

NEW ATELURINAE (ZYGENTOMA: NICOLETIIDAE) FROM NORTHERN AUSTRALIA

Graeme B. Smith

Australian Museum, 1 William Street, Sydney, New South Wales 2010, Australia
Federation University Australia, PO Box 663, Ballarat, Victoria 3353, Australia
Email: le_gbsmith@optusnet.com.au

Summary

New species of the genera *Allatelura*, *Ausallatelura* and *Pseudogastrotheus* are described as well as species of two new genera, *Wooroonaatelura* and *Australotheus*. *Allatelura hilli* is redescribed from topotypic material collected in nests of the type host. *Atelura similata* Silvestri, 1908 is transferred to *Australotheus*. A key to the genera of Australian Atelurinae is provided.

Keywords. Thysanura, taxonomy, new species, new genus, new combination, redescription, key, *Allatelura*, *Ausallatelura*, *Australotheus*, *Pseudogastrotheus*, *Wooroonaatelura*.

INTRODUCTION

Silverfish of the subfamily Atelurinae are generally found as specialised inquilines (tolerated guests) of ants and termites although Smith & McRae (2014) described three species from deep subterranean habitats in Western Australia's Pilbara that appeared to be living independently of such hosts. Some 134 extant species of Atelurinae have been described worldwide and display a comparatively large diversity of forms with 69 described genera, many of them monotypic, arranged into five tribes (Mendes, 2012). To date twelve Australian species in seven genera have been described, all currently placed within a single tribe, the Atopatelurini Mendes, 2012. This tribe has a Gondwanan distribution, being also known from South America, sub-Saharan Africa, India and Southeast Asia although the type genus (*Atopatelura* Silvestri, 1908) extends to the Palaearctic Near East (Mendes, 2012). The other genera included in the tribe are *Allatelura* Silvestri, 1947, *Arabiatalura* Mendes, 1995, *Ausallatelura* Smith, 2007, *Australiatelura* Mendes, 1995, *Dodecastyla* Paclt, 1974, *Ecnomatelura* Wygodzinsky, 1961, *Galenatelura* Smith, 2009, *Pseudogastrotheus* Mendes, 2003, *Rasthegotus* Mendes, 2001 and *Troglotheus* Smith & McRae, 2014.

This paper redescribes *Allatelura hilli* Silvestri, 1947 from topotypic material collected with the type host. It also describes three new atelurin species, including one new genus, that were collected with ants or termites in Queensland and the Northern Territory and two new subterranean species, including one new genus, from lava tubes in Queensland and the Pilbara of Western Australia (Figure 1).

MATERIALS AND METHODS

Specimens of two species were collected by various workers investigating termites or found during biological survey work in the Pilbara, while others were collected by the present author. Most specimens are deposited in the museums from which they were borrowed or in the museum of the Australian state in which they were collected; some paratypes are deposited within the AMS collection. The respective repository museum is indicated by the following abbreviations with the lists of material examined — AMS: Australian Museum, Sydney, Australia; ANIC: Australian National Insect Collection, CSIRO, Canberra, Australia; MUSA: Museo di Entomologia "Filippo Silvestri", Università degli Studi di Napoli Federico II, Portici, Italy (a unique centre within the museums of the Dipartimento di Agraria; previously the IEA (Instituto di Entomologia Agraria, Portici)); QM: Queensland Museum, Brisbane, Australia; WAM: Western Australian Museum, Perth, Australia; ZMB: Zoologisches Museum, Museum für Naturkunde der Humboldt Universität, Berlin, Germany.

Locality co-ordinates for specimens collected by the author, were made using a hand held Garmin eTrex®10 GPS with a claimed accuracy usually under five metres. Photographs of specimens in the field were made with a Ricoh CX2. All specimens are stored in 75-80% ethanol unless noted as slide mounted.

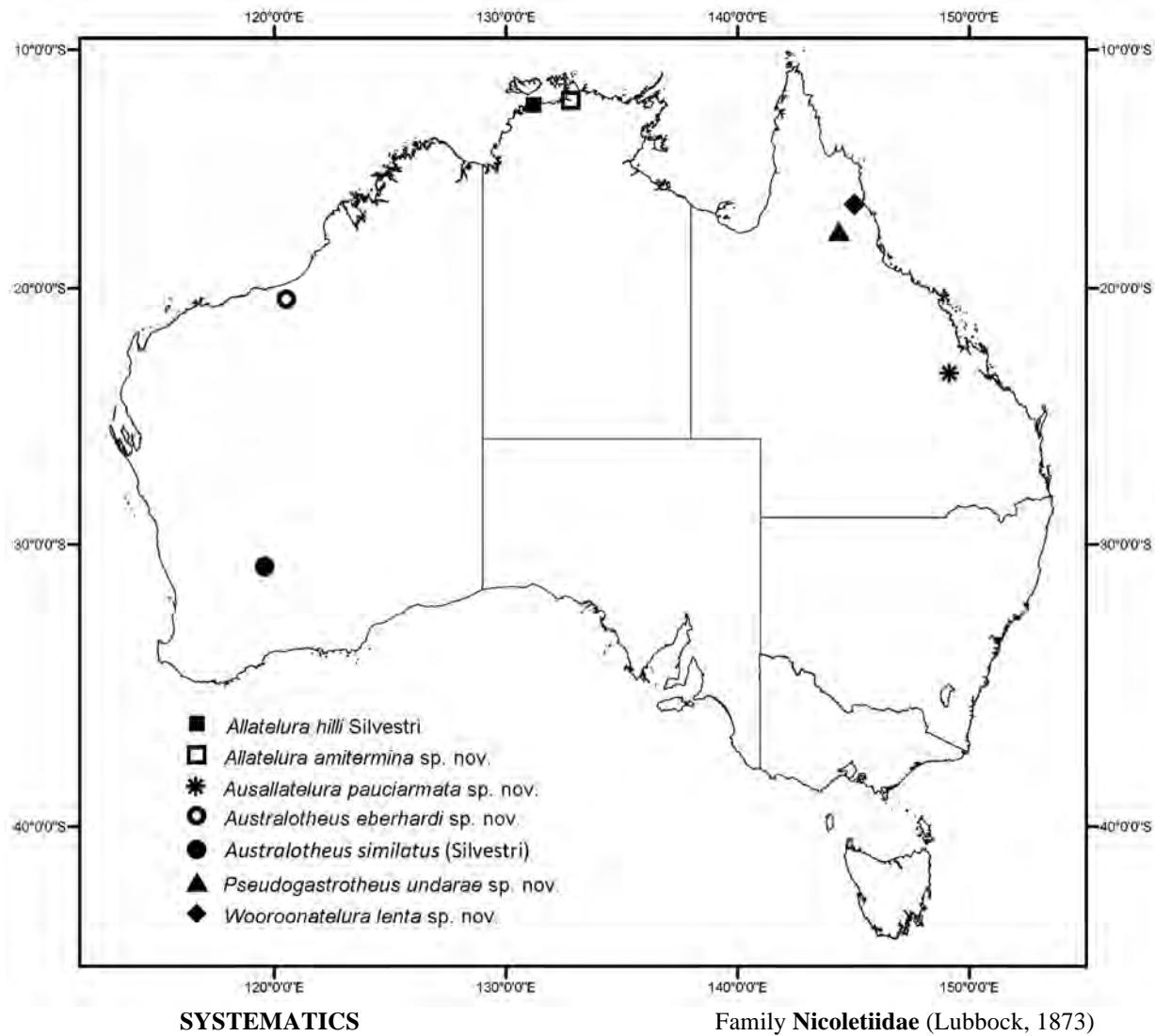
Measurement data of whole specimens in alcohol and dissection methods used are as described in Smith (2013). The relative length of the thoracic nota is calculated from measurements of entire specimens, not the dissected nota and therefore excludes the over-lapped portion of the meso and metanota. In most cases, dissected specimens were each mounted

on two slides using Tendeiro medium (Molero-Baltanás *et al.*, 2000), with the head and thorax mounted on one slide and the abdomen on a second slide. Roman numerals are used to indicate abdominal segment number. The following abbreviations are also used: asl: above sea level (in metres); HW: head width (in millimetres); H+B: head and body length (in millimetres); H+Th: head and thorax; L/W: length to width (ratio); NSW: New South Wales; NT: Northern Territory; QLD: Queensland; PI, PII, PIII: legs of pro-, meso- and metathorax respectively; WA: Western Australia. The term *macrochaetae* refers to the larger stronger bristles, *setae* refers to smaller thinner bristles (usually simple) and *setulae* to the very small, usually straight, microsetae. The term *abiesiform* is used to describe the dorsal submarginal macrochaetae as defined in Smith and McRae (2014).

Where there is any uncertainty with an observation this is noted in the text with a question mark (?).

Terminology for the “segments” of the antennae, terminal filaments and ovipositor follows that explained in Smith (2015) where the term *annulus* will be used for each single unit of the flagellum (excluding pedicel and scape), usually a widened region carrying a single rosette of setae (but occasionally with a smaller secondary rosette), *T-annulus* for each annulus bearing a trichobothrium, *interval* for the group of annuli between T-annuli with the T-annulus being the most distal annulus of the interval. For the terminal filaments and ovipositor, the term *division* will be used for each “segment” defined by a visible suture, albeit often faint.

Figure 1. Collection localities of named species.'



Subfamily **Atelurinae** Remington, 1954
 Tribe **Atopatelurini** Mendes, 2012

Allatelura Silvestri, 1947

Allatelura Silvestri, 1947: 74.

Type species: *Allatelura hilli* Silvestri, 1947 by original designation.

Redefinition. Small to medium sized silverfish of ateluriform shape. Scales multi-radiate, both dorsal and ventral scales with ribs surpassing the posterior end of the membranes by about 10% of their length. Head without scales, with long strong setae in irregular rows. Macrochaetae and many setae with delicately bifurcate apices; abiesiform macrochaetae absent. Head largely free, only slightly covered along its posterior margin. Flagellum of antennae with up to 16 intervals (excluding the scape and pedicel), the more distal intervals divided into four annuli. Pedicel in mature males with an obvious fovea. Mandibles comparatively small with a reduced or absent(?) molar region. Lacinia and galea about the same length, pectinate process of lacinia easily surpasses the apical tooth. Maxillary palp of mature males with wart-like process on penultimate article, ultimate article with one or two apical feathered papillae. Labium with distinct forward directing process on each of the postero-lateral corners of postmentum; last article of labial palp very elongate oval with usual six apical papillae.

Thoracic nota with setae along lateral margins and multiple irregular rows of somewhat raised macrochaetae on the face rather than near the margin. Legs with scales on coxae only. Pretarsus with three claws and two large membranous pulvilliæ.

Abdominal tergites each with a single irregular row of somewhat raised long macrochaetae as well as a marginal macrochaeta in each postero-lateral corner. Urotergite IX with indentations adjacent to the cerci which are held quite erect. Urotergite X small with rounded posterior corners, each armed with a macrochaeta and a rounded concave posterior margin between them. The underside of urotergite X in the males with 1+1 fields of pegs. Urosternites I-V without vesicles or styli, urosternite VI with short styli and lacking eversible vesicles, although a hollow may be found mediad of each stylus where vesicles would be found in other genera of the Atopatelurini; urosternite VII with short styli and pseudovesicles, urosternite VIII in male entire with concave posterior margin and short styli; urosternite VIII in female divided into separate coxites; urosternite IX in both sexes divided into separate coxites with longer styli. Penis short, parameres deeply set in urosternites IX, long and wide with very large numbers of minute glandular rods or setae set in circular bases densely

clustered into large fields on the inner surface of each paramere.

Subgenital plate in female subtriangular. Ovipositor thick but not bulbous, pseudo-segmented with simple fine setae.

Cerci short, basal division in both sexes several times longer than remaining divisions, basal division in mature males with group of pegs; median dorsal appendage twice long as cerci, and curved downwards without pegs in both sexes.

Remarks. *Allatelura* seems to be very close to *Galenatelura* Smith, 2009, with *Galenatelura* showing the more divergent morphology. Mendes (2012) tentatively placed both these genera within his Atopatelurini noting them as somewhat atypical because they did not have the setated vesicles on urosternite VI. This placement is supported here.

Silvestri's original description of *Allatelura hilli* was very good and the redescription below, based on topotypic material collected with the type host, simply adds more detail regarding the fields of pegs on the underside of urotergite X and the basal division of the cerci in mature males. It notes the presence of the wart-like processes on the penultimate article of the maxillary palp in mature males. These are very difficult to see on slide material, especially on *A. hilli*, and would have easily have been overlooked.

Allatelura hilli Silvestri, 1947

Figures 2-34

Allatelura hilli Silvestri, 1947: 78.

Type localities. NT: Koolpunybah and near Darwin (Silvestri, 1947).

Type host: *Mastotermes darwiniensis* Froggatt, 1897 [MASTOTERMITIDAE].

Material examined: ♂ (HW 0.83) NT: Lee Point, Darwin, 12.3°S 130.9°E, 3.vii.1983, J.A.L. Watson, with *Mastotermes darwiniensis* (two slides) ANIC 5-000051; ♀ (HW 0.83) same data as previous (alcohol) ANIC 5-000052; ♂ (HW 0.75) same data as previous (alcohol) ANIC 5-000053; ♂ (HW 0.73) NT: Lee Point, Darwin 12.3°S 130.9°E, 16.iv.1975, R. Paton, from nest of *Mastotermes darwiniensis* Froggatt (alcohol) ANIC 5-000054; ♂ (HW 0.70) same data as previous (alcohol) ANIC 5-000055; ♂ (HW 0.68) same data as previous (alcohol) ANIC 5-000056; ♀ (HW 0.83) NT: Coolalinga, near Darwin 12.5°S 131.0°E, 30.vi.2000, G.B. Smith, under cement paver/wood in *Mastotermes darwiniensis* test plot (two slides) ANIC 5-000057; ♀ (HW 0.78) same data as previous (alcohol) ANIC 5-000058; ♀ (HW 0.80)

NT: Darwin 12.5°S 131.0°E, July xxs1983, with *Mastotermes darwiniensis* (alcohol) ANIC 5-000059.

Description. Appearance when live yellowish-gold, alcohol preserved specimens off-white. Medium size, elongate ateluriform shape (Fig 2).

Body length: Up to 6.6 mm in specimens examined; 2.5-3.0 times longer than wide; small sized head, range of HW 0.68–0.83 mm; head hypognathous, antennae up to 2.3 mm or 0.4-0.6 H+B; cerci quite short, conical, longest measured cercus 0.63 mm or 0.09-0.12 H+B; longest measured median dorsal appendage 1.25 mm or 0.21-0.25 H+B.

Scales: Similar in shape on both dorsal and ventral surfaces (Figure 3), mostly rounded or somewhat pointed apically, with numerous ribs that extend beyond the apex of the joining lamina by about 10% of their length; scales lacking from head and its appendages, from the legs (although present on coxae), paramera, cerci and median dorsal appendage and ovipositor (present on subgenital plate).

Macrochaetae: Simple or with delicate apical bifurcations (Figure 4).

Head: Only partially covered by prothorax at hind margin, vertex with scattered small, fine setae as well as distinctly stronger macrochaetae in about three transverse rows, the rows becoming less distinct anteriorly where the setae become smaller and more numerous (Figure 5). — Labrum typical for family with a few fine setae. — Antennae (Figure 6) 0.39-0.60 times H+B; scape fairly short, about the same length as the pedicel (Figure 7) with a subapical rosette of strong setae; pedicel of adult male with a shallow fovea on ventral face with numerous short setae within

Thorax: Large, about 0.33-0.42 H+B, all nota strongly arched and with strong apically bifurcate setae along lateral margins with the most posterior being twice as long as the rest. Prothoracic notum (Figure 14) not particularly long, about 0.37-0.44 of the length of whole thorax and about 1.3 times longer than the mesonotum (range 1.0-1.5) which is about 1.1 times longer than the metanotum (range 0.84-1.5) with three or four irregular rows of long, delicately apically bifurcate macrochaetae which are obliquely raised from the surface in entire specimens, as well as some smaller straight setae. Mesonotum (Figure 15) with two to three irregular rows of macrochaetae and the metanotum (Figure 16) with two irregular rows and some straight setae.

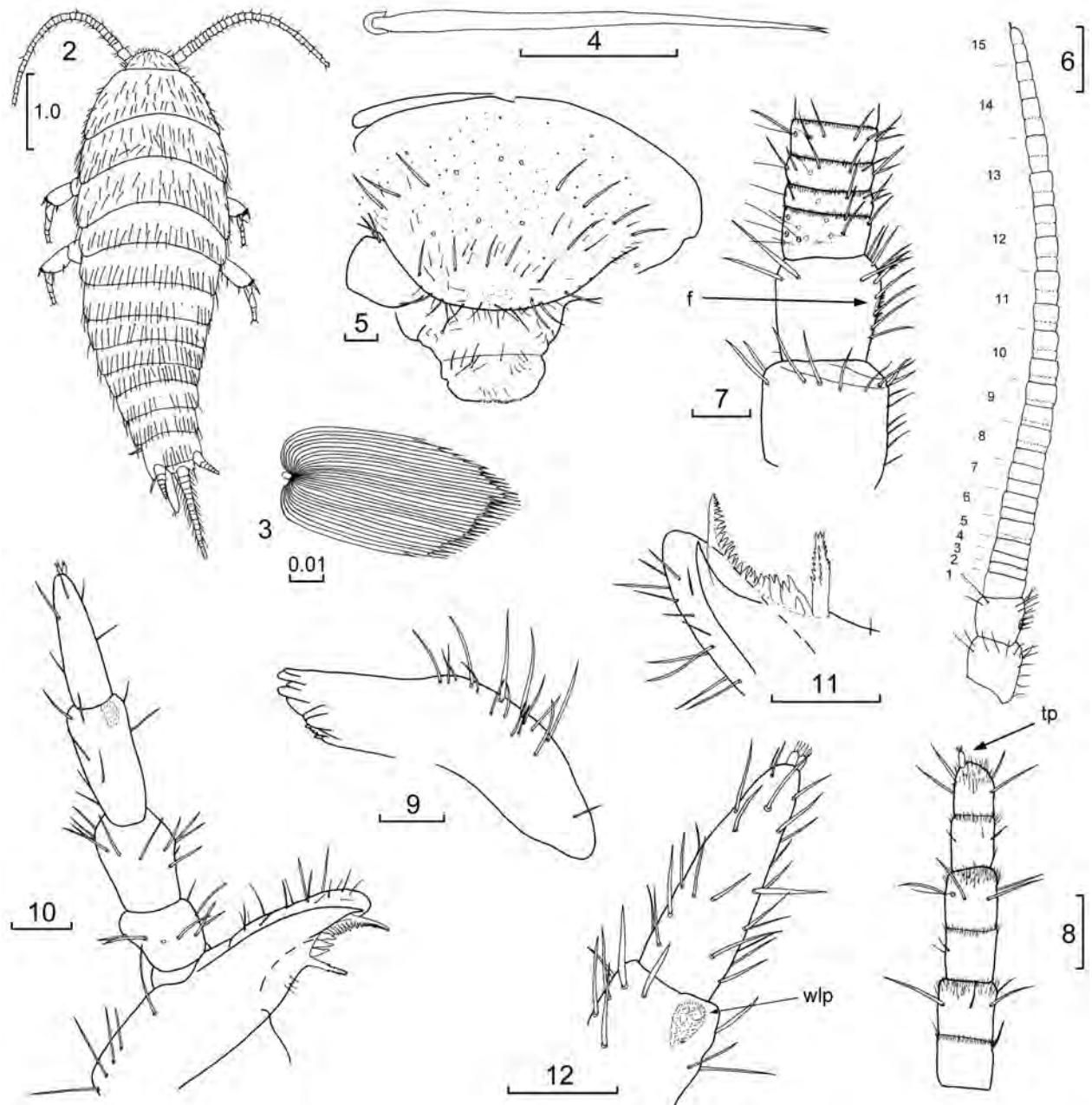
Legs typical for genus (Figures 17, 18), quite stout, tibia L/W ratio of legs PI 2.6 (range 2.3-2.7), PII 2.6 (2.2-3.1), PIII 2.8 (2.5-3.1); tarsi L/W ratio PI 5.2 (range 4.2-6.0), PII 5.6 (4.3-6.4), PIII 5.6 (5.0-6.4). No great difference in length from PI to PIII (ratio of

tibia length PI to PIII = 0.76 (range 0.72-0.82) and tarsus 0.79 (range 0.62-0.92). Precoxa of PI with five setae; coxa large and flat with a few scales on ventral face in proximal medial quarter, the rest of the surface covered with fine setae with some longer stronger setae along the lateral margin; femur with one strong, fairly robust deeply bifurcated sub-lyriform macrochaeta sub-distally on anterior edge and two stout macrochaetae on posterior margin; tibia with about eleven robust subdistal lyriform macrochaetae, ventral posterior margin with two stronger stout macrochaetae near the distal end and another robust macrochaeta about $\frac{1}{3}$ the distance along the tibia from its proximal end, one on the ventral surface near the external margin at about the same level plus the usual long apical spine; tarsi of four articles; pretarsus with two quite long and slender, simple, curved, smooth lateral claws and a shorter, sharp, erect medial empodial claw, as well as 1+1 large lamellate pulvilli. **Abdomen:** Not much narrower than metanotum at its base. All urotergites wrap around the sides of the body making it difficult to lay them out flat when slide mounting without either tearing off the paratergite or having it lying underneath the urotergite (Figures 19, 20). Each urotergite with a quite irregular submarginal transverse row of strong semi-erect setae each with a short delicate apical bifurcation and a macrochaeta of similar size in each postero-lateral corner as well as about 12 setae on the lateral margins (Figure 20) which, because of the fold, are mostly located mediad and ventral to the largest postero-lateral marginal macrochaeta of each segment; transverse rows of macrochaetae decreasing in number from anterior to posterior (i.e. I = 24-26, II = 22-26, III = 20-24, IV = 18-23, V = 17-23, VI = 17-21, VII = 14-18, VIII = 12-14, IX = 6). Urotergite IX (Figure 21) with distinct indentations in the posterior margin on each side, presumably to facilitate elevating the cerci. Urotergite X (Figure 22) short with rounded postero-lateral corners each armed with a long apically bifurcate macrochaeta, posterior margin with round concavity; underside in mature males with 1+1 large lateral fields of about 50 modified sclerotised pegs (Figure 23).

Urosternites much narrower than urotergites; urosternite I glabrous with a small convex region in the middle of the posterior margin; II-V (Figure 24) with 1+1 stronger submarginal setae submedially and usually a smaller seta on the margin between or laterad to these stronger setae as well as two to three fine setae on each postero-lateral corner; urosternite VI (Figure 25) with short styls as well as 1+1 posterior submedial submarginal setae with a seta

between the 1+1 submedial setae and 2+2 smaller marginal setae between these and the styli, without vesicles although there is a distinct indentation in the posterior margin mediad of both styli in the position occupied by large vesicles in most species of the Atopatelurini suggesting these have been lost in this genus; urosternite VII with small styli, pseudovesicles and 1+1 submarginal setae as well as some finer setae

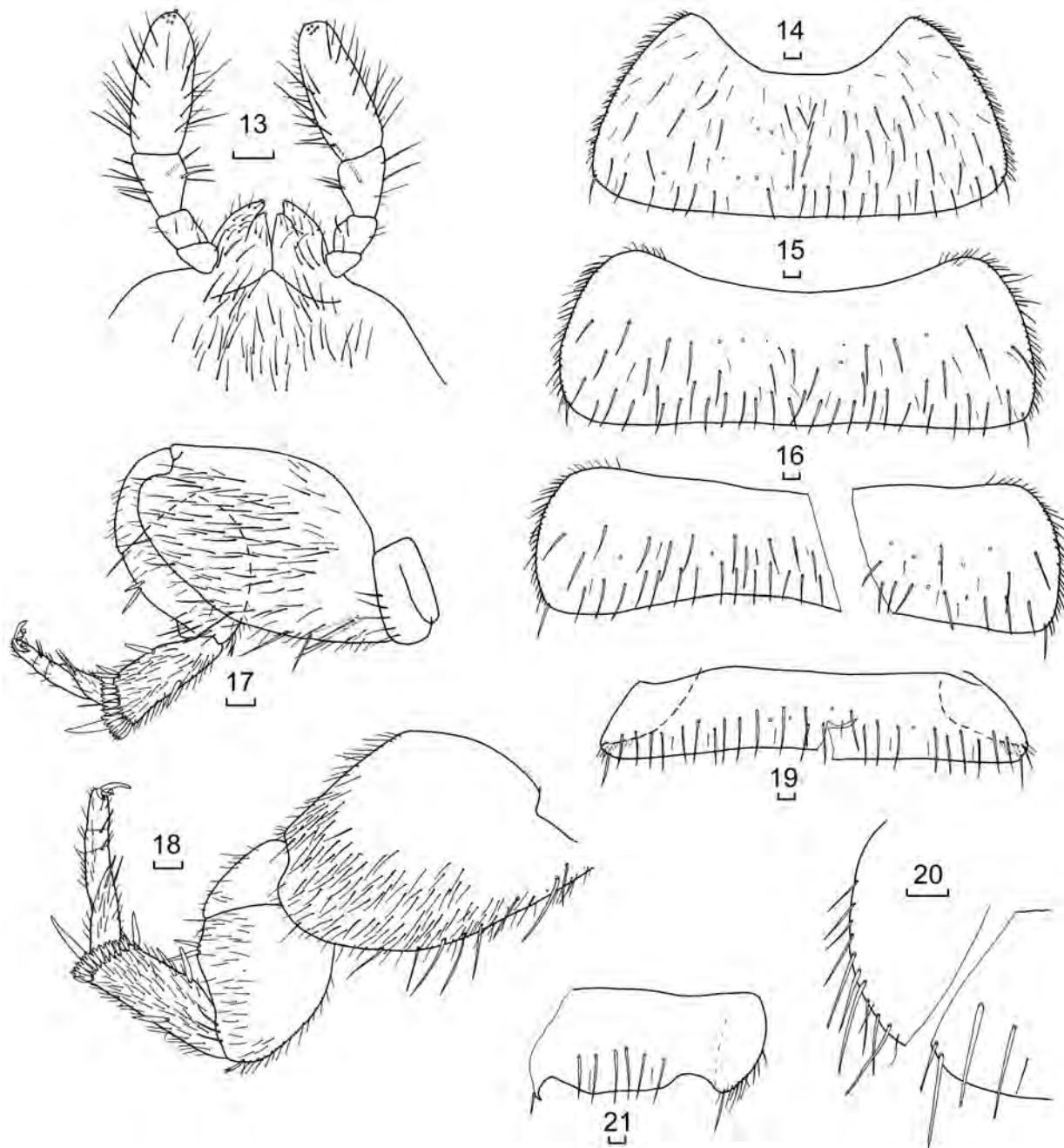
laterad to and between the submedial setae as well as two small setae on each posterolateral corner; urosternite VIII (Figure 26) in male entire with slightly larger styli, the posterior margin quite strongly concave with several setae along the posterior margin, postero-lateral corners each with two small setae; urosternite IX in male divided into separate narrow coxites each bearing a larger stylus,



Figures 2-12. *Allatelura hilli* Silvestri ♂ (specimen 5-000051) unless otherwise noted by specimen number (2) habitus ♀ (specimen 5-000052); (3) ventral scale; (4) macrochaeta from urotergite I; (5) head ♀ (specimen 5-000057); (6) antenna with intervals of flagellum numbered; (7) idem, scape, pedicel and four basal intervals of flagellum, with position of fovea (f) on side indicated; (8) idem, apex of antennae showing terminal papilla (tp); (9) mandible; (10) maxilla; (11) idem, enlargement of lacinia, galea and prostheca; (12) idem, palp showing wart-like process (wlp). Scale bars = 0.1 mm unless otherwise indicated.

and a very broad apically rounded paramere reaching to about half the length of the styli, parameres (Figure 27) with large fields of glands along inner margins, each gland circular in shape with a seta or rod emerging from the middle (Figure 28), the setae appearing longer towards the medial margin and distal ends, as well as many stronger setae on the laterad half. Small styli present on VI-IX, those on

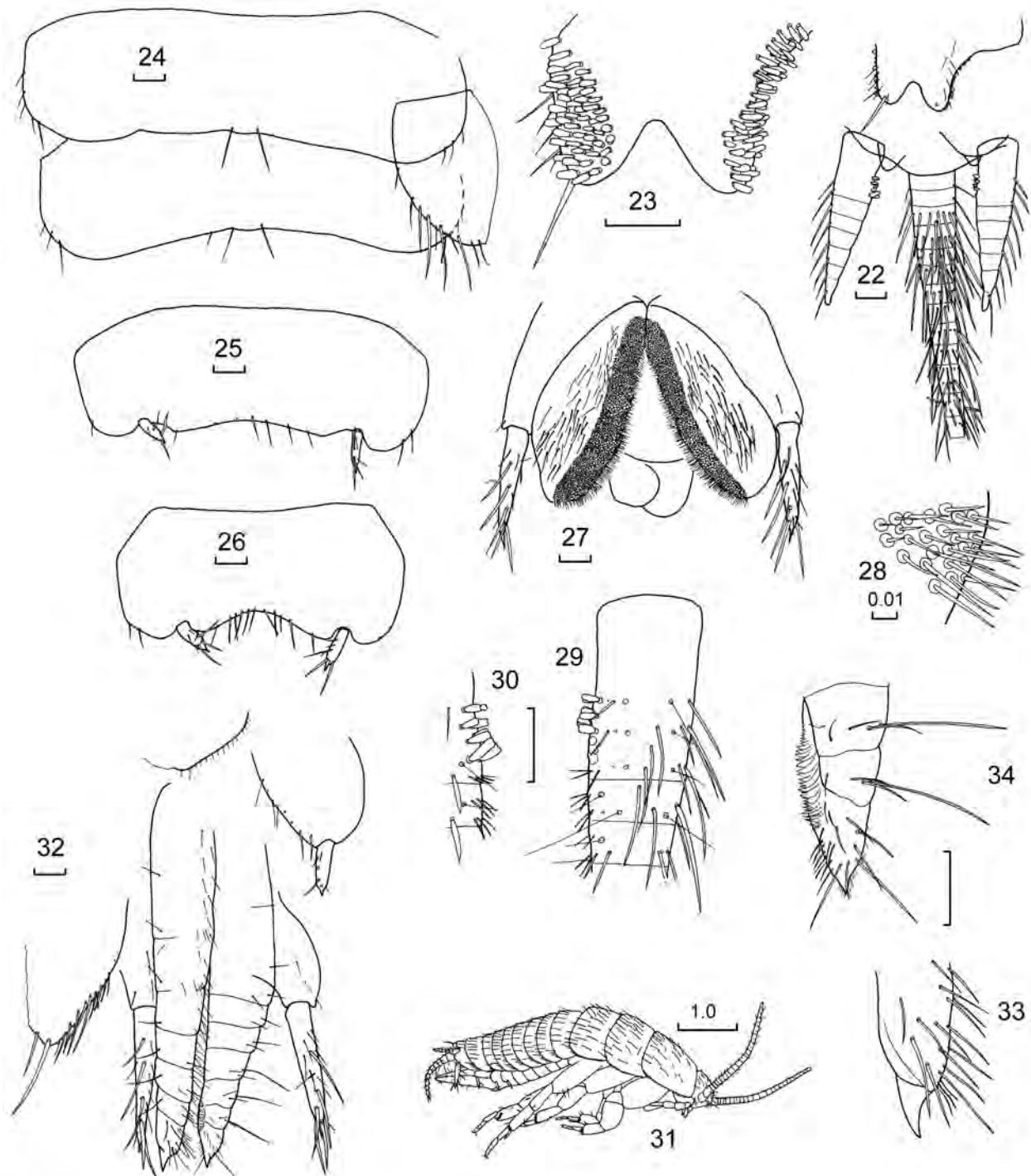
VII only about half the length of those on IX (range 0.38-0.50); styli not particularly large, each with an apical spine as well as some strong curved setae. Penis not easily seen, hidden by large parameres. Cerci short, of six or seven divisions, extending beyond the apex of the short urotergite X (excluding the terminal macrochaetae) by about three times the length of the processes of urotergite X; basal division



Figures 13-21. *Allatelura hilli* Silvestri ♂ (specimen 5-000051) (13) labium; (14) pronotum; (15) mesonotum; (16) metanotum (in two pieces); (17) PI; (18) PIII; (19) urotergite I; (20) lateral comb of urotergite II (torn along suture between tergite and paratergite); (21) urotergite IX. Scale bars = 0.1 mm.

(Figures 29, 30) as long as or longer than the next four divisions together, with about eight pegs in distal half of division on the inner margin adjacent to similar pegs on the underside of urotergite X, as well

as setae and trichobothria; following four or five divisions shorter than wide with setae and trichobothria only. Median dorsal appendage incomplete in dissected male specimen and of 15



Figures 22-34. *Allatelura hilli* Silvestri ♂ (specimen 5-000051) except where indicated by specimen number (22) urotergite X and terminal filaments; (23) underside of urotergite X; (24) urosternites II and III?; (25) urosternite VI; (26) urosternite VIII; (27) coxites IX and parameres; (28) enlargement of circular glands of parameres; (29) basal divisions of cercus; (30) sensory pegs of other cercus; (31) female, lateral view (5-000059); (32) subgenital plate (part), urosternite VIII, urosternites IX and ovipositor of ♀ (5-000057); (33) idem, apex of anterior gonapophyses of ♀; (34) idem, apex of posterior gonapophyses of ♀. Scale bars = 0.1 mm unless otherwise indicated.

divisions in dissected female, up to 0.12 H+B on specimen ANIC 5-000055 (δ), with setae and trichobothria only, some of the setae on the more distal divisions of dissected male with strong apical bifurcations which were not seen in the dissected female.

Female. Similar to male (Figure 31) except urosternites VIII divided into separate coxites also with styli and lateral macrochaetae (Figure 32), with subtriangular subgenital plate; urosternite IX also divided into separate coxites with larger styli (almost twice as long as those on other segments); ovipositor (Figures 32-34) moderately bulbous with perhaps ten divisions, those near base difficult to ascertain, apices of anterior gonapophyses produced into small triangular processes, apices of posterior gonapophyses produced into a small pectinate knob, bearing field of curved rows of hooks subapically; both sets of gonapophyses also with some thin simple setae.

Ecology. Termitophile with *Mastotermes darwiniensis* Froggatt, 1897 [MASTOTERMIDAE].

***Allatelura amitermina* sp. nov.**

Figures 35-65

Material examined: Holotype δ (HW 0.53) NT: 18 km NE of Gunbalanya (as Oenpelli), 12.2°S 133.1°E, 4.vi.1975, A.H.W. (presumably A.H. Whetherly) with *Amitermes laurensis* (two slides) ANIC 5-000060. Paratype φ (HW 0.43) same data as holotype (two slides NB urosternite I with H+Th) ANIC 5-000061. Type host: *Amitermes laurensis* (Mjöberg, 1920) [TERMITIDAE].

Diagnosis. This species is easily distinguished from *Allatelura hilli* Silvestri, 1947 by its much smaller size, the longer postero-lateral macrochaeta on the tergites (twice the length of the macrochaetae of the subposterior transverse row versus about the same length in *A. hilli*), the comparatively shorter cerci (about twice the length of the processes of urotergite X (versus three times in *A. hilli*), the larger number of pegs (circa 14 versus eight) on the first article of the cerci on mature males and the much smaller number of pegs (circa 30 on the underside of urotergite X versus 50).

Description. Appearance when live unknown, alcohol preserved specimens off-white. Small, typical elongate ateluriform shape (Figure 35).

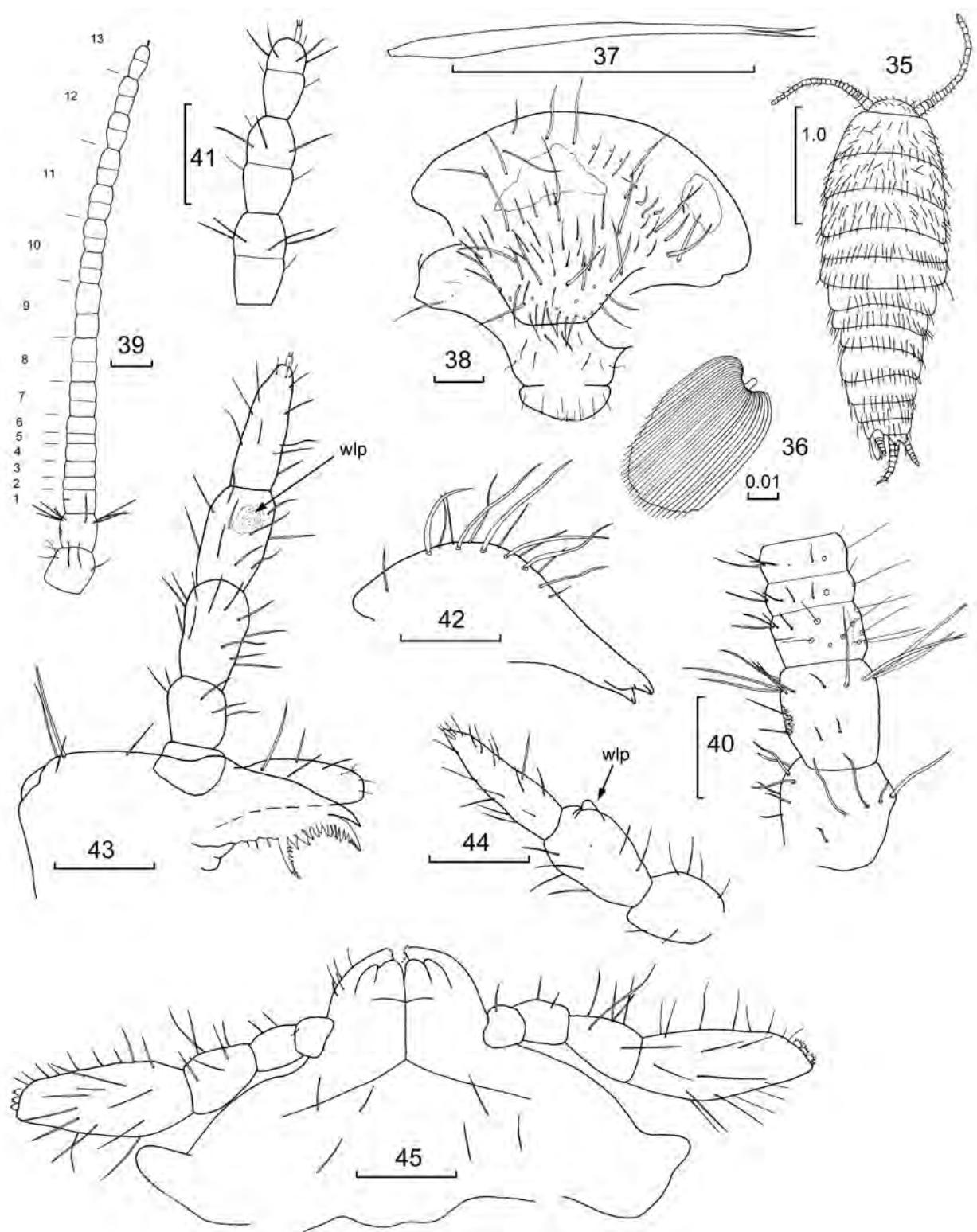
Body length: Small silverfish (about 3 mm in largest specimen examined, an estimate due to the curved position of the body), about 3.0 times longer than wide; range of head width 0.43–0.53 mm; head hypognathous, antennae 1.13 mm or 0.37 H+B; cerci

quite short, conical and held quite elevated, 0.3 mm or 0.10 H+B; median dorsal appendage damaged in all specimens, longest surviving section 0.21 H+B.

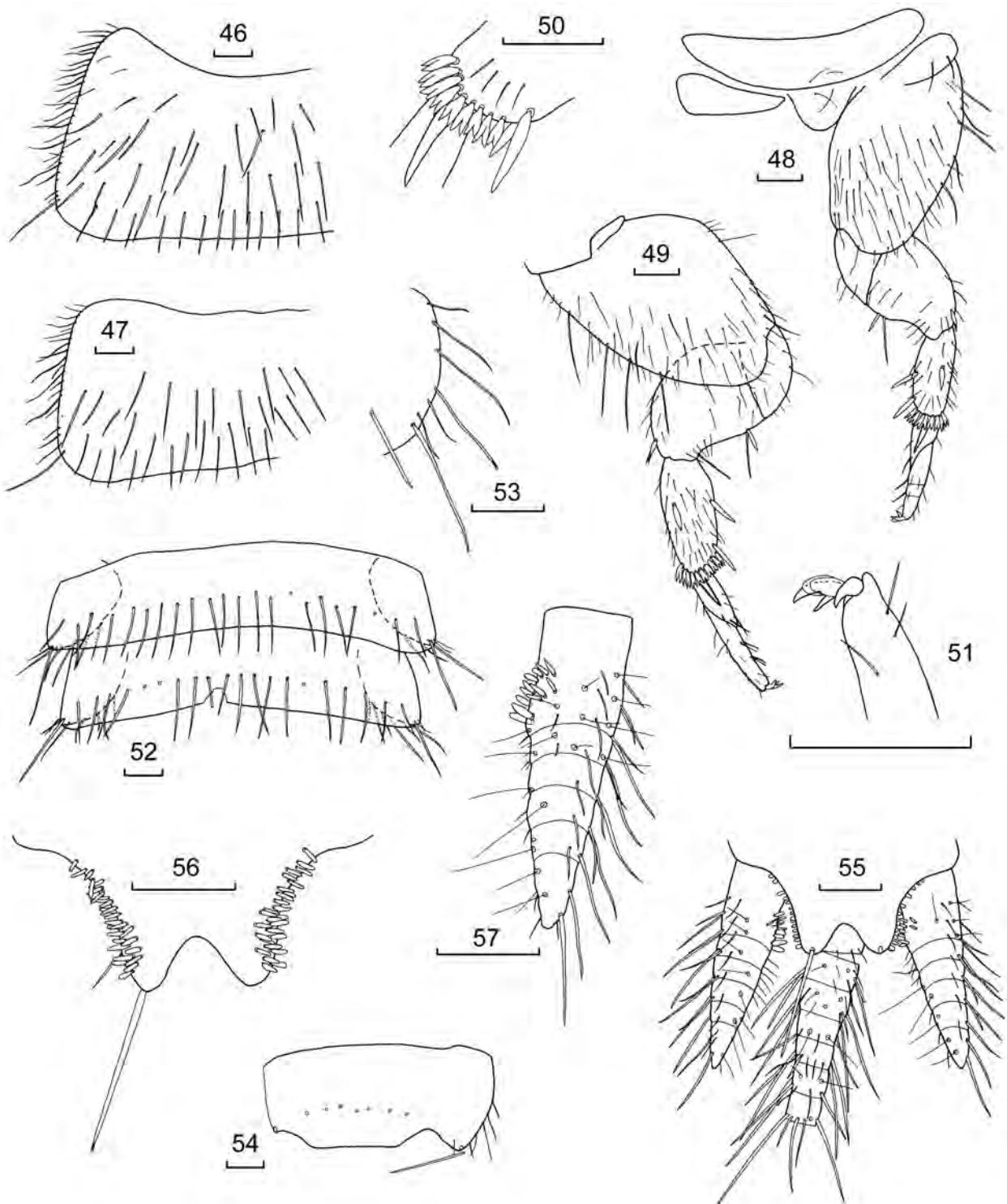
Scales: Similar in shape on both dorsal and ventral surfaces (Figure 36) but mostly rounded or somewhat pointed apically, with 20-30 ribs which extend beyond the apex of the joining lamina by about 10% of their length; scales lacking from head and its appendages, from the legs (although present on coxae), paramera, cerci and median dorsal appendage and ovipositor (present on subgenital plate).

Macrochaetae: Simple and usually with long delicate apical bifurcations (Figure 37), some on median dorsal appendage with very strong apical bifurcations.

Head: Partially covered by prothorax at hind margin, vertex with scattered smaller and larger strong macrochaetae which are not arranged into well-defined rows (Figure 38). — Labrum typical for family with a few fine setae. — Antennae 0.37 times H+B (Figure 39); scape fairly short, about the same length as the pedicel; pedicel of adult male (Figure 40) with a shallow fovea on ventral face with numerous short setae within or on the margins of the depression, and a rosette of long, apically bifurcate or simple setae. Flagellum with about 13 intervals; first annulus of flagellum with eight trichobothria; intervals subdivide into two annuli from the sixth interval and further subdivide from the tenth although the suture delineating this subdivision appears to be rigid not flexible; intervals until at least the tenth or eleventh with two trichobothria in their most distal annulus, subsequent intervals with just a single trichobothrium; most distal annulus with typical three-pronged sensillae (Figure 41). — Mandibles (Figure 42) quite small, with a few small incisor teeth and no obvious molar region (orientation issue?). — Maxilla (Figures 43, 44) with lacinia about the same length as the galea, lacinia with simple pointed apex, pectinate prostheca extending well beyond tip of lacinia and with an equally long pectinate lamellate process proximally; galea without apical conule. Maxillary palp short, stout, with two(?) papillae distally; apical article of palp 2.4-2.9 times longer than wide with tapering sides, 1.0-1.3 times longer than penultimate article and slightly thinner; penultimate article in male with subapical “wart-like” process (Figure 44) which are both poorly aligned in slide material and impossible to observe clearly, ideally more material and the use of an electron microscope would be preferred. — Labium with forward pointing rounded lateral projections on posterolateral margins (Figure 45); ultimate article of palp quite long, ovate about 1.8 times longer than wide with usual six sensory papillae distally; all articles including base with many smaller and a few



Figures 35-45. *Allatelura amitermina* sp. nov. holotype ♂ unless otherwise noted by specimen number (35) habitus ♀ (5-000061); (36) ventral scale; (37) dorsal macrochaeta from urotergite; (38) head; (39) antenna with intervals of flagellum numbered; (40) idem, scape, pedicel and three basal intervals of flagellum; (41) idem, apex of antennae; (42) mandible; (43) maxilla, showing position of wart-like process (wlp); (44) idem, palp; (45) labium. Scale bars = 0.1 mm unless otherwise indicated.



Figures 46-57. *Allatelura amitermina* sp. nov. holotype ♂ (46) pronotum; (47) mesonotum; (48) pre sternum and PI; (49) PIII; (50) idem, apex of tibia with lyriform macrochaetae; (51) idem, pretarsus; (52) urotergites IV and V with paratergites folded under; (53) details of lateral paratergal chaetotaxy of urotergite VI; (54) urotergite IX; (55) urotergite X, cerci and median dorsal appendage; (56) urotergite X, underside; (57) cercus. Scale bars = 0.1 mm.

few somewhat stronger setae.

Thorax: Large, about 0.3 H+B, all nota strongly arched with long fine, delicately apically bifurcate setae along lateral margins, with the most posterior being twice as long as the rest. Prothoracic notum (Figure 46) about 1.5 times longer than the mesonotum which is slightly longer than the metanotum, with three or four irregular rows of long, delicately apically bifurcate macrochaetae which are obliquely raised from the surface in entire specimens. Mesonotum (Figure 47) with two to three irregular rows of macrochaetae and the metanotum with two irregular rows.

Legs typical for genus (Figures 48, 49), quite stout, tibia L/W ratio of legs PI 2.6 (range 2.2-3.0), PII 2.2 (2.1-2.3), PIII 2.4 (2.2-2.6); tarsi L/W ratio PI 3.8, PII 4.6, PIII 2.7 (2.4-2.9). PI not much shorter than PIII (ratio of tibia length PI to PIII = 0.84 (range 0.83-0.84) and tarsus 0.70 (range 0.68-0.72). Precoxa of PI with two setae; coxa large and flat with some scales on ventral face in proximal medial quarter, the rest of the surface covered with fine setae and some longer setae along the lateral margin; femur with one strong, fairly robust, deeply bifurcated, sub-lyriform macrochaeta sub-distally on anterior edge and two (or three on PIII) longer macrochaetae as shown in figure 49; tibia with about ten robust subdistal lyriform macrochaetae (Figure 50), ventral posterior margin with two stronger stout macrochaetae near the distal end and another robust macrochaeta about $\frac{1}{3}$ the distance along the tibia from its proximal end, one on the ventral surface near the external margin at about the same level plus the usual apical long spine; tarsi of four distinct articles; pretarsus with two quite long and slender, simple, curved, smooth lateral claws and a shorter, sharp erect medial empodial claw with large lamellate pulvilli (Figure 51).

Abdomen: Not much narrower than metanotum at its base. All urotergites wrap around the sides of the body part making it difficult to lay them out flat when slide mounting (Figure 52). Each urotergite with a slightly irregular submarginal transverse row of strong semi-erect setae each with a delicate apical bifurcation and a much longer macrochaeta (about twice as long) in each postero-lateral corner as well as several setae on the lateral margins (Figure 53) which, because of the fold are actually located mediad and ventral to the largest lateral macrochaeta; transverse rows of macrochaetae decreasing in number from anterior to posterior (i.e. I = 28-29, II = 26, III = 24, IV = 22, V = 19-20, VI = 19, VII = 16-17, VIII = 15-16, IX = 6-7). Urotergite IX (Figure 54) with distinct indentations in the posterior margin on each side, presumably to facilitate elevating the cerci. Urotergite X (Figure 55) short with rounded postero-

lateral corners each armed with a long apically bifurcate macrochaeta, posterior margin with round concavity; underside in mature males with 1+1 elongated lateral fields of about 28 modified sclerotised pegs (Figure 56) adjacent to similar fields on the cercus (Figure 57).

Urosternites much narrower than urotergites; urosternite I glabrous (?); II-V (Figure 58) with 1+1 longer submarginal setae submedially and often a smaller seta on the margin between or lateral to these longer setae as well as usually one fine seta on the postero-lateral corner; urosternite VI (Figure 59) with short styli as well as 1+1 posterior submedial submarginal setae, without vesicles although there may be a small indentation in the posterior margin mediad to both styli in the position occupied by large vesicles in most species of the Atopatelurini; urosternite VII (Figure 60) with small styli, pseudovesicles and 1+1 submarginal setae as well as some finer setae laterad to the submedial seta and a small seta on the posterolateral corner of each side; urosternite VIII in male entire (Figure 61) with slightly larger styli, the posterior margin quite strongly concave with 1+1 longer submarginal submedial setae and 2+2 smaller setae between these and the styli, postero-lateral corners also with one small seta; urosternite IX in male divided into separate narrow coxites each bearing a stylus, parameres very broad, apically rounded reaching to about $\frac{1}{3}$ the length of the styli, the parameres (Figure 62) with large fields of glands along inner margins, each gland circular in shape with a setula emerging from the middle, the setulae appearing longer towards the medial margin and distal ends, as well as small setae on the laterad half. Small styli present on VI-IX, those on VII only about two thirds the length of those on IX (range 0.53-0.75); the styli on coxites IX not particularly large, with an apical spine as well as some strong curved setae. Penis not easily seen, largely hidden by large parameres.

Cerci (Figures 55, 57) short, of six divisions, surpassing the apex of the short urotergite X (excluding the terminal macrochaetae) by less than twice the length of the processes of urotergite X; basal division as long as or longer than the next three divisions together with about 14 pegs in distal half of division on the inner margin adjacent to similar pegs on the underside of urotergite X (Figure 57) as well as setae and trichobothria; following four divisions shorter than wide with setae and trichobothria only. Median dorsal appendage incomplete on holotype, with only nine divisions, about 0.12 H+B on paratype and less than 50% longer than the cerci, with setae and trichobothria, large macrochaetae on ventral surface deeply apically bifurcate.

Female. Similar to male except pedicel without fovea, penultimate article of maxillary palp without wart-like expansion, urosternites VIII divided into separate coxites with subtriangular subgenital plate (Figure 63); ovipositor (Figures 63-65) not well preserved, weakly bulbous with about nine divisions, apices of anterior gonapophyses produced into small triangular processes, while the apex of the posterior gonapophyses is produced into a slightly pectinate knob; both sets of gonapophyses also with some fine simple setae.

Ecology. Collected with *Amitermes laurensis* (Mjöberg, 1920), a termite species occurring on both Cape York and in Arnhem Land.

Ausallatelura Smith, 2007

Ausallatelura Smith, 2007: 19.

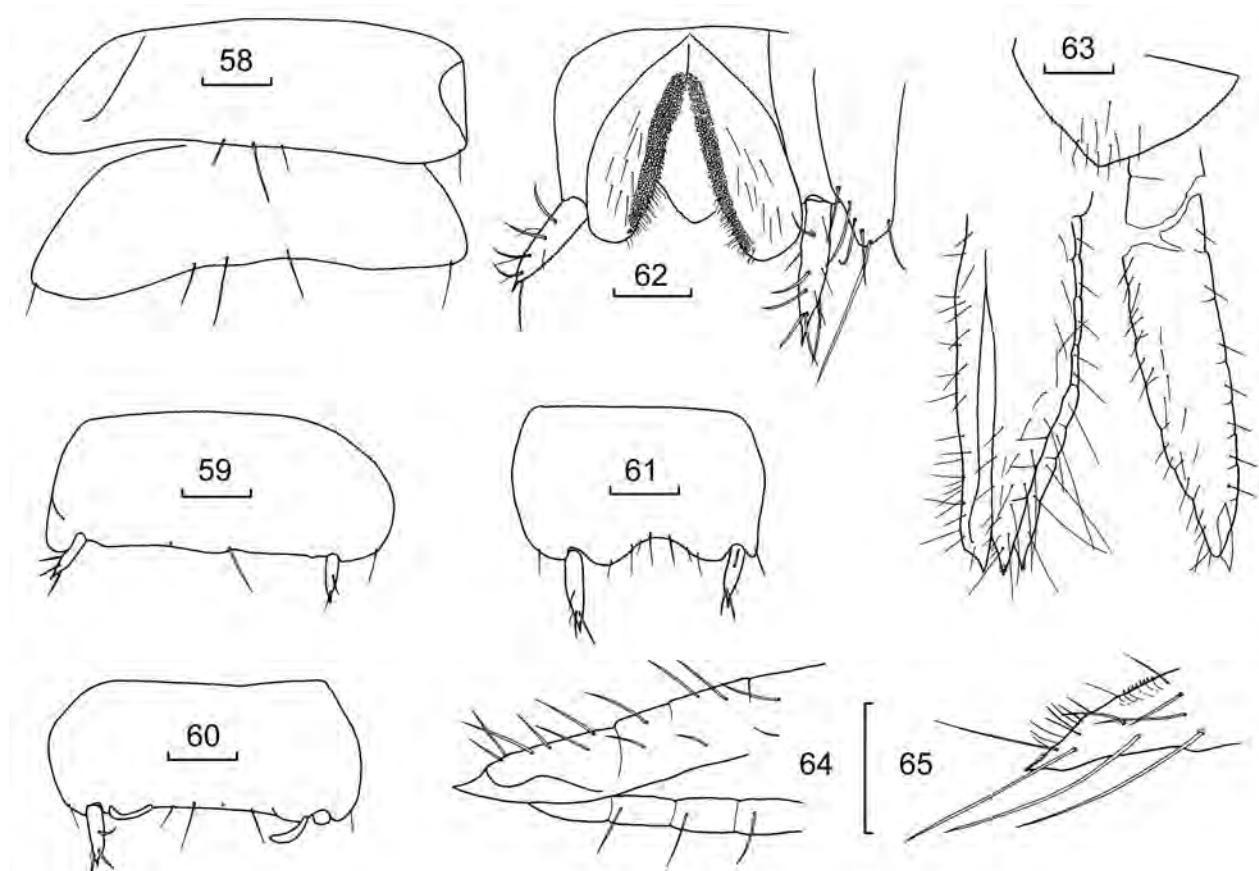
Type species: *Ausallatelura ordoarmata* Smith, 2007 by original designation.

Redefinition. Small, elongate, ateluriform, pale gold/off white in colour, devoid of pigment, densely clothed in scales except for head, ovipositor, and

appendages with exception of a few scales present on coxa of meso- and meta-thoracic legs (?); scales with numerous ribs extending about 10% of their length beyond the margins. Macrochaetae thin, with delicate apical bifurcations or simple.

Head exposed, with long setae. Mandibles with strong teeth but only a small molar area. Maxillae with lacinia slightly longer than galea with simple pointed apex or with a small secondary tooth, pectinate prostheca extending beyond tip of lacinia. Apical conule of galea either broad and flattened or absent. Labium typical for subfamily with large oval apical article on palp. Labial and maxillae palps with usual apical sensillae.

Thoracic tergites with distinct row of long thin macrochaetae well back from hind margin as well as smaller, thinner long macrochaetae arranged in three to five irregular rows on the pronotum, and one to two rows on the meso and metanota. Legs armed with a few or many lyriform spines apically on the tibia; pretarsi with three simple claws lacking pulvilli.



Figures 58-65. *Allatelura amitermina* sp. nov. holotype ♂. **Figures 63-65.** *Allatelura amitermina* sp. nov. paratype ♀ (5-000061) (58) urosternites III and IV (?); (59) urosternite VI; (60) urosternite VII; (61) urosternite VIII; (62) coxites IX, parameres and paratergite IX; (63) subgenital plate and ovipositor of ♀ (parts separated on slide); (64) apex of anterior gonapophyses of ♀; (65) apex of posterior gonapophyses of ♀. Scale bars = 0.1 mm.

Abdominal urotergites densely covered in scales, urotergites I-IX with single row of long, thin macrochaetae set well forward from posterior margin. Urotergite X subtrapezoidal with slightly or deeply concave posterior margin and just 1+1 larger macrochaetae apically. Urosternite I without setae; remaining urosternites with 1+1 submedial setae and one or two postero-lateral setae. Eversible vesicles present on urosternite VI with small setae on each

vesicle and pseudovesicles on urosternite VII. Small styli on urosternites V-IX or VI-IX, styli IX about twice the size of the others, styli with very small apical spine. Cerci short and tapering. Medium dorsal appendage thinner and up to about twice as long as cerci. Subgenital plate parabolic; ovipositor somewhat bulbous spindle-shaped.

Males unknown.

Figure 66. *Ausallatelura pauciarmata* sp. nov. and host termite worker (*Amitermes* sp.)



***Ausallatelura pauciarmata* sp. nov.**

Figures 66-100

Material examined: Holotype ♀ (HW 0.23) QLD: Blackdown Tableland National Park near campsite, 23.794°S 149.068°E 813m asl, 9.v.2011, G.B. Smith (two slides) QM T23466.

Type host: *Amitermes* sp. [TERMITIDAE].

Diagnosis. This species is easily distinguished from *Ausallatelura ordoarmata* Smith, 2007 by its smaller size (3.4 vs 4.5 mm), the presence of only two (versus about 14) lyriform macrochaetae distally on the tibia and the presence of five pairs of styli (versus four).

Description. Appearance when live pale gold/off-white (Figure 66), alcohol preserved specimens off-white. Narrow ateluriform shape (Figure 67).

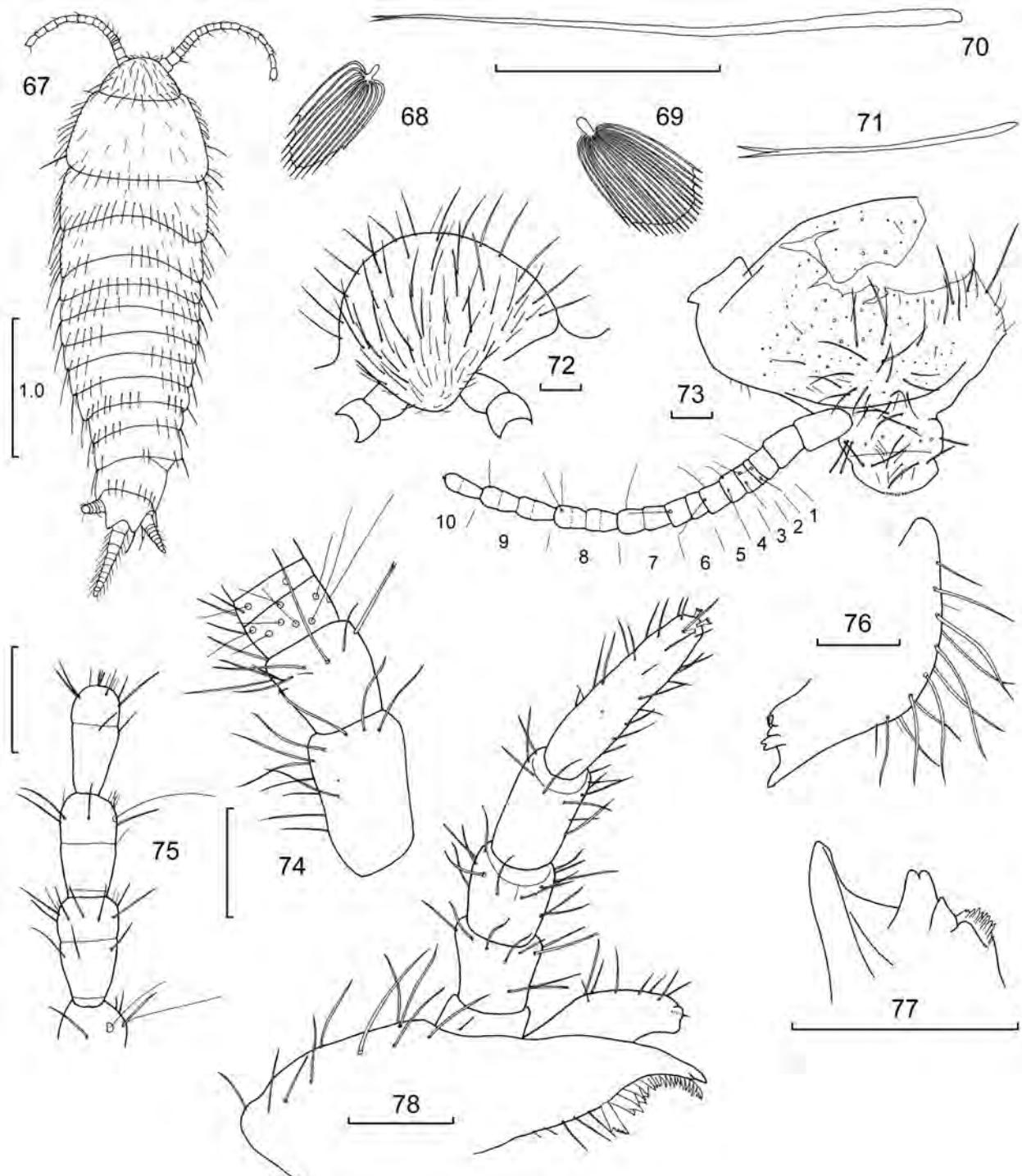
Body length: Small silverfish (about 3.4 mm), about three times longer than wide; head narrow, hypognathous, antennae 1.2 mm or 0.35 H+B; cerci quite short, conical and held elevated, cercus 0.4 mm or 0.12 H+B; median dorsal appendage 0.6 mm or 0.18 H+B. Cuticle of body and appendages with pilose appearance in many unscaled areas but not all;

some areas with smooth cuticle or with tessellated pattern.

Scales: Similar in shape on both dorsal and ventral surfaces (Figures 68, 69), round with about 12-18 strong ribs that extend about 10% beyond the joining lamina; scales lacking from head and its appendages, from the legs (although present on coxae of PII and PIII), cerci and median dorsal appendage and ovipositor (present on subgenital plate).

Macrochaetae: Simple and usually with long delicate apical bifurcations (Figures 70, 71).

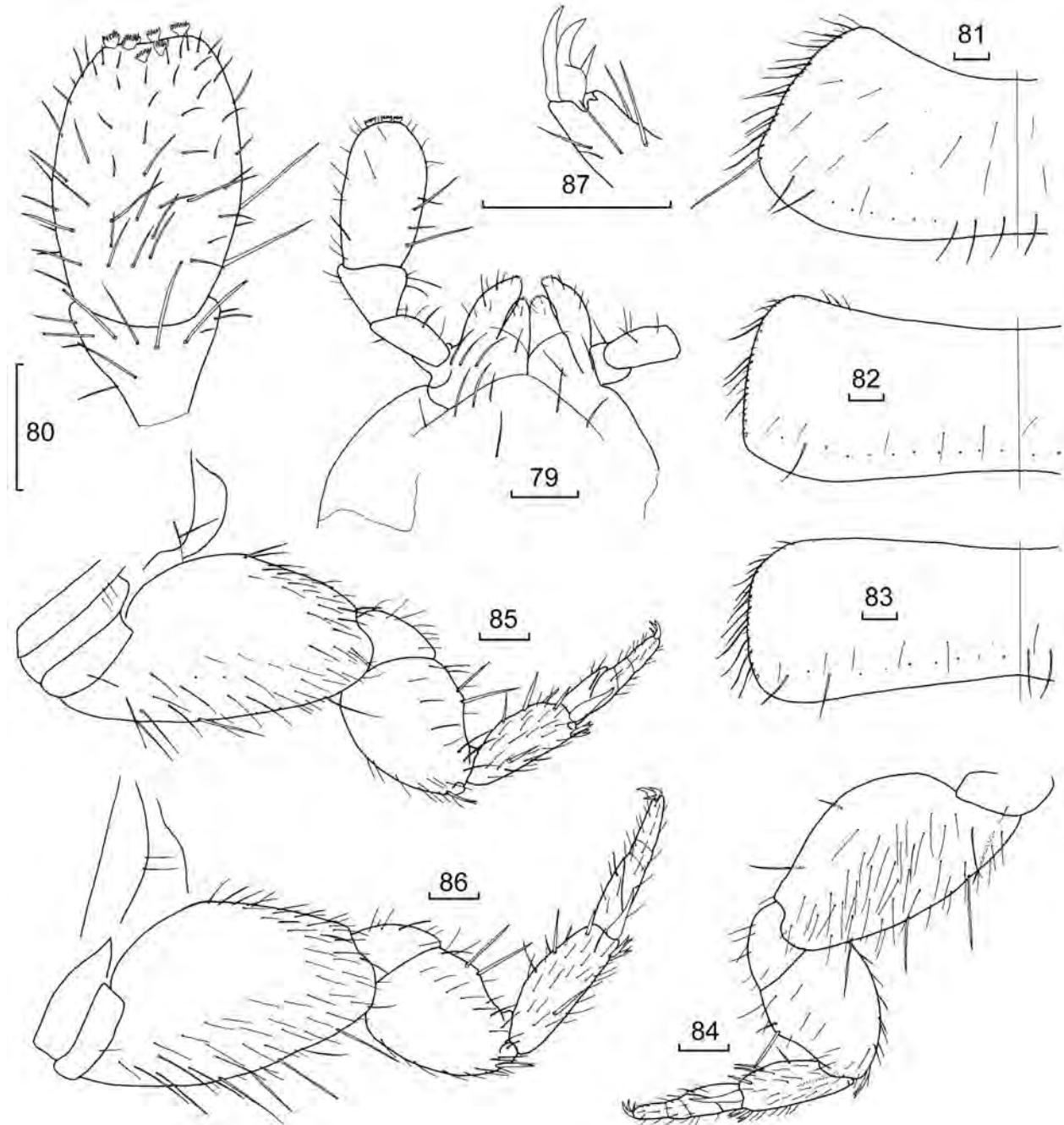
Head: Partially covered by prothorax at hind margin, vertex with many long thin macrochaetae which are not arranged into well-defined rows (Figures 72, 73) becoming smaller and more closely spaced anteriorly and onto the clypeus. — Labrum with a few fine setae. — Antennae short, 0.35 times H+B (Figures 73-75) cuticle with numerous hair-like extensions; scape not short, about one third longer than the pedicel, with subapical rosette of fine macrochaetae and a line of thin setae down one side; pedicel with subapical rosette of long setae, one of which is distinctly apically bifurcate. Flagellum with ten or



Figures 67-78. *Ausallatelura pauciarmata* sp. nov. holotype ♀ (67) habitus; (68) dorsal scale; (69) ventral scale; (70) poster-lateral macrochaeta of pronotum; (71) posterior submarginal macrochaeta of pronotum; (72) head, in alcohol; (73) head and antennae, after dissection, intervals of flagellum numbered; (74) scape, pedicel and basal two intervals of flagellum; (75) distal intervals of flagellum; (76) mandible; (77) idem, molar and incisor regions; (78) maxilla. Scale bars = 0.1 mm unless otherwise indicated.

eleven intervals; first annulus of flagellum with eight trichobothria; intervals subdivide into two annuli from the sixth interval and further subdivide from the eighth although the suture delineating this subdivision appears to be rigid not flexible; intervals two to eight with two trichobothria, interval nine with just one in its apical annulus, ultimate interval with short typical sensilla (Figure 75). — Mandibles (Figures 76, 77)

with a large incisor and a small molar region with about 12 quite strong simple setae externally. — Maxilla (Figure 78) with lacinia slightly longer than the galea, lacinia with simple pointed tooth and a smaller subapical tooth, pectinate prostheca extending slightly beyond tip of lacinia and with an equally long pectinate lamellate process proximally; galea with broad flat apical conule. Maxillary palp short, stout,



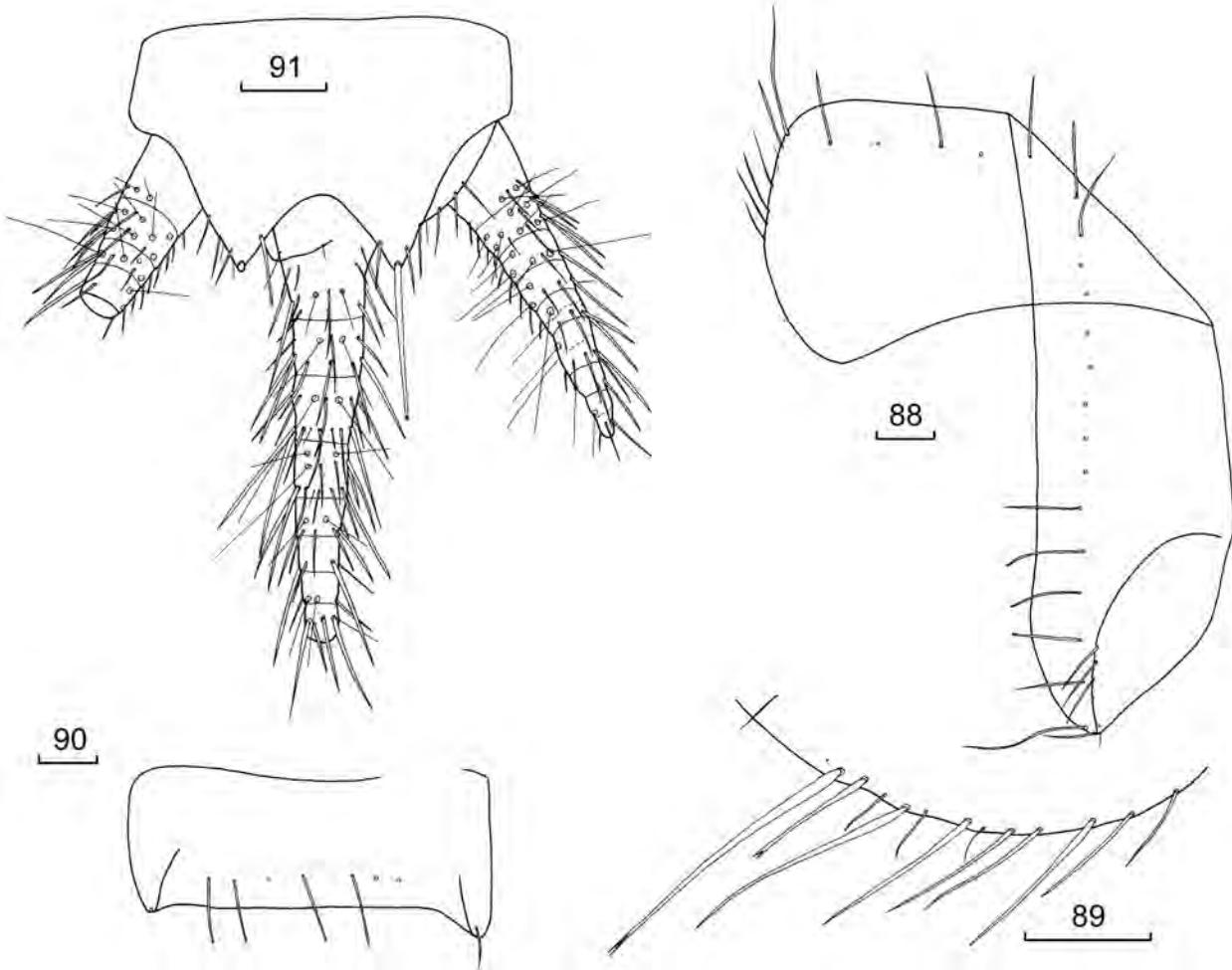
Figures 79-87. *Ausallatelura pauciarmata* sp. nov. holotype ♀ (79) labium; (80) idem, ultimate and penultimate articles of palp; (81) pronotum; (82) mesonotum; (83) metanotum; (84) PI; (85) PII; (86) PIII; (87) idem, pretarsus. Scale bars = 0.1 mm.

with three (?) feathered papillae distally; apical article of palp 3.5 times longer than wide, more than 1.3 times longer than penultimate article and considerably thinner. — Labium without forward pointing rounded lateral projections on posterolateral margins (Figures 79, 80); ultimate article of palp quite long, ovate about 1.5 times longer than wide with usual six sensory papillae distally and two stronger long setae on ventral face; all articles with some smaller and a few slightly stronger setae.

Thorax: Large, about 0.33 H+B, all nota strongly arched and with long, fine setae along lateral margins, with the most posterior being twice as long as the rest and apically bifurcate. Prothoracic notum (Figure 81) about 1.75 times longer than the mesonotum which is about the same length as the metanotum, with a submarginal row of 22 long apically bifurcate macrochaetae that overlap the margin by almost half their length, the disc of the notum with two to three irregular rows of scattered long thin, simple setae.

Meso and metanota (Figures 82, 83) similar to pronotum with two to three irregular rows of 22 and 20 submarginal macrochaetae respectively but only a single irregular row of long, fine setae on the disc.

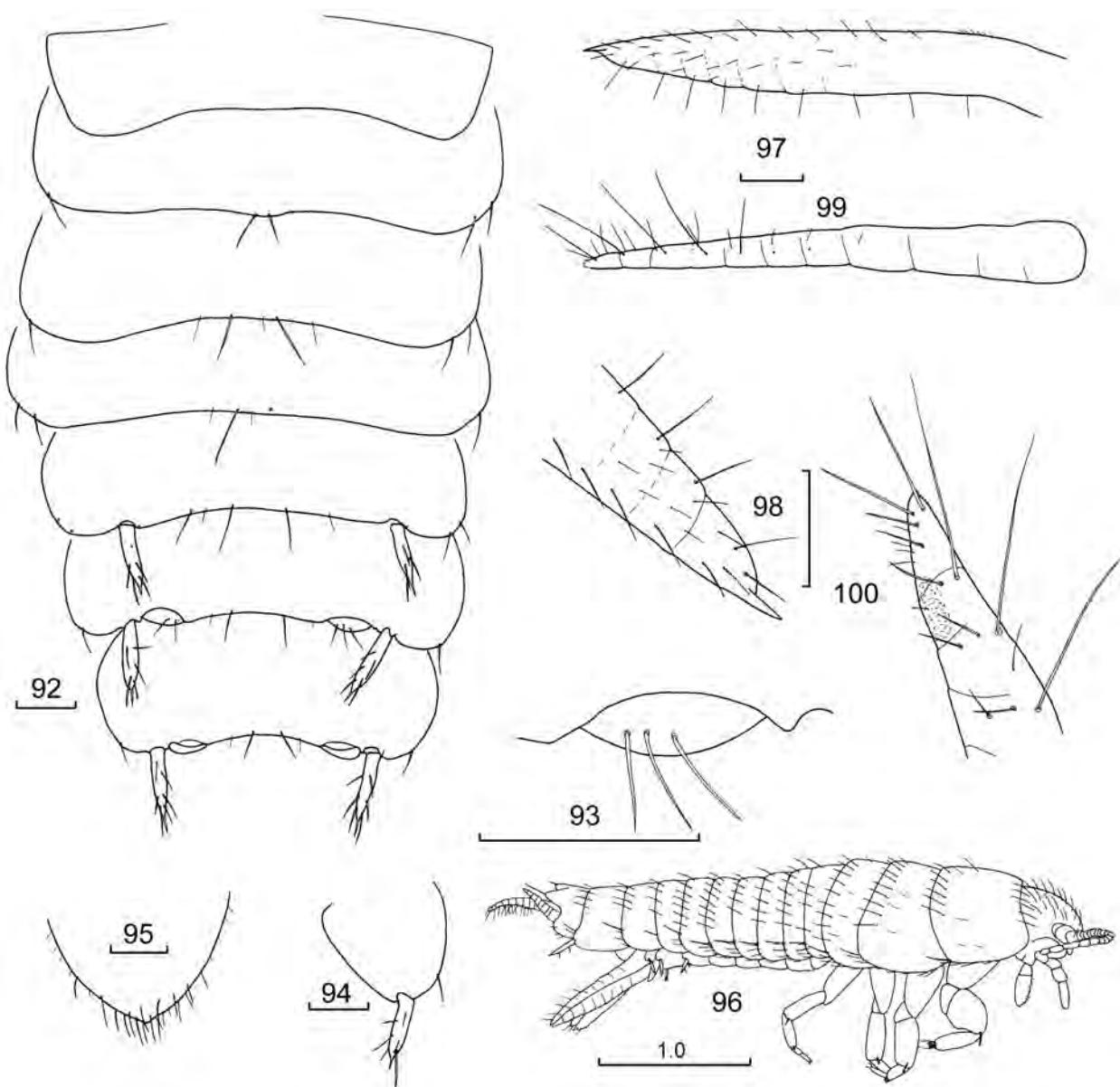
Legs typical (Figures 84-86) for genus, tibia L/W ratio of legs PI 2.6, PII 3.1, PIII 3.2; tarsi L/W ratio PI 5.3, PII 6.2, PIII 5.8. No great difference in length from PI to PIII (ratio of tibia length PI to PIII = 0.77 and tarsus = 0.86). Coxae large and flat with some scales on ventral face in proximal medial half on PII and PIII, the rest of the surface covered with short and long fine setae and some long macrochaetae along the outer margins; trochanter with a few fine setae; femur with one strong, long deeply bifurcated sub-lyriform macrochaeta sub-distally on anterior edge and two longer macrochaetae midway along the posterior margin; tibia with two (PII and PIII) or three (PI) robust subdistal lyriform, macrochaetae, ventral posterior margin with two stronger stout macrochaetae near the distal end, another (the



Figures 88-91. *Ausallatelura pauciarmata* sp. nov. holotype ♀ (88) urotergite I; (89) paratergite IV; (90) urotergite IX; (91) urotergite X and terminal filaments. Scale bars = 0.1 mm.

strongest) about $\frac{2}{3}$ from the proximal end and another smaller macrochaeta about $\frac{1}{3}$ the distance from its proximal end, and another on the ventral face near the external margin at about the same level plus the usual long glabrous apical spine; tarsi of four distinct articles, the basal article short, only about the same length as the tibial spine; pretarsus with two quite long and slender, simple, curved, smooth lateral claws and a shorter, sharp erect medial empodial claw; without pulvilli (Figure 87).

Abdomen: All urotergites wrap around the sides of the body but the suture with the paratergites is hardly distinguishable. Each urotergite with a transverse row of strong thin semi-erect macrochaetae well anterior to the posterior margin (Figure 88) decreasing in number from anterior to posterior (i.e. I = 19, II = 18, III = 17, IV = 16, V = 13, VI = 12, VII = 12, VIII = 9, IX = 7); with a longer marginal macrochaeta and a seta on each side mediad of the suture with the paratergites; margins of paratergites each with five to



Figures 92-100. *Ausallatelura pauciarmata* sp. nov. holotype ♀ (92) urosternites I-VII; (93) vesicle of urosternite VI; (94) coxite VIII; (95) subgenital plate; (96) habitus, lateral view; (97) ovipositor, anterior valve; (98) idem, apex of valve; (99) ovipositor, posterior valve; (100) idem, apex of valve. Scale bars = 0.1 mm unless otherwise indicated.

seven long simple setae and a few setulae (Figure 89) which, because of the fold are actually located mediad and ventral to the largest lateral macrochaetae of each segment. Urotergite IX (Figure 90) with only a slightly concave posterior margin and small posterior lobes each bearing a small macrochaeta. Urotergite X (Figure 91) trapezoidal with deep rounded incision in posterior margin, posterior corners armed with a single, strong, apically bifurcate macrochaeta and a single seta internal to this, outer margin with two or three setae.

Urosternites (Figure 92) much narrower than urotergites; urosternite I glabrous; II with 1+1 submedial apically bifurcate setae on a slight bulge in the posterior margin plus one to two lateral setae; III and IV with 1+1 simple submedial setae plus two or three setulae on the posterior margin as well as one or two lateral setae on each side; V with 1(2)+1 simple submedial setae, two setulae, two setae on the lateral margins as well as a pair of styli; VI similar but also with 1+1 eversible vesicles each bearing two or three simple setae (Figure 93); VII similar but with pseudovesicles; urosternite VIII (Figure 94) separated into two coxites each bearing a stylus and a single lateral seta; coxites IX lost during dissection. Subgenital plate (Figure 95) large, sub-semi-oval with fine marginal and submarginal setae as well as scales. Ovipositor (Figures 97-100) not particularly bulbous with eleven divisions, apices of anterior gonapophyses produced into an acute triangular processes, while the apex of the posterior gonapophyses is produced into a slightly pectinate knob; both sets of gonapophyses also with some fine simple setae.

Cerci short, conical, of eight (?) divisions, some of which appear to be subdivided by a fine uneven suture, the cerci extending beyond the apex of urotergite X by about twice the length of the processes of urotergite X (Figure 91); basal division a bit longer than the rest, all divisions with several trichobothria and longer setae on the outer margin. Median dorsal appendage also with eight (?) divisions and about 0.18 H+B and less than 50% longer than the cerci, with setae and trichobothria, some larger macrochaetae on ventral surface deeply apically bifurcate.

Male. Unknown.

Etymology. From the Latin words *pauci-* meaning few and *armatus* meaning armed, referring to the limited number of lyriform spines found on the tibia compared to *Ausallatelura ordoarmata*.

Ecology. Collected with termites of the genus *Amiatermes* Silvestri, 1901 under rocks.

Remarks. The species is included in *Ausallatelura* mainly because of its dorsal chaetotaxy with a submarginal row of macrochaetae plus additional rows of long but much thinner setae on the nota and also the presence of vesicles on urosternite VI bearing setae. It differs from *Ausallatelura ordoarmata* quite noticeably in the greatly reduced number of lyriform macrochaetae on the tibia and presence of an additional pair of styli. While the number of styli has been used for the erection of new genera in this tribe (even in this paper) it seems unnecessary at this stage to create yet another monotypic genus. Should new information show that the number of styli is of greater phylogenetic significance then this arrangement could be reconsidered.

Australotheus gen. nov.

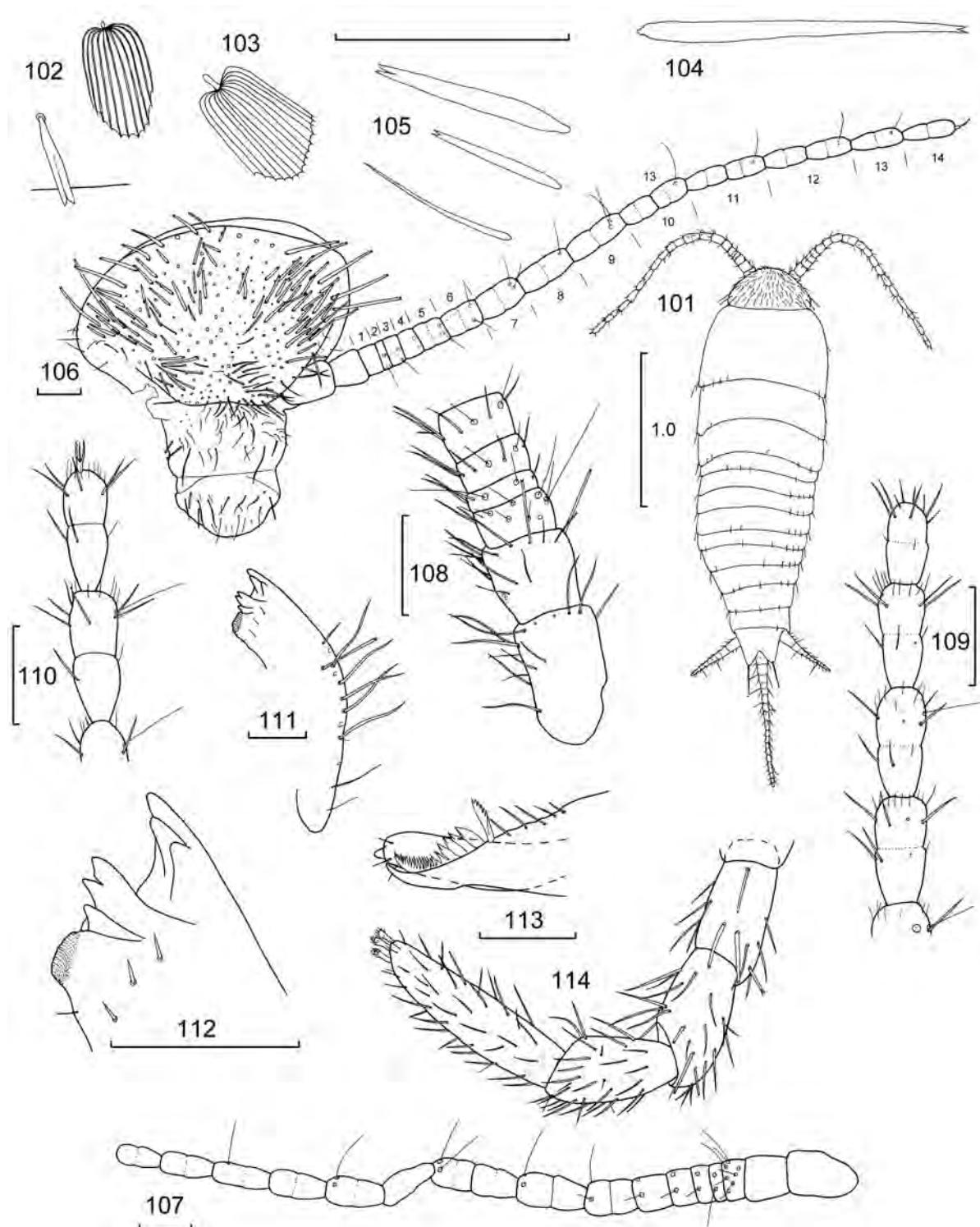
Type species: *Australotheus eberhardi* sp. nov.

Diagnosis. Small silverfish. Body shape ateluriform. Pigment absent. All nota with posterior submarginal row of abiesiform macrochaetae. Scales with about 12 to 15 ribs, the ribs on the ventral scales extending only very slightly beyond the membrane, those on the dorsal surface not extending beyond the margin. Head, hypognathous with scattered flattened macrochaetae, lacking scales. Apical article of labial palp oval. Antennae short, with the intervals subdivided into separate annuli. Lateral margins of nota with numerous short setae and a larger macrochaeta in each postero-lateral corner. Tarsi with four articles, pretarsus with two claws and a medial empodial claw, without pulvilli. Urotergites I-IX with a single submarginal row of abiesiform macrochaetae. Urotergite X trapezoidal with deep acute posterior incision, the posterior corners each with a strong macrochaeta. Urosternites I-IV without special features. Urosternites I-V without vesicles, urosternite VI with large vesicles bearing setae, urosternite VII with pseudovesicles. Styli present on urosternites V-IX. Ovipositor short and bulbous.

Male. Similar to female but with fovea on pedicel, an entire urosternite VIII, coxites IX bearing cylindrical parameres, underside of urotergite X with 1+1 groups of pegs, basal article of cerci also with some pegs.

Etymology. The genus name is a combination of the latin adjective *australis* meaning southern, with the suffix *-otheus* recognising its close relationship with *Pseudogastrotheus*. It is treated as grammatically masculine.

Remarks. The three genera *Dodecastyla*, *Australotheus* and *Pseudogastrotheus* appear to be very closely related to each other, differing only in the number of abdominal segments bearing styli.



Figures 101-114. *Australotheus eberhardi* gen. et. sp. nov. holotype ♂ unless otherwise indicated by specimen number (101) habitus (WAM E89243); (102) dorsal scale and abiesiform macrochaeta of pronotum; (103) ventral scale of urosternite II; (104) largest macrochaeta from postero-lateral corner of head (WAM E89243); (105) medium and small sized flattened macrochaetae from surface of frons and simple seta from its margin; (106) head and antenna, intervals of flagellum numbered (WAM E89243); (107) antenna; (108) pedicel, scape and basal four annuli of flagellum; (109) idem, distal intervals of flagellum; (110) distal intervals of flagellum of ♀ paratype (WAM E89243); (111) mandible; (112) idem, molar and incisor regions; (113) maxilla, lacinia, galea and prostheca; (114) maxillary palp. Scale bars = 0.1 mm unless otherwise indicated.

Given the variability in the number of styli within some genera of the Zygentoma, it is quite possible that this construct may not reflect phylogenetic history. It is however a practical arrangement in the absence of additional data. Similarly, it may prove practical to create a new genus for similar species bearing only three pairs of abdominal styli (e.g. *Gastrotheus* (*Gastrotheus*)*tristilatus* Mendes, 2004 from the Middle East). *Rasthegotus sextilatus* Mendes, 2001 from central Africa also has three pairs of styli but differs where the posterior submarginal row of abiesiform macrochaetae is absent from the last few abdominal nota.

***Australotheus similatus* comb. nov.**

Atelura similata Silvestri, 1908: 55.

Gastrotheus (*Gastrotheus*) *similatus* (Silvestri).—Paclt, 1963: 9.

Ateluroides similatus (Silvestri).—Wygodzinsky, 1963: 266.

Remarks. Silvestri (1908) described the species from Boorabbin in Western Australia (Figure 1). Paclt (1963) later included it in *Gastrotheus* (*Gastrotheus*) without comment. Wygodzinsky (1963) criticized Paclt arrangement believing the number of styli to be more significant placing the specimen in *Ateluroides* Silvestri. Smith (1998) initially followed Wygodzinsky's arrangement, but Mendes (2003) strongly disagreed. Smith & McRae (2014) accepted Mendes' position, suggesting a redescription and new genus would be required for the species. While the type material of *Atelura similata* has not yet been re-examined (at least part of which is in alcohol at ZMB), its original description is sufficient for it to be placed in *Australotheus*.

***Australotheus eberhardi* sp. nov.**

Figures 101-137

Material examined: Holotype ♂ (HW 0.63) WA: Yarrie Station, 200 km E of Port Hedland, Callawa (drill hole CA0019-seLN2321) 20.64605°S 120.29725°E, 24.iv. 2008, Peter Bell and Daniel Eberhard, leaf litter traps at 37m depth (two slides) (WAM E89242). Paratype ♀ (HW 0.64) Yarrie Station, Callawa (drill hole CA0024-seLN2324) 20.64006°S 120.30663°E, 23.iv.2008, Peter Bell and Daniel Eberhard, leaf litter traps at 35m depth (two slides) (WAM E89243).

Diagnosis. This species differs from *Australotheus similatus* by its smaller size (2.8 mm vs 3.5 mm), by the greater number of annuli in each interval of the distal flagellum (four versus two), its much longer cerci (surpassing the apex of the process of urotergite X by about twice the length of the process (excluding the macrochaetae) versus surpassing by less than the length of the process), the subapical rosette of strong

apically bifurcate setae on the second article of the maxillary palp, the much shorter abiesiform macrochaetae (e.g. about 0.2 times the length of tergite IV vs 0.3), the acute inner medial angle of the posterior incision of urotergite X (versus rounded) and the smaller number of trichobothria on the first annulus of the flagellum (8 vs 10).

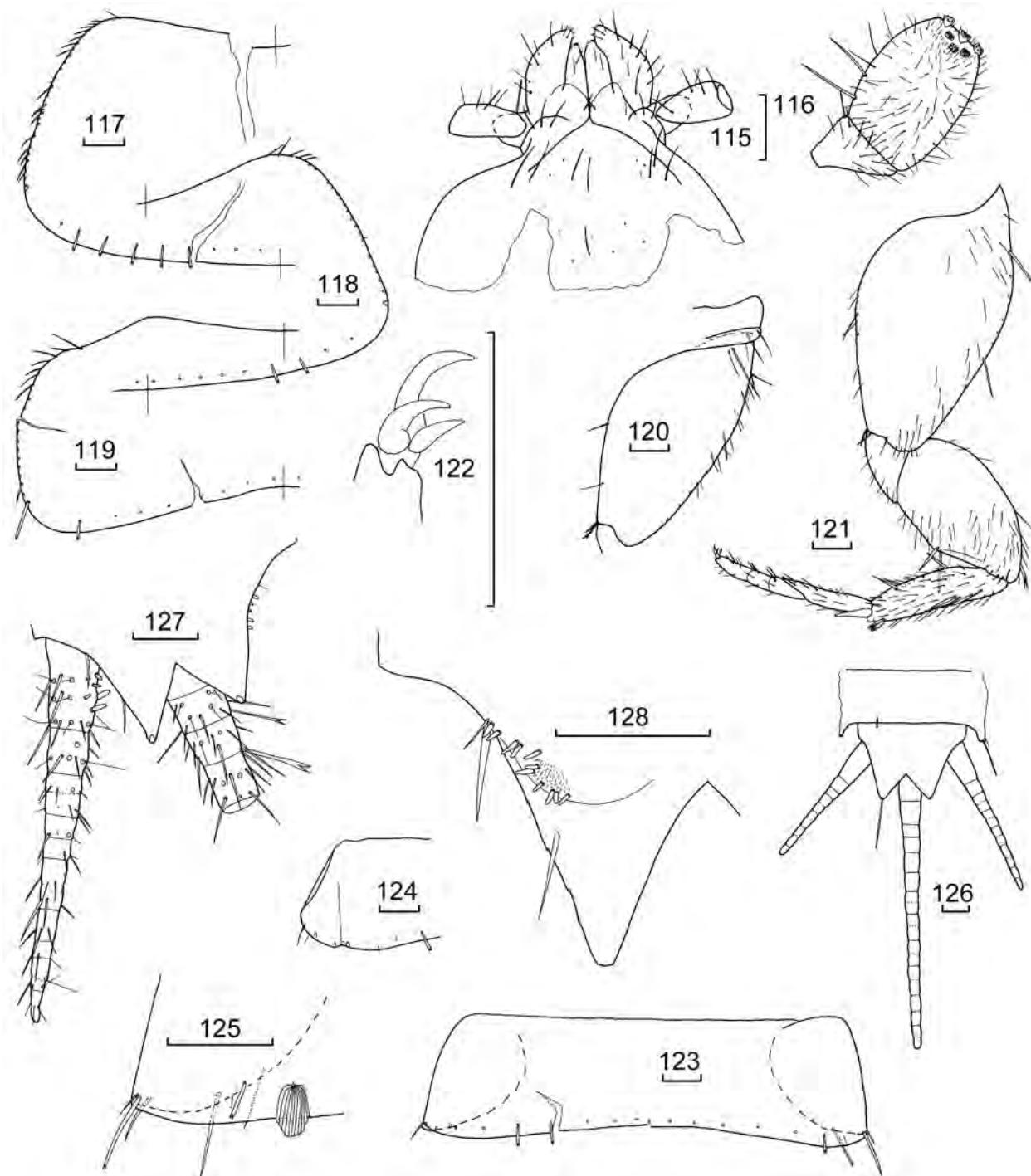
Description. Appearance when live not recorded, alcohol preserved specimens off-white. Small, slender ateluriform shape, not strongly convex (Figure 101).

Body length: Small silverfish (about 2.8 mm), about three times longer than wide; head narrow, hypognathous, antennae 1.63 mm or 0.58 H+B; cerci fairly long, tapering, cercus 0.5 mm or 0.19 H+B; median dorsal appendage 0.9 mm or 0.34 H+B.

Scales: Scales on dorsal surface with about 12 ribs extending only very slightly beyond the margin (Figure 102), scales on ventral surface with the ribs only extending a little beyond the end of the membranes (Figure 103); scales lacking from head and its appendages, from the legs (although present on coxae PII and PIII), cerci and median dorsal appendage and ovipositor (present on subgenital plate).

Macrochaetae: Those on head strong and somewhat flattened, almost abiesiform; those on tergites typical abiesiform (Figure 102); most setae simple, but some e.g. on pedicel, with apical bifurcations (Figures 104-105).

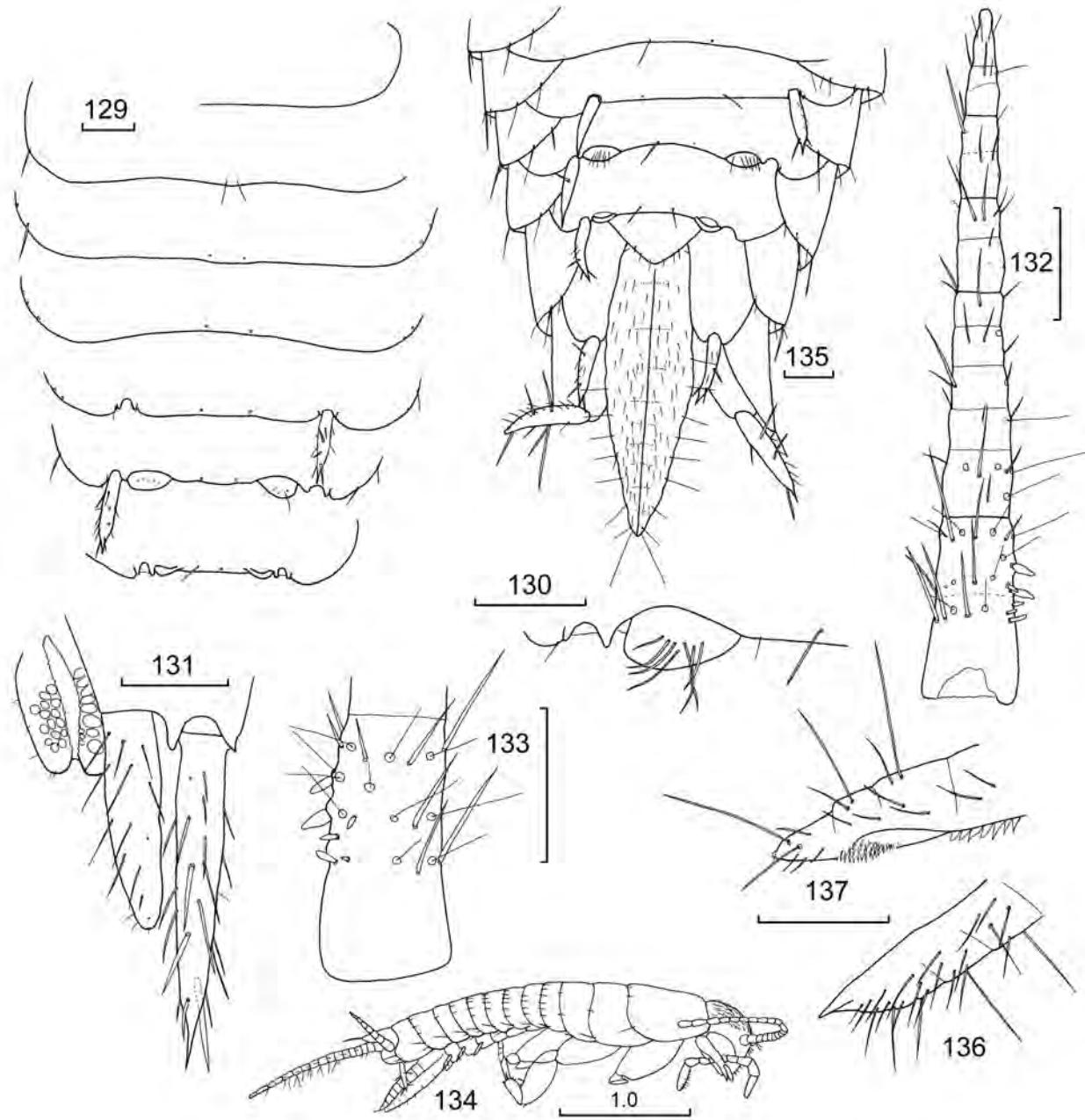
Head: Not covered by prothorax at hind margin, vertex with dense covering of short to long, somewhat flattened macrochaetae which are not arranged into well-defined rows (Figure 106), those at the back and sides longer and stronger becoming smaller anteriorly, with some long but simple setae along the anterior margins of the frons and on the clypeus. — Labrum (Figure 106) with a few fine setae, the most external with short stout apical bifurcations. — Antennae (Figures 106, 107), scape fairly short, only a little longer than the pedicel (Figure 108) with a rosette of long setae subapically and some stronger setae on one side; pedicel with subapical rosette of setae, at least two of which are stronger and distinctly apically bifurcate, some smaller setae on the face and, in the male, a fovea in the basal third. Flagellum with 11 intervals in holotype but 14 in paratype; first annulus of flagellum with eight trichobothria; second interval short with two trichobothria and some setae, the succeeding intervals similar but becoming increasingly longer until the fifth or sixth when they divide into two annuli, the two trichobothria restricted to the distal annulus; intervals further subdivide from interval eight or nine but there is no movement possible at this



Figures 115-128. *Australotheus eberhardi* gen. et. sp. nov. holotype ♂ unless otherwise indicated by specimen number (115) labium, apical articles of palps missing; (116) idem, ultimate and penultimate articles of palp; (117) pronotum (damaged); (118) mesonotum; (119) metanotum (damaged); (120) coxa of PI; (121) PII; (122) idem, pretarsus; (123) urotergite III (?); (124) urotergite V (?), paratergite unfolded; (125) urotergite IV (?), lateral part of tergite and paratergite lying underneath (broken line); (126) urotergite IX (damaged), X and terminal filaments of ♀ paratype (WAM E89243); (127) urotergite X and terminal filaments; (128) underside of urotergite X. Scale bars = 0.1 mm.

secondary suture; two trichobothria in the distal annulus of each interval until the ninth, then only one in the following intervals(?), ultimate article without trichobothria, the holotype apparently without the typical atelurin terminal papilla (Figure 109) however a long papilla exists on each of the antennae of the ♀ paratype (Figure 110), suggesting the apex of the antennae in the holotype has been broken off, even

though there is no obvious sign of damage. The other antenna of the holotype is clearly broken off beyond the ninth interval. — Mandibles (Figures 111, 112) with large incisor region and small but distinct molar region with several strong macrochaetae on the outer face. — Maxilla (Figures 113, 114) with lacinia with simple pointed apex, about the same length or just slightly shorter than both the galea and the pectinate



Figures 129, 131-133. *Australotheus eberhardi* gen. et. sp. nov. holotype ♂. **Figures 130, 134-137.** paratype ♀ (WAM E89243) (129) urosternites I-VII; (130) vesicle of urosternite VI (WAM E89243); (131) coxite IX, penis, paramere and stylus; (132) cercus; (133) basal division(s) of other cercus; (134) habitus, lateral view; (135) urosternites IV-IX, subgenital plate and ovipositor; (136) ovipositor, apex of anterior valve; (137) idem, posterior valve. Scale bars = 0.1 mm unless otherwise indicated.

prostheca; galea with single apical conule. Maxillary palp short, stout, with three pectinate papilla distally; apical article of palp 3.5 times longer than wide (range 3.3-3.6) and 1.7 times longer than penultimate article and slightly thinner. Second article in both sexes with subapical rosette of stronger, apically bifurcate setae. — Labium (Figure 115) typical for the *Pseudogastrotheus* group of genera, ultimate article ovate about 1.4 times longer than wide (Figure 116) with two strong simple setae on inner face in proximal half and the usual six papillae; all articles with many smaller and a few somewhat stronger setae.

Thorax: About 0.34-0.39 H+B, all nota with numerous short, stout, simple setae along the lateral margins and a larger macrochaeta on each postero-lateral corner (lost or broken in holotype) and a submarginal row of abiesiform macrochaetae each slightly shorter than adjacent scales (pronotum with 18(?), mesonotum with 17 and metanotum with 17). Prothoracic notum (Figure 117) 1.5-1.9 times longer than the mesonotum (Figure 118) which is about the same length as the metanotum (Figure 119).

Legs, all missing below coxae except PII on paratype WAM E89243, tibia L/W ratio of PII 3.2; tarsi L/W ratio PII 8.0. Coxa of PI (Figure 120) with one long strong macrochaeta and a seta on the antero-lateral corner as well as several setae and macrochaetae along the outer margin, three (?) small setae apically over the articulation with the trochanter. PII (Figure 121) coxa with a large apically bifurcate macrochaeta near the exterior anterior "shoulder" and a few further macrochaetae (simple?) and setae along the external margin, with some fine setae over the face in the lateral half and scales in the medial half; trochanter with small setae only; femur with a long sub-lyriform macrochaeta on the anterior margin distally and two strong macrochaetae on the angle of the posterior margin; tibia with two strong macrochaetae on the face near the external margin and two stronger setae near them, internal margin with one macrochaeta about one third of the way along the margin and another two macrochaetae about three quarters along, posterior end with one strong seta, the usual tibial spur is about half the length of the first tarsal article and two(?) lyriform spines; pretarsus with four articles, the first about equal in length to the next three together; pretarsus (Figure 122) with two long lateral claws and a simple medial empodial claw, pulvilli absent. Coxa of PIII similar to that of PII.

Abdomen: All urotergites wrap around the sides of the body with a very sharp fold laterally on the faint suture with the paratergites, making it difficult to lay them out flat when slide mounting (Figures 123, 124). Each urotergite with a submarginal transverse row of

short abiesiform macrochaetae which decrease in number posteriorly (e.g. I=16-17, II-III=13-14, IV-V=12-13, VI=8-11, VII=8, VIII=5(?), some urotergites lost or damaged during dissection) and a longer macrochaeta (almost twice as long as the abiesiform macrochaetae) in each postero-lateral corner with a small seta near its base (Figures 124, 125), then nearby, but on the other side of the suture is medium sized seta, then a longer seta (almost as long as the postero-lateral macrochaeta) and another smaller seta, all of which, because of the fold, are located mediad and ventral to the largest lateral macrochaeta of each segment. Urotergite IX (Figure 126) damaged in holotype; female paratype also damaged with paratergites beyond suture missing, with distinct postero-lateral expansions with a large macrochaeta at the postero-lateral corner and with a submarginal row of only one or two (?) abiesiform macrochaetae. Urotergite X (Figures 126, 127) trapezoidal with deep acute triangular posterior incision, each acute postero-lateral corner armed with a long apically bifurcate macrochaeta, medial posterior margin glabrous. Underside of urotergite X in male with eight to eleven pegs partially enclosing a small spinulate area on each side (Figure 128).

Urosternites (Figure 129) much narrower than urotergites; urosternite I glabrous; II-IV with 1+1 small medial setae becoming progressively further apart and larger (?) posteriorly as well as one to three setae on each lateral margin; V similar but also with small styli; VI similar to V but also with eversible vesicles each with an irregular row of five or six simple (?) setae (Figure 130); VII with submedial setae, pseudovesicles and styli; VIII lost during dissection; coxites IX (Figure 131) bearing cylindrical parameres 3.7 times longer than wide, with a few scattered setae; stylus insertion with acute points. Penis (Figure 131) with longitudinal opening with glands on either side.

Small styli present on V-IX, those on VII less than half the length of those on IX (range 0.39-0.45); each stylus with a distinct apical spine, as well as some strong setae (Figure 131).

Cerci (Figures 126-127, 132-133) fairly long, suture between basal two divisions very weak in both sexes, inner face of basal division of the male with a small peg more dorsal and two larger pegs on the medial or slightly ventral face, the second division similarly with one small more dorsal peg and two much larger pegs more ventrally; a total of about fourteen divisions, although this is probably formed from the subdivision of about eight primary divisions, cerci extending beyond the apex of urotergite X (excluding the terminal macrochaeta) by more than twice the length of the processes of urotergite X; with setae and

trichobothria. Median dorsal appendage incomplete on holotype (only three divisions remaining), without modified chaetotaxy, with setae and trichobothria only, the ventral macrochaetae strongly bifurcate; complete on female paratype about twice the length of the cerci and with about 18 divisions; apparently without deeply bifurcated macrochaetae on ventral face.

Female. See figure 134; as for male except, lacking fovea on pedicel, without modified chaetotaxy on base of cerci and underside of urotergite X, coxites VIII separate, subgenital plate subtriangular with small setae around the margins; ovipositor (Figures 135-137) short, not very bulbous, fusiform with pseudosegmentation difficult to discern, perhaps ten or eleven divisions; apices of anterior gonapophyses produced into small triangular processes, while the apex of the posterior gonapophyses is produced into a slightly pectinate knob, before the apex is a smallish raised area of curved spines; both sets of gonapophyses with long and short fine simple setae as illustrated.

Etymology. The species is named after Daniel Eberhard, one of the collectors of the specimens.

Ecology. Collected from mining exploration drill holes using leaf litter traps, baited with local spinifex (*Triodia* sp.) leaves that had been sterilised before use, suspended at depths of 35 and 37 metres for two months. See Smith *et al.*, 2012 for details of this and other subterranean collection methods. Within the same samples were a single unidentified ant, three troglomorphic Tetrablemmid spiders, four troglomorphic Pselaphine beetles, a Cryptorhynchine beetle, an unidentified spider and an unidentified mite. The unidentified spider, mite and ant were not obviously troglomorphic and the litter trap collections did not show a strong association of the silverfish with any host ant or termite species.

This species has a narrower body and much longer antennae and terminal filaments than epigean Atelurinae, a morphology that probably reflects a considerable degree of adaptation for life underground.

Pseudogastrotheus Mendes, 2003

Grassiella Silvestri pro parte.—Silvestri, 1898: 35.

Atelura Heyden pro parte.—Escherich, 1905: 118.

Grassiella Silvestri pro parte.—Silvestri, 1912: 211.

Gastrotheus Casey, 1890: 503 *pro parte*.

Gastrotheus (Gastrotheus) Casey *pro parte*.—Paclt, 1963: 7.

Pseudogastrotheus Mendes, 2003: 344.

Type species: *Grassiella pallens* Escherich, 1903 by original designation.

Pseudogastrotheus undarae sp. nov.

Figures 138-175

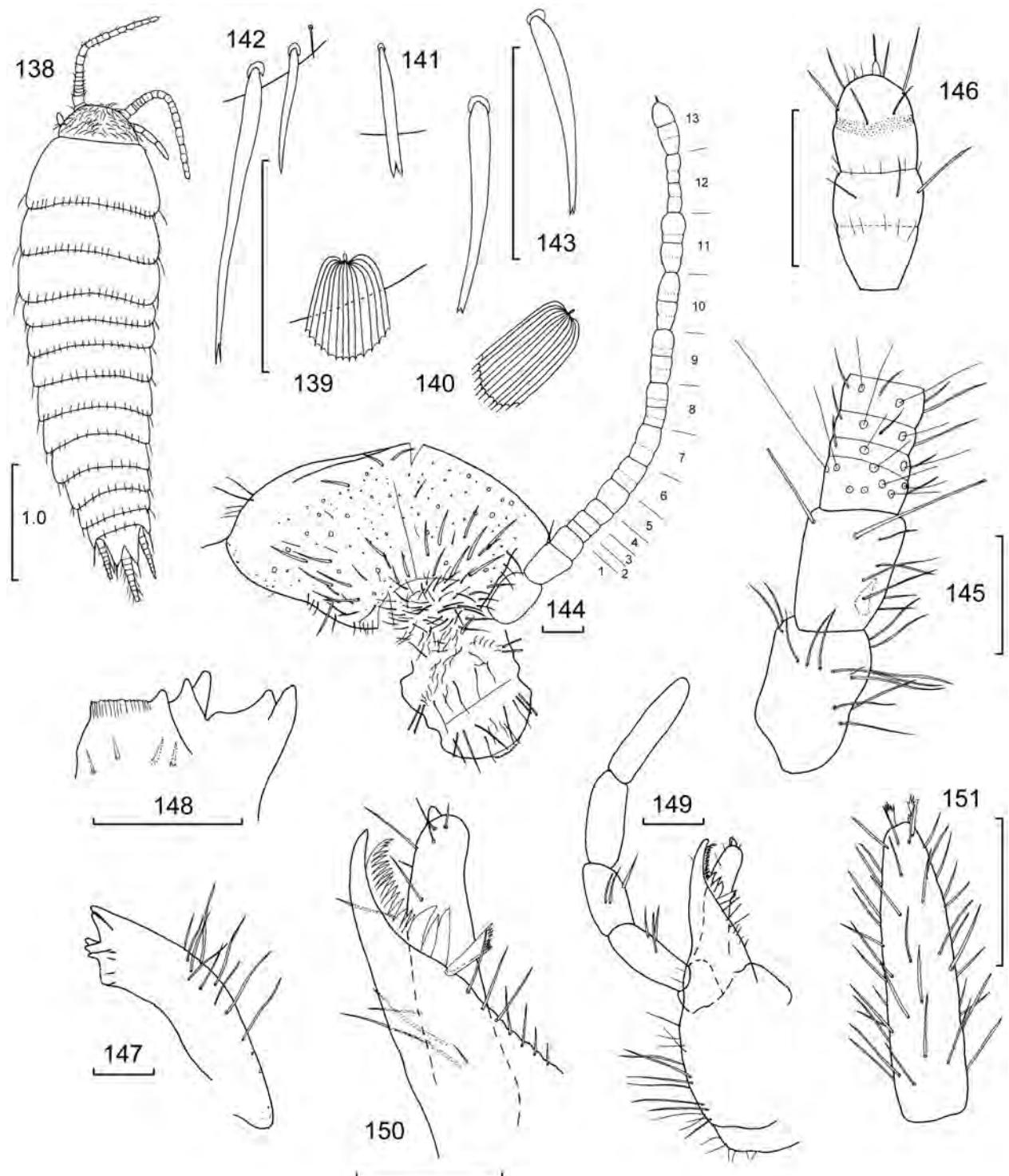
Material examined: Holotype ♂ (HW 0.68) QLD: Barkers Cave, Undara 18.252°S 144.522°E, 27.iv.2011, G.B. Smith, Joe Sydney, Dave Rothery (two slides) QM T234670. Paratypes: ♀ (HW 0.70) same data as holotype (two slides) QM T234671; ♂ (HW 0.63) same data as holotype (alcohol) AMS K377717; ♀ (HW 0.60) same data as holotype (alcohol) AMS K377718; ♀ (HW 0.63) same data as holotype (alcohol) AMS K377719; ♀ (HW 0.65) same data as holotype (alcohol) AMS K377720; ♀ (HW 0.60) same data as holotype (alcohol) AMS K377721; juvenile ♀ (HW 0.48) same data as holotype (alcohol) AMS K377722; ♀ (HW 0.63) same data as holotype (alcohol) AMS K377723; ♀ (HW 0.58) same data as holotype (alcohol) AMS K377724.

Diagnosis. This species differs from other species of the genus by a combination of characters such as the presence of only a single large macrochaeta (not deeply cleft) and a single seta mediad of the suture with the paratergites (rather than two robust deeply cleft macrochaetae), the simple setae on the vesicle of urosternite VI (rather than apically bifurcate), the presence of abiesiform macrochaetae on urotergite IX, the absence of macrochaetae on the internal margins of the posterior incision of urotergite X and in mature males by the rounded protruding posterior margin of urosternite VIII, the long thin parameres as well as the number and arrangement of the sensory pegs on the underside of urotergite X and the inner face of the cerci.

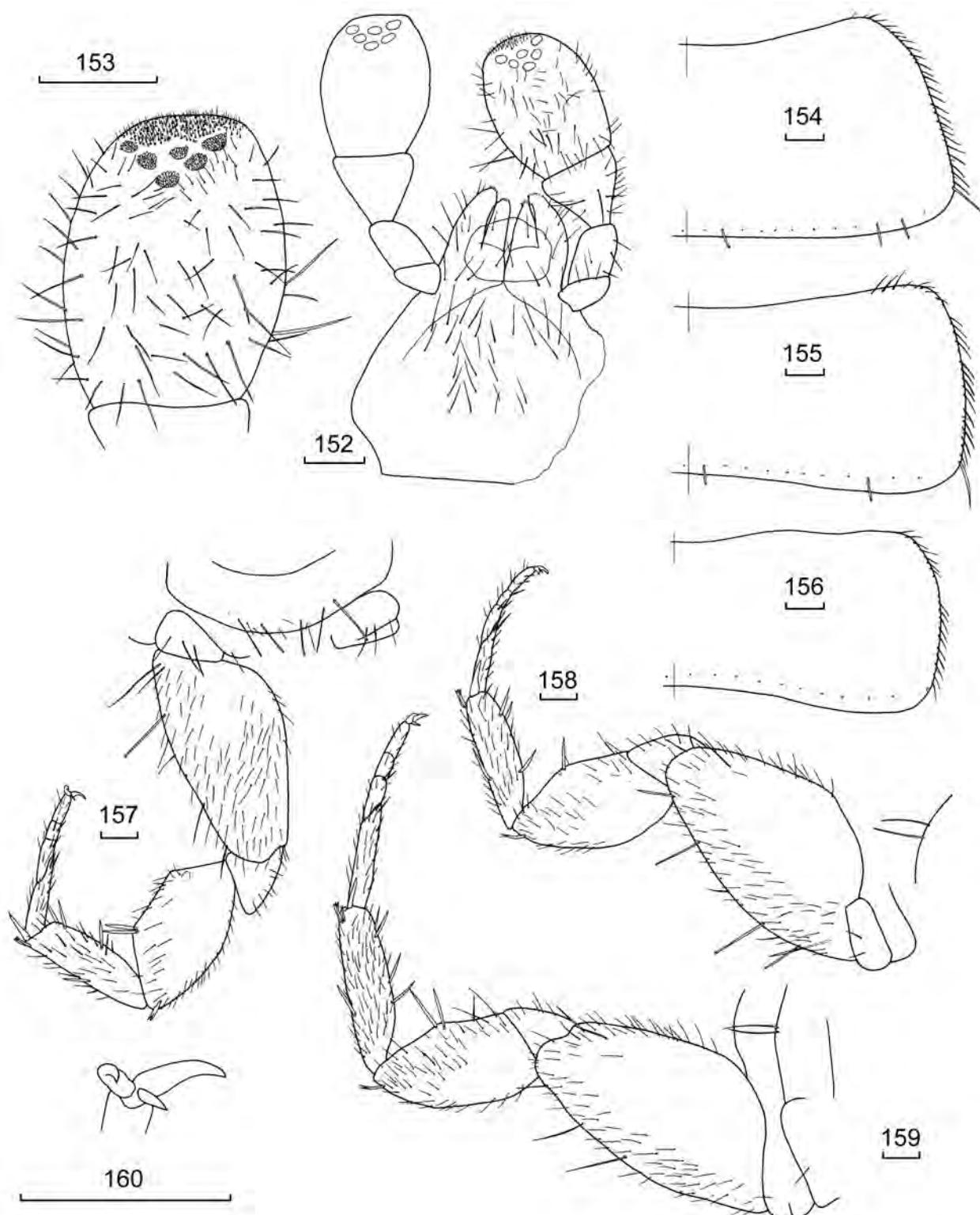
Description. Appearance when live yellowish-white; alcohol preserved specimens off-white. Small size, elongate ateluriform shape (Figure 138).

Body length: Up to 3.8 mm in specimens examined; 3.3 times longer than wide (range 3.0-3.9); range of head widths 0.58–0.70 mm; head hypognathous, antennae up to 1.4 mm or 0.26-0.39 times H+B; cerci quite short, longest measured cercus 0.53 mm or 0.11-0.16 H+B; longest measured median dorsal appendage 0.98 mm or 0.24 H+B.

Scales: Small, similar in shape on both dorsal and ventral surfaces (Figures 139, 140), with about 14 quite well-defined ribs that extend just a little beyond the apex of the joining lamina on the dorsal surface but by about 10% of their length on the ventral surface; scales lacking from head and its appendages, from the legs (although present on coxae of PII and PIII), terminal filaments, styli and ovipositor (present on subgenital plate).



Figures 138-151. *Pseudogastrotheus undarae* sp. nov. holotype ♂ (138) habitus; (139) dorsal scale; (140) ventral scale; (141) abiesiform macrochaeta from pronotum; (142) posterolateral macrochaeta, seta and setula from pronotum; (143) two macrochaetae from head; (144) head and antenna, with intervals numbered; (145) antenna, scape, pedicel and basal four intervals; (146) idem, distal interval; (147) mandible; (148) idem, molar and incisor regions; (149) maxilla (larger setae only on palp); (150) idem, lacinia and galea; (151) idem, apex of maxillary palp. Scale bars = 0.1 mm unless otherwise indicated.



Figures 152-160. *Pseudogastrotheus undarae* sp. nov. holotype ♂ (152) labium; (153) ultimate article of labial palp; (154) pronotum; (155) mesonotum; (156) metanotum; (157) PI and pre sternum; (158) PII and mid-section of sternum; (159) PIII and part of sternum; (160) idem, pretarsus. Scale bars = 0.1 mm.

Macrochaetae: Abiesiform macrochaetae on tergites not very robust (Figure 141), other setae and macrochaetae simple or with delicate apical bifurcations (Figure 142); larger macrochaetae of head not obviously flattened except towards apically bifurcate tips (Figure 143).

Head: Not covered by prothorax at hind margin, vertex with many stronger macrochaetae not arranged in obvious rows, the setae becoming smaller and more numerous towards the front of the head (Figure 144). — Labrum typical for family with a few fine simple setae, the outer two on each side slightly thicker and distinctly apically bifurcate. — Antennae (Figure 144) with well-developed scape and pedicel; scape with a subapical rosette of long setae as well as smaller setae on the ventro-lateral face; pedicel of adult male (Figure 145) with two larger apically bifurcate setae sub-apically and some smaller setae on the ventro-lateral face, a raised crescent-shaped ridge present, probably defining one side of the fovea but certainly not obviously. Flagellum with about 13 to 15 intervals; first annulus of flagellum with eight trichobothria; intervals subdivide into two annuli from the sixth to eighth interval and further subdivide from the eighth to thirteenth interval although the suture delineating this subdivision appears completely rigid not flexible; intervals until the tenth or eleventh with two trichobothria in the most distal annulus of each division, remaining articles to the penultimate with only a single trichobothrium, most distal annulus with typical three-pronged sensilla (Figure 146) as well as several rows of small spots subapically, lacking trichobothria. — Mandibles (Figures 147, 148) with well-developed incisor and molar regions. — Maxilla (Figures 149-151) with lacinia about the same length as the galea, lacinia with simple pointed apex, pectinate prostheca extending only to the apex of lacinia as well as a long pectinate process at the proximal end of the lamellae; galea with prominent apical conule. Maxillary palp short, stout, with three (?) papillae distally; apical article of palp 3.9 times longer than wide (range 3.3-4.7), about 1.6 times longer than penultimate article (range 1.4-2.3) and slightly thinner. — Labium (Figure 152) with rounded posterolateral corners on mentum; ultimate article of palp subrectangular, a little longer than wide (1.2-1.5 times) with usual six papillae distally as well as a dense field of small sensory setae along distal margin; mentum and post mentum with long thin delicately apically bifurcate setae (Figure 153).

Thorax: Large, about 0.32-0.41 H+B, all nota strongly arched and with short strong setae along lateral margins (about as long as the subposterior abiesiform setae) with each posterolateral macrochaeta being two to three times as long as the

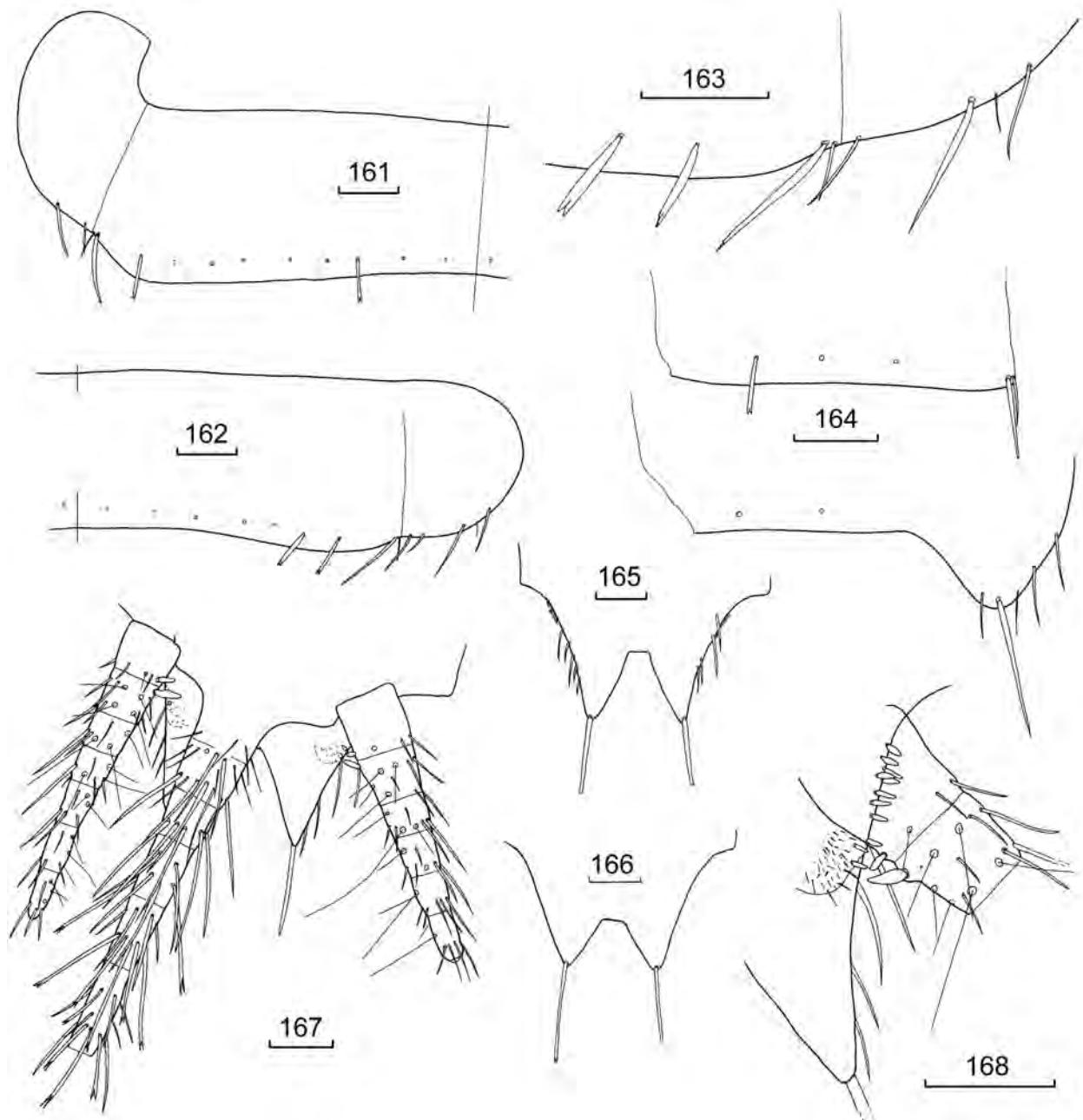
lateral setae and with a delicate apical bifurcation. Prothoracic notum (Figure 154) not particularly long, about 0.4 length of whole thorax (range 0.34-0.46) and about 1.3 times longer than the mesonotum (range 1.0-2.0) which is about 1.1 times longer than the metanotum (range 0.8-1.6), with a single submarginal row of 22-23 abiesiform macrochaetae. Mesonotum similar (Figure 155) with single row of 20-21 abiesiform macrochaetae and the metanotum with 19-20 abiesiform macrochaetae (Figure 156).

Legs typical for genus (Figures 157-159), tibia L/W ratio of legs PI 3.4 (range 3.1-4.1), PII 3.5 (3.2-4.1), PIII 4.4 (3.1-6.1); tarsi L/W ratio PI 7.4 (range 7.0-7.8), PII 8.4 (7.4-9.5), PIII 11.5 (9.6-12.9). No great difference in leg length between PI and PII but PIII noticeably longer with ratio of tibia length PI to PIII = 0.73 (range 0.59-0.84) and tarsus 0.65 (range 0.62-0.68). Presternum (Figure 157) fairly long with several fine setae on face. Preoxa of PI with three setae; coxa fairly elongate and narrow, without scales, the surface covered with fine setae with some longer stronger setae along the lateral margin; femur with a fairly robust deeply bifurcated sub-lyriform macrochaeta sub-distally on anterior edge and two stout macrochaetae on posterior margin; tibia of all legs with three robust subdistal lyriform macrochaetae, ventral posterior margin with two stronger stout macrochaetae near the distal end and another robust macrochaeta almost $\frac{1}{2}$ the distance along the tibia from its proximal end, one on the ventral surface near the external margin at about the same level as the previous plus the usual long apical spine; tarsi of four distinct articles; pretarsus with two quite long and slender, simple, curved, smooth lateral claws and a shorter, sharp erect medial empodial claw (Figure 160). Sternum of meso and metathorax with 1+1 medial setae. PII and PIII similar to PI.

Abdomen: Not much narrower than metanotum at its base. All urotergites wrap around the sides of the body making it difficult to lay them out flat when slide mounting without either tearing off the paratergite or having it lying underneath the urotergite (Figures 161-163). The junction with the paratergite is less obvious on urotergite I than on subsequent urotergites where there is a distinct indentation in the posterior margin of the urotergite at the junction with the paratergites when folded flat. Each urotergite with a submarginal row of abiesiform macrochaetae and a simple apically bifurcate macrochaeta about twice as long in each posterolateral corner as well as a smaller seta mediad of the suture with the paratergite (infralateral group of Mendes, 1986) and two or three setae and a setula on the paratergite (Figure 163) which, because of the fold are beneath the body and mediad of the most

lateral point (laterotergites of Mendes, 1986); transverse rows of abiesiform macrochaetae decreasing in number from anterior to posterior (i.e. I = 19, II = 16-18, III = 15-16, IV = 14, V = 13-14, VI = 11-12, VII = 9, VIII = 3(?)-7). Urotergite IX (Figure 164) with distinct posterior directed lobes on the postero-lateral corners each armed with a large

macrochaeta and some three to five setae on the postero-lateral margin on each side external to the long macrochaeta, posterior margin with two (?) to four abiesiform macrochaetae. Urotergite X (Figures 165, 166) with deep medial trapezoidal incision which is slightly deeper in male than female, each posterior corner quite acute and armed with a strong

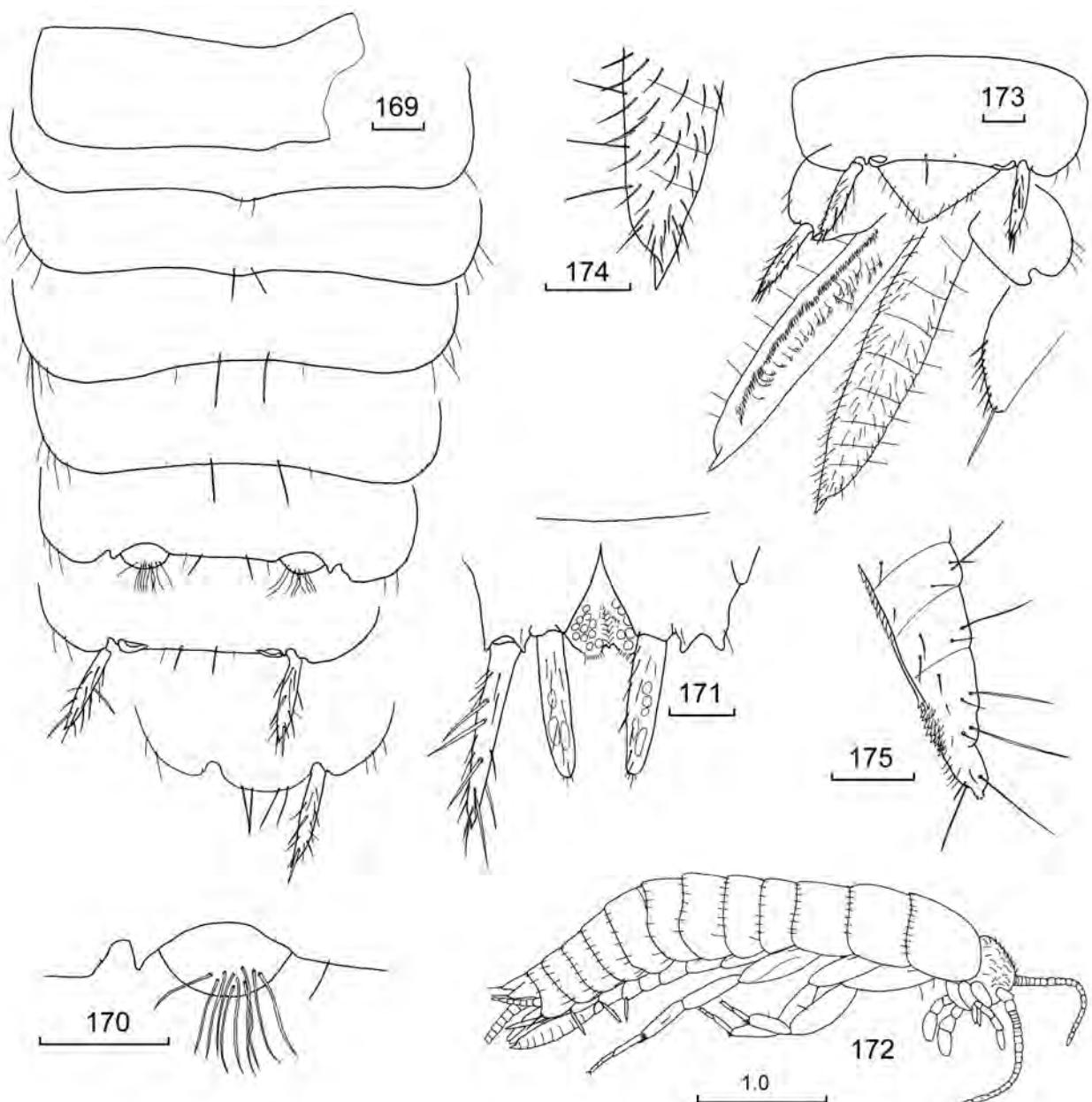


Figures 161-168. *Pseudogastrotheus undarae* sp. nov. holotype ♂ unless otherwise indicated by specimen number (161) urotergite II(?); (162) urotergite V(?); (163) urotergite IV(?), lateral chaetotaxy; (164) urotergite VIII and IX (damaged); (165) urotergite X; (166) urotergite X of ♀ (T234671); (167) urotergite X and terminal filaments from below; (168) modified chaetotaxy of underside of urotergite X and base of cercus of ♂ (former drawn through the cercus). Scale bars = 0.1 mm.

macrochaeta, outer margin with three or more setae in male but glabrous in female, inner margin glabrous (a seta can be seen on one side of the slide mount of T234671 but this is believed an artefact and is not illustrated, its base appears to lie over a scale insertion and no other setae were seen along the medial margins in the remaining alcohol specimens);

underside of urotergite X in mature males with 1+1 lateral fields of about 11 modified sclerotised pegs (Figures 167, 168) ending in a raised mound of small setae.

Urosternites (Figure 169) much narrower than urotergites; urosternite I glabrous with a small convex region in the middle of the posterior margin;



Figures 169-175. *Pseudogastrotheus undarae* sp. nov. holotype ♂ unless otherwise indicated by specimen number (169) urosternites I-VIII; (170) vesicle of urosternite VI; (171) coxites IX with parameres, stylus and penis; (172) habitus ♀, lateral (T234671); (173) urosternite VII, coxites VIII, subgenital plate and anterior gonapophyses (T234671); (174) apex of anterior gonapophyses (T234671); (175) apex of posterior gonapophyses (T234671). Scale bars = 0.1 mm unless otherwise indicated.

urosternite II with two small setulae on median protrusion and one or two small setae laterally; urosternite III with 1+1 submedian submarginal macrochaetae and three or four fine marginal setae outside the postero-lateral corners; urosternites IV and V similar to urosternite III but also with 1+1 setulae on the posterior margin; urosternite VI with short styli as well as 1+1 posterior submedial submarginal setae and 1+1 setulae as well as large evversible vesicles mediad of the styli, each vesicle with nine to twelve long thin simple setae arranged in two or three rows (Figure 170); urosternite VII similar to VI but with glabrous pseudovesicles; urosternite VIII in male entire with slightly larger styli, the posterior margin quite strongly convex with 2+2 setae along the posterior margin, postero-lateral corners each with two or three small setae; urosternite IX in male (Figure 171) divided into separate coxites each bearing a larger stylus, long thin parameres (4.3-4.9 times longer than wide) reaching to about three quarters the length of the styli, each with some apical setulae as well as some glands just visible under the surface and some setae on the ventral surface.

Small styli present on VI-IX, those on VI-VIII only about half to three quarters the length of those on IX; styli not particularly large, each with a very small apical point as well as some strong setae. Penis (Figure 171) with longitudinal opening, some apical setulae and very obvious subsurface glands.

Cerci short, of eight divisions, extending beyond the apex of urotergite X (excluding the terminal macrochaetae) by about the length of urotergite X (Figure 167); all divisions of similar length, cerci of mature males with two large pegs basally on the inner face, one distally on the basal division and one much larger basally on the second division, adjacent to similar but smaller pegs on the underside of urotergite X (Figure 167) as well as setae and trichobothria; following divisions with setae and trichobothria only. Median dorsal appendage incomplete, almost twice as long as the cerci (up to 0.24 H+B on ♀ K377720), with longer divisions distally, with setae and trichobothria only, most macrochaetae on the more distal divisions of both sexes with strong apical bifurcations.

Female: (Figure 172) similar to male except lacking fovea on pedicel, without modified chaetotaxy on terminal filaments; urosternite VIII divided into separate coxites which are round in shape bearing a stylus and two to three fine setae on the lateral margins; subgenital plate subtriangular with scales and several fine submarginal setae along each margin (Figure 173); urosternite IX also divided into separate coxites which are very narrow and bear larger styli (almost twice as long as those on other segments);

ovipositor (Figures 173-175) moderately bulbous with nine divisions, apices of anterior gonapophyses produced into small triangular processes, posterior gonapophyses bearing field of curved rows of hooks subapically, apex produced into a small pectinate knob; both sets of gonapophyses also with some thin simple setae.

Juvenile stages: a juvenile ♀ (HW 0.48) (K377722) had an ovipositor that was about half the size as that of a mature female.

Biology. Collected on mud surface with scattered guano pellets in greatly elevated CO₂ zone about 30 metres before end of tourist path without any obvious host association. This was at the end of a very wet "wet season" where many of the caves at Undara were filled with water.

Remarks. The descriptions of all species of *Pseudogastrotheus* are by no means complete or easily comparable making absolute certainty on the identity of the new species impossible. Comparison of all published descriptions and their illustrations suggests that the Australian species differ from the African species in the development of the lateral macrochaetae of the urotergites. In most (all?) African species there are two strong, deeply bifurcate macrochaetae mediad of the suture with the paratergites (laterotergites of Mendes, 1986). In the Australian species there is one strong apically bifurcate (but not very deeply so) and one smaller seta mediad of the suture. From the illustration in Silvestri (1908: Fig. 83) the larger lateral macrochaeta on *Ps. disjunctus* may be abiesiform, but this needs to be confirmed with reference to the type material as this macrochaeta, in other Australian Atelurinae, is not abiesiform but apically bifurcate. Furthermore, the setae on the evversible vesicle on urosternite VI, in most African species, are distinctly bifurcate where they are simple in *Ps. undarae* (unclear in the illustration of *Ps. disjunctus*). *Ps. undarae* differs obviously from *Ps. disjunctus* by the absence of medial macrochaetae on the margins of the posterior incision of urotergite X (3+3 present in *Ps. disjunctus*) and the much narrower parameres on the new species (L/W 4.5 vs about 3). Silvestri, unfortunately, did not describe the secondary sexual characters on the cerci and underside of urotergite X with this and several other species of Nicoletiinae. Specimens of this genus from several Australian localities, collected with both ants and termites, are available and the genus clearly requires more detailed examination along with a redescription of *Ps. disjunctus*, the type material of which is held in MUSA and ZMB.

Howarth & Stone (1990) reported the presence of atelurin silverfish in areas of high carbon dioxide concentrations within Bayliss Cave at Undara, believing the species to be associated with an ant (*Paratrechina* sp.). It is quite likely that the Howarth & Stone material is conspecific with *Ps. undarae* but their material needs to be examined (material in QM and Bishop Museum, Honolulu). They reasonably believed their species to be a trogloxene i.e. an animal capable of visiting caves but not able to live their whole lives within them. Recently, however, Smith & McRae (2014) described three species of

Atopatelurini living deep within rock in the Kimberley region of north-west Australia, with any host association being tenuous at best. One species (*Trogloteus bifurcus*) displayed some of the typical troglomorphic features, suggesting the Atelurinae may not be obligated to live with a host species if conditions are otherwise suitable. In the case of the Barkers Cave material, no obvious ant host could be seen and population densities of the silverfish were estimated at about $30/m^2$ suggesting these silverfish are able to live in the absence of an ant host under these high moisture and high CO₂ conditions.

Figure 176. *Wooroona telura lenta* gen. et sp. nov. ♀



Wooroona telura gen. nov.

Type species: *Wooroona telura lenta* sp. nov.

Diagnosis. Very small silverfish. Body shape onisciform head exposed. Pigment absent. Macrochaetae long thin with delicate apical bifurcations. Dorsal scales with about nine strong ribs most of which extend beyond the membrane by almost half their length. Ribs of ventral scales a little more numerous and closer together, only extending beyond the membrane by about 10% of their length. Scales absent from the head. Head with scattered macrochaetae. Mandible with long incisor and shorter molar regions. Lacinia shorter than pectinate prostheca and galea, the latter without apical conules. Apical article of labial palp elongate oval. Antennae

short, with the intervals not distinctly subdivided into separate annuli. Pronotum with four or five irregular transverse rows of long macrochaetae, the meso- and metanota with two to three irregular rows; lateral margins with long setae and a larger macrochaeta in each postero-lateral corner. Tarsi with four articles, pretarsus with two claws each with a keeled appearance ventrally and a simple medial empodial claw, without pulvilli. Urotergites I-IX with a single submarginal row of macrochaetae. Urotergite X trapezoidal with deep acute posterior incision, the posterior corners each with a strong macrochaeta. Urosternites I-V without special features. Urosternite VI with glabrous eversible vesicles, urosternite VII with pseudovesicles. Styli present on urosternites VI-IX. Ovipositor short and very bulbous.
Male. Unknown.

Etymology. The genus is described from two specimens collected in the Wooroonan National Park, in Queensland's wet tropical north. The genus name is based on a combination of the national park name with "atelura", the type genus of the subfamily. It is treated as grammatically feminine.

Remarks. This genus is quite unusual in comparison to the other Atelurinae found so far in Australia, especially in the highly unusual scales and the keeled pretarsal claws, characters not reported in the Atopatelurini. Such characters are however found in some Dionychellini (Mendes pers. comm.), a tribe with an amphi-Atlantic distribution and which also has no scales on the head. Without a mature male specimen, where the secondary sexual characters add much valuable information, it is not possible at this stage to unambiguously place *Wooroonatelura* within any of the current tribes.

***Wooroonatelura lenta* sp. nov.**

Figures 176-204

Material examined: Holotype ♀ (HW 0.48) QLD: Wooroonan National Park, Goldsbrough Valley road, bend on top of hill at road junction, 17.21004°S 145.74976°E 111m asl, 13.vii.2013, G.B. Smith (two slides) QM T234672. Paratype ♀ (HW 0.48) same data as holotype (alcohol) AMS K377725.

Type host: *Monomorium* sp. [FORMICIDAE].

Description. Appearance when live pale gold (Figure 176), alcohol preserved specimens off-white. Small, broad ateluriform shape (Figure 177) with cerci held quite elevated.

Body length: Small silverfish (circa 2.3 mm), about three times longer than wide; head narrow, hypognathous, antennae 1.25 mm or 0.55 H+B; cerci quite short, conical, 0.33 mm or 0.15 H+B; median dorsal appendage broken >0.4 mm or >0.17 H+B.

Scales: Scales on dorsal surface with about nine strong ribs extending well beyond the margin (Figure 178), the medial rib being shorter than those either side of it, scales on ventral surface with the ribs only extending about 10% of their length beyond the membranes (Figure 179); scales lacking from head and its appendages, from the legs (although present on coxae PII and PIII), cerci and median dorsal appendage and ovipositor (present on subgenital plate).

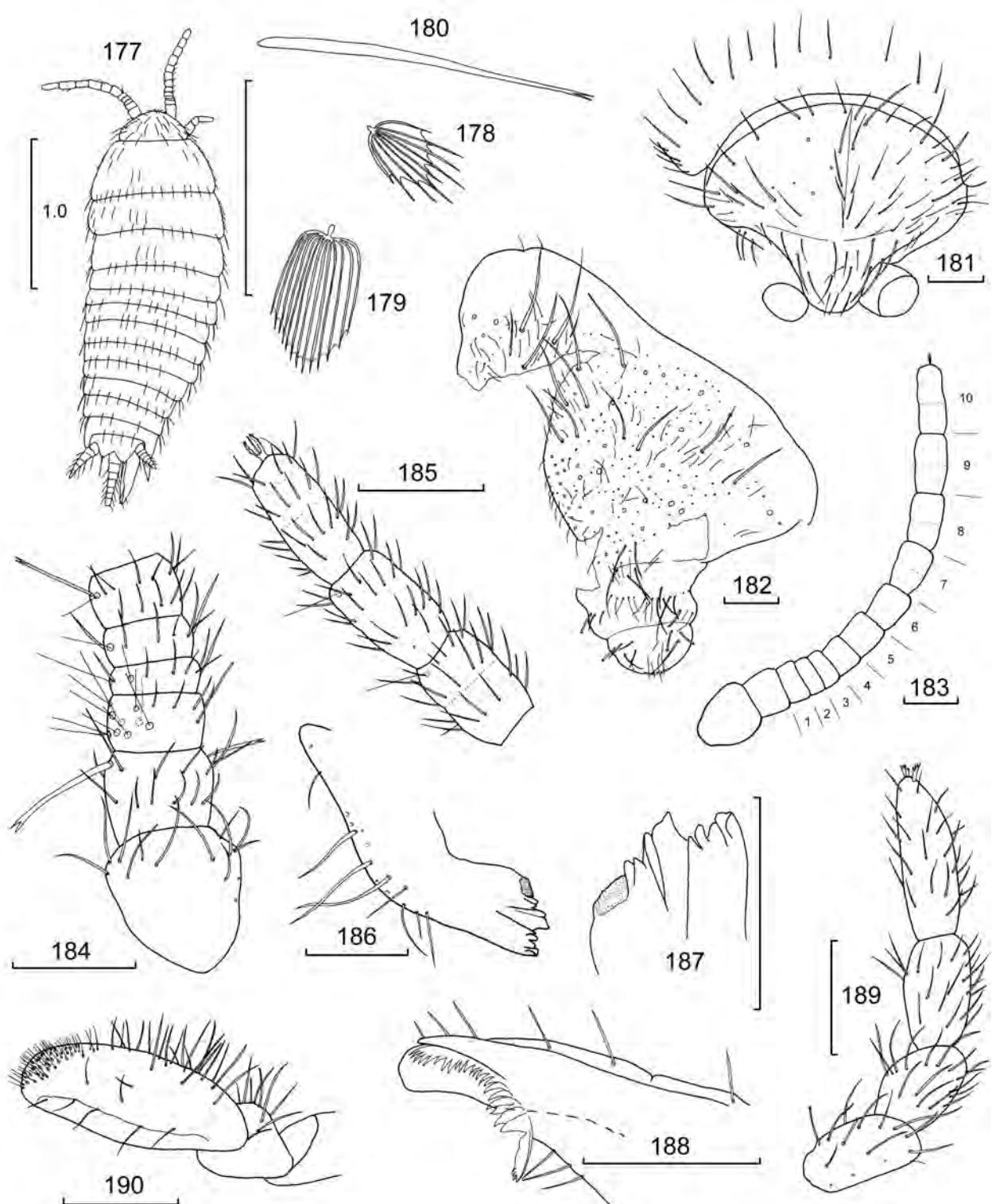
Macrochaetae: Simple and usually with long delicate apical bifurcations (Figures 180).

Head: Not covered by prothorax at hind margin, vertex with many long thin simple macrochaetae which are not arranged into well-defined rows (Figures 181, 182), as well as thinner long setae

becoming smaller but not very dense anteriorly and onto the clypeus. — Labrum with a few fine setae, the most external are short stout with bifurcate apices. — Antennae 0.55 times H+B (Figure 183); scape fairly short, only a little longer than the pedicel (Figure 184) which has two longer, stronger, apically bifurcate macrochaetae and two rosettes of small simple setae. Flagellum with ten or 12 intervals (different for each side of the holotype); first annulus of flagellum with ten trichobothria; intervals do not subdivide into distinct annuli but faint sutures divide the intervals into two from the seventh with no movement between the parts; intervals II to VIII with two trichobothria, subsequent intervals apparently only with one trichobothrium, the ultimate article without trichobothria but with the typical atelurin terminal papilla (Figure 185). — Mandibles (Figures 186, 187) with large incisor region and distinct molar region, with a few macrochaetae on the outer face. — Maxilla (Figures 188, 189), lacinia with simple pointed apex, slightly shorter than both the galea and the pectinate prostheca; galea without apical conule. Maxillary palp short, stout, with three (?) pectinate papillae distally; apical article of palp 2.4 times longer than wide, almost 1.3 times longer than penultimate article and slightly thinner. — Labium not well preserved and not well aligned on slide, ultimate article of palp quite long, ovate about 1.2 times longer than wide (Figure 190); all articles with many smaller and a few somewhat stronger setae.

Thorax: Large, about 0.35 H+B, all nota strongly arched and with long fine, setae along lateral margins, with the most posterior being much stronger and somewhat longer than rest. Prothoracic notum (Figure 191) about 1.3 times longer than the mesonotum which is about the same length as the metanotum, with four or five irregular rows of long, delicately apically bifurcate macrochaetae which are obliquely raised from the surface in entire specimens, with a transverse row of about 19 macrochaetae anterior to the posterior margin (excluding the postero-lateral marginal macrochaetae). Mesonotum (Figure 192) and metanotum (Figure 193) with two to three irregular rows of macrochaetae of about 22 and 20 submarginal macrochaetae respectively.

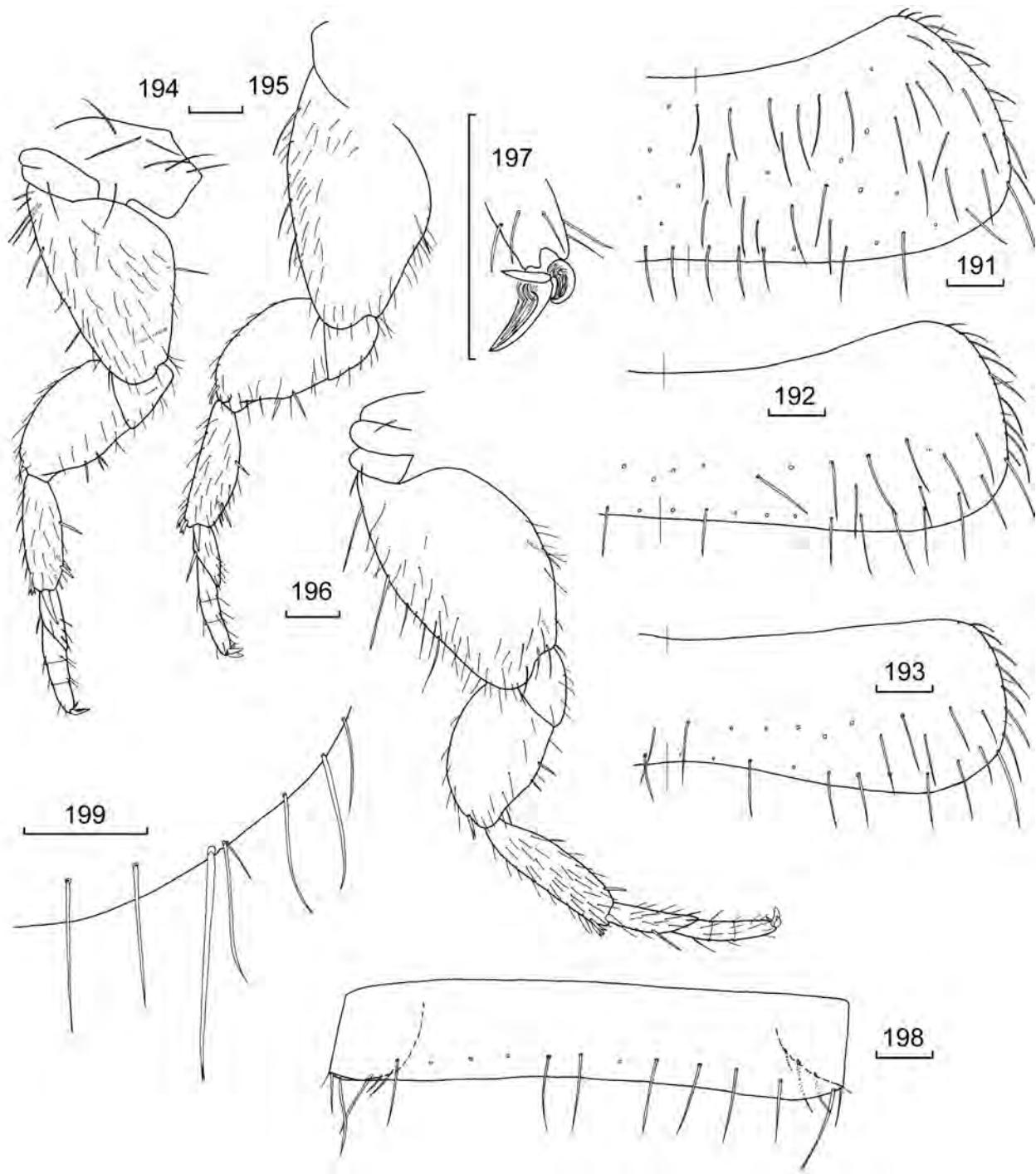
Legs typical for subfamily (Figures 194-196), tibia L/W ratio of legs PI 3.0 (range 2.8-3.0), PII 2.4, PIII 3.0 (2.2-3.8); tarsi L/W ratio PI 5.2 (5.1-5.3), PII 5.1, PIII 6.3 (5.4-7.1). No great difference in length from PI to PIII (ratio of tibia length PI to PIII = 0.84 and tarsus = 0.75). Presternum of PI wide with several thin setae; precoxa with one fine seta; coxae with some scales on ventral face in proximal medial quarter only on PII and PIII, the rest of the surface covered with fine setae and some longer setae along



Figures 177-190. *Wooroonaatelura lenta* gen. et. sp. nov. ♀ holotype unless otherwise indicated by specimen number (177) habitus, dorsal; (178) dorsal scale; (179) ventral scale; (180) macrochaeta of pronotum; (181) head and anterior of pronotum (in alcohol) (K377725); (182) head (damaged during dissection and mounting); (183) antenna, with numbered intervals of flagellum; (184) idem, scape, pedicel and first four divisions of flagellum; (185) idem, distal three intervals of flagellum; (186) mandible; (187) idem, molar and incisor regions; (188) maxilla, lacinia and galea; (189) maxillary palp; (190) ultimate article of labial palp (from side and partially contracted). Scale bars = 0.1 mm unless otherwise indicated.

the lateral margin; femur with one deeply bifurcated sub-lyriform macrochaeta sub-distally on anterior edge, a few setae scattered over the posterior ventral surface and two somewhat stronger setae on the posterior margin; tibia with two subdistal lyriform

macrochaetae, ventral posterior margin with two stronger setae near the distal end and another stronger seta about $\frac{1}{3}$ the distance along the tibia from its proximal end, plus the usual apical spine, this spine is longest on PI and shortest on PIII where it is only

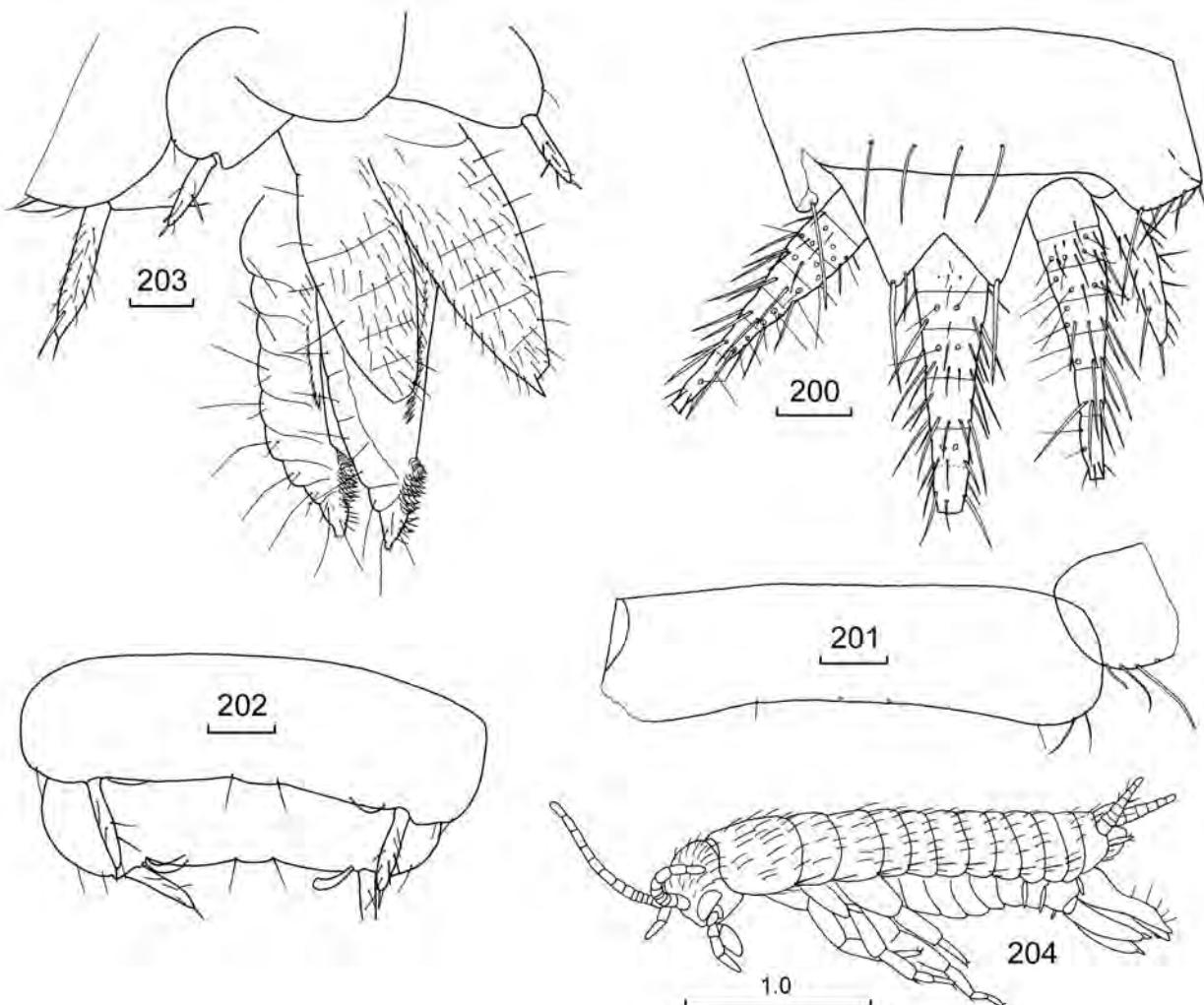


Figures 191-199. *Wooroontelura lenta* gen. et. sp. nov. ♀ holotype (191) pronotum; (192) mesonotum; (193) metanotum; (194) PI; (195) PII; (196) PIII; (197) idem, pretarsus; (198) urotergite VI, with paratergites folded underneath; (199) chaetotaxy of the right posterolateral corner of urotergite III. Scale bars = 0.1 mm.

about the same length as the diameter of the tarsus; tarsi of four distinct articles, the basal article bearing an unusually strong seta apically on its dorsal surface but otherwise with simple chaetotaxy; pretarsus unusual, with two long outer claws that appear to have a deep striated keel beneath and a simple lanceolate medial empodial claw, pulvilli not observed (Figure 197).

Abdomen: All urotergites wrap around the sides of the body making it difficult to lay them out flat when slide mounting (Figure 198) but the suture with the paratergites was not visible, and in only one instance did they tear along the presumed suture during dissection suggesting this suture is largely obsolete. Each urotergite with a submarginal transverse row of strong obliquely raised macrochaetae each with a delicate apical bifurcation, decreasing in number posteriorly (e.g. I-IV=16, V=13, VI=11, VII=10, VIII

lost during dissection) and a macrochaeta about one third longer in each postero-lateral corner as well as several setae on the margin of the paratergites in a regular arrangement (Figure 199) which, because of the fold, are actually located mediad and ventral to the largest lateral macrochaeta of each segment. Urotergite IX (Figure 200) with medium sized postero-lateral expansions, the apex of which bears a long macrochaeta and the infralateral margins with five small setae and a setula; the posterior margin with four submarginal macrochaetae. Urotergite X (Figure 200) trapezoidal with deep triangular posterior incision, each acute postero-lateral corner armed with a long apically bifurcate macrochaeta, medial posterior margin may have a small seta mediad of the macrochaeta (visible on left side but not the other and may be an artefact).



Figures 200-204. *Wooroonatelura lenta* gen. et. sp. nov. ♀ holotype unless otherwise indicated by specimen number (200) urotergites IX and X and terminal filaments; (201) urosternite V and its paratergite; (202) urosternites VI and VII; (203) coxites VIII, styli, subgenital plate and ovipositor; (204) habitus, lateral view (K377725). Scale bars = 0.1 mm unless otherwise indicated.

Urosternites much narrower than urotergites; urosternite I glabrous (still attached to PIII on slide mount); II also glabrous along posterior margin (damaged near centre and right sides in holotype but intact on paratype) but with one small seta postero-laterally, without any sign of vesicles; III (also damaged) with 1+1 medial simple submedial setae and 2+2 (?) small fine lateral setae; IV with 1+1 long submedial setae with a setula on each side laterad to the submedial setae and 1+1 postero-lateral fine setae; V with 1+1 long submedial setae with one or two setulae on each side between the submedial setae and the 2+2 postero-lateral setae (Figure 201); VI with 1+1 submedial setae and 1+1 glabrous eversible vesicles, 1+1 small styli and 1-2 small fine setae postero-laterally (Figure 202); VII similar to VI but with pseudovesicles (Fig.202); coxites VIII apically round, each with a stylus and a single small lateral seta; the subgenital plate sub-semicircular (Figure 203) and covered with scales but without any setae; coxites IX not easy to see in dissected material, to a large extent covered by the paratergites of urotergite IX.

Small styli present on VI-IX, those on VII only about half the length of those on IX (range 0.43-0.48); each stylus with a small but robust apical seta, the styli on coxites IX not particularly large, with a short apical seta as well as a strong subapical seta.

Cerci short, of seven subequal divisions, extending beyond the apex of the short urotergite X (excluding

the terminal macrochaetae) by more than twice the length of the processes of urotergite X, with setae and trichobothria as shown in Figure 200. Median dorsal appendage incomplete on both specimens (maximum preserved section only five divisions or 0.17 H+B), with setae and trichobothria only, the ventral macrochaetae not very strongly bifurcate (Figure 200).

Ovipositor (Figures 203, 204) short, very bulbous, fusiform with pseudosegmentation difficult to discern, perhaps six or seven divisions; apices of anterior gonapophyses produced into small triangular processes, while the apex of the posterior gonapophyses is produced into a slightly pectinate knob, before the apex is a very strongly developed and raised area of curved spines; both sets of gonapophyses with both long and short fine simple setae as illustrated.

Male. Unknown.

Etymology. The species name is derived from the Latin adjective *lentus* meaning slow, sluggish or lingering, a name inspired by the observation that these small silverfish did not run away quickly when disturbed, a behaviour very unlike that of other myrmecophilic silverfish seen by the author.

Ecology. Collected within an ant nest (*Monomorium* sp.) in small piece of rotting tree branch partially embedded in wet soil.

Table 1 – Number of described species of each genus of the Atopatelurini by region

	Central and southern Africa	North Africa / Middle East	Australia / PNG	Southern and south east Asia	South America	North America	Europe / North Asia	World
<i>Allatelura</i>	-	-	2	-	-	-	-	2
<i>Arabiatelura</i>	-	3	-	-	-	-	-	3
<i>Atopatelura</i>	1	1	-	-	-	-	-	2
<i>Ausallatelura</i>	-	-	2	-	-	-	-	2
<i>Australotheus</i>	-	-	2	-	-	-	-	2
<i>Australiatelura</i>	-	-	5	-	-	-	-	5
<i>Dodecastyla</i>	-	-	2	-	1	-	-	3
<i>Ecnomatelura</i>	1	-	-	-	-	-	-	1
<i>Galenatelura</i>	-	-	1	-	-	-	-	1
<i>Pseudogastrotheus</i>	16	1	3	3	1	-	-	24
<i>Rasthegotus</i>	1	-	-	-	-	-	-	1
<i>Troglotheus</i>	-	-	1	-	-	-	-	1
Total number of genera (spp)	4 (19)	3 (5)	8 (18)	1 (3)	2 (2)	0 (0)	0 (0)	12(47)

DISCUSSION

With the possible exception of *Wooroona telura lenta* sp. nov., the Australian Atelurinae all appear to belong to the Atopatelurini, a tribe with a distribution best treated with caution because of the very poor state of Zygentoma research in much of the world. Very little work has been carried out in the Americas (apart from the extensive work of Espinasa on the subterranean Nicoletiinae and Cubacubaninae) and Asia. These regions are likely to yield interesting discoveries if sufficient attention were to be paid to the group.

While a similar number of species have been described from Africa, the Australian Atopatelurini would appear to be more diverse, although this could well be reflection on sampling methods used. For example two Australian genera are only known from sampling deep subterranean habitats via mining exploration drill holes, a collection method that has probably not yet been used outside Australia.

Most genera of the Atopatelurini possess eversible vesicles on urosternite VI that bear apically bifurcate or simple setae, as well as a submarginal posterior row of short abiesiform macrochaetae on the tergites in addition to flattened macrochaetae on the head; the tibia of many are armed with several lyriform macrochaetae. While the Australian *Australiatelura*, *Australothelus*, *Dodecastyla* and *Pseudogastrotheus* have both the abiesiform macrochaetae and setated eversible vesicles VI, they all have a low number of lyriform macrochaetae (only two or three per tibia). *Troglotheus* would appear to be close to this group of genera but has lost all the abiesiform macrochaetae from the terga. Interestingly, when setae are present on vesicles VI in all Australian species (*Australiatelura*, *Ausallatelura*, *Dodecastyla*, *Pseudogastrotheus* and *Troglotheus*), they are simple,

centred on central and southern Africa and Australia but extending into North Africa and the Middle East, southern Asia and South America (see Table 1). This distribution pattern needs to be noted as it is not apically bifurcate as seen in many African species (*Pseudogastrotheus* and *Rasthegotus*).

Another group of three genera have diverged from this pattern quite strongly. Rather than having abiesiform macrochaetae near the posterior margins of all tergites and flattened macrochaetae on the head, they have long dorsal and cephalic macrochaetae present in multiple rows on the head and nota. Of these genera, setated vesicles VI are present only in *Ausallatelura* but there are hollows mediad of styli VI on *Galenatelura* and at least one species of *Allatelura* (e.g. see figure 31 in Smith, 2009 and figure 25 above) suggesting these may have secondarily been lost. Both *Allatelura* and *Galenatelura* and one of the two species of *Ausallatelura* display a large number of lyriform tibial spines. *Ausallatelura* would appear to be somewhat intermediate between the two different groups of Australian Atopatelurini.

This paper completes the description of at least one species from all Australian genera that the author has collected or seen in museum collections which allows a key to be proposed to the genera of Australian Atelurinae. It is not an indication of the total number of species in each genus, with many *Australiatelura* and *Pseudogastrotheus* species still awaiting description and no doubt many more to be collected. Given the still very limited efforts to collect silverfish in Australia and the specialised biology of this subfamily it is quite likely that more genera will be discovered and will most likely be found by specialists sampling from within the nests of ants and termites or from deep subterranean habitats.

Key to the genera of Atelurinae recorded in Australia

1. - Vesicles on urosternite VI glabrous; dorsal scales with several strong ribs that extend for $\frac{1}{3}$ or more of their length beyond the membranes *Wooroona telura* gen. nov.
- Vesicles absent on urosternite VI or when present, large, with prominent setae on the vesicle; scales with ribs that do not extend much more than 10% (rarely 25% but then lacking vesicles VI) of their length beyond the membranes ATOPATELURINI 2
2. - Tergites glabrous except for 1+1 macrochaetae in each postero-lateral corner, elongate, subterranean *Troglotheus* Smith & McRae, 2014
- Tergites with transverse rows of macrochaetae 3
3. - All tergites with subposterior row of abiesiform macrochaetae as well as 1+1 postero-lateral macrochaetae 4
- Nota with several rows of long simple macrochaetae, urotergites with single submarginal row of simple macrochaetae as well as 1+1 postero-lateral macrochaetae 7

4. - Urosternite III with 1+1 medial styli, IV-IX with lateral styli *Australiatelura* Mendes, 1995
- Urosternite III without medial styli, lateral styli on IV-IX, V-IX or VI-IX 5
5. - Styli present on urosternites VI-IX *Pseudogastrotheus* Mendes, 2003
- Styli more numerous 6
6. - Styli present on urosternites IV-IX *Dodecastyla* Paclt, 1974
- Styli present on urosternites V-IX *Australotheus* gen. nov.
7. - Eversible vesicles with prominent setae on urosternite VI *Ausallatelura* Smith, 2007
- Vesicles absent on urosternite VI 8
8. - Almost no macrochaetae with bifurcated tips; males with deflexed urotergite X with large field of pegs, exposed so that fields of pegs point backwards *Galenatelura* Smith, 2009
- Many macrochaetae with bifurcated tips; urotergite X of males small but not deflexed so that the small fields of pegs point downwards or slightly laterally *Allatela* Silvestri, 1947

ACKNOWLEDGEMENTS

I would like to thank Queensland National Parks for collection permits and the advice and cooperation of their park rangers, Debbie Jennings of ANIC for the extended loan of the specimens, Mr Joe Sydney and Mr Dave Rothery for assistance in collecting in the Undara lava tubes, Dr Stefan Eberhard for the opportunity to examine subterranean fauna from the Pilbara, Dr Robert Taylor, (CSIRO, Canberra) and Mr Derek Smith (AMS) for identification of host ants, Mr Scott Kleinschmidt (ATP Research), Mr. Russell Cox (AMS) and Mr Robert Eldridge for help with termite identification and Dr Luis Mendes of the Instituto de Investigação Científica Tropical, Jardim Botânico Tropical (IICT/JBT), Lisbon, Portugal for discussions and his opinion on the phylogeny of *Wooroonatelura*.

REFERENCES

- Casey, T.L. (1890). Coleopterological Notices V. [*Gastrotheus termitarius* gen. et sp. nov.] *Annals of the New York Academy of Sciences* **5**: 503.
- Escherich, K. (1905). Das System der Lepismatiden. *Zoologica* (Stuttgart) **43**: 1–164.
- Howarth, F.G. & Stone, F.D. (1990). Elevated carbon dioxide levels in Bayliss Cave, Australia: Implications for the evolution of obligate cave species. *Pacific Science* **44**(3): 207–218.
- Mendes, L.F. (1986). Novos dados sobre os Zygentoma do Zaire. Notas e descrição de *Gastrotheus* (*G.*) *ornatus* sp.n. (Ateluridae). *Revue Zoologique Africaine* (Bruxelles) **100**: 289–305.
- Mendes, L.F. (2003). On *Gastrotheus* Casey, 1890 *sensu* Paclt, 1963, and description of a new genus (Zygentoma, Nicoletiidae). *Boletim da Sociedade Portuguesa de Entomologia* **210**: 341–349.
- Mendes, L.F. (2012). Description of the male of *Lasiotheus* Paclt, 1963, its implication in Atelurinae supra-generic taxonomy and keys for the genera (Insecta: Zygentoma). *Zootaxa* **3573**: 18–32.
- Molero-Baltanás, R., Gaju-Ricart, M. & Bach de Roca, C. (2000). On the taxonomic use of the distribution pattern of the antennal asteriform sensilla in *Neoasterolepisma* and *Tricholepisma* (Insecta, Zygentoma, Lepismatidae). *Pedobiologia* **44**: 248–256.
- Paclt, J. (1963). Thysanura. Fam. Nicoletiidae. *Genera Insectorum* **216**: 1–56.
- Silvestri, F. (1898). Primera noticia acerca de los Tisanuros argentinos. *Comunicaciones del Museo Nacional de Buenos Aires* **1**: 33–37.
- Silvestri, F. (1908). Thysanura. pp. 47–68 in Michaelsen, W. & Hartmeyer, R. (eds) *Die Fauna Südwest-Australiens. Ergebnisse der Hamburger südwestaustralischen Forschungsreise 1905*. Jena: Gustav Fischer Vol 2.
- Silvestri, F. (1912). Tisanuri finora noti del Messico. *Bollettino del Laboratorio di Zoologia Generale e Agraria della Facoltà Agraria in Portici* **6**: 204–221.
- Silvestri, F. (1947). Lepismatidarum (Thysanura) genus novum terminophilum ex Nova-Hollandia. Gen. *Allatela* nov. *Tijdschrift voor Entomologie* **88**: 74–78.
- Smith, G.B. (1998). Zygentoma (Thysanura) pp. 7–20, 397–399, 403 in Houston, W.W.K. & Wells, A. (eds) *Zoological Catalogue of Australia*. Vol. 23. Archaeognatha, Zygentoma, Blattodea, Isoptera, Mantodea, Dermaptera, Phasmatodea, Embioptera, Zoraptera. Melbourne: CSIRO Publishing, Australia. 464 pp.
- Smith, G.B. (2007). A new inquiline silverfish (Zygentoma: Nicoletiidae: Atelurinae) from Australia. *General and Applied Entomology* **36**: 19–23.
- Smith, G.B. (2009). A new inquiline silverfish genus (Zygentoma: Nicoletiidae: Atelurinae) from Western Australia. *General and Applied Entomology* **38**: 15–21.
- Smith, G.B. (2013). A new species of *Heterolepisma* from Barrow Island (Zygentoma: Lepismatidae). *Records of the Western Australian Museum Supplement* **83**: 229–240.
- Smith, G.B. (2015). New silverfish species (Zygentoma: Lepismatidae) from Barrow Island. *Records of the Western Australian Museum* **30**: 98–131.
- Smith, G.B., Eberhard, S.M., Perina, G. & Finston, T. (2012). New species of short range endemic troglobitic silverfish (Zygentoma: Nicoletiidae) from subterranean habitats in Western Australia's semi-arid Pilbara region. *Records of the Western Australian Museum* **27**: 101–116.
- Smith, G.B. & McRae, J.M. (2014). New species of subterranean silverfish (Zygentoma: Nicoletiidae: Atelurinae) from Western Australia's semi-arid Pilbara region. *Records of the Western Australian Museum* **29**: 105–127.
- Wygodzinsky, P. (1963). On J. Paclt's Nicoletiidae (Thysanura) in the "Genera Insectorum". *Annals and Magazine of Natural History* (13) **6**: 265–269.