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Source: American Museum Novitates, 2012(3748) : 1-18

Published By: American Museum of Natural History

URL: https://doi.org/10.1206/3748.2

AMERICAN MUSEUM NOVITATES

Number 3748, 18 pp. June 25, 2012

A new species of *Urodacus* (Scorpiones: Urodacidae) from Western Australia

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ABSTRACT

A new urodacid scorpion, *Urodacus butleri*, n. sp., is described from Barrow Island and the Pilbara bioregion of Western Australia. This species is unusually dark in color; it is compared and contrasted with three morphologically similar species, *Urodacus manicatus* (Thorell, 1876), *Urodacus novaehollandiae* Peters, 1861, and *Urodacus planimanus* Pocock, 1893.

INTRODUCTION

The scorpion genus *Urodacus* Peters, 1861, is endemic to mainland Australia and currently comprises 20 species (Koch, 1977; Volschenk et al., 2000). The monophyly of *Urodacus* has twice been tested and supported (Prendini, 2000; Volschenk and Prendini, 2008). Its close phylogenetic relationship with the endemic Malagasy genus *Heteroscorpion* Birula, 1903, albeit contentious (Stockwell, 1989; Prendini, 2000; Soleglad and Fet, 2003; Prendini and Wheeler, 2005; Soleglad and Fet, 2005), was well supported in the most recent analysis (Volschenk and Prendini, 2008).

Although the phylogenetic position of *Urodacus* has received recent attention, its taxonomic diversity has been neglected. In a sweeping revision of the Australian scorpions, Koch (1977) recognized 19 species of *Urodacus*, after synonymizing 13 of the previously described species, and

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 ISSN 0003-0082

describing seven new ones. Subsequent taxonomic work on the genus was limited to two contributions by Volschenk et al. (2000) and Harvey and Volschenk (2002). The description of all but the most morphologically distinct species (e.g., *Urodacus mckenziei* Volschenk et al., 2000) has been impeded by Koch's (1977) revision, because the limits of most of the other species are so broadly and vaguely defined. A complete reassessment of the validity and diagnosis of each nominate taxon within this complex genus is required to resolve the confusion, a task that represents one of the primary goals of a collaborative project to revise the systematics of the genus.

In the present contribution, we describe one of the more distinctive new species of *Urodacus* discovered as a result of recent fieldwork conducted during the above-mentioned project. Collections of scorpions from the Pilbara bioregion of Western Australia, including the adjacent Barrow Island, uncovered several specimens of an unusually dark species of *Urodacus*, known from widely separated localities (fig. 1). It was at first difficult to assess whether the disjunct populations warranted recognition as separate species because the limited number of available specimens prevented an assessment of the extent of intraspecific variation. Additional specimens, comprising 10 adult males and two adult females, subsequently collected from Barrow Island, permitted a better understanding of the variation within this particular population. Specimens

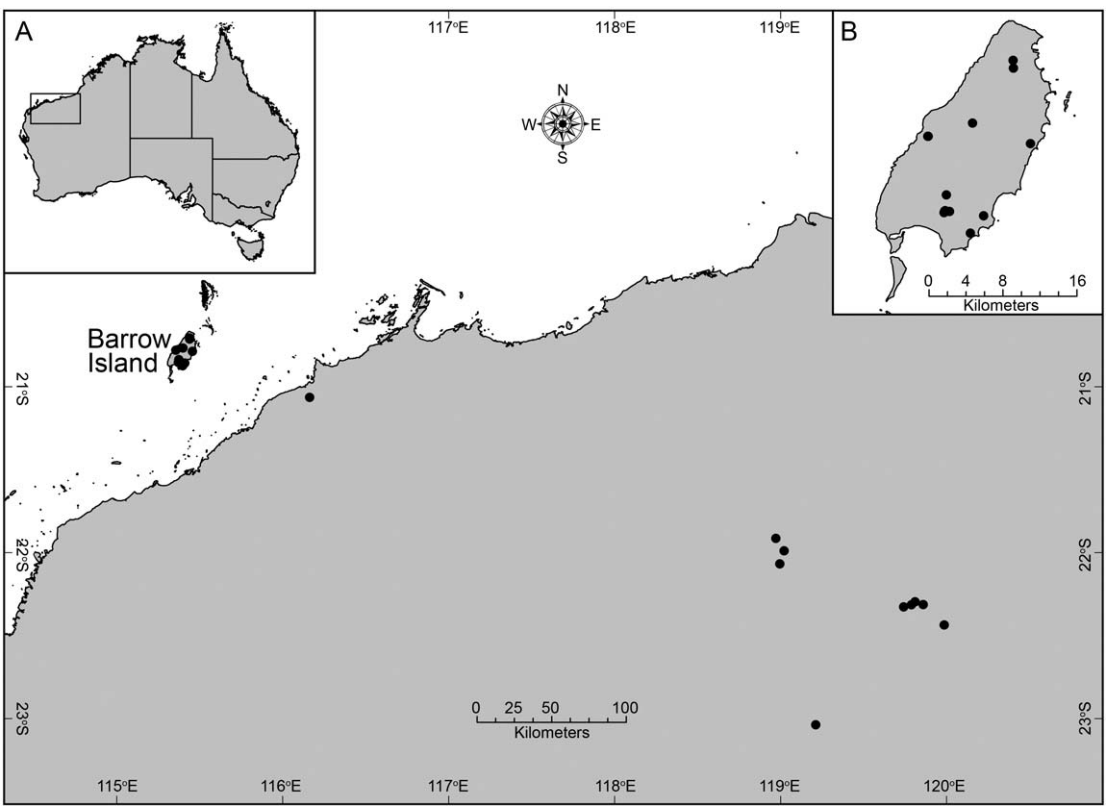


FIG. 1. Map of the central western coastline of Western Australia with known distribution of *Urodacus butleri*, n. sp. (solid circles). Inset **A** illustrates the continent of Australia and the area containing the known distribution. Inset **B** illustrates an enlargement of Barrow Island with the distribution plotted.

from the Western Australian mainland fall well within the variation observed in the series from Barrow Island and we therefore conclude that they are conspecific.

MATERIALS AND METHODS

General terminology follows Sissom (1990), Hjelle (1990) and Prendini (2000); trichobothrial terminology follows Vachon (1974); pedipalp and metasomal carination terminology follows Prendini (2000); pedipalp chela finger dentition terminology follows Soleglad and Sissom (2001); hemispermatophore terminology is adapted from Monod and Volschenk (2004); mensuration follows Stahnke (1970), for a sample size of nine specimens. Measurement ranges are followed by the mean, in square brackets [$n = 7♂, 2♀$].

Material examined in this study is deposited in the collections of the Western Australian Museum, Perth (WAM) and the American Museum of Natural History, New York (AMNH).

Microscopic examination was conducted using a Leica MZ6 dissecting microscope (Leica Microsystems, Wetzlar, Germany). Measurements were recorded using an ocular micrometer, calibrated against a Leica stage micrometer.

Hemispermatophores were dissected and prepared from male specimens, fixed and preserved in 75% ethanol, using a method modified from Prendini et al. (2006). Pencil sketches of diagnostic characters were prepared using a camera lucida attached to the microscope. These sketches were digitally inked using a Wacom Intuos3 (12 × 12) graphics tablet (Wacom, Saitama, Japan) and Corel Draw X3 (Corel Corporation, Ottawa, Canada) graphics suite. Maps were generated using ArcMap 9.1 (ESRI, Redlands, California). Morphological characters were scored using DELTA 1.4 (CSIRO, Canberra, Australia) (Dallwitz et al., 1999), which was also used to generate a natural language description that was subsequently edited further.

SYSTEMATICS

Urodacus butleri, n. sp.

Figures 1–20, 23–29

Type Material: **AUSTRALIA:** ***Western Australia*:** Holotype ♂ (WAM T85141), Barrow Island, F block Site SS08.8, 20°51′07″S 115°22′24″E, 4.ii.2008, K. Edwards and N. Gunawardene. Paratypes: Barrow Island, 20°46′S 115°24′E, 9.ii.1977, W.H. Butler, active on road at night, 1♂ (WAM T41114); Barrow Island, Airport Road, 20°51′25″S 115°24′39″E, 25–27.ii.2008, K. Edwards and T. Lardner, 1♂ (WAM T85177); same data except "20°52′26″S 115°23′52″E," 1♂ (WAM T85176); Barrow Island, Biggada Creek Road, 20°46′46″S 115°21′23″E, 25–27.ii.2008, K. Edwards and T. Lardner, 1♂ (WAM T85169), 1 juv. (WAM T85170); Barrow Island, F block Site SS08.8, 20°51′10″S 115°22′39″E, 4.ii.2008, K. Edwards and N. Gunawardene, 1♂ (WAM T85115); same data except "20°51′14″S 115°22′20″E," 1♂ (WAM T85140); Barrow Island, G Block near G22A, 20°51′10″S 115°22′27″E, 4.ii.2008, K. Edwards and N. Gunawardene, 1♀ (WAM T85155); Barrow Island, N of Terminal Tanks, 20°47′12″S 115°27′23″E, 30.xi.2003, R. Teale and G. Harold, 1♀ (WAM T57739); Barrow Island, N of White's beach turnoff, 20°42′20″S 115°26′22″E, 4.ii.2008, K. Edwards and N. Gunawardene, 1♂

(AMNH ex WAM T85142); same data except "20°42′47″S 115°26′23″E," 1♂ (WAM T85143); Barrow Island, pre-commissioning sites (LNG building facility), 9.ii.2011, M. Allen, 1♂ (WAM T111312); Cape Preston, 20°03′51″S 116°09′47″E, 10–25.iv.2000, R. Teale, 1♂ (WAM T41660); Chichester Range, Port Hedland–Newman railway, 21°54′49″S 118°58′19″E, 12.iii–1.iv.2004, R. Teale et al., 1♂ (WAM T78174); same data except "21°59′18″S 119°01′19″E," 1♂ (WAM T78175); same data except "22°04′04″S 118°59′44″E," 1♂ (WAM T78173); Chichester Range, 108 km N of Newman, 22°18′47.77″S 119°51′35.80″E, 24.iii–30.iv.2011, E.S. Volschenk and V.W. Framenau, 1 subadult (WAM T114301); Chichester Range, 118 km N of Newman, 22°17′43.74″S 119°48′39.14″E, 24.iii–29.iv.2011, E.S. Volschenk and V.W. Framenau, 1♂ (WAM T114300); Chichester Range, 115 km N of Newman, 22°18′48.49″S 119°47′18.98″E, 25.iii–29.iv.2011, E.S. Volschenk and V.W. Framenau, 1♂ (WAM T114229); Chichester Range, 105 km, heading 14° from Newman, 22°26′08.04″S 119°59′12.37″E, 11.iv.2011, J. Clark and R. Elis, 2♂ (WAM T114293, T114299); Chichester Range, 114 km, heading 0.4° from Newman, 22°19′36.93″S 119°44′32.45″E, 13.iv.2011, J. Clark and R. Elis, 1♂ (WAM T114294).

Etymology: This new species of *Urodacus* is named after William Henry, "Harry," Butler, an eminent Australian naturalist and consultant who has worked on the fauna of Barrow Island since 1964. His documentary television programs were a great inspiration to the first author, contributing to his fascination with natural history.

Diagnosis: *Urodacus butleri*, n. sp., differs from all other *Urodacus* species, except *Urodacus manicatus* Thorell, 1876, *Urodacus novaehollandiae* Peters, 1861, and *Urodacus planimanus* Pocock, 1893, on the basis of its extremely dark coloration (figs. 2–5). The carapace of *U. butleri*, n. sp., is smooth whereas that of *U. manicatus* is finely granular. *Urodacus butleri* can be distinguished from *U. planimanus* by the absence of prominent spiniform granules at the posterior ends of the dorsosubmedian carinae on metasomal segments II–IV in the adult male (figs. 9, 12). Prominent spiniform granules are evident in the male of *U. planimanus*.

Urodacus butleri, n. sp., closely resembles *U. novaehollandiae*, some populations of which may be very dark in coloration. *Urodacus butleri*, n. sp., differs from *U. novaehollandiae* by the smooth carapace and dark coloration of the legs. The legs of *U. novaehollandiae* are typically much paler and contrast strikingly with the dark mesosoma.

The pedipalp chelae of *U. butleri*, n. sp., and *U. novaehollandiae* are similar in proportions, differing from the chela of *U. planimanus*, which is more slender (figs. 20–22). *Urodacus butleri*, n. sp., differs further from *U. novaehollandiae* and *U. planimanus* in the proportions

Table 1. Meristic values, given as mean (range), for males of *Urodacus butleri*, n. sp., *Urodacus novaehollandiae* Peters, 1861, and *Urodacus planimanus* Pocock, 1893.

	U. butleri	*U. novaehollandiae*	*U. planimanus*
	n = 10	*n* = 5	*n* = 8
Carapace total length	8.47 (7.75–9.30)	8.35 (7.92–8.91)	9.37 (8.12–10.42)
Metasoma I width	3.87 (3.31–4.36)	4.74 (4.43–5.05)	3.92 (3.67–4.26)
Metasoma IV length	7.75 (7.21–8.75)	7.01 (5.21–7.90)	10.99 (9.24–12.66)
Metasoma V length	10.32 (9.49–11.30)	10.19 (7.89–11.07)	13.82 (11.74–16.14)

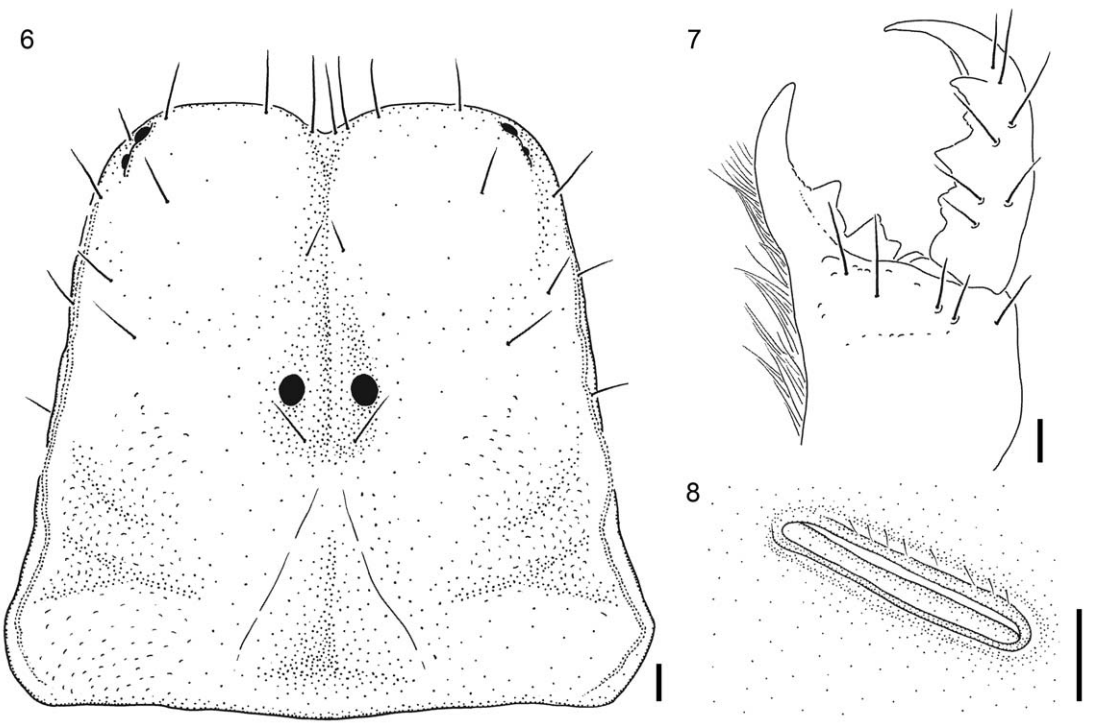
FIGS. 2–5. *Urodacus butleri*, n. sp., habitus. **2, 3.** Holotype ♂ (WAM T85141), dorsal and ventral aspects. **4, 5.** Paratype ♀ (WAM T85155), dorsal and ventral aspects. Scale bars = 10 mm.

of metasoma IV, which is consistently shorter than *U. planimanus* and shallower than in *U. novaehollandiae* (fig. 30).

Description: Based on holotype and paratypes.

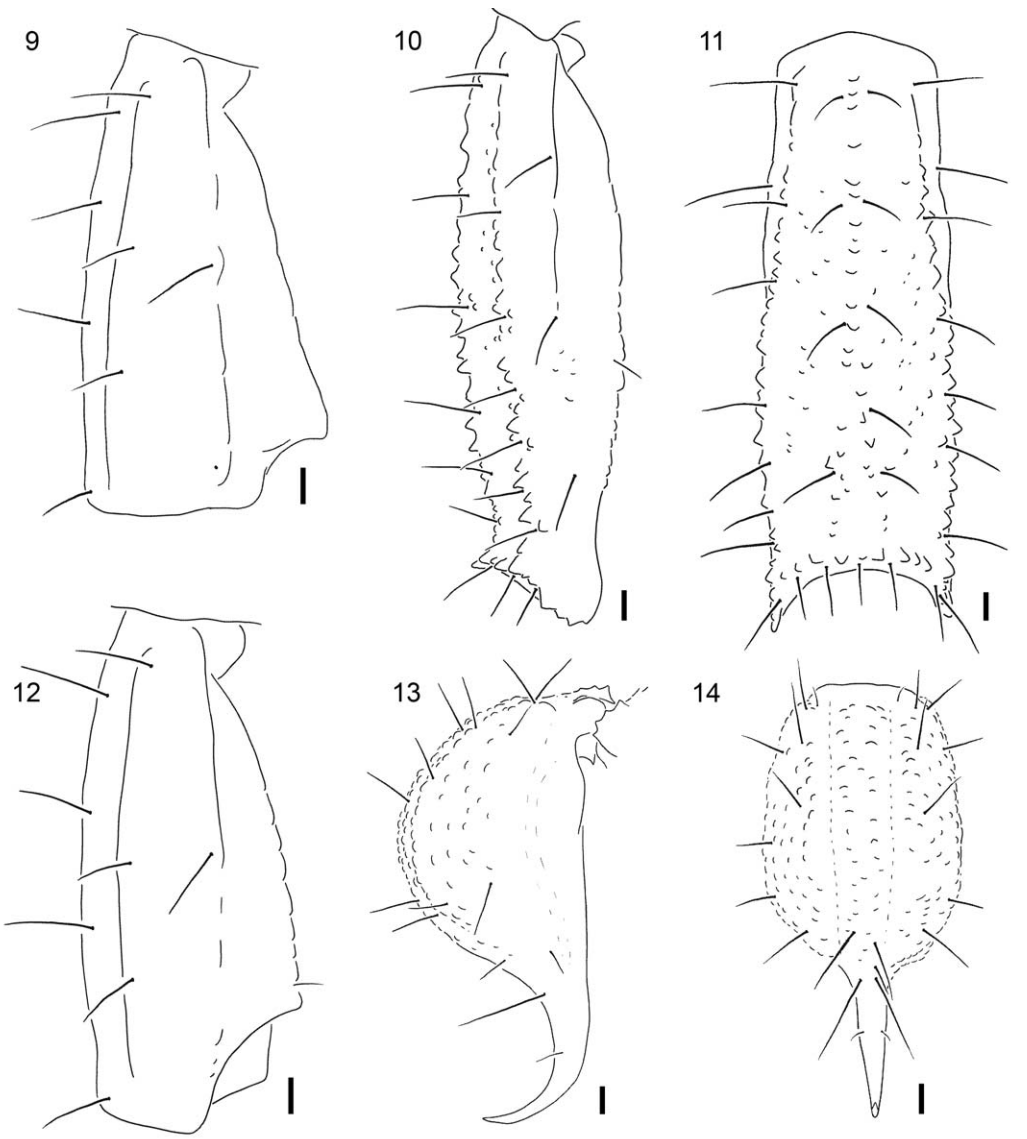
Coloration: Carapace, base color dark brownish-tan, with pronounced blackish-brown infuscations, becoming paler in posterior half to quarter (figs. 2, 4). Mesosomal tergites, base color yellowish tan-brown, with pronounced blackish-brown infuscations. Mesosomal sternites, pectines and genital opercula, uniform yellowish tan, lateral margins of sternites V–VII slightly infuscated, progressively more infuscated posteriorly (figs. 3, 6). Metasoma, base color dark blackish brown, slightly paler on segment I, gradually becoming darker posteriorly. Telson dark blackish brown with black aculeus. Pedipalps uniformly and with pronounced blackish-brown infuscations, chela fingers more darkly infuscated. Legs, dorsal surfaces with uniform dark tan-brown infuscations, femur and patella more darkly infuscated; trochanter, femur and patella, ventral surfaces fading from blackish brown at prolateral and retrolateral margins to tan-brown medially on each segment.

Carapace: Almost square, subparallel laterally (fig. 6); anterior margin with well-developed median notch; frontal lobes rounded. Two pairs of lateral ocelli, each situated on anterolateral margin, anterior ocelli notably larger than posterior ocelli; median ocular tubercle raised, situated anteromedially. Anterior transverse, anterolateral and median lateral sulci absent; median longitudinal sulcus broad, suturiform, bifurcated anteriorly; posterolateral sulcus distinct, shallow; poste-

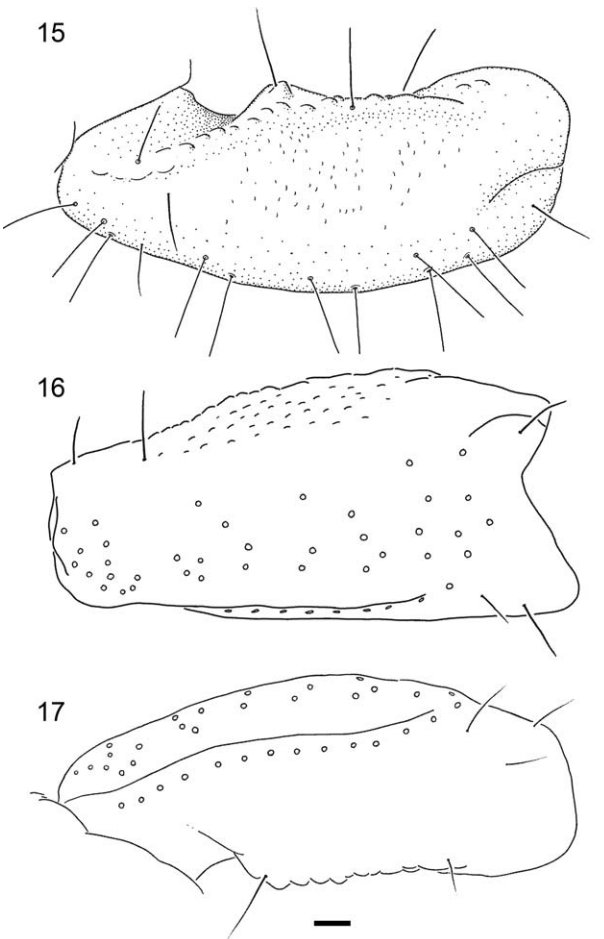


FIGS. 6–8. *Urodacus butleri*, n. sp., holotype ♂ (WAM T85141). **6.** Carapace, dorsal aspect. **7.** Dextral chelicera, dorsal aspect. **8.** Sternite V, sinistral spiracle. Scale bars = 0.5 mm.

rior depression deep; posteromedian sulcus extending from posterior depression to median ocular tubercle; posterior sutures present. Anterolateral margins and interocular surface smooth and glossy; lateral and posteromedian surfaces matt, sparsely and finely granular in places. Measurements: Carapace length, 7.08–9.30 [8.52] (♂), 9.07–9.54 [9.30] (♀); anterior margin to median ocular tubercle distance, 2.86–3.87 [3.57] (♂), 3.83–4.26 [4.04] (♀); posterior margin to median ocular tubercle distance, 3.69–4.95 [4.47] (♂), 4.66–4.95 [4.8] (♀); anterior margin width, 4.66–6.41 [6.03] (♂), 6.34–6.98 [6.66] (♀); posterior margin width, 6.10–10.80 [8.74] (♂), 8.91–9.64 [9.27]



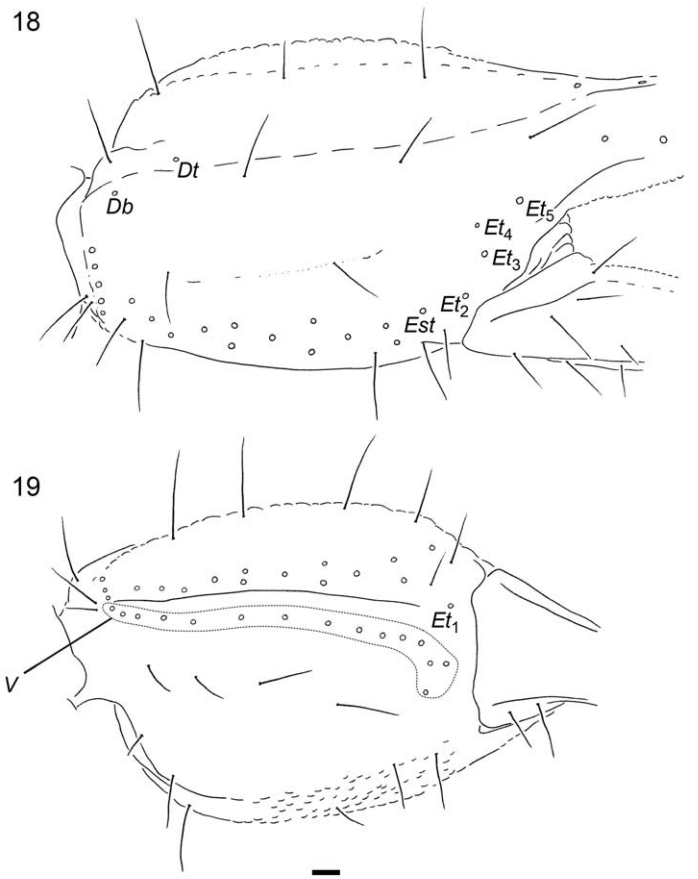
FIGS. 9–14. *Urodacus butleri*, n. sp., holotype ♂ (WAM T85141). **9.** Metasomal segment II, lateral aspect. **10, 11.** Metasomal segment V, lateral and ventral aspects. **12.** Metasomal segment IV, lateral aspect. **13, 14.** Telson, lateral and ventral aspects. Scale bars = 0.5 mm.



FIGS. 15–17. *Urodacus butleri*, n. sp., holotype ♂ (WAM T85141), dextral pedipalp patella, illustrating distribution of trichobothria (open circles). **15.** Dorsal aspect. **16.** External aspect. **17.** Ventral aspect. Scale bar = 0.5 mm.

(♀). Median ocular tubercle, ocular diameter, 0.44–0.58 [0.53] (♂), 0.46–0.46 [0.46] (♀); interocular distance, 0.52–0.83 [0.69] (♂), 0.63–0.73 [0.68] (♀).

Mesosoma: Tergites III–VI, dorsomedian carina vestigial, reduced to low, smooth mound (figs. 2, 4); dorsosubmedian and dorsolateral carinae absent; surfaces matt, finely and evenly granular. Tergite V, dorsomedian, dorsosubmedian and dorsolateral carinae absent; surfaces matt, densely covered in granules of similar size. Tergite VII, ventromedian carina absent; ventrosubmedian and ventrolateral carinae vestigial, each reduced to low, sparsely granular mound; surfaces smooth. Sternites III–VII, ventral surfaces entirely smooth (figs. 3, 5); VII with ventrosubmedian carinae absent and ventrolateral carinae costate. Book lung spiracles slit shaped (fig. 8). Measurements: Tergite I, width, 6.49–9.11 [7.93] (♂), 8.95–9.89 [9.42] (♀); pretergite length, 0.23–0.47 [0.34] (♂), 0.37–0.51 [0.44] (♀); posttergite length, 0.78–1.17 [1.01] (♂), 0.95–



FIGS. 18–19. *Urodacus butleri*, n. sp., holotype ♂ (WAM T85141), dextral pedipalp chela manus, illustrating distribution of trichobothria (open circles). **18.** External aspect. **19.** Ventral aspect. Scale bar = 0.5 mm. Abbreviations: *Db*, dorsal basal; *Dt*, dorsal terminal; *Est*, external subterminal; *Et*, external terminal; *V*, ventral.

1.02 [0.98] (♀). Tergite II, width, 6.44–9.27 [7.95] (♂), 9.32–10.23 [9.77] (♀); pretergite length, 0.40–0.63 [0.55] (♂), 0.28–0.49 [0.38] (♀); posttergite length, 0.89–1.28 [1.1] (♂), 1.17–1.18 [1.17] (♀). Tergite III, width, 6.73–9.78 [8.42] (♂), 9.42–10.28 [9.85] (♀); pretergite length, 0.56–0.87[0.71] (♂), 0.66–0.69 [0.67] (♀); posttergite length, 1.56–8.46 [2.93] (♂), 1.79–2.03 [1.91] (♀). Tergite IV, width, 7.06–9.79 [8.64] (♂), 9.58–10.29 [9.93] (♀); pretergite length, 0.58–1.00 [0.84] (♂), 0.79–0.90 [0.84] (♀); posttergite length, 2.06–2.67 [2.34] (♂), 2.35–2.65 [2.5] (♀). Tergite V, width, 6.72–9.54 [8.35] (♂), 9.10–10.25 [9.67] (♀); pretergite length, 0.78–1.09 [0.99] (♂), 0.73–1.10 [0.91] (♀); posttergite length, 2.43–3.02 [2.68] (♂), 2.68–3.00 [2.84] (♀). Tergite VI, width, 6.51–8.78 [7.81] (♂), 8.52–9.91 [9.21] (♀); pretergite length, 0.76–1.15 [0.97] (♂), 0.98–1.00 [0.99] (♀); posttergite length, 2.91–3.41 [3.11] (♂), 3.15–4.26 [3.70] (♀). Tergite VII, width, 5.68–7.82 [6.87] (♂), 7.69–8.40 [8.04] (♀); pretergite length, 0.49–1.48 [0.90] (♂), 0.93–

1.21 [1.07] (♀); posttergite length, 3.69–4.66 [4.16] (♂), 3.85–4.02 [3.93] (♀). Sternite V, width, 7.01–9.45 [8.62] (♂), 9.97–11.48 [10.72] (♀), presternite length, 0.47–1.35 [0.67] (♂), 0.58–0.84 [0.71] (♀); poststernite length, 3.40–3.45 [4.68] (♂), 4.10–4.32 [4.21] (♀). Sternite VII, width, 5.71–7.40 [6.85] (♂), 7.97–8.57 [8.27] (♀); presternite length, 0.49–0.57 [0.53] (♂), 0.51–0.54 [0.52] (♀); poststernite length, 3.70–4.77 [4.45] (♂), 4.17–4.67 [4.42] (♀).

Metasoma: Metasomal segments I–IV, dorsal surfaces smooth; dorsosubmedian carinae costate-granular, continuous along length of segment, each with prominent spiniform granule posteriorly (figs. 9, 12); dorsolateral carinae costate-granular on segment I, costate on II–IV, continuous along length of segment; median lateral carinae costate-granular on segment I, vestigial, reduced to low mound posteriorly on II, absent on III and IV; ventrolateral and ventromedian carinae costate, continuous along length of segment. Metasomal segment V, dorsal surface smooth, shiny, slightly concave in transverse section; dorsosubmedian carinae absent; dorsolateral carinae costate-granular, continuous along length of segment; median lateral carinae costate-granular, restricted to anterior half of segment (fig. 10); ventrolateral carinae costate-granular, comprising small, rounded granules anteriorly, becoming progressively larger and spiniform posteriorly, continuous along length of segment (fig. 11); ventrosubmedian carinae absent; ventromedian carina granular, comprising small, rounded granules anteriorly, becoming progressively larger and spiniform posteriorly, continuous for most of length, bifurcating in posterior half of segment; ventral intercarinal surfaces with or without few scattered granules. Measurements: Segment I, length, 5.05–6.59 [6.02] (♂), 4.51–4.57 [4.54] (♀); width, 3.02–4.36 [3.92] (♂), 3.69–3.87 [3.78] (♀); height, 2.44–3.68 [3.27] (♂), 2.93–3.25 [3.09]. Segment II, length, 5.39–7.13 [6.53] (♂), 4.90–5.15 [5.02] (♀); width, 3.05–4.31 [3.83] (♂), 3.39–3.63 [3.51] (♀); height, 2.71–3.95 [3.54] (♂), 2.93–3.59 [3.26]. Segment III, length, 5.88–7.83 [7.11] (♂), 4.75–5.24 [4.99] (♀); width, 2.99–4.02 [3.62] (♂), 3.30–3.48 [3.39] (♀); height, 2.9–3.99 [3.59] (♂), 2.99–3.44 [3.22]. Segment IV, length, 6.34–8.76 [7.59] (♂), 5.15–5.73 [5.43] (♀); width, 2.71–3.64 [3.26] (♂), 3.05–3.23 [3.14] (♀); height, 2.30–3.41 [3.08] (♂), 2.93–3.25 [3.09]. Segment V, length, 8.77–11.31 [10.30] (♂), 7.44–7.83 [7.63] (♀); width, 2.83–3.68 [3.19] (♂), 2.96–3.18 [3.07] (♀); height, 2.06–2.99 [2.67] (♂), 2.56–2.94 [2.75].

Telson: Vesicle globose; ventral surface with few granules in anterior two-thirds, becoming less granular posteriorly (figs. 13, 14), without ventromedian carina; lateral surfaces densely granular in the anterior two-thirds; macrosetae sparsely and evenly distributed. Aculeus stout, strongly curved. Measurements: Telson, total length, 6.90–8.84 [7.91] (♂), 6.90–8.06 [7.48] (♀). Vesicle width, 2.99–4.17 [3.56] (♂), 2.65–2.94 [2.79] (♀); height, 3.06–3.77 [3.30] (♂), 2.61–2.83 [2.72] (♀). Aculeus length, 1.69–2.70 [2.33] (♂), 2.49–2.86 [2.68].

Chelicerae: Coxal scaphotrix and trichocopae absent. Movable finger with two subdistal teeth; distal external tooth smaller than distal internal tooth; teeth with weak secondary serrations, most obvious on subdistal and medial teeth (fig. 7).

Pedipalps: Coxa, ventrointernal surface coarsely granular. Femur, dorsointernal, dorsoexternal, and ventrointernal carinae well developed, costate-granular, comprising granules of irregular size; ventroexternal carina absent; dorsal intercarinal surface sparsely covered with granules of equal size; internal intercarinal surface densely covered with granules of unequal size. Measure-

ments: femur, length, 4.75–6.71 [6.00] (♂), 5.91–6.41 [6.16] (♀); width, 2.31–2.99 [2.71] (♂), 2.59–2.96 [2.77] (♀); height, 2.34–3.28 [2.88] (♂), 2.94–3.09 [3.02] (♀).

Patella, dorsointernal carina well developed, costate-granular; ventroexternal carina well developed, costate; ventrointernal carina obsolete, granular; dorsoexternal and ventromedian carinae absent; dorsal intercarinal surface densely covered with large and small granules; internal processes equally developed, dorsointernal process occasionally larger than ventrointernal process. Measurements: patella, length, 5.88–7.75 [7.1] (♂), 7.20–7.67 [7.44] (♀); width, 2.31–3.48 [3.07] (♂), 3.10–3.38 [3.24]; height, 2.92–6.89 [3.96] (♂), 3.83–4.70 [4.26] (♀).

Chela manus, digital carina costate, more strongly developed in distal quarter (fig. 20); dorsomarginal and ventroexternal carinae well developed, costate; dorsal secondary carina obsolete, comprising a few granules proximally; external secondary carina obsolete, smooth; subdigital, ventromedian, ventrointernal and internomedian carinae vestigial, indicated by low mounds proximally; dorsointernal carina absent. Dorsal and external intercarinal surfaces granular-reticulate, with moderate to dense, irregular depressions formed by reticulate arrangement of small granules; internal intercarinal surfaces sparsely covered with small granules. Fixed finger without distal diastema and with weakly developed hooklike terminal denticle; dentate margin with multiple denticle rows proximally and single row distally; five or six external accessory denticles and four or five internal accessory denticles. Movable finger without distal diastema and hooklike terminal denticle; dentate margin entire, not scalloped, without basal lobe or concavity; multiple denticle rows proximally and single row distally; four or five external accessory denticles and three or four internal accessory denticles. Measurements: Chela, total length 11.30–15.64 [14.37] (♂), 14.90–16.26 [15.58] (♀). Manus, length along ventroexternal carina, 5.24–7.98 [6.95] (♂), 7.60–7.87 [7.73] (♀); width, 4.46–6.43 [5.82] (♂), 6.28–7.08 [6.68] (♀); height, 3.75–5.79 [4.80] (♂), 5.48–5.88 [5.68] (♀). Fixed finger, length, 4.62–6.59 [5.88] (♂), 6.05–6.88 [6.46] (♀). Movable finger, length, 6.47–9.34 [8.16] (♂), 8.37–9.44 [8.90].

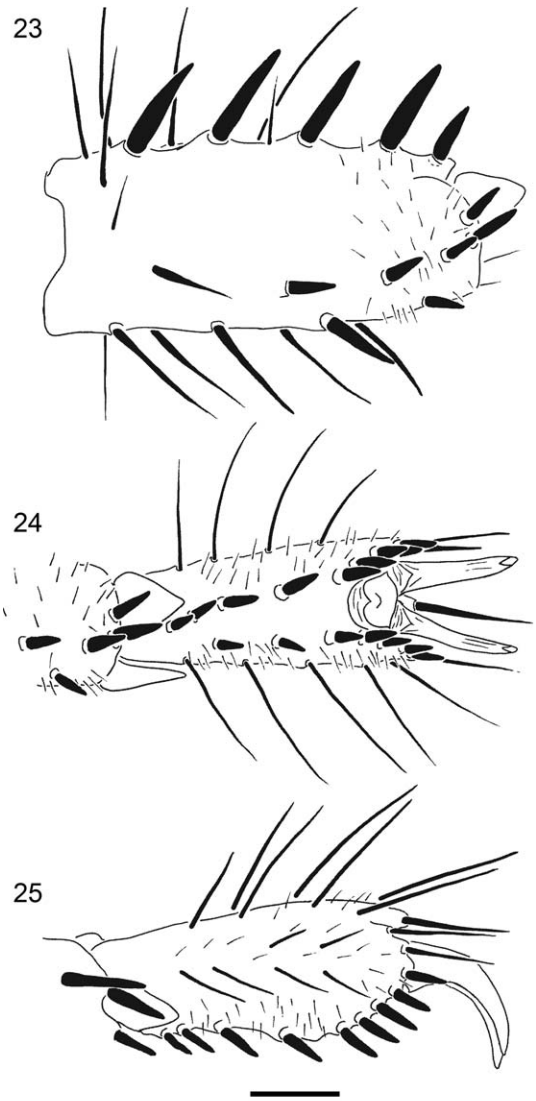
Trichobothria: Pedipalp neobothriotaxic, Type C. Femur with 3 trichobothria: *i* situated dorsobasally on internal surface; *d* situated in proximal half of dorsal surface, closer to dorsoexternal carina; *e* situated in proximal half of external surface, closer to dorsoexternal carina. Patella with 47–59 (♂) or 48–53 (♀) trichobothria: *i*, 2 *d*, 33–42 (♂) or 32–37 (♀) *e*, and 11–15 (♂) or 13 (♀) *v* (figs. 15–17); d_1 situated in proximal half of dorsal surface, internal to dorsointernal carina; d_2 situated medially on dorsal surface, between trichobothrium *i* and dorsointernal process. Chela with 44–64 (♂) or 54–55 (♀) trichobothria; four situated on fixed finger, 2 *i*, 4 *d*, 4 *e*; 36–56 (♂) or 46–47 (♀) situated on manus, *Dt*, *Db*, 5 *Et*, *Est*, 9–21 (♂) or 15 (♀) *Em*, *Esb* (not obviously petite), 5 *Eb*, 13–21 (♂) or 17–18 (♀) *V* (figs. 18, 19); *Db* situated proximally on dorsal surface of manus; *Dt* situated proximally on external surface of manus; Est_1 situated on ventral surface of manus; *db* situated at base of finger, on dorsal surface; *dsb* situated in proximal half of finger, on dorsal surface; *dst* situated medially on finger, on dorsal surface, closer to *dt* than to *dsb*; *dt* situated in distal half of finger, on internal surface; *eb* situated at base of finger, opposite *db*; *esb* situated in proximal half of finger, opposite *dsb*; *est* situated medially on finger, opposite *dst*; *et* situated in distal

FIGS. 20–22. *Urodacus* Peters, 1861, dextral pedipalp chela, dorsal aspect. **20.** *Urodacus butleri*, n. sp., holotype ♂ (WAM T85141). **21.** *Urodacus planimanus* Pocock, 1893, ♂ (WAM T41311). **22.** *Urodacus novaehollandiae* Peters, 1861, ♂ (WAM T80254). Scale bar = 1 mm.

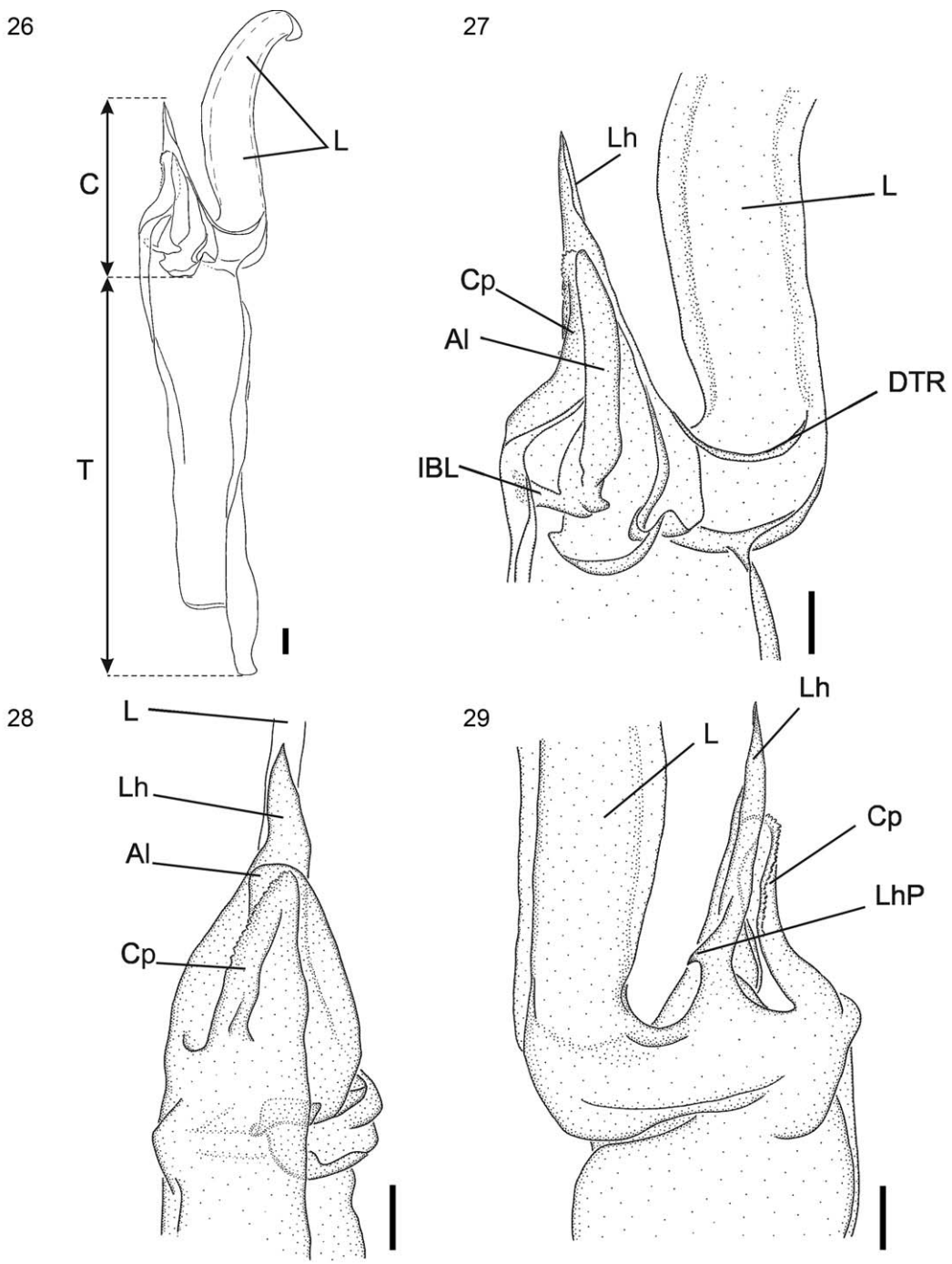
half of finger, opposite *dt*; *it* and *ib* situated distally on manus, close to base of fixed finger; trichobothrial sulci absent.

Coxosternal sclerites: Coxapophysis I expanded anteriorly, subtriangular; fused to coxa of leg I. Coxapophysis II fused to coxa of leg II. Sternum subpentagonal; posterior depression incomplete, emarginate posteriorly.

Legs: Legs I–IV, trochanter, femur, and patella, retrolateral surfaces granular, other surfaces smooth; basitarsi each with prolateral pedal spurs, without retrolateral pedal spurs (fig. 23); telotarsi each with laterodistal lobes rounded, median dorsal lobe similar in length to laterodistal lobes, ungues not elongated, equal in length, with paired pro- and retroventral rows of spiniform macrosetae, without ventromedian row of spinules or setiform macrosetae (figs. 24, 25). Legs I and II, femur and patella, ventral surfaces each with angular, subspiniform granules; tibia and basitarsus, each with comblike retrolateral row of macrosetae; basitarsus slightly broadened and dorsoventrally compressed (fig. 23); telotarsus, retroventral row of spiniform macrosetae with more setae than proventral row. Legs III and IV, femur, ventral surface with rounded, well-developed granules; patella, ventral surface with low, weakly developed granules; basitarsus terete, without comblike retrolateral row of macrosetae. Spiniform macrosetal counts: Leg I, basitarsus, retrolateral row, 5–6 (♂), 5 (♀); telotarsus, retroventral row, 9–10 (♂), 9 (♀); telotarsus, proventral row, 6–7 (♂), 6 (♀). Leg II, basitarsus, retrolateral row, 5 (♂, ♀); telotarsus, retroventral row, 9–11 (♂), 9–10 (♀); telotarsus, proventral row, 6–8 (♂, ♀). Leg III, basitarsus, retrolateral row, 4 (♂, ♀); telotarsus, retroventral row, 9–10 (♂), 9 (♀); telotarsus, proventral row, 6–8 (♂), 7–8 (♀). Leg IV, basitarsus, retrolateral row, 1–2 (♂, ♀); telotarsus, retroventral row, 9–10 (♂), 9 (♀); telotarsus, proventral row, 6–8 (♂), 5–7 (♀).



FIGS. 23–25. *Urodacus butleri*, n. sp., holotype ♂ (WAM T85141), dextral leg illustrating spiniform macrosetae. **23.** Basitarsus, ventral aspect. **24, 25.** Telotarsus, ventral and lateral aspects. Scale bar = 0.5 mm.



FIGS. 26–29. *Urodacus butleri*, n. sp., paratype ♂ (WAM T85141). **26.** Dextral hemispermatophore, dorsal aspect. **27–29.** Detail of capsule lamellae, dorsal, ental, and ventral aspects. Abbreviations: Al, anterior lobe; C, capsule; Cp, conical process; DTR, distal transverse ridge; L, lamella; Lh, lamellar hook; Lhp, lamellar hook process; IBL, internobasal lobe; T, trunk. Scale bars = 0.5 mm.

Pectines: Three marginal lamellae; 3–5 median lamellae; pectinal tooth count: 15–20 (♂), 11–16 (♀).

Genital opercula: Opercula divided (♂) or fused (♀); genital papillae (♂) long, protruding from beneath opercula.

Hemispermatophore: Distal lamella up to twice length of capsule (figs. 26–29), angularly truncated distally, tapering to rounded point and directed away from capsule; distal crest absent; lamellar hook situated proximally, modified into long, tapering projection, posterior margin with low eminence or conspicuous posteriorly directed spur; distal transverse ridge costate, continuous from leading to trailing margins, merging with lamellar hook; capsule orientation (lateral view) in same plane as lamella; anterior lobe broad and terminally rounded, without process, distal edge forming acute angle with longitudinal axis of capsule; conical process developed into broad subtriangular lobe, distal anterior margin serrate; internobasal lobe, margin subserrate terminally.

Sexual Dimorphism: The pedipalps of adult females of *U. butleri*, n. sp., are less granular and their carinae less developed than those of the adult males. Adult females also possess shorter, broader, and less granular metasomal segments, which lack prominent spiniform granules at the posterior edge of the dorsosubmedian carinae on segments II–IV.

Distribution: *Urodacus butleri*, n. sp., is known from Barrow Island, where it is the only species of *Urodacus* recorded, and the adjacent Pilbara bioregion of Western Australia (fig. 1). It is most likely more widely distributed in the Pilbara than current records indicate. It is not known to be sympatric with *U. manicatus*, *U. novaehollandiae,* or *U. planimanus*, which are

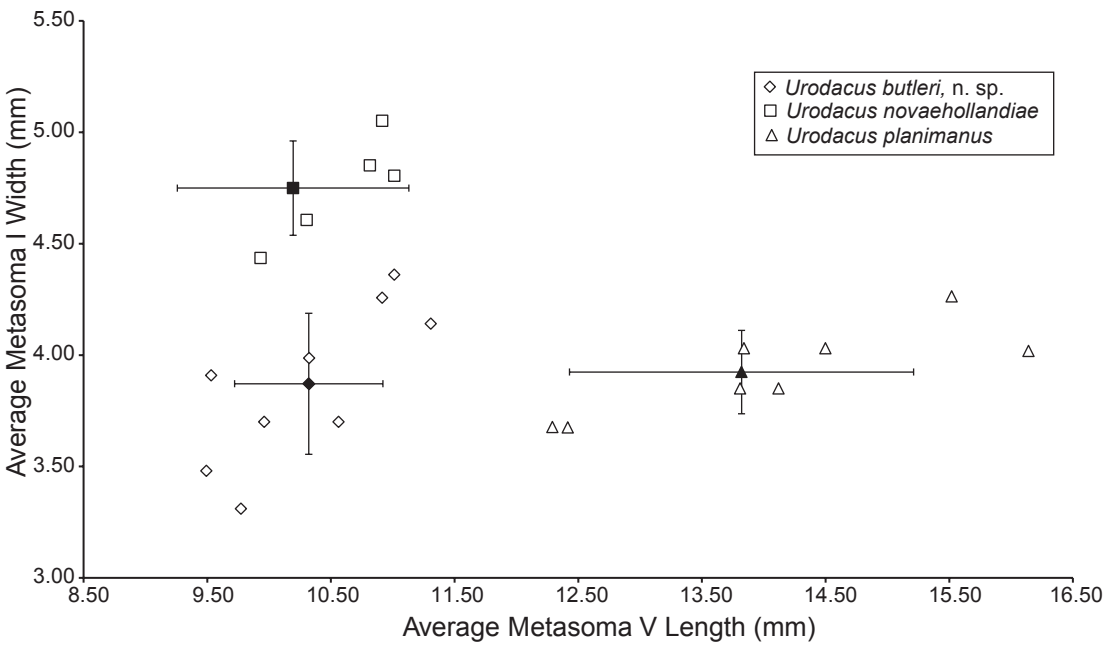


FIG. 30. Chart plotting metasoma I width against metasoma V length in *Urodacus butleri*, n. sp., *Urodacus novaehollandiae* Peters, 1861, and *Urodacus planimanus* Pocock, 1893. Hollow (white) symbols indicate raw data points; solid (black) symbols, averages; error bars, one standard deviation.

restricted to southeastern Australia (*U. manicatus*) and southwestern Australia (*U. novaehollandiae* and *U. planimanus*) (Koch, 1977).

Ecology: All specimens of *U. butleri*, n. sp., thus far collected were found at night on consolidated sandy substrates using ultraviolet light detection. Although no specimens were excavated from burrows during this study, the retrolateral rows of stout macrosetae on the basitarsi of the first two pairs of legs (fig. 23), short curved telotarsal ungues (figs. 24, 25) and robust habitus (figs. 2–5) suggest that this species is fossorial and pelophilous (Prendini, 2001).

COMPARATIVE MATERIAL EXAMINED

Urodacus manicatus (Thorell, 1876): **AUSTRALIA: *South Australia*:** Coffin Bay National Park, Yangie Bay campground, 34°38′23″S 135°21′43″E, 20–22.xi.2002, M.S. Harvey and M.E. Blosfelds, 1 ♂, 3 ♀, 1 juv. (WAM T81633–T81637); NE R Crossing, Flinders Chase, Kangaroo Island, 36°01′S 136°44′E, 22.x.1974, Baker, 1 ♂ (WAM T41333). ***Victoria*:** Castlemaine District, 37°04′S 144°13′E, 31.v.1926, J. Dixon, 2 ♂ (WAM 26/293, 294); Mount Arapiles, 36°45′S 141°50′E, 12.v.1980, M.S. Harvey and P.J. Gullan, 3 ♀ (WAM T41348); Mount Difficult, Grampian Ranges, 37°01′S 142°26′E, 15.xi.1980, in grass in pine plantation, A. Andersen, 1 ♂ (WAM T41346); 6.5 km SW of Stuart Mill near St Arnaud, 36°50′S 143°14′E, 3.xii.1977, M.S. Harvey, 1 ♂ (WAM T41341); same data except "36°50′S 143°13′E, 14.i.1978," 1 ♂ (WAM T41316); 4 km WSW of Stuart Mill near St Arnaud, 36°49′S 143°14′E, 22.i.1978, M.S. Harvey, 1 ♂ (WAM T41342); same data except "36°50′S 143°16′E," 1 ♂ (WAM T41345).

Urodacus novaehollandiae Peters 1861: **AUSTRALIA: *Western Australia*:** Boyanup, SE on Hurst Road (site BOYAN2), 33°30′57″S 115°45′18″E, 9.iii.2005, under log, M.S. Harvey, J.M. Waldock and K. Edward, 1♂ (WAM T63209); Bremer Bay, Peppermint Beach, south end, 34°23′37″S 119°29′32″E, 7.vi.2007, under rock, M.L. Moir and M.C. Leng, 1♀ (WAM T80301); Busselton, 15 km SW (site TUT03), 33°43′56″S 115°29′26″E, 17.ii.2007, dry pitfall, P. Runham, 3♂ (WAM T80249, T80254, T80261); Cape Le Grand National Park, Mississippi Hill, 33°59′39″S 122°15′16″E, 4.v.2007, under rock, M.L. Moir and M.C. Leng, 1♀ (WAM T80300); Fitzgerald River National Park, East Mt Barren, near summit, 33°55′29″S 120°01′05″E, 26.v.2007, under rock, M.L. Moir and M.C. Leng, 1♀ (WAM T80775); Mandurah, Caddadap Reserve, 32°37′11.1″S 115°38′21.82″E, 22.xii.2006, J. Wolcox and R. King, 1♀ (WAM T80247); Ravensthorpe Range South, near Mt Chester, 33°36′04.00″S 120°08′29.00″E, 255 m, 10.ix.2007, under rock, M.C. Leng, 1♀ (WAM T81262); Yoganup, 12 km SSE of Capel (site YOG1), 33°39′10″S 115°36′38″E, 14–20.xi.2006, wet pitfall, G. Humphreys, 1♂ (WAM T80216).

Urodacus planimanus Pocock 1893: **AUSTRALIA: *Western Australia*:** Araluen, 32°07′S 116°06′E, 1.xi.1972, T. McNeill, 1♂ (WAM 97/2641); Boddington Town, *ca.* 15 km NW, 32°42′57.1″S 116°20′32.1″E, 21.viii.2011, A. Rakimov, 1♂ (WAM T116903); same data, except "32°37′14.6″S 116°17′34.1″E, 23.viii.2011," 1♀ (WAM T116914); same data, except "32°41′09.9″S 116°27′10.6″E," 4♀ (WAM T116921, WAM T116927, T116946, T116961); 'Canning Dam, 32°09′S 116°08′E, 1.i.1985, D. Mead-Hunter 1♂, 1♀ (WAM 97/2659, 2660); Coolup, 32°45′S 115°52′E, 3.vii.1967, D.E. Morgan, 2♀ (WAM 66/172, 173); Dianella, 31°53′S 115°52′E,

15.vii.1969, Mr Holland, 1♂, 1♀ (WAM 69/1932, 1933); Mt Cooke, 32°25′S 116°18′E, 31.iii.1968, E.G. Cockett, 1♀ (WAM 68/243), 20.iv.1968, L.E. Koch, F.H.U. Baker and E.G. Cockett 1♂ (WAM 69/933); Mt Dale, 32°08′S 116°18′E, 15.xi.1970, G.W. Kendrick, under stones near summit, 1♀ (WAM 97/2664), 5.x.1992, J.M. Waldock, 1♂ (WAM 97/2666); Mundaring, Mundaring Weir Youth Hostel, 31°57′S 116°10′E, 20.ii.1978, D. Marsh, 1♂ (WAM 97/2667); Serpentine National Park, Serpentine Falls, 32°22′S 116°00′E, 3.ii.1972, T. McNeill, 1♂ (WAM 97/2672); Waroona, 3 km SE, N side of Samson Brook, 32°52′S 115°56′E, 12.ix.1997, under granite rock, A.F. Longbottom, 1♂ (WAM T41311).

ACKNOWLEDGMENTS

We are grateful to Chevron Pty. Ltd. for financial support toward our ongoing revision of *Urodacus* and for supporting the recent collection of additional specimens from Barrow Island; Biota Environmental Sciences for financial support, and for collecting many specimens from the Pilbara bioregion; and the Australian Biological Resources Study for grant number 206-54. We thank Karl Edwards (Curtin Consultancy) for enthusiastically collecting specimens from Barrow Island. The first author acknowledges Phoenix Environmental Sciences, Subterranean Ecology and Ecologia Environment for supporting the study.

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