924. Five years later basically

the same arrangement was repeated (Mauriès 1992), except that the position of Pseudonannolenidea was changed to the subordinal level under Spirostreptida (still including Iulomorphidae and Pseudonannolenidae). Cambalidea were still combined with “Julidea” to constitute the order Julida, and the position of Choctellidae remained unresolved (Fig. 1).

This classification, however, did not become widely accepted; Enghoff, for instance, in his cladistic classifications (1981, 1984, 1991) did not include cambalideans or pseudonannolenideans in Julida. The most recent classifications, by Hoffman (1999) and Shelley (2003), considered them again in the Spirostreptida, and recognized three suborders within it: Cambalidea (Cambalidae *et al.*), Epinannolenidea (Iulomorphidae *et al.*), and Spirostreptidea. Shelley (2003) synonymized Mauriès’ suborder Pseudonannolenidea at the ordinal level with Epinannolenidea Chamberlin, 1922 (Fig. 1). Confusion still reigns in the various classification databases available on the WWW, and the position of all the “cambalidan” families are chaotic (Shelley 2003, 2007). According to Shelley (2007) a particular difference between the three suborders is in the number of leg pairs modified into gonopods in males (8th, or both 8th and 9th). Resolutions of the systematic positions and statuses of Cambalidea and Epinannolenidea call for an appropriate phylogenetic analysis based on reexamination of morphological characters and preferably molecular data as well sourced from as many geographically dispersed species as possible.

The family Iulomorphidae was introduced by Verhoeff (1924). Within the Cambaloidea, Verhoeff (1924) differentiated Iulomorphidae from Glyphiulidae by the absence of knobs or longitudinal keels on the pleuroterga, and by the presence of the ozopores from the 6th ring onwards (in Glyphiulidae they start on the 5th, as usual in millipedes). With regards to gonopods: Verhoeff (1924) gave the following diagnosis: Iulomorphidae have the anterior gonopods provided with a flagellum or a pseudoflagellum, where the latter is associated with an enlarged gonopod telopodite with a groove to fit the pseudoflagellum in. In 1924, Verhoeff did not consider *Eumastigonus*, only *Dimerogonus* Attems, 1903, which was originally characterized by its author with the male first legpair being short, clawless, with the three basalmost segments being especially short and thickened (incl. femur, Figs. 2-3), and a real, muscle-supported flagellum on the anterior gonopods. Verhoeff (1924) noticed the difference in the structure of first male legpairs between the Australian *D. orophilus* Attems, 1903 (three basal segments widened) and the New Zealand *D. insulanus* (only coxa and prefemur widened), and in 1944, he erected *Insulocambala* Verhoeff, 1944 for the New Zealand species. However, he still overlooked Chamberlin’s *Eumastigonus*, which was based on the same difference more than 20 years previously. Only in 1972 did Hoffman synonymize *Insulocambala* with *Eumastigonus*.

Hoffman, in his classification (1980), placed three southern hemisphere genera in the Cambalidae (namely *Dimerogonus*, *Proscelomerion* Verhoeff, 1924, and *Eumastigonus*), although the family had all its members otherwise distributed in the northern hemisphere (North America, Hawaiian Islands, Japan, and as an exception, one or two species of *Zinagon* Chamberlin, 1957 from Chile). Since then, the Chilean genus *Zinagon* has been excluded, and a member of the Cambalidae (*Chiraziulus kaiseri* Mauriès, 1983) was also found in Iran, hence inducing more speculation on the zoogeographical importance of its distribution (Golovatch 1983). Mauriès (1987) placed *Eumastigonus* in the family Iulomorphidae, and this seems to be more justified at least by geography (Jeekel 1985). Jeekel (2006) recently added a fourth genus (*Apocoptogonus* Jeekel, 2006) to the group of three genera mentioned above (*Dimerogonus*, *Eumastigonus*, and *Proscelomerion* in Hoffman 1980) which are now all from Australia or New Zealand. Jeekel (2006) keyed *Dimerogonus* against *Proscelomerion* (another Australian genus in the family Cambalidae in his sense, but in Iulomorphidae, according to Mauriès 1987) on the basis of a missing pseudoflagellum (attached to the telopodite of the anterior gonopod), and against *Apocoptogonus*, partly by its hairless coxa of the male first legpair. However, a re-examination of *Dimerogonus orophilus* specimens from South Australia (ZMUC, see list of acronyms in Materials and Methods) proved that there is a dense hairy field (*hf*) on the anterior side of each male first coxa (Fig. 2).

Jeekel (2004, 2006) nevertheless does not elaborate in detail on the distinction between the two families Cambalidae and Iulomorphidae, except to note that the possible prime feature, the presence or absence of a

flagellum, is variable at the species level, as it is in Julidae. In addition to *Eumastigonus*, the three Australian genera also may find a much better place in Iulomorphidae, among other Gondwanan genera from Australia, Tasmania, South Africa and Chile (Schubart 1966). As regards *Eumastigonus*, with a compact distribution at hand, we can certainly reject Hoffman's (1972) conjecture that the type locality for *E. insulanus* was Stephens Is., British Columbia, rather than Stephens Island, New Zealand, whence the Schauinsland Expedition (1896–1897) also collected the famous Tuatara (as *Hatteria* Gray, 1842; see also Udvardy 1996).

Finally, Schubart (1966), in his excellent monograph dealing with all South African species of the family, used the then-prevalent term “Julomorphidae”, based on *Julomorpha*. Jeekel (1970) showed that “Julomorpha” is a misspelling of Porat's original *Iulomorpha* (Porat 1872: 13), so the family name should be Iulomorphidae, and its author is Verhoeff (1924). According to Mauriès (1987), it consists of the following 14 genera: *Amastigogonus* Brölemann, 1913, *Apocoptogonus* (an addition by Jeekel 2006), *Atelomastix* Attems, 1911, *Dimerogonus*, *Dinocambala* Attems, 1911, *Eumastigonus*, *Iulomorpha* Porat, 1872, *Merioproscelum* Verhoeff, 1924, *Podykipus* Attems, 1911, *Proscelomerion*, *Samichus* Attems, 1911, *Stenjulomorpha* Schubart, 1966, *Thaumaceratopus* Verhoeff, 1924, and *Victoricocambala* Verhoeff, 1944.

It should be mentioned that, without any explanation or morphological justification, Attems (1909) described the Japanese species *Dimerogonus flagellatus* Attems, 1909. It is a real taxonomic enigma, and it is maintained as it is now in *Nannolene* Bollman, 1887 (Jeekel 2004). *Dimerogonus*, in its present sense, is a monotypic genus occurring in the southeastern part of Australia only (*Dimerogonus orophilus* Attems, 1903).

Without detailed study of further Australian, South African and Chilean species this problem of placing the New Zealand species into either the Cambalidae or Iulomorphidae and their respective suborders, is left unresolved, but we opt for its present position in the latter family.

Thus the genus *Eumastigonus* is placed now in the order Spirostreptida, suborder Epinannolenidea, family Iulomorphidae. Chamberlin (1920) erected his new genus *Eumastigonus* with *E. kaorinus* as its type species but the first recognisable species described and now belonging to this genus is *Dimerogonus insulanus* Attems, 1903. Attems (1903) included two species in his *Dimerogonus*: *D. orophilus* from the Australian Blue Mountains, and *D. insulanus* from Stephens Island. Hoffman (1972) restudied Chamberlin's type material in the Museum of Comparative Zoology, USA, and, though he could not locate *E. kaorinus*, he reinvestigated the type of only one of the five other Chamberlin species, *E. distinctior*, and redefined *Eumastigonus*, including now Attems' *D. insulanus* also in this genus. He also synonymised *Insulocambala* Verhoeff (1944) under *Eumastigonus* Chamberlin, 1920. During the present study, with the kind help of G. Giribet and L. Leibensperger, we found the type of *Eumastigonus kaorinus* Chamberlin, 1920 in the general collection of the MCZ, under the name of “*wheeleri*” Chamberlin in ms. The type material is redescribed below.

The situation became a little more complicated as Chamberlin (1920) introduced both *Dimerogonus kaorinus*, and, two pages later, *Eumastigonus kaorinus* as new species. Hoffman (1972) restricted *Dimerogonus* to the Australian *D. orophilus* Attems, 1903, and placed *Dimerogonus* (= *Insulocambala*) in synonymy under *Eumastigonus* thus creating two *E. kaorinus* (secondary) homonyms. However, he did not state explicitly which one he considered to be senior. Mauriès (1983), when examining the paratypes of *Dimerogonus kaorinus*, found that it is a synonym of *Eumastigonus insulanus* (Attems, 1903), as is another Chamberlin's species, *E. fasciatus*. Because page precedence does not count in the sense of ICZN, we as first revisers take the opportunity here to choose *Eumastigonus kaorinus* Chamberlin, 1920 as senior homonym, thus preserving its generotypic status for *Eumastigonus* as originally designated by Chamberlin (1920).

Up to now, 7 nominal species are known as belonging to *Eumastigonus*: *E. kaorinus*, *E. distinctior*, *E. maior*, and *E. parvus*, all by Chamberlin (1920); *E. insulanus* (Attems, 1903), and *E. ater* (Chamberlin, 1920), both originally assigned to *Dimerogonus*, are now placed in *Eumastigonus* as well. Mauriès (1983) described one further species, *E. hemmingseni*.

There remain two names (and species). *Iulus (Spirostreptus) striatus* Hutton, 1877, is valid and available, and was tentatively listed by Johns & Pollard (2002) in their catalogue as *Eumastigonus striatus* (Hutton, 1877), on the basis that Hutton had recorded the syntype(s) in his personal manuscript as being in the Canterbury Museum, Christchurch. Unfortunately those syntype(s) are not present and a neotype has to be

established. Also *Iulus* (*Spirostreptus*) *antipodarum sensu* Hutton (1878) is a misidentified *Eumastigonus*. This was realised by Pocock (undated manuscript (Natural History Museum, London, seen by PMJ) who renamed it in the combination *Julomorpha huttoni*. This name is, however, unavailable. Hutton based his description on material from Wellington, Dunedin, Clyde and Preservation Inlet, Fiordland. His 1877 specimens have not survived, although there is one 1900 specimen labelled as *Iulus antipodarus* by his hand in the Museum's collection and without doubt it is a species of *Eumastigonus*. It is a credit to Pocock's astuteness in realising that it was a "*Julomorpha*" and it is to be commemorated in a new species name (Johns & Korsós in prep.).

Material and methods

The type specimens of the species described by Attems (1903) and Chamberlin (1920) were examined by PMJ in 1967. However, in the following 40 years a considerable amount of samples (over 4000 specimens) have been accumulated due to extensive collecting efforts on the whole archipelago of New Zealand, and facilitated a much more detailed review of the entire genus. This material is now housed in CMNZ, and became the subject of two study trips by ZK in 2006 and 2008. The present paper is the first of the results of this joint research, and its goal is to diagnose and to summarise the taxonomically useful characters of the genus, to redescribe *E. kaorinus* Chamberlin, 1920, the type species of the genus (which was hiding under the name "*E. wheeleri*" in the collection of MCZ) and to add two distinct new species which were immediately recognised in the bulk of the material. The complete descriptions of all the other new species (about a dozen) and an attempt at an analysis of their New Zealand distribution pattern will be the subject of subsequent paper(s) already in preparation. This is a large collection from many localities (see www.nzbiodiversity.com) and it is hoped that all species are represented. Judging from these known species and the diversity of other millipede genera in New Zealand, the *Eumastigonus* fauna is unlikely to exceed 30 species.

Type material is deposited as indicated under the species chapters; museum abbreviations are as follows: CMNZ—Canterbury Museum, Christchurch, New Zealand; HNHM—Hungarian Natural History Museum, Budapest, Hungary; MCZ—Museum of Comparative Zoology, Harvard University, Cambridge, United States; MNHN—Museum National d'Histoire Naturelle, Paris, France; ZMUC—Zoological Museum, Natural History Museum of Denmark, Copenhagen, Denmark.

Scanning electron micrographs were prepared in the School of Biological Sciences, University of Canterbury, Christchurch, using a Leica S 440 electron microscope. Gonopod and vulva drawings were made from temporary glycerin and oil of clove slide preparations.

Apart from the type series details, complete data of the material examined are not given, because of the large numbers of specimens and localities for the new species. All data pertaining to the specimens and their repositories are held in a database in the Canterbury Museum, Christchurch, New Zealand (contact info@canterburymuseum.com). Localities are given within the present-day Regional Council boundaries which also Google Maps® follow.

Genus *Eumastigonus* Chamberlin, 1920

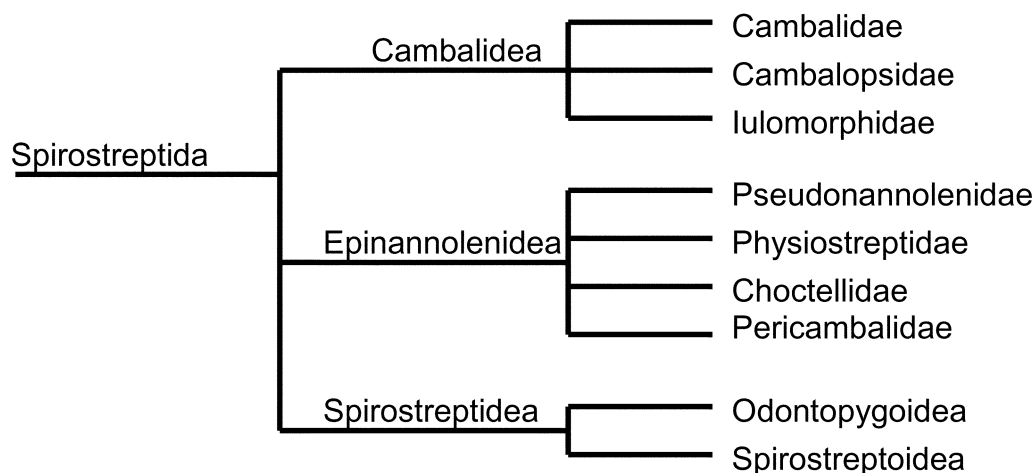
Eumastigonus Chamberlin, 1920: 62; Jeekel 1970: 09; Hoffman 1972: 200; Mauriès 1983: 256; 1987: 198; Shelley 2003: 196.

Dimerogonus Attems, 1903 partim. Verhoeff 1924: 74, 82.

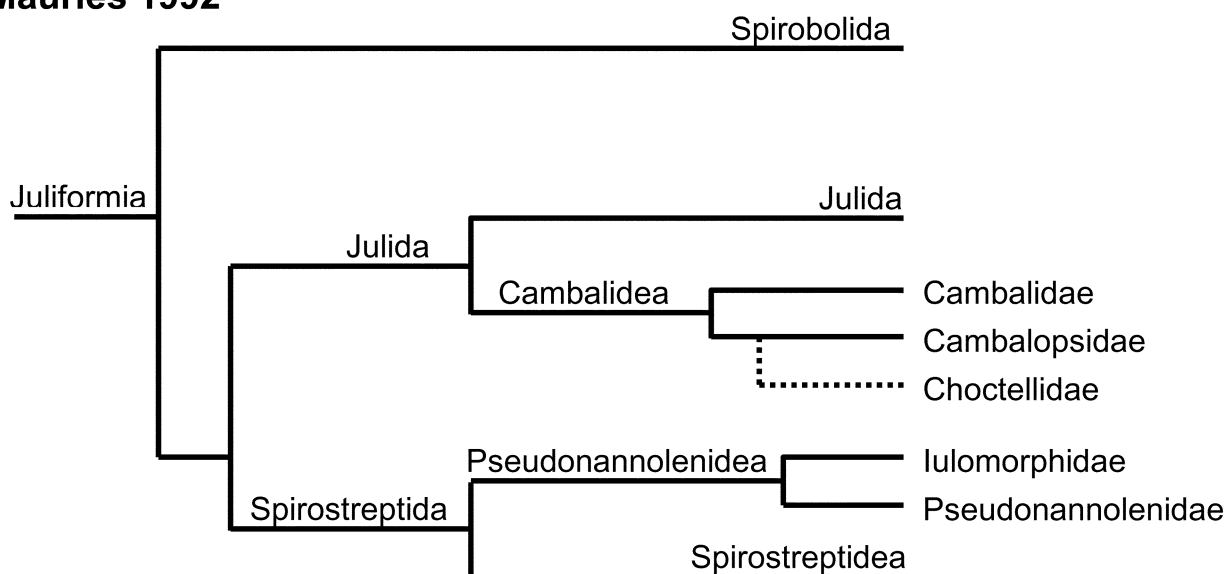
Insulocambala Verhoeff, 1944: 31; Hoffman 1972: 200.

Diagnosis: An epinannolenidean genus with modified first male legpair, and with well-developed flagellum in anterior male gonopods. Anterior gonopods with strong, hairy or pectinate coxal and telopodal processes which form sheath around straight and slender posterior gonopods.

Hoffman 1980



Mauriès 1992



Shelley 2003

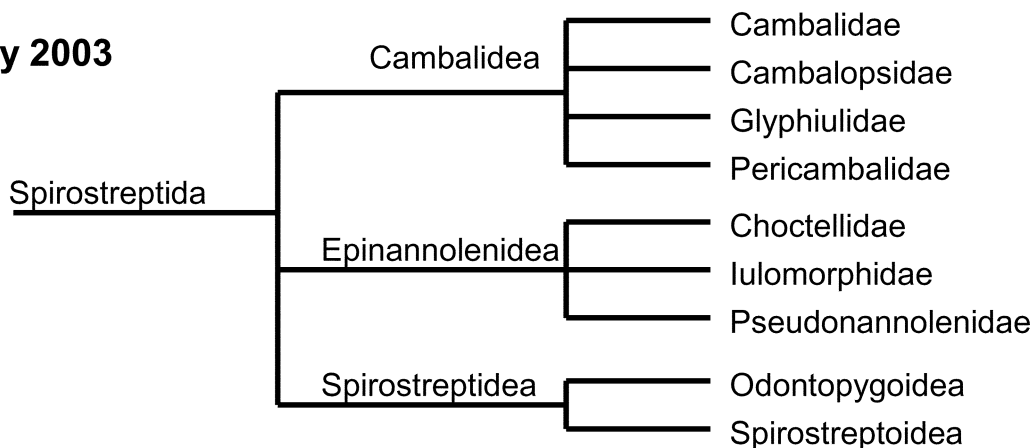
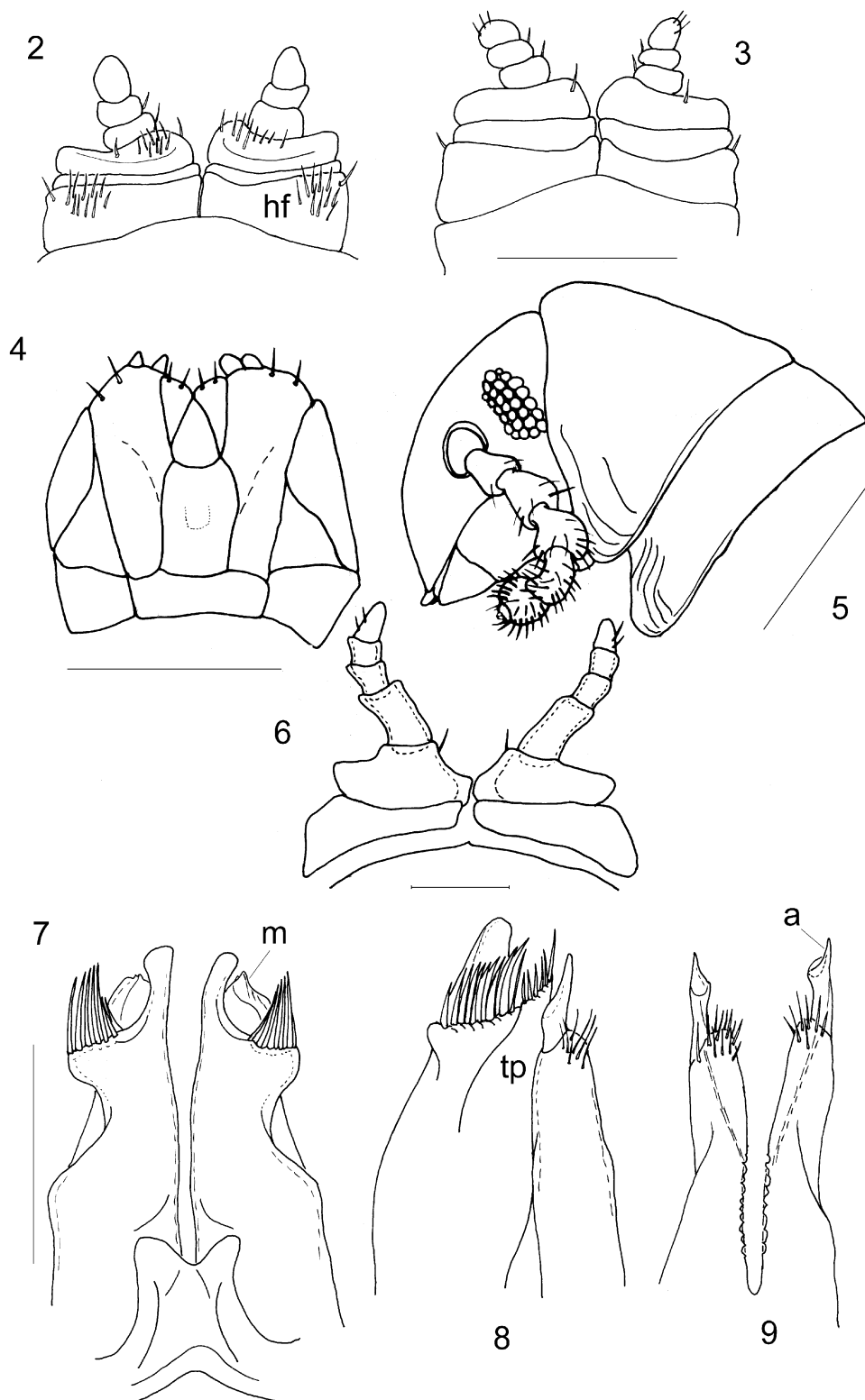


FIGURE 1. Position of Iulomorphidae in the order Spirostreptida according to different authors.



FIGURES 2–3. *Dimerogonus orophilus*: male first legpair. 2: Anterior view (hf= hairy field), 3: posterior view. Scale 0.5 mm.

FIGURES 4–9. *Eumastigonus kaorinus*. 4: Gnathochilarium of paratype female (MCZ 4868), ventral view, 5: head of holotype male (MCZ 4867), left lateral view, 6: first male legpair, posterior view, 7: anterior gonopods, anterior view (*c*= coxa, *m*= median lobe), 8: right gonopods, right lateral view, posterior gonopod removed from embrace of anterior ones, flagellum omitted (*tp*= telopodite process), 9: posterior gonopods, posterior view (*a*= apex). Scales 4–5: 1 mm, 6–9: 0.5 mm.

Type species: *Eumastigonus kaorinus* Chamberlin, 1920 by original designation.

Other included species: *E. insulanus* (Attems, 1903), *E. ater*, *E. distinctior*, *E. maior*, *E. parvus* (all Chamberlin, 1920), *E. hemmingseni* Mauriès, 1983, and *E. hallelujah* **sp. n.**, *E. waitahae* **sp. n.**

Description: Size: Length from 15 up to 80 mm, maximum midbody diameter between 1.4–4.5 mm, number of podous rings: 30–59, with 0–4 apodous, and telson.

Head as in Fig. 5; gnathochilarium generalized epinannolenidean type (cf. with Fig. 4, see also Jeekel 1985) where mentum and promentum separate; mentum large, trapezoid, widely separating gnathochilarial stipites from each other; promentum undivided, large, triangular, separating laminae linguales which contact each other at their tips, with two setae each, close to the mouth opening. Gnathochilarial stipites widening and slightly bulging frontally, with two setae along their anterior margins and more on their basal parts; in males with pair of gnathochilarial pits (*gp*) each with one short seta, whose function is probably sensory. Posterior surface of gnathochilarial stipites and mentum rugose, but with a smooth half-circle centrally. Gular (hypostomal) plate in males with two lateral depressions (probably for the anterior projections of the first legpair to fit in). Mandibular stipites in males slightly widening. No frontal setae.

Ocelli (10–45) usually in 2–5 rows or irregularly arranged in a rectangular, oval, triangular or almond-shaped ocellarium, posterior row parallel with anterior margin of collum. Antenna generally short, antennomeres 2–6th subequal in length, 1st and 7th shorter, small, with four apical sensory cones.

Collum smooth, or with three or four weak marginal furrows on its lateral anterior corner; prozonae with irregular lines, whereas metazonae with longitudinal sutures, but only in the ventral third of the segmental part below ozopores. No metazonal setae.

Ozopores only from 6th ring caudad, behind vertical segmental suture, usually small, inconspicuous, and in some cases hardly detectable on preserved specimens.

Telson invariably without projection, paraprocts rounded, smooth, hairless, or 2+2 setae along the margin of anal opening, or rarely (in one species) entirely densely setose.

Colouration: Typically uniformly dark or lighter brown, but sometimes with characteristic colour pattern: interocular region, collum anteriorly and laterally, and telson with dark brown markings, prozonae dark, metazonae, paraprocts and legs lighter. Terga sometimes with dark middorsal stripe or series of dark middorsal spots, accompanied by two longitudinal light stripes, or one wide middorsal light stripe with two dark parallel longitudinal stripes, or dorsum generally dark brown, sides below ozopores lighter.

Male sexual characters: Mandibular stipites strongly widening, trapezoidal, their ventral sides not sclerotized, slightly swollen. Gnathochilarial stipites anteriorly with one sensory pit each in a seemingly soft, slightly swollen field. 1st legpair modified, short, stout, generally hidden between head and 2nd legpair, coxa fused with sternum (coxosternum), anteriorly provided with setae at the margin, prefemur short and wide, twice as wide as long, with two anterior blunt processes whose function is unknown (but Krabbe (1979) suggested a clasping role during mating for similar processes in Spirostreptidae), femur almost normal, its length twice its width, mesal side straight, lateral side strongly concave, three apical podomeres (postfemur, tibia, and tarsus) subsimilar to each other, small, subequal in lengths and widths, tarsus without (or occasionally with) claw (Fig. 13).

Penis closely behind 2nd legpair, deeply bifurcated, with two long apical branches, reaching almost to the end of prefemur, tips tube-like with hairy openings.

Protrusion on 7th ring variable, sometimes glabrous and simple, in other cases rugose and significantly protruding, hence protecting the gonopods which emerge slightly between them.

Legpairs before and behind gonopodal ring with or without tarsal or femoral pads.

Gonopods: Anterior gonopods: sternum forming a strong, bilobed plate in anterior view; coxal processes long, promerite-like, each with one inner process and one or two marginally hairy or pectinate, median and/or lateral lobes or processes. Telopodite caudo-basally with a field of spine-like setae. All these lobes or processes form an envelope into which the posterior gonopod is accommodated; flagellum long, well-developed, curving into a groove on posterior gonopods but then, together with them, comes back in between

the processes of the anterior gonopods; posterior gonopods slender, long, more simple, usually with hairy coxal knob and thin, bent lamella (telopodite) at tip.

Female sexual characters: Vulvae embedded behind 2nd pair of legs in 3rd ring, relatively large, strongly flattened, disk-shaped, valves of bursa closely pressed against each other. Operculum small, narrow, situated anterio-laterally, tightly attached to bursa, thus whole vulva is very compact. Bursal valves with or without marginal hairs. Apodematic tube and ampulla could not be observed.

Distribution: New Zealand. Estimated to include about 30 species altogether. Some species are widespread, whereas others have restricted distributions.

Remarks: The group of spines on the posterior surface of the telopodite of the anterior gonopods can be considered as the remnant of the second telopodomere. Enghoff (1985, 1991) noticed a similar structure on the posterior gonopods of certain Nemasomatoida (cf. Fig. 42ss in Enghoff 1985, or Fig. 22f in Enghoff 1991). Nemastomatoids are considered to be close to the groundplan of Julida, and Iulomorphidae to the groundplan of Epinannolenidea, so this character can be seen as a possible sympleisiomorphy.

Eumastigonus kaorinus Chamberlin, 1920

Figs. 4–15, 22.

Eumastigonus kaorinus Chamberlin, 1920: 162. Hoffman 1972: 200.

Types: Holotype ♂ (MCZ 4867), paratype ♀ (MCZ 4868). – New Zealand, near Swainson (= Swanson, Auckland, North Island), kaori (= kauri) forest, leg. W. M. Wheeler 1914 (labelled as *Eumastigonus wheeleri*).

Other material studied: 43♂, 35♀, and 4 juvs

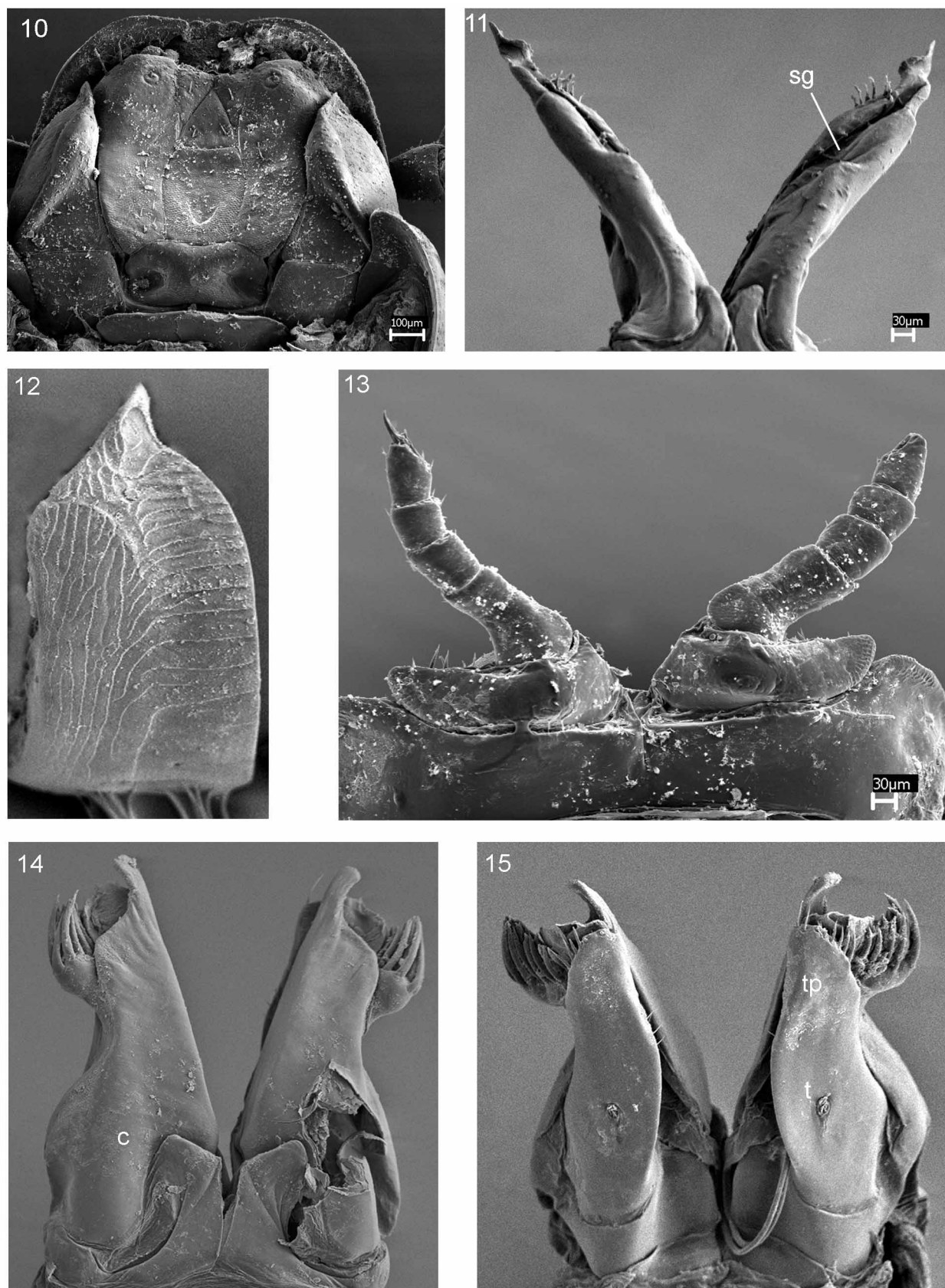
New locality records: Northland Region: Mangamuku Gorge, picnic area, 85 m, leg. F. M. Climo, 1 May 1968, 2♂, 2♀ (CMNZ). Russell, Ngaiotonga Scenic Reserve, leg. PMJ, 18 Dec. 1963, logs, 1♂, 1♀ (CMNZ). Maungaturoto, leg. PMJ, 3 Dec. 1963, in taraire-kohekohe broadleaf forest, 1♂ (CMNZ). Utakura, Matakia, 269 m, leg. PMJ, 19–26 Feb. 2006, nikau fronds, 1♂, 1♀ (CMNZ) and kanuka, 1♂, 1juv. (CMNZ). Waipoua, Trounson Kauri Park, 240 m, leg. PMJ, 3–4 Dec. 1963, logs, 2♂ (CMNZ). Whangaruru, head of peninsula, leg. F. M. Climo, 28 Apr. 1968, 2♂, 4♀ (HNHM, vulva removed for drawing) and 28 May 1968, 1♂, 4♀ (CMNZ).

Auckland Region: Waiwera, leg. PMJ, 3 Dec. 1963, pohutukawa-taraire forest, 4♂, 3♀, 1 juv. (CMNZ). Warkworth, Kowhai Park, leg. PMJ, 22 Oct. 1999, under logs and stones, 5♂, 1♀ (CMNZ). „Ahureka”, Whitford–Maraetai road, leg. P. M. Johns (PMJ), 5 Nov. 1995, under logs and stones in *Dysoxylum*, 1♂ (CMNZ). Pollok, 90 m, leg. PM & M. Johns, 7 Jan. 1964, pohutukawa-taraire forest, 1♂, 2♀ (CMNZ). Waiuku, Bush reserve, Kemps Road, 80 m, leg. PM & M. Johns, 7 Jan. 1964, 12♂, 8♀, 2 juvs (CMNZ: 1 male dissected for SEM: anterior and posterior gonopods). Waitakere Mt Range, Piha Gorge, leg. PM & M. Johns, 11 Jan. 1964, in regenerated kauri forest, 2♂, 2♀ (CMNZ: one male is dissected for SEM: head, 1st legpair, 2nd legpair with penis, gonopods, 7th ring).

Bay of Plenty Region: Rotorua, Toruhepe Scenic Reserve, 540 m, leg. PMJ, 20 Dec. 1973, ferns etc, 6♂, 7♀ (CMNZ).

Redescription based on type and recent material: Length: 32–41 mm, max. midbody diameter: 1.8–2.3 mm, no. of rings: 39–59 (holotype ♂ with 50+1+telson, paratype ♀ 47+2+telson).

Head as in Fig. 5, mandibular lobe deep, produced anteriorly, its margin broad, thin, mesal face not swollen; ocellarium broad, elongate oval or subtrapezoidal in outline, approx. 30–35 ocelli in 4–5 rows (in paratype female 5+8+9+9), smallest ocelli along anterior edge. Antennae short, antennomeres 2–6 subequal in length, 1–3 glabrous, 4th weakly, 5–7 densely setose, apically with four sensory papillae. Collum subtriangular, glabrous, posterior margin with incomplete furrow, lateral corner on both sides with 3–4 slightly bent furrows.



FIGURES 10–15. *E. kaorinus* male from Waitakere Range, Auckland Region, scanning electronmicrographs. 10: Gnathochilarium, ventral view, 11: posterior gonopods, anterior view (*sg*= seminal groove), 12: 7th ring, right lateral view, 13: first legpair, posterior view, 14: anterior gonopods, anterior view (*c*= coxa), 15: anterior gonopods, posterior view (*tp*= telopodite process, *t*= remnant of second telopodomere).

Body rings with 8–12 fine striae on metazonae only on the lower third part of the area below ozopores. Ozopores weak, closely behind suture. Telson blunt, glabrous, paraprocts rounded, with 2+2 marginal setae (cf. Fig. 48).

Colouration: Almost uniformly dark brown, the posterior edge of each ring slightly paler; head with dark vertex, pale front and sides; collum with submarginal dark band, more extensive laterally; telson dark with pale margin, anal valves dark; legs light brown.

Male sexual characters: 1st legpair short, without (rarely with) claws (Figs. 6 and 13); legs 2–6 unmodified; legs of ring 8 onwards with small prefemoral pads, decreasing in size caudally. Penis closely behind 2nd legpair, clearly divided into two branches, apical parts are long and attenuated.

Protrusion on 7th ring (Fig. 12) well-developed, protecting slightly emerging gonopods.

Gonopods, illustrated here for the first time (Figs. 7–9, 11, 14–15), heavily built, anterior gonopod coxae (*c*) basally broad, in anterior view rectangular, on their posterior surfaces mediobasally with a small field of setae (here considered as remnant of telopodite, *t* on Fig. 15), coxal processes distally with a strong lateral constriction, then widening again, almost to the same width as their bases, forming on each side a subtriangular, pectinate shoulder and a long, blunt inner process. Medial lobe of anterior gonopod (*m*) thin, membraneous, not reaching tip of inner process, posterior lobe (=telopodite process, *tp*) strong again, apical margin densely setose. Posterior gonopod slender, cylindrical, coxa with longitudinal lamina sheathing flagellum in situ, the lower inner part of its margin caudally crenulate. Posterior gonopod apically clearly articulated, tip of coxa round, obtuse, setose, telopodite slim, its length about one-sixth of entire posterior gonopod, apex (*a*) pointed, subapically a spoonlike, rounded depression. Seminal groove (*sg*) runs along anterior surface, starting on the inner side, first concealed by the lamina then reaching the setose top of coxa and going into the pointed telopodite.

Females vulvae (Fig. 22): Bursa compact, valves compressed against each other, their tips slightly pointed, anterior and posterior valves marginally with 3 and 1 setae, respectively. Operculum (*o*) small, pointed, hidden behind bursa. Inner structure not observed.

Distribution: New Zealand, North Island, Auckland and Northland Regions. See Fig. 52.

Remarks: Hoffman (1972) could not find the type of *E. kaorinus* in the MCZ, because it was labelled as *E. wheeleri* (although Hoffman surmised it, implying that Chamberlin could have changed the name without changing the original label). We found *E. wheeleri* in the MCZ under Nos 4867 and 4868, which proved to be the types of *E. kaorinus* and herewith selected these specimens as types of *E. kaorinus*.

Eumastigonus distinctior Chamberlin, 1920

Figs. 16–17, 23.

Eumastigonus distinctior Chamberlin, 1920: 164. Hoffman 1972: 202, Figs. 1–5. Mauriès 1983: 258–259, Fig.. 23.

Types: Holotype ♂ (MCZ 4872). – New Zealand, North Island, Days Bay near Wellington, leg. W. M. Wheeler 1914.

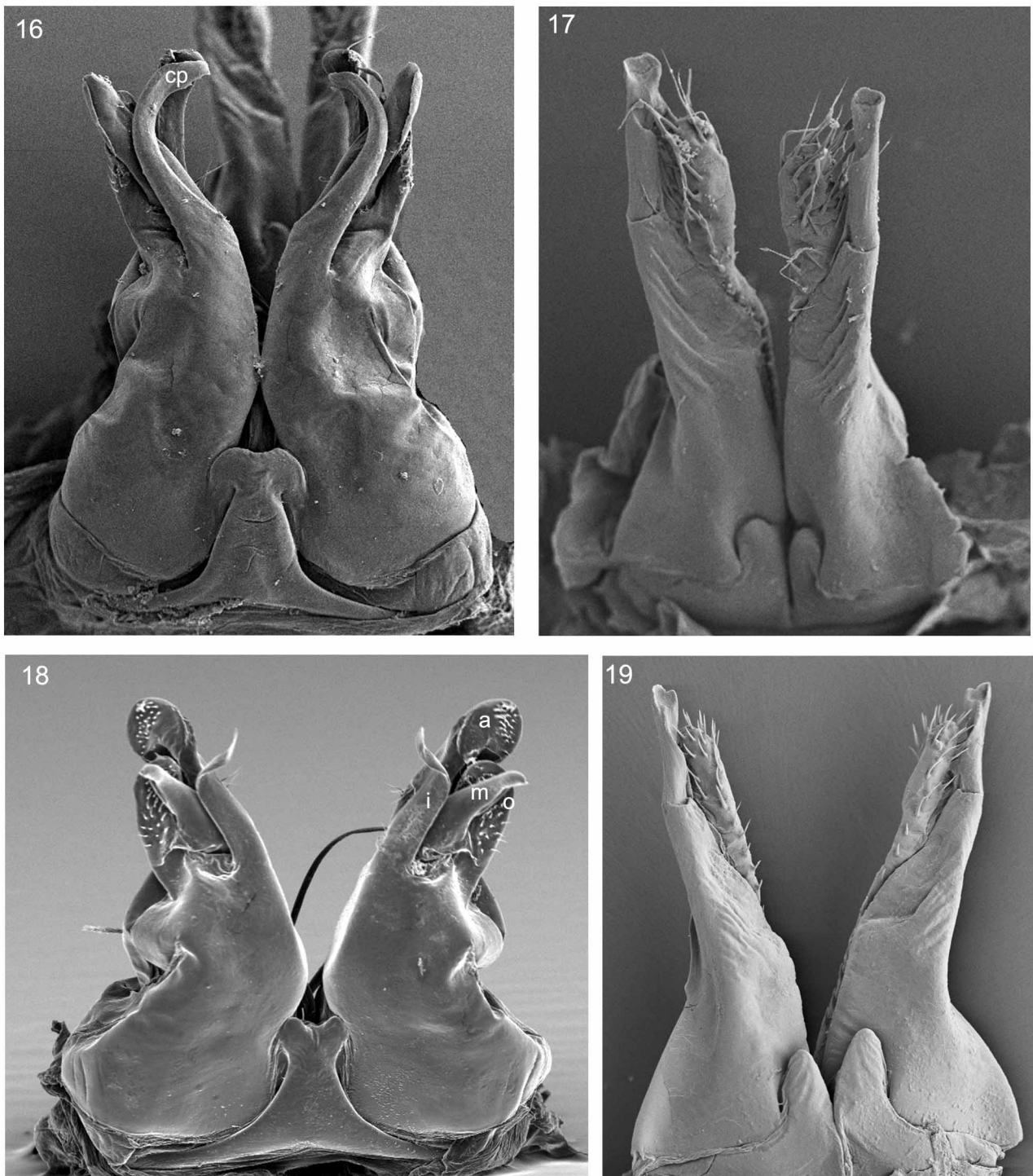
Other material studied: 2♂, 1♀ – Wellington, Porirua, 24. Dec. 1951, leg. Galathea Exp., det. Mauriès 1982 (ZMUC); and 7♂, 10♀, according to the following new records.

New locality records: New Zealand, North Island, Wellington Region: Days Bay, 120 m, leg. P. M. Johns, 15 Jan. 1964, logs, 2♂, 1♀ (CMNZ: one male is dissected for SEM: head, 1st and 2nd legpair with penis together, gonopods). Hutt Valley, Silverstream, Keith George Park, 120 m, leg. P. M. Johns, 30 Nov. 1963, mixed broadleaf forest, under logs, 1♂, 4♀ (CMNZ). Otaki, Te Horo, 25 m, leg. P. M. Johns, 30 Nov. 1963, in *Podocarpus halli* forest, under logs and stones, 3♂, 5♀ (CMNZ). Wellington, Whitemans Valley, leg. F. R. Allison, 20 May 1965, in *Nothofagus* logs, 1♂ (CMNZ).

Distribution: New Zealand, North Island, Wellington Region. See Fig. 52.

Description: The species is properly redescribed and illustrated based on the paratype material (Hoffman

1972, Mauriès 1983). It is easily recognisable by the slender, bent inner coxal process (*cp*) of the anterior gonopod (Fig. 16). As an addition, the narrow ocellarium consists of only 6–8 ocelli in 2(3) rows, and there are 2+2 setae on the paraprocts. Body rings characteristically with dark median stripe on dorsum, composed of a series of subtriangular spots, rest of body and legs lighter.



FIGURES 16–17. *E. distinctior* topotypical male from Days Bay, Wellington Region, scanning electronmicrographs. 16: Anterior gonopods, anterior view (*cp*= coxal process), 17: posterior gonopods, anterior view.

FIGURES 18–19. *E. hemmingseni* male from Otaki Forks, Wellington Region, scanning electronmicrographs. 18: Anterior gonopods, anterior view (*i*= inner lobe, *m*= median lobe, *o*= outer lobe, *a*= apex of spatulate telopodite process), 19: posterior gonopods, anterior view.

Female vulva (Fig. 23) shows the typical *Eumastigonus* characters: disc-shaped, valves and operculum (*op*) strongly compressed, each valve with pointed tip, anterior with 9–12, posterior with only one or two setae along margin. Apodemetic tube and ampulla could not be observed.

***Eumastigonus hemmingseni* Mauriès, 1983**

Figs. 18–21, 24.

Eumastigonus hemmingseni Mauriès, 1983: Bull. Mus. natn. Hist. nat., Paris (4)5(A1): 259–261, Figs. 24–26.

Types: Holotype ♂, 2♂, 2♀, and 1 imm. ♀ paratypes (ZMUC), 1 ♂ paratype (MNHN). – New Zealand, North Island, Waikato Region, Kaimanawa Mountains (State Forest), leg. A. M. Hemmingsen, 12 Dec. 1972.

Other material studied: 20♂ and 33♀

New locality records: New Zealand, North Island, Waikato Region: Waituhi Kuratau Scenic Reserve, lookout point, S38°51'46.8 – E175°32'43.2, 930 m, leg. PMJ & Z. Korsós, 27 Jan. 2008, under logs, 1♂ (CMNZ: dissected for SEM: anterior and posterior gonopods).

Taranaki Region: Mt Egmont Nat. Park, Dawson Falls and tracks nearby, 915 m, leg. M. Buchler, 6 Nov. 1963, 1♂ (CMNZ); Stratford, leg. R. S. Bigelow, 13 Dec. 1976, mailbox, 1♂ (CMNZ).

Waikato Region: Tongariro Nat. Park, Chateau, 1100 m, leg. PMJ, 8 Dec. 1961, 1♂, 7♀ (CMNZ).

Wellington Region: Akatarawa, leg. V. M. Stout, 24 Jan. 1960, in logs, 6♂, 6♀ (CMNZ) and leg. PMJ, 30 Nov. 1963, *Fuchsia* broadleaf forest, 2♂, 7♀ (HNHM, left vulva removed for drawing). Otaki Forks, Field's track, *Podocarpus* broadleaf forest, leg. PMJ, 21 Oct. 1965, 3♂, 10♀ (CMNZ: one male is dissected for SEM: head, 1st legpair, 2nd legpair with penis, gonopods, 7th ring). Tararua Range, Mangahao Dam, 340 m, leg. P. G. McGregor, 2 Nov. 1980, 2♂ (CMNZ).

Hawkes Bay Region: Outlet of Lake Waikaremoana, leg. PMJ, 4 Dec. 1961, 3♂, 3♀ (CMNZ).

Distribution: New Zealand, North Island, Auckland, Waikato, Taranaki, Bay of Plenty, Hawkes Bay and Wellington Regions. See Fig. 52.

Description: The species was properly described and illustrated by Mauriès (1983). It is notable for its relatively large size (length 68–78 mm, max. midbody diameter 3.8–4.3 mm, no. of rings 52–59+telson), and large ocellarium with ocelli in four complete rows. Body colour dark brown, but legs and paraprocts conspicuously paler, almost yellow. Paraprocts with 2+2 marginal setae. Males with femoral pads on their postgonopodal legs. Anterior gonopods with bulky, broad coxae, inner process (*i*) thin, membranous; median process (*m*) slender, smooth, bent laterally; there is also a third, flat outer process (*o*) on anterior gonopod which is provided with short setae; flagellum apically penicillate (Fig. 21, as in *distinctior*; Hoffman 1972). Telopodite longest, apically spatulate (*a*), laterally setose, broad, rounded, mediobasally with setose field (remnant of second telopodomere, *t* in Fig. 20). Posterior gonopods apically divided, setose tip of coxa extended, its length subequal to telopodite which is slim, cylindrical, tube-like, without pointed apex (Figs. 18–20).

Female vulva (Fig. 24) large, up to 1.5 mm in diameter, disc-shaped, compact. Operculum (*op*) small, narrow, triangular, anterior valve with 12–16 long marginal setae, posterior one with only one or two. Internal structure, apodemetic tube and ampulla could not be observed.

Description of new species

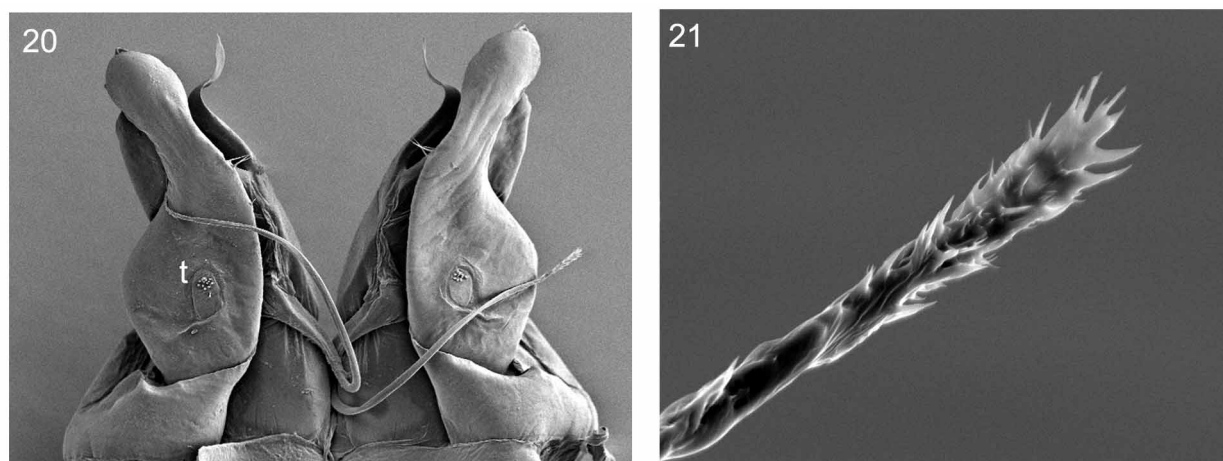
***Eumastigonus hallelujah* sp. n.**

Figs. 25, 27–32, 50.

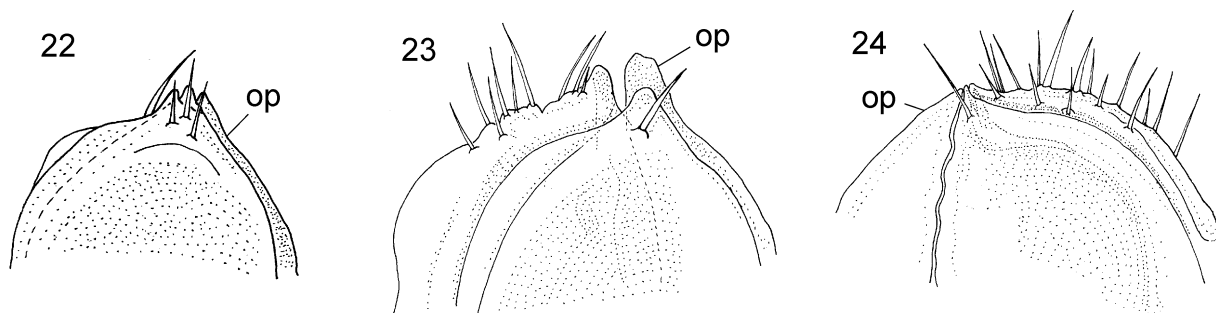
Type material: Holotype ♂ (CMNZ): New Zealand, South Island, Canterbury Region, Arthur's Pass Nat.

Park, along Hallelujah Flat to Saddle–Andrew’s Stream, leg. P. M. Johns, 20 Nov. 1961, *Nothofagus cliffortioides*, under logs.

Paratypes (25♂, 24♀, and 5 juveniles): 2♂, 2♀ (CMNZ: one male is dissected for SEM: gonopods, 7th ring) – Same locality and date 5♂, 4♀ and 2 juveniles (CMNZ) – Arthur’s Pass Nat. Park, Cass, Hallelujah Flat, Andrews Stream mouth, river terrace, 750 m, leg. P. M. Johns & M. Williams, 14 Oct. 1960, under logs; 8♂, 8♀ (HNHM, vulva prep.) – Craigieburn Range, Cave Stream, leg. Z. Korsós & Aorangi Exp., 8 Feb. 1995, in *Nothofagus* forest; 2♂ (see Fig. 24) and 1 f# (HNHM) – Craigieburn Forest Park, Lyndon Hut, S43°09’–E171°43’, picnic area, 821 m, leg. Z. Korsós, 28 May 2006, in *Nothofagus cliffortioides* forest; 1♂, 4♀ (CMNZ) – Craigieburn Range, Lyndon Hut, Cave Stream, Ski Club/picnic area, 900 m, leg. P. M. Johns, 28 May 2006, under *Nothofagus* logs; 4♂, 2♀, and 3 juveniles (ZMUC Copenhagen) – Arthur’s Pass Nat. Park, Hallelujah Flat, 750 m, leg. P. M. Johns, 22 Nov. 1961, under logs; 3♂, 3♀ (MNHN) – Arthur’s Pass Nat. Park, Poulter Valley, Rabbit Farm hut/Aeroplane Flat, 610 m, leg. P. M. Johns, 10 Feb. 1962, under logs.



FIGURES 20–21. *E. hemmingseni* male from Otaki Forks, Wellington Region, scanning electronmicrographs. 20: Anterior gonopods, posterior view (*t*= remnant of second telopodomere), 21: tip of flagellum.



FIGURES 22–24. Female vulvae (*op*= operculum). 22: *E. kaorinus* from Whangaruru headland, Northland Region, right vulva, anterior view, 23: *E. distinctior* from Porirua, Wellington Region, Galathea Expedition, 1951 (ZMUC), left vulva, posterior view, 24: *E. hemmingseni* from Akatarawa, Wellington Region, right vulva, posterior view. Scales 0.5 mm.

Other material studied: 529♂, 457♀, and 32 juveniles from about 150 sites.

Diagnosis: Closest to *E. insulanus* in size, colour, and partly in gonopod structure, but differing in ocellarium (ocelli arranged usually in 3–4 rows, in a triangular shape) and by the details of gonopods: median process of anterior gonopods have a thin, beak-like process pointed mesad, telepodite of anterior gonopods flat, parallel-sided, slightly directed mesad, apically setose. Posterior gonopods with broad, pointed apical lamella.

Etymology: Named after the type locality.

Description: Length: 19–32 mm, max. midbody diameter: 1.8–2.8 mm, no. of rings: 37–44 podous, 2–4

apodous, plus telson.

Head rounded, with no sculpture, no setae. Gnathochilarium typical cambalidean, antennae of average length, reaching 2nd ring if bent backwards. About 22–36 ocelli in 4 (rarely in 5) rows, in a triangular or elongated rectangular field.

Collum broad, rounded, covering caudal part of head until ocellarium, with only a few (2–3) short striae at its corner. Prozonae of each rings with slightly punctated surface, metazonae below ozopores with 10–14 longitudinal striae turning upwards along suture and melt into the sculpture of prozonae. Ozopores situated at about ½–1/3 of metazonal length behind suture, openings very small, sometimes hardly visible. Telson smooth, without striae, with no projection, smoothly overlaying paraprocts. Subanal plate normal, triangular without any modifications. Paraprocts glabrous, without setae.

Colouration: Live colour uniformly brown (Fig. 25), dark brown or black-brown, head, legs and paraprocts lighter, rings usually without any specific colour pattern, pro- and metazonae with same colouration. Preserved specimens in alcohol turn to almost black, or later fading to light amber colour, legs lighter or bright yellow.

Male sexual characters: Mandibular stipites, gnathochilarial stipites, 1st and 2nd legpair, and penis as characteristic for the genus. 3–7th legs normal, without modifications, walking legs from 10th onwards with femoral pads, slightly decreasing in size and finally disappearing towards end of body.

Gonopods (Figs. 27–32): Coxal part (*c*) of anterior gonopods thick, more-or-less parallel-sided, sternum (*st*) inbetween strong, wide, with two lobes obtusely rounded. Anterior gonopods with typical 3+1 well-developed distal processes. Inner coxal process (*i*) longest or subequal to telopodite; smooth, laterally flattened, shovel-shaped, subapically sometimes with stronger caudal excision. Median process (*m*) shorter, with two overlapping lobes: apical lobe beak-like, pointed mesad (this is considered as a diagnostic character), other lobe laterally attached to it like a shoulder. Outer process (*o*) blunt, obliquely cut, with a set of short hairs. Telopodite (*tp*) of anterior gonopods longer than the two coxal processes, sometimes longer than the third, inner process, wide, rounded, with longer hairs and setae along the margin. Remnant of second telopodomere missing. Flagellum long, pointed, tip without hairs, fits into seminal groove of posterior gonopods. Posterior gonopods in situ inbetween coxal and telopodital processes of the anterior gonopods, with tips (tibiotarsal part) protruding anteriorly. Sternal parts of posterior gonopods widely separated, coxal part (*c*) subparallel-sided, telopodite divided into two processes, inner one blunt, densely hairy, outer part thin, slightly bent lamella, with tip (*a*) tapering and pointed. Anterior side of posterior gonopods longwise split, with overlapping clefts housing flagellum in situ. Margin of cleft mediobasally strongly serrated, with small spikes sitting on each tooth. Tip of telopodite separated by a groove resembling a division of joints.

Protrusion on 7th ring not particularly well-developed, ventral margin just encapsulating the slightly protruding gonopods in situ.

Female sexual characters: Vulva (Fig. 50) characteristic for *Eumastigonus*, disc-shaped, compact. Tip of bursal valves pointed, anterior with 5–6, posterior with 1–2 long setae. Operculum (*op*) small, concealed behind bursa. Internal structure, apodemetic tube and ampulla could not be observed.

Distribution: New Zealand, South Island (Fig. 52). It is widespread from Nelson to Fiordland and especially common in the higher rainfall (1500–6000 mm) *Nothofagus* forests of the main alpine chain and lowland podocarp forests of Westland. Populations do exist at three very isolated sites: (1) Lake Forsyth on Banks Peninsula (dry shrubby vegetation), (2) Lindis Pass, North Otago, in rock scree under shrubby matagouri (*Discaria toumatou*), and (3) in windswept podocarp-broadleaf forest at Mt Cargill, Dunedin.

***Eumastigonus waitahae* sp. n.**

Figs. 26, 33–49, 51.

Type material: Holotype ♂ (CMNZ): New Zealand, South Island, Canterbury Region, Kaikoura, Ohau Point Scenic Reserve, 15 m, leg. P. M. Johns, 26 Aug. 2000, under rocks.

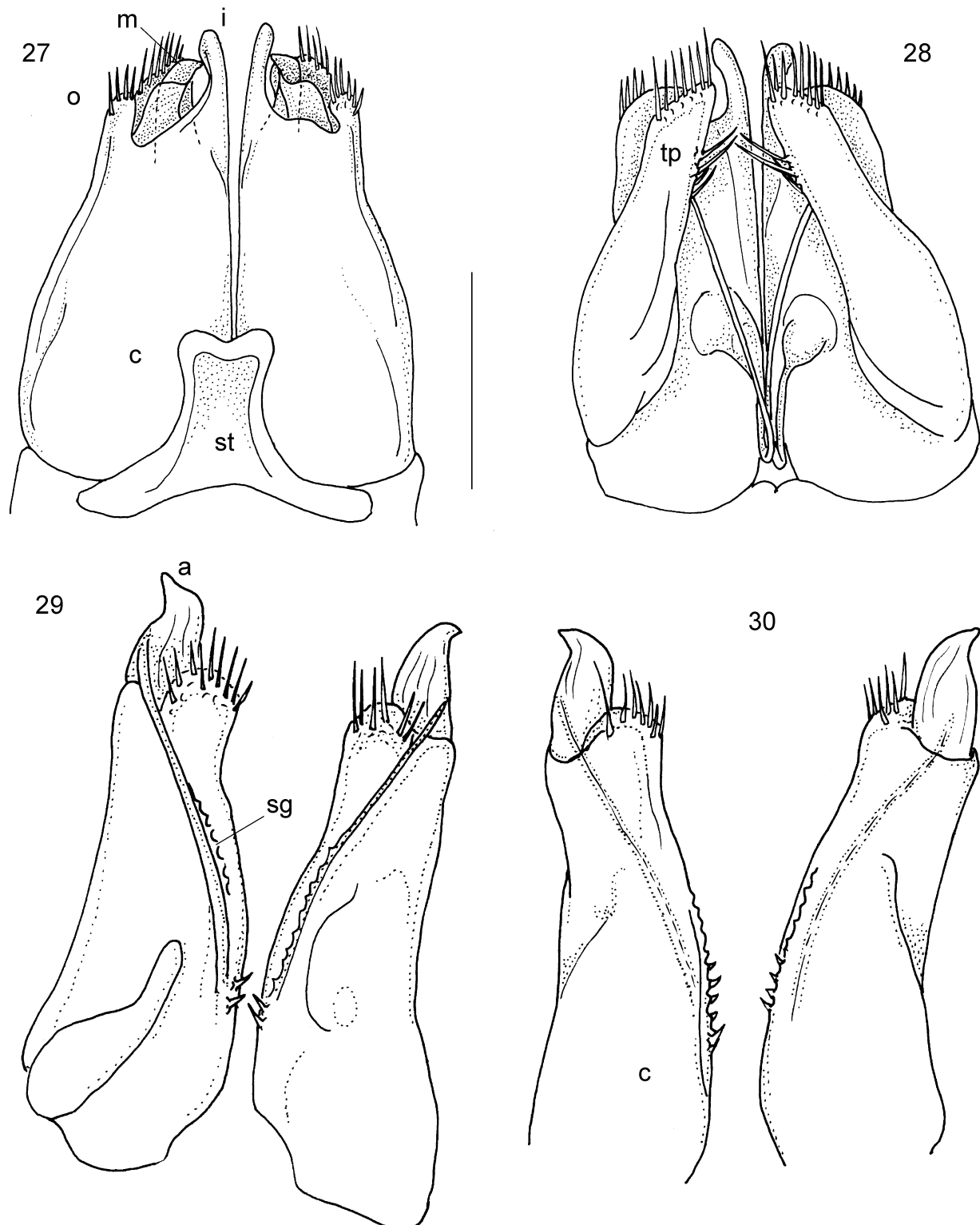


FIGURE 25. *E. hallelujah* paratype male from Craigieburn Forest Park, Canterbury Region.

FIGURE 26. *E. waitahae* paratype female from Kaikoura, Mt Fyffe Conservation Area, Marlborough Region.

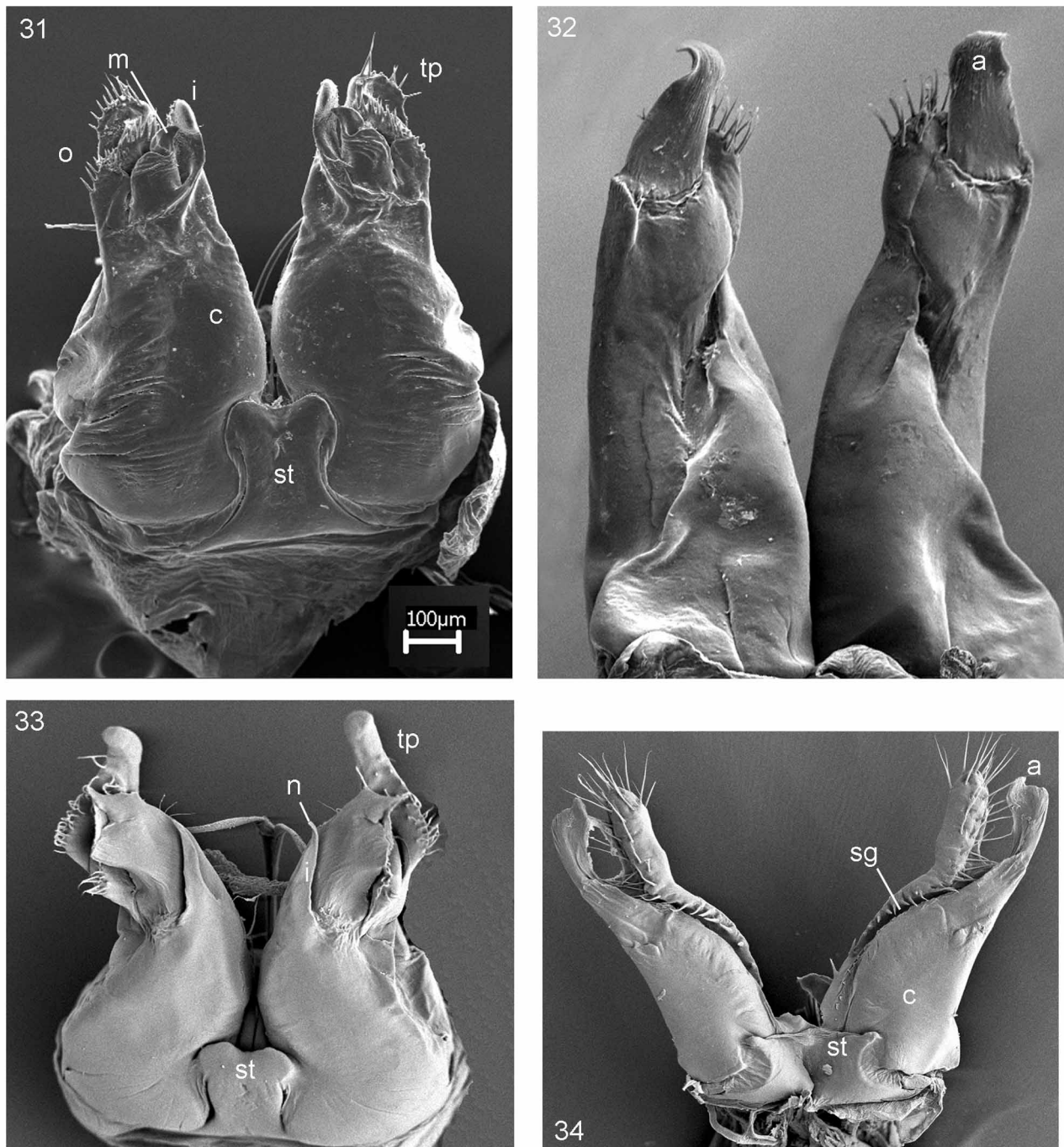
Paratypes (10♂ and 11♀): 1♀ – Same locality and date (CMNZ); 2♂, 2♀ – Kekerengu, coastal ngaio bush, 3-20 m, leg. P. M. Johns & W. Thomas, 19 July 1963; 4♂, 3♀ (CMNZ: one male is dissected for SEM: head with 1st legpair, 2nd legpair with penis, gonopods, 7th ring) – Kaikoura, Kahautara River, 280 m, leg. P. M. & M. Johns, 23 March 1962; 2♀ (HNHM, see Fig. 25, also vulva prep.) – Kaikoura, Mt. Fyffe

Conservation Area, S42° 21' – E173° 34', 192 m a.s.l., leg. Z. Korsós & P. M. Johns, 3 June 2006, coastal broadleaf forest; 1♂ (CMNZ: dissected for SEM: head, 1st legpair, 2nd legpair with penis, gonopods, anal ring). – Oxford, Okuku Pass, leg. P. M. Johns & Z. Korsós, 15 March 2008; 1♂ (MNHN Paris) – Rangiora,



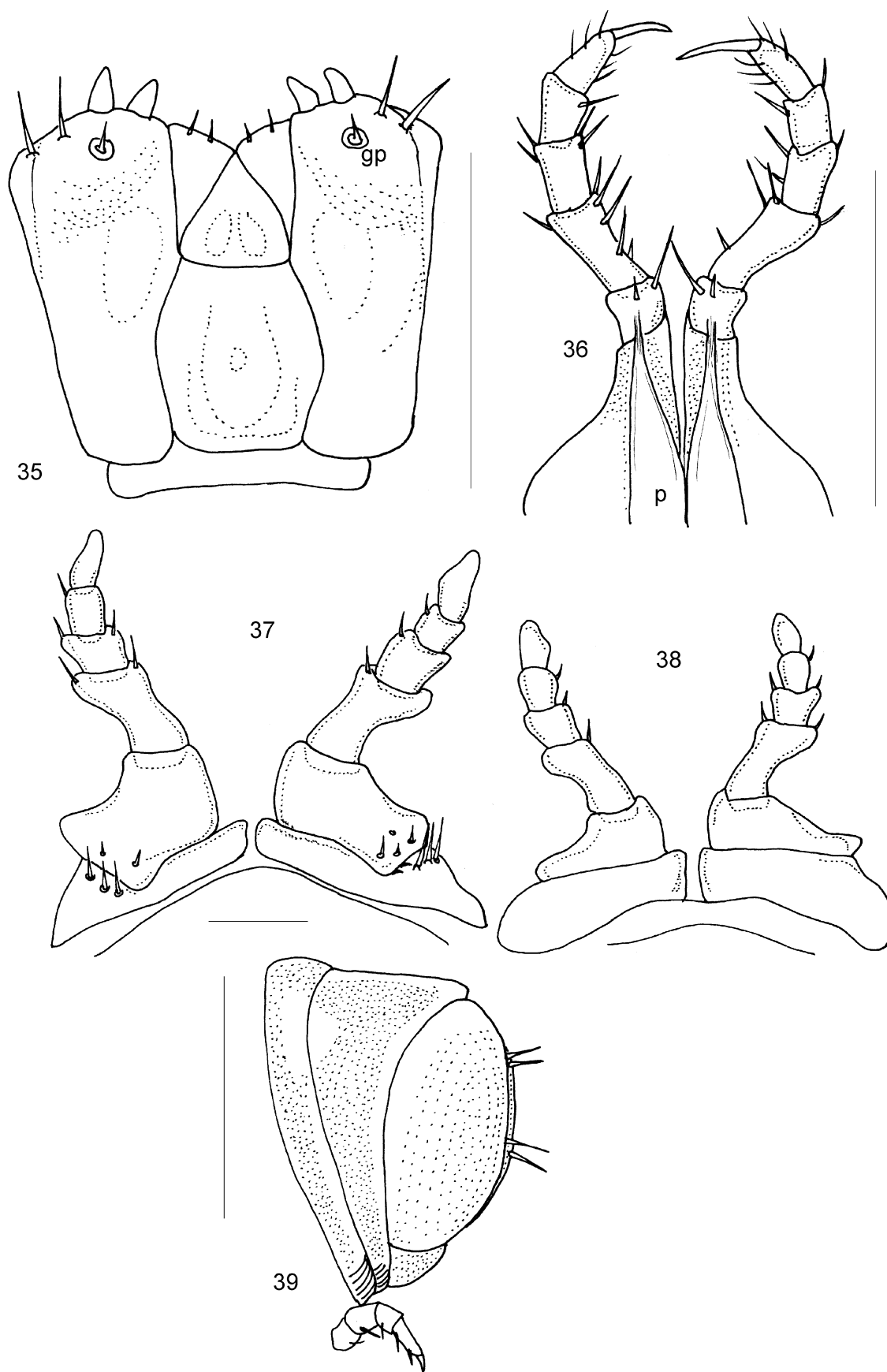
FIGURES 27–30. *E. hallelujah* paratype male from Craigieburn Range, Canterbury Region, 27: anterior gonopods, anterior view (*i*= inner lobe, *m*= median lobe, *o*= outer lobe, *c*= coxa, *st*= sternal plate), 28: anterior gonopods, posterior view (*tp*= telopodite process), 29: posterior gonopods, anterior view (*a*= apex, *sg*= seminal groove), 30: posterior gonopods, posterior view (*c*= coxa). Scale 0.5 mm.

Okuku Pass (lower stream flat) (420 m original labels), 370 m, leg. P. M. Johns, 27 Feb. 1972, stones, under *Nothofagus*; 2♂, 3♀ (ZMUC Copenhagen) – Rangiora, Okuku Pass (lower stream flat), 370 m (original label: 420 m), leg. P. M. Johns, 14 March 1970, stones, under *Nothofagus*.

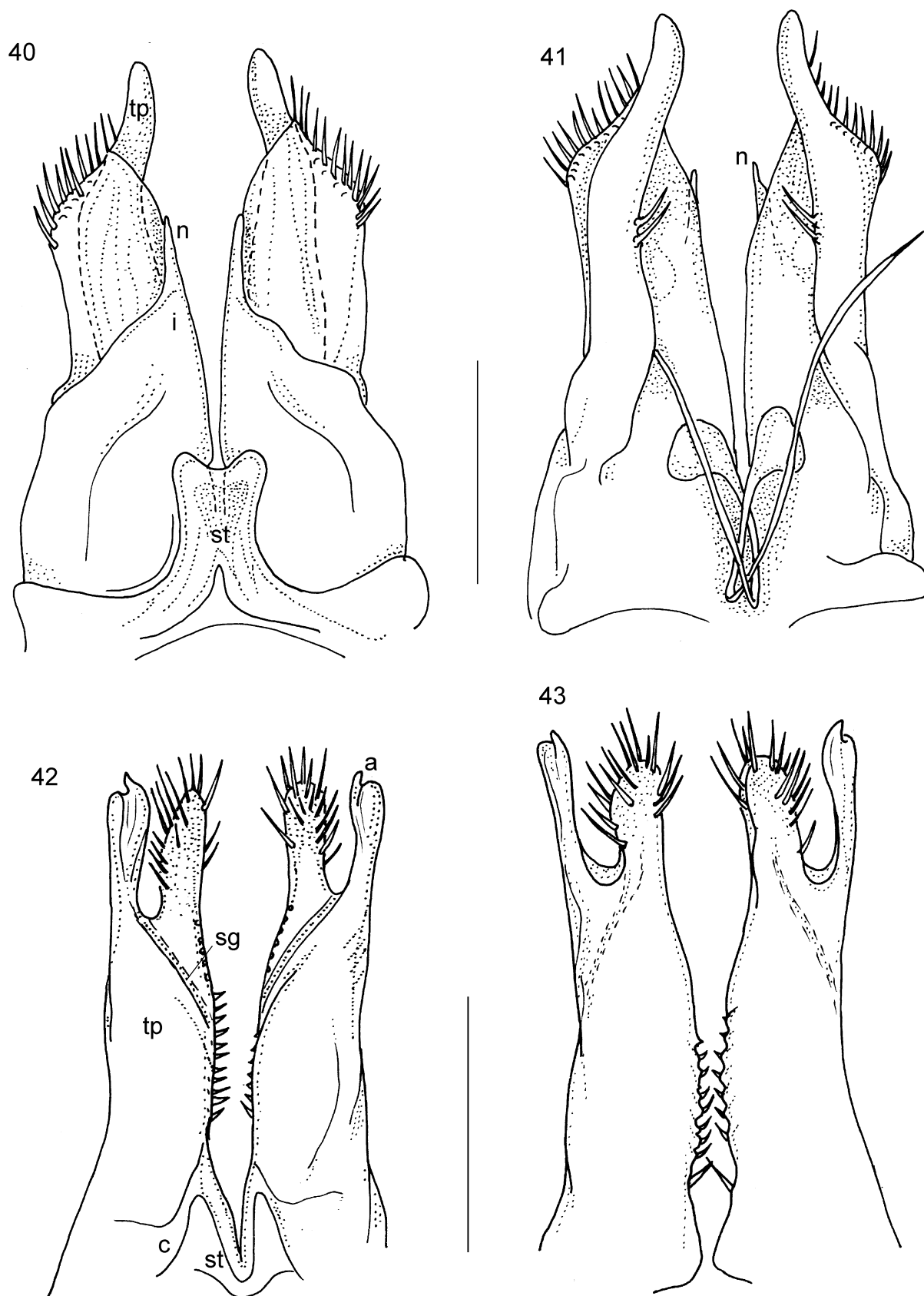


FIGURES 31–32. *E. hallelujah* paratype male from Hallelujah Flat, Arthur's Pass National Park, Canterbury Region, scanning electronmicrographs. 31: Anterior gonopods, anterior view (*i*= inner lobe, *m*= median lobe, *o*=outer lobe, *c*= coxa, *st*= sternal plate, *tp*= telopodite process), 32: posterior gonopods, posterior view (*a*= apex).

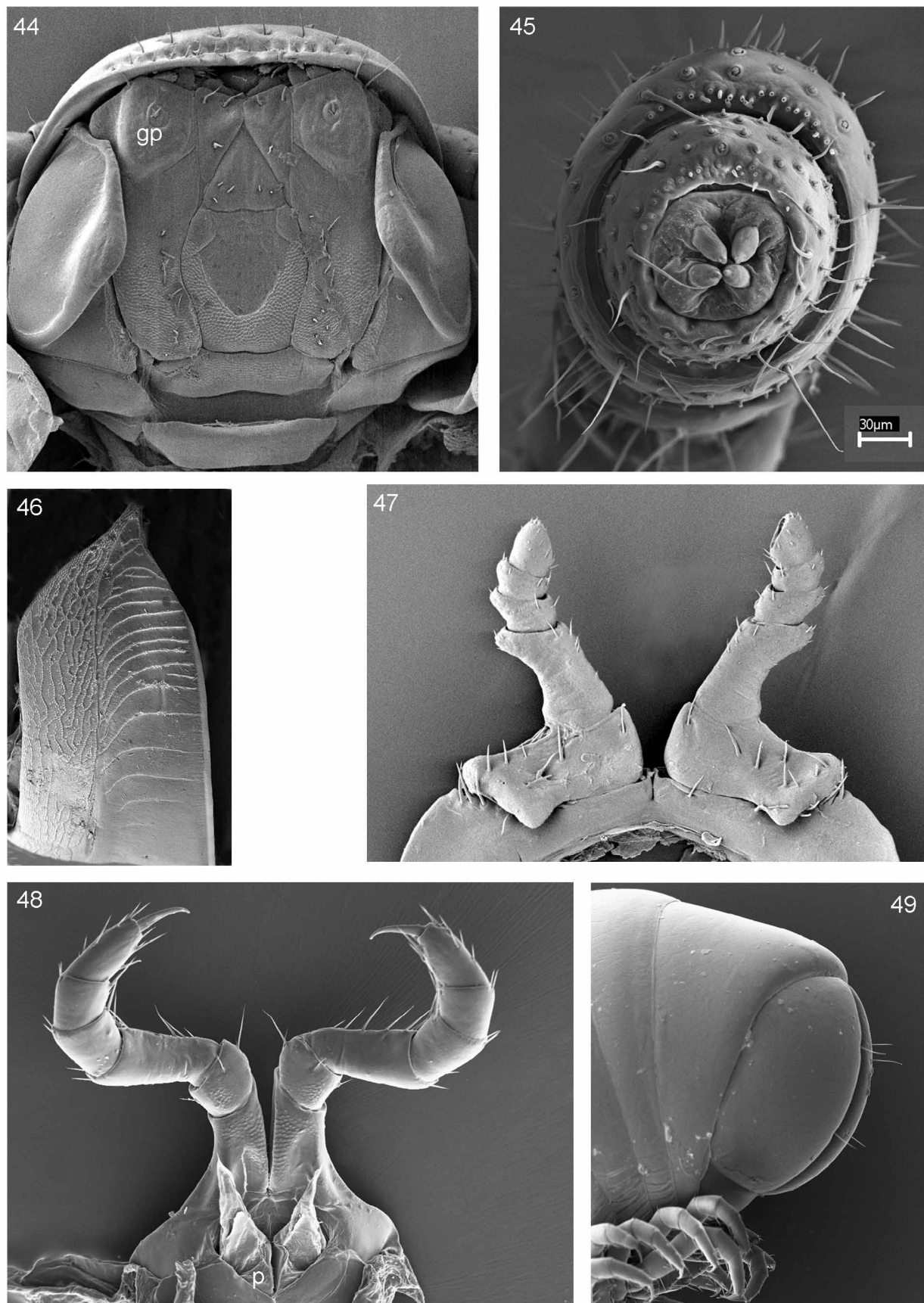
FIGURES 33–34. *E. waitahae* paratype male from Okuku Pass, Canterbury Region, scanning electronmicrographs. 33: Anterior gonopods, anterior view (*i*= inner lobe, *n*= needle-like tip, *tp*= telopodite process, *st*= sternal plate), 34: posterior gonopods, anterior view (*sg*= seminal groove, *c*= coxa, *st*= sternal plate, *a*= apex).



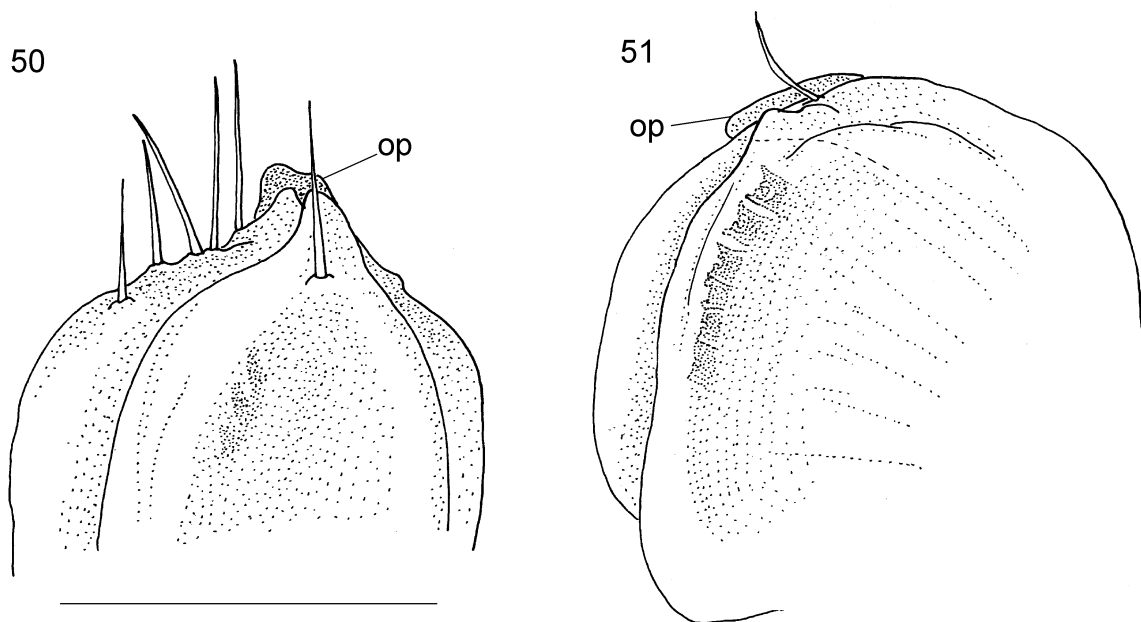
FIGURES 35–39. *E. waitahae* male from Okuku Pass, Canterbury Region. 35: Gnathochilarium, ventral view (*gp*= gnathochilarial pit), 36: 2nd legpair, posterior view (*p*= penis), 37: first legpair, anterior view, 38: first legpair, posterior view, 39: body end, left lateral view. Scales 35, 39: 1 mm, 36–38: 0.5 mm.



FIGURES 40–43. *E. waitahae* male from Okuku Pass, Canterbury Region. 40: Anterior gonopods, anterior view (*tp*= telopodite process, *i*= inner lobe, *n*= needle-like tip, *st*= sternal plate), 41: anterior gonopods, posterior view (*tp*= telopodite process, *n*= needle-like tip of inner lobe), 42: posterior gonopods, anterior view (*sg*= seminal groove, *tp*= telopodite, *c*= coxa, *st*= sternal plate, *a*= apex), 43: posterior gonopods, posterior view. Scales 0.5 mm.



FIGURES 44–49. *E. waitahae* paratype male from Okuku Pass, Canterbury Region, scanning electronmicrographs. 44: Gnathochilarium, ventral view (*gp*= gnathochilarial pit), 45: antennal tip, 46: 7th ring, right lateral view, 47: first legpair, anterior view, 48: 2nd legpair with penis (*p*), posterior view, 49: body end, left lateral view.



FIGURES 50–51. Left female vulvae, posterior view (*op*= operculum). 50: *E. hallelujah* paratype female from Craigieburn Range, Canterbury Region, 51: *E. waitahae* paratype female from Kaikoura, Mt Fyffe Conservation Area, Marlborough Region. Scales 0.5 mm.

Other material studied: 131♂, 201♀, and 12 juveniles from 60 sites.

Diagnosis: A species of *Eumastigonus*, standing quite alone with its characteristic live colour pattern (Fig. 26, and described below), and diagnostic shape of gonopods: inner coxal process short, needle-like, telopodites with wide oblique lamella marginally strongly setose, and two long cylindrical processes almost crossing each other. Posterior gonopods with two subequal processes, one blunt and hairy, the other slim and with a slightly pointed tip.

Etymology: Named after the distribution of the species, eastern part (Waitaha) of the South Island, New Zealand.

Description: Slightly smaller than the previous species, length: 16–28 mm, max. midbody diameter: 1.4–2.4 mm, no. of rings: 30–45 podous + 1–4 apodous and telson.

Head rounded, glabrous, with typical pattern, no setae, gnathochilarium and antennae as in generic description (Figs. 35, 44–45). Ocelli in 3–4 rows, in less number (14–23) than the previous species, in a compact irregular, oval or subrectangular field.

Collum broad, rounded, covering caudal part of head until ocellarium, with a few (2–3) but distinct short striae at its corner. Prozonae of each ring with slightly reticulated surface, metazonae below ozopores with 10–14 longitudinal striae turning upwards along suture and melting into the sculpture of prozonae. Ozopores situated at about 1/2 metazonal length behind suture, openings distinct, easily visible. Telson smooth, without striae and/or projection, paraprocts with 2+2, rarely 1+1 marginal setae (Figs. 39, 49).

Colouration: The typical live colouration involves a light greyish-brown ground colour with conspicuous dark brown markings (Fig. 26): a transversal stripe between ocellaria, broad anterior margin on collum, antero-lateral edge of mandibular stipites, a series of dark brown side spots on the lower third of metazonae and at about the level of ozopores, and transversally oval or diamond-shaped patches along the dorsum. This colour pattern can fade, especially in populations going inland on the northeastern part of South Island; most typical pattern shown in the east coast specimens. Head pattern and dark brown telson with contrastingly light paraprocts are invariable, however.

Male sexual characters: Mandibular and gnathochilarial stipites, first legpair (Figs. 37–38, 47) as for *Eumastigonus*, coxa wide, flat, laterally with small group of setae; prefemur with strong triangular process

(provided with short setae) directed frontally; femur, postfemur, tibia and tarsus normal, clawless. 2nd legpair (Figs. 36, 48) normal, coxae separate, elongated, deeply bifurcated penis (*p*) closely behind them, its tips tube-like with hairy openings. Prefemur subquadrate, caudally with 2+2 setae, one long and one short, femur and other podomeres normal, claw long. 3–7th legs normal, without modifications, walking legs from 10th onwards with femoral pads.

Protrusion on 7th ring (Fig. 46) conspicuous, surrounding and protecting embedded gonopods behind.

Gonopods (Figs. 33–34, 40–43): Anterior gonopods with wide, bilobed sternal plate (*st*), inner coxal process (*i*) short, reaching only to half of length of entire gonopod, with pointed, needle-like tip (*n*) closely clung to median lobe. Telopodites (*tp*) each with a lateral, obliquely cut shoulder marginally with a set of hairs, and a pair of long cylindrical processes bent mesad, almost like wanting to cross each other. Remnant of second telopodomere missing. Flagellum attached to coxae of anterior gonopods, long, pointed, tip not penicillate, in situ fits into seminal groove of posterior gonopods. Coxal parts of posterior gonopods (*c*) widely separated, telopodite (*tp*) parallel-sided, apically divided into two processes subequal in length, inner one blunt, densely setose, lateral part slimmer and thinner, its tip (*a*) small, tooth-like. Anterior side of posterior gonopods longwise split, with overlapping clefts housing flagellum in situ. Margin of cleft mediobasally strongly serrated, with small spikes sitting on each tooth. Seminal groove (*sg*) runs entirely on anterior side along cleft, and ends between the two terminal branches, perhaps opening at base of lateral one.

Female sexual characters: Vulva (Fig. 51) typical *Eumastigonus*-like, disc-shaped, compressed, opculum (*op*) very small. Posterior bursal valve with a single seta only, anterior hairless. Instead, in bursal opening, between valves a series (5–6) of peculiar small, quadratic objects whose fine structure, however, even with SEM could not be revealed.

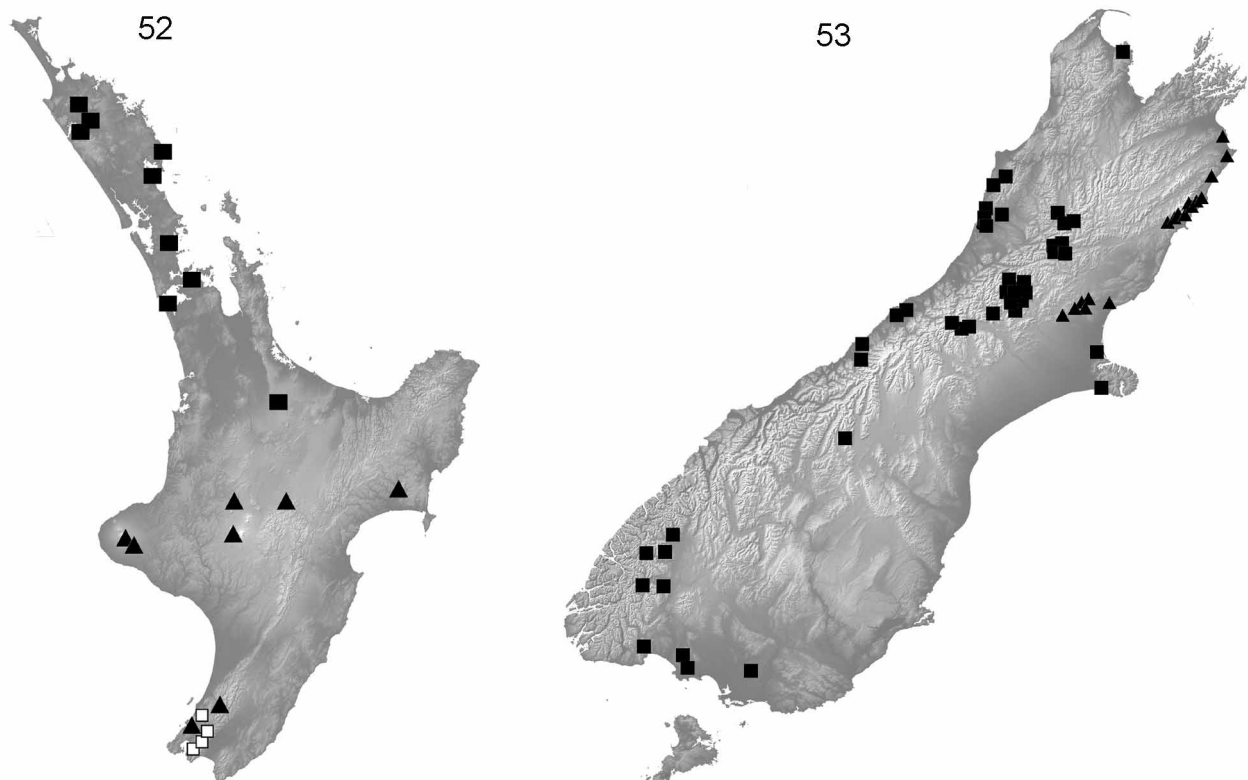


FIGURE 52. New Zealand, North Island, distributions of *E. kaorinus* (infilled squares), *E. distinctior* (blank squares), and *E. hemmingseni* (infilled triangles).

FIGURE 53. New Zealand, South Island, distributions of *E. hallelujah* (infilled squares), and *E. waitahae* (infilled triangles).

Distribution: New Zealand, South Island, Canterbury and Marlborough Regions (Fig. 53). All records are centered on low broadleaf forest or shrub vegetation. Some sites are quite dry with yearly rainfall being less than 700 mm. It is restricted to the north-eastern portion of the South Island from Dashwood Pass, Blenheim, to Kaikoura where it is very common in the steep forest down to the tussocks close to the sea. In North Canterbury it is in podocarp and *Nothofagus* forests, and on Banks Peninsula it is in many types of vegetation, some of which has been modified over the years by farming.

Acknowledgements

We express our grateful thanks to Anthony Wright, Jerry Champion, Lesley Colsell, Simon Pollard, and Evelien Huismans in the Canterbury Museum, Christchurch, for their permits and arrangements during the work. ZK's two visits to New Zealand were financially supported by the Systematic Research Fund of the Linnean Society, London, the Mason Fund, Christchurch, the Hungarian Scientific Research Fund (OTKA 69235), and the Hungarian Natural History Museum, Budapest (Director-General István Matskási). Neil Andrews, University of Canterbury, School of Biological Sciences, helped to prepare the scanning electron micrographs. We are grateful to Henrik Enghoff, Natural History Museum of Denmark, Copenhagen, for his comments during the finalization of the manuscript, which was done during a visit to Copenhagen by ZK supported by a grant from the European Commission's (FP 6) Integrated Infrastructure Initiative programme SYNTHESYS (DK-TAF 4798). Helpful comments by Rowland M. Shelley (North Carolina State Museum of Natural Sciences, Raleigh, USA) and William A. Shear (Hampden-Sydney College, Virginia, USA) as referees are also greatly acknowledged.

References

- Attems, C. (1903) Beiträge zur Myriopodenkunde. II. Reisebeute der Herren Dr. Michaelsen, Dr. Plate, Dr. Bürger und Dr. Schauinsland. *Zoologischer Jahrbücher, Abteilung für Systematik* 18(1), 79–92.
- Attems, C. (1909) Die Myriopoden der Vega-Expedition. *Arkiv för Zoologi* 5(3), 1–84.
- Attems, C. (1914) Die indo-australischen Myriopoden. *Archiv für Naturgeschichte* 80, 1–398.
- Attems, C. (1928) The Myriopoda of South Africa. *Annals of the South African Museum* 26, 1–431, plates 1–26.
- Chamberlin, R.V. (1920) The Myriapoda of the Australian region. *Bulletin of the Museum of Comparative Zoology*, 64(1), 1–269.
- Golovatch, S.I. (1983) A contribution to the millipede fauna of Iran (Diplopoda). *Annalen des Naturhistorischen Museums in Wien* 85B, 157–169.
- Enghoff, H. (1981) A cladistic analysis and classification of the millipede order Julida. *Zeitschrift für zoologische Systematik und Evolutionsforschung* 19, 285–319.
- Enghoff, H. (1984) Phylogeny of millipedes – a cladistic analysis. *Zeitschrift für zoologische Systematik und Evolutionsforschung* 22, 8–26.
- Enghoff, H. (1985) The millipede family Nemasomatidae. With the description of a new genus, and a revision of *Orinisobates* (Diplopoda: Julida). *Entomologica Scandinavica* 16, 27–67.
- Enghoff, H. (1991) A revised cladistic analysis and classification of the millipede order Julida. With establishment of four new families and description of a new nemasomatoid genus from Japan. *Zeitschrift für zoologische Systematik und Evolutionsforschung* 29, 241–263.
- Hoffman, R.L. (1972) On the identity of three genera of Cambaloid millipeds from the Australian region (Spirostreptida). *Psyche*, Cambridge, USA 79(3), 200–208.
- Hoffman, R.L. (1980) *Classification of the Diplopoda*. Muséum d'Histoire Naturelle, Genève, 237 pp.
- Hoffman, R.L. (1999) *Checklist of the millipeds of North and Middle America*. Virginia Museum of Natural History Special Publication No. 8, Radford, 584 pp.
- Hutton, F.W. (1877) Descriptions of new species of New Zealand Myriapoda. *The Annals and Magazine of Natural History*, ser. 4, 20, 114–117.
- Hutton, F.W. (1878) Notes on the New Zealand Myriopoda in the Otago Museum. *Transactions of the New Zealand Institute* 10, 288–293.
- Jeekel, C.A.W. (1970) *Nomenclator generum et familiarum Diplopodorum*. Monografie No. 5, Nederlandse

Entomologische Vereniging, Amsterdam, 142 pp.

- Jeekel, C.A.W. (1985) The distribution of the Diplocheta and the „lost” continent Pacifica. – *Bijdragen tot de Dierkunde* 55(1), 100–112.
- Jeekel, C.A.W. (2004) A bibliographic catalogue of the “Cambaloidea” (Diplopoda, Spirostreptida). *Myriapod Memoranda* 7, 43–109.
- Jeekel, C.A.W. (2006) Millipedes from Australia, 17: A new genus and two new species of Cambalidae from New South Wales (Diplopoda, Spirostreptida). *Myriapod Memoranda* 8, 65–73.
- Johns, P.M. & Korsós, Z. (in prep.) The millipede genus *Eumastigonus* in New Zealand: new species and an analysis of the distribution mosaics. *Records of the Canterbury Museum*
- Johns, P. M. & Pollard, S. (2002) Canterbury Museum invertebrate types other than arachnid, insect and molluscan. *Records of the Canterbury Museum* 16, 89–93.
- Krabbe, E. (1979) The first legpair of legs in male Spirostreptidae: Their function and taxonomic importance. In: Camatini, M. (Ed.), *Myriapod biology*. Academic Press, London, pp. 59–72.
- Mauriès, J.-P. (1983) Cambalides nouveaux et peu connus d’Asie, d’Amerique et d’Océanie. I. Cambalidae et Cambalopsidae (Myriapoda: Diplopoda). *Bulletin du Museum national d’Histoire naturelle*, serie 4, 5A(1), 247–276.
- Mauriès, J.-P. (1987) Cambalides nouveaux et peu connus d’Asie, d’Amerique et d’Océanie. II. Pseudonannolenidae, Choctellidae (Myriapoda: Diplopoda). *Bulletin du Museum national d’Histoire naturelle*, serie 4, 9A(1), 169–199.
- Mauriès, J.-P. (1992) Sur la vraie place du genre *Protosilvestria* Handschin dans la classification des Diplopodes Iuliformes. *Berichte des Naturwissenschaftlich-Medizinischen Vereins in Innsbruck Supplementum* 10, 23–31.
- Porath, C. O. (1872) Myriopoda Africae australis, in Museo Regio Holmiensi asservata. *Öfversigt af Kongl. Vetenskaps-Akademiens Förhandlingar* 29(5), 3–46.
- Schubart, O. (1966) Diplopoda III: Pselaphognatha, Opisthospermophora, Colobognatha. In: Hanström, B. & Brinck, P. (Eds.), *South African animal life. Results of the Lund University Expedition in 1950–1951*. Swedish Natural Science Research Council, Stockholm 12, 9–227.
- Shelley, R.M. (2003) A revised, annotated family-level classification of the Diplopoda. *Arthropoda Selecta* 11(3), 187–207.
- Shelley, R.M. (2007) Taxonomy of extant Diplopoda (Millipeds) in the modern era: Perspectives for future advancements and observations on the global diplopod community (Arthropoda: Diplopoda). In: Zhang, Z.-Q. & Shear, W.A. (Eds.), *Linnaeus Tercentenary: Progress in Invertebrate Taxonomy*. *Zootaxa*, 1668, 343–362.
- Udvardy, M.D.F. (1996) Three months on the Coral Island (Laysan) by Hugo H. Schauinsland [1899]. *Atoll Research Bulletin*, No. 432, National Museum of Natural History, Smithsonian Institution, Washington, 61 pp.
- Verhoeff, K.W. (1924) Results of Dr E. Mjöberg's Swedish Scientific Expeditions to Australia, 1910–1913. 34. Myriapoda: Diplopoda. *Arkiv for Zoologi* 16(5), 1–142.
- Verhoeff, K.W. (1944) Zur Kenntnis der Cambaliden und über einige neue australische Formen derselben. *Zoologischer Anzeiger* 145, 27–45.