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A new species of troglobitic *Anatemnus* (Pseudoscorpiones: Atemnidae) from the Pilbara bioregion of Australia

Jason B. Alexander[1], Mieke A.A. Burger[2] and Mark S. Harvey[2,3]

[1] Biota Environmental Sciences, 1/228 Carr Place, Leederville, Western Australia 6007, Australia.

[2] Department of Terrestrial Zoology, Western Australian Museum, Locked Bag 49, Welshpool DC, Western Australia 6986, Australia.

[3] Research Associate, Division of Invertebrate Zoology, American Museum of Natural History, 79th Street @ Central Park West, New York, New York 10024–5192, USA. Research Associate, Department of Entomology, California Academy of Sciences, Golden Gate Park, San Francisco, California 94103–3009 USA. Adjunct, School of Animal Biology, University of Western Australia, Crawley, Western Australia 6009, Australia. Adjunct, School of Natural Sciences, Edith Cowan University, Joondalup, Western Australia 6027, Australia.

ABSTRACT – A new species of the pseudoscorpion genus *Anatemnus*, *A. subvastus*, is described from subterranean environments in the Pilbara bioregion of Western Australia. Like *Oratemnus cavernicola* from New South Wales, it lacks eye spots, and has slightly elongated appendages and pallid colouration. It is known from only a small area of less than 20 km^2. We also attribute *Oratemnus cavernicola* to the genus *Anatemnus*, forming the new combination *Anatemnus cavernicola* (Beier, 1976), but note that the generic assignment of both species should be reviewed pending an assessment of all genera of Atemninae.

KEYWORDS: taxonomy, morphology, subterranean

INTRODUCTION

The semi-arid Pilbara bioregion of north-western Australia is a hotspot for subterranean biodiversity, with numerous new and distinctively modified troglobitic and stygobitic species being described over the past decade. Arthropods such as insects, arachnids and crustaceans dominate the fauna (Eberhard et al. 2005), with the arachnid fauna including schizomids (Harvey et al. 2008), spiders (Burger et al. 2010; Baehr et al. 2012) and pseudoscorpions (Harvey and Edward 2007; Harvey and Volschenk 2007; Edward and Harvey 2008; Harvey and Leng 2008a, 2008b). This fauna has generated much interest due to the interplay between the extraction of minerals, principally iron-ore, and conservation of a relictual and highly distinctive subterranean fauna.

Amongst samples collected from subterranean ecosystems in the Hamersley Range of the Pilbara bioregion were some unusual pseudoscorpions of the family Atemnidae with distinctly troglobitic facies including slender pedipalps and legs, pallid colour and no eyes. To better document the subterranean fauna of the region, we here describe this atemnid species. The atemnid fauna of continental Australia is restricted to just four species of *Oratemnus* Beier, 1932, *O. cavernicola* Beier, 1976, *O. curtus* (Beier, 1954), *O. distinctus* (Beier, 1948) and *O. punctatus* (L. Koch and Keyserling, 1885) (Beier 1948, 1954, 1966, 1976; Harvey 2013). The new species shows many similarities with *O. cavernicola*, particularly in the disposition of the trichobothria of the fixed chelal finger, which differs from the arrangement of other species of *Oratemnus*. Instead, the pattern is more reminiscent of species of *Anatemnus* Beier, 1932, and we suggest that both species can be accommodated in this genus.

MATERIAL AND METHODS

The holotype used in this study was collected from subterranean environments using baited colonisation traps, which are left suspended at depths through bore hole profiles for a minimum of six weeks. Traps were baited with locally sourced leaf litter material, which is soaked and irradiated to kill surface fauna and facilitate breakdown of the litter. Other specimens were collected by scraping a weighted net vertically up the sides of bore holes, which collects fauna utilising the side of the

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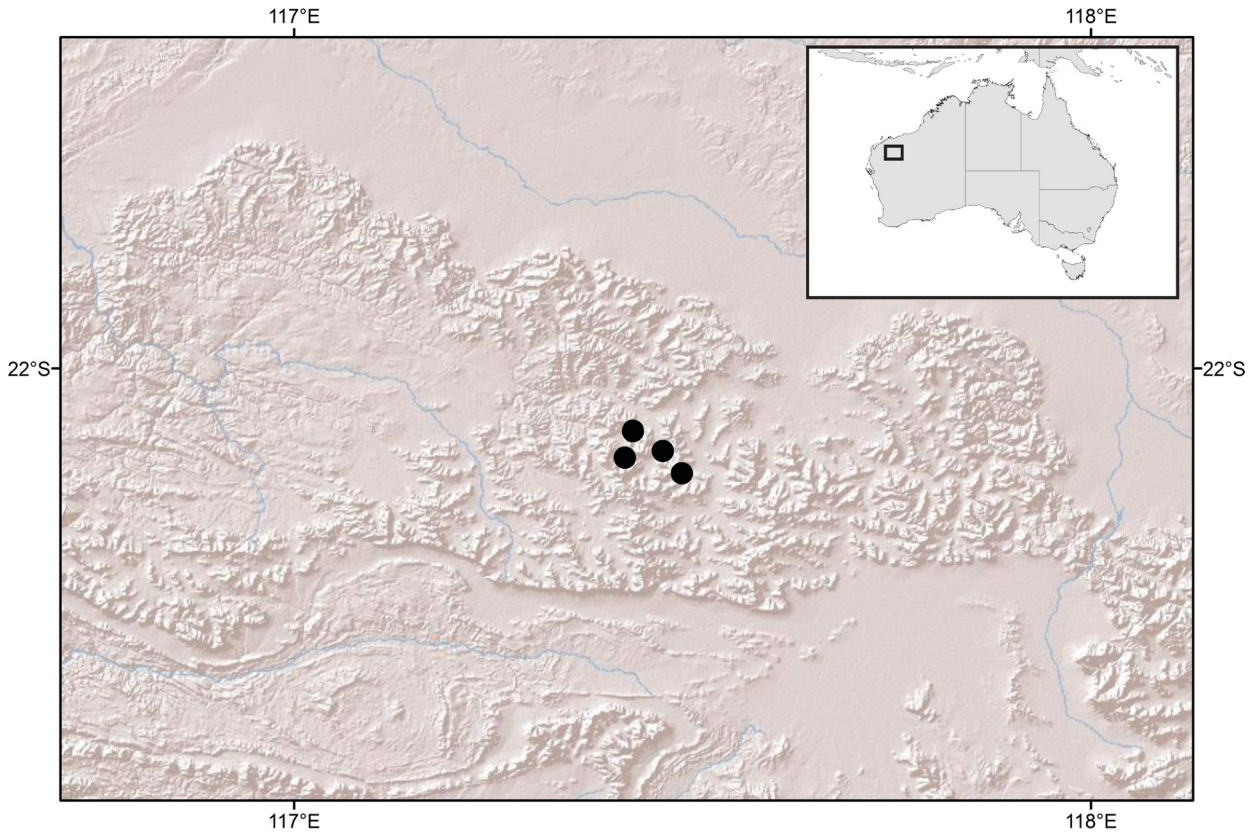

FIGURE 1 Known distribution of *Anatemnus subvastus* sp. nov.

bore (Halse and Pearson 2014). Collected specimens are lodged in the Western Australian Museum, Perth (WAM), and were examined using a temporary slide mount prepared by immersion of the specimens in 50% lactic acid at room temperature for several days. They were then mounted on a microscope slide with a 10 mm coverslip supported by small sections of 0.25 or 0.35 mm diameter nylon fishing line. After study the specimens were returned to 75% ethanol with the dissected portions placed in 12 x 3 mm glass genitalia microvials (BioQuip Products, Inc.). Specimens were examined with a Leica MZ–16A dissecting microscope, and a Leica DM2500 compound microscope, the latter fitted with interference contrast, and illustrated with the aid of a drawing tube attached to the compound microscope. Measurements were taken at the highest possible magnification using an ocular graticule.

Terminology and mensuration mostly follow Chamberlin (1931), with the exception of the nomenclature of the pedipalps, legs and with some minor modifications to the terminology of the trichobothria (Harvey 1992), chelicera (Judson 2007) and faces of the appendages (Harvey et al. 2012). Morphological characters were scored using Open DELTA 1.0 (Atlas of Living Australia, Canberra, Australia) (Dallwitz et al. 1999 onwards), which was also used to generate a natural language description that was subsequently edited further.

Family Atemnidae Kishida, 1929

Subfamily Atemninae Kishida, 1929

Genus *Anatemnus* Beier, 1932

Anatemnus Beier 1932: 578.

TYPE SPECIES

Chelifer javanus Thorell, 1883, by original designation.

REMARKS

The genera of Atemninae are, in general, poorly defined and in need of reassessment and revision (Klausen 2005). Some of the features used by Beier (1932a, 1932b) when the generic classification was first established have since been shown to be of dubious utility. For example, *Titanatemnus* Beier, 1932 was separated from other genera mainly by its large size, and *Catatemnus* Beier, 1932, *Metatemnus* Beier, 1932, *Stenatemnus* Beier, 1932, and *Tamenus* Beier, 1932 were segregated from the other atemnine genera by the presence of a transverse furrow on the carapace (Beier 1932b). Klausen (2005) has since suggested that the presence of a furrow has been frequently misinterpreted in atemnids and is of dubious usefulness to separate genera.

The new species described below, as well as *O. cavernicola* from New South Wales, have trichobothria *it* and *isb* widely spaced, with *it* either midway between *isb* and the tip of the finger, or with *it* closer to the tip than to *isb*. Only a few genera of Atemninae have species with this configuration including some species of *Anatemnus* Beier, 1932 and *Catatemnus* Beier, 1932, and all species of *Mesatemnus* Beier and Turk, 1952, *Metatemnus* Beier, 1932, *Stenatemnus* Beier, 1932, *Synatemnus* Beier, 1944 and *Tamenus* Beier, 1932 (e.g. Beier 1932b; Vachon 1938; Beier 1944, 1951a, 1951b; Beier and Turk 1952; Beier 1957, 1965; Muchmore 1972; Mahnert 1978). We suggest that this feature might be of some value in diagnosing genera of Atemninae, and accordingly place the new species and *O. cavernicola* amongst this group of genera. Not all species of *Anatemnus* and *Catatemnus*, however, have this arrangement. For example, *A. luzonicus* Beier, 1932, *A. madecassus* Beier, 1932, *A. nilgiricus* Beier, 1932, *A. orites* (Thorell, 1889), *A. subindicus* (Ellingsen, 1910), *A. subvermiformis* Redikorzev, 1938), *A. tonkinensis* Beier, 1943, *C. braunsi* (Tullgren, 1907) and *C. comorensis* (Ellingsen, 1910) have *isb* and *it* situated adjacent to each other or with *it* only slightly distal to *isb* (e.g. Beier 1932b, 1951a). It is currently difficult, or impossible, to adequately diagnose *Mesatemnus*, with the sole species *M. cyprianus* (Beier and Turk) from Cyprus, which was poorly described (Beier and Turk 1952) and has not since been redescribed. Likewise, the African genus *Synatemnus* is poorly characterized (Beier 1944).

Our decision to include the new subterranean species and *O. cavernicola* in *Anatemnus* is clearly provisional, but there appears to be nothing in the generic descriptions that precludes their inclusion in the genus (Beier 1932a, 1932b), and we are unable to suggest an alternative generic arrangement. For example, both species lack the gaping chelal fingers that are characteristic of *Metatemnus* (Beier 1932b, 1952; Muchmore 1972), they lack the long tarsal claws of *Stenatemnus* (Beier 1932b), and they lack the extremely distal position of *it* that is found in *Tamenus*.

Likewise, due to the position of trichobothria *isb* and *it*, they are unlikely to be included in *Oratemnus*, the only other atemnid genus currently recorded from mainland Australia. However, even this is somewhat confounded as the Australian species currently placed in this genus, *O. curtus*, *O. distinctus* and *O. punctatus*, lack the narrow pedicel of the pedipalpal patella found in the type species *O. articulosus* (Simon, 1899) which was originally used to define the genus (Beier 1932a, 1932b). The narrow pedicel occurs in other Australasian species such as *O. boettcheri* Beier, 1932, *O. brevidigitatus* Beier, 1940, *O. confusus* Murthy and Ananthakrishnan, 1977, *O. manilanus* Beier, 1932, *O. proximus* Beier, 1932, *O. timorensis* Beier, 1932 and *O. yodai* Morikawa, 1968 (e.g. Beier 1932a, 1932b, 1940; Morikawa 1968; Murthy and Ananthakrishnan 1977), but is lacking in other species including *O. afghanicus* Beier, 1959, *O. semidivisus* (Redikorzev, 1938) and *O. loyolai* Sivaraman, 1980 from Asia, and *O. samoanus* Beier, 1932 from the Pacific region (e.g. Beier 1932a, 1932b; Redikorzev 1938; Beier 1948, 1954, 1959, 1976; Sivaraman 1980). To further confuse matters, it is possible that there might be slight sexual dimorphism in those species with narrow pedicels. The illustrations of *O. samaonus* by Chamberlin (1939) show the male with a slightly longer and thinner pedicel that the female, and those species with a more extenuated pedicel that were illustrated by Beier (1932b) all appear to be males rather than females.

Therefore, we attribute *A. subvastus* and *Oratemnus cavernicola* to the genus *Anatemnus*, forming the new combination *Anatemnus cavernicola* (Beier, 1976), but note that the generic assignment should be reviewed pending an assessment of all atemnine genera which are currently poorly defined and badly in need of redefinition (Klausen 2005). These are not the only Australian species of *Anatemnus*, as other species have been collected in rainforest habitats in eastern Australia (MSH, unpublished data). It is presumed that they represent undescribed species, but further work is needed on the atemnid fauna of Australia to adequately resolve their status.

***Anatemnus subvastus* sp. nov.**

Figures 2–18

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MATERIAL EXAMINED

Holotype

Australia: ***Western Australia:*** ♂, Blackjack, c. 75 km NNW. Tom Price, site HPRC0426, 22°06’42.3"S, 117°24’54.4"E, 14 April–14 June 2011, subterranean trap, 40 m, D.C. Main, J.W. Quartermaine (WAM T119416)

Paratypes

Australia: ***Western Australia:*** 1 ♀, Champion, c. 75 km NNW. Tom Price, site HPRC0553, 22°06’11.6"S, 117°27’46.2"E, 14 April 2011, stygofauna net, 22 m, J.S. Cocking, M.K. Curran (WAM T119417); 1 ♂, c. 80 km NW. of Tom Price, bore HPRC2089, site FLI091, 22°07’52.9"S, 117°29’12.2"E, 24 June 2010, J.S. Cocking, D.C. Main (WAM T108774); 1 ♂, Homestead, 77.7 km NNW. of Tom Price, bore RHWRC0249P1-1, 22°04’42"S, 117°25’31"E, 29 January 2010, scraping borehole, G. Humphreys (WAM T102542).

DIAGNOSIS

Anatemnus subvastus differs from all other species of the genus, except *A. cavernicola*, by the lack of eye-spots. It differs from *A. cavernicola* by the size and shape of the pedipalps, with *A. subvastus* with a pedipalpal femur length of 0.59–0.71 (♂), 0.64 (♀) mm, and *A. cavernicola* of 1.25 (♀) mm.

DESCRIPTION

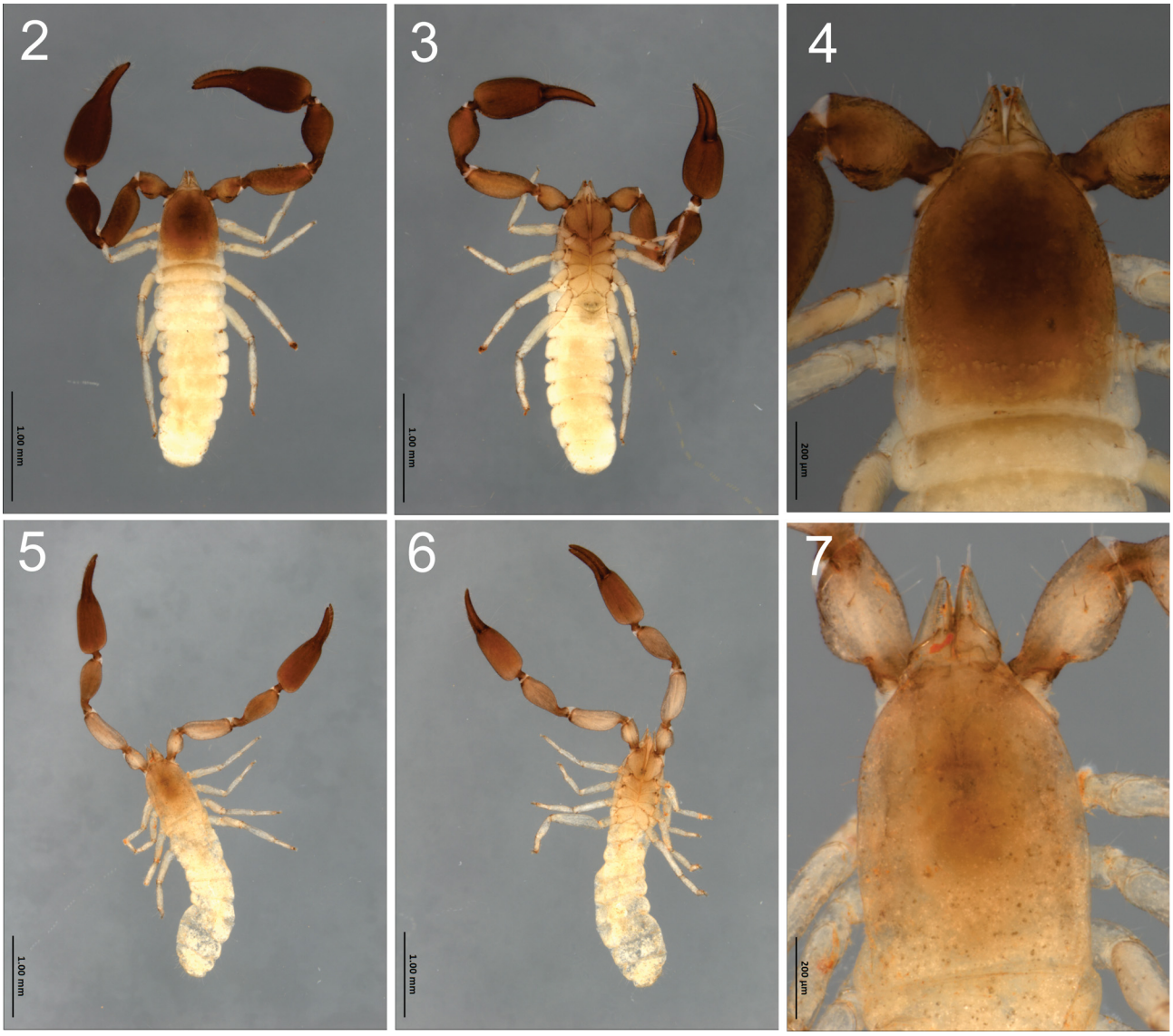
Adults

Colour (Figures 2–7): carapace and pedipalps dark red-brown; coxae red-brown; abdomen and legs pale yellow-brown.

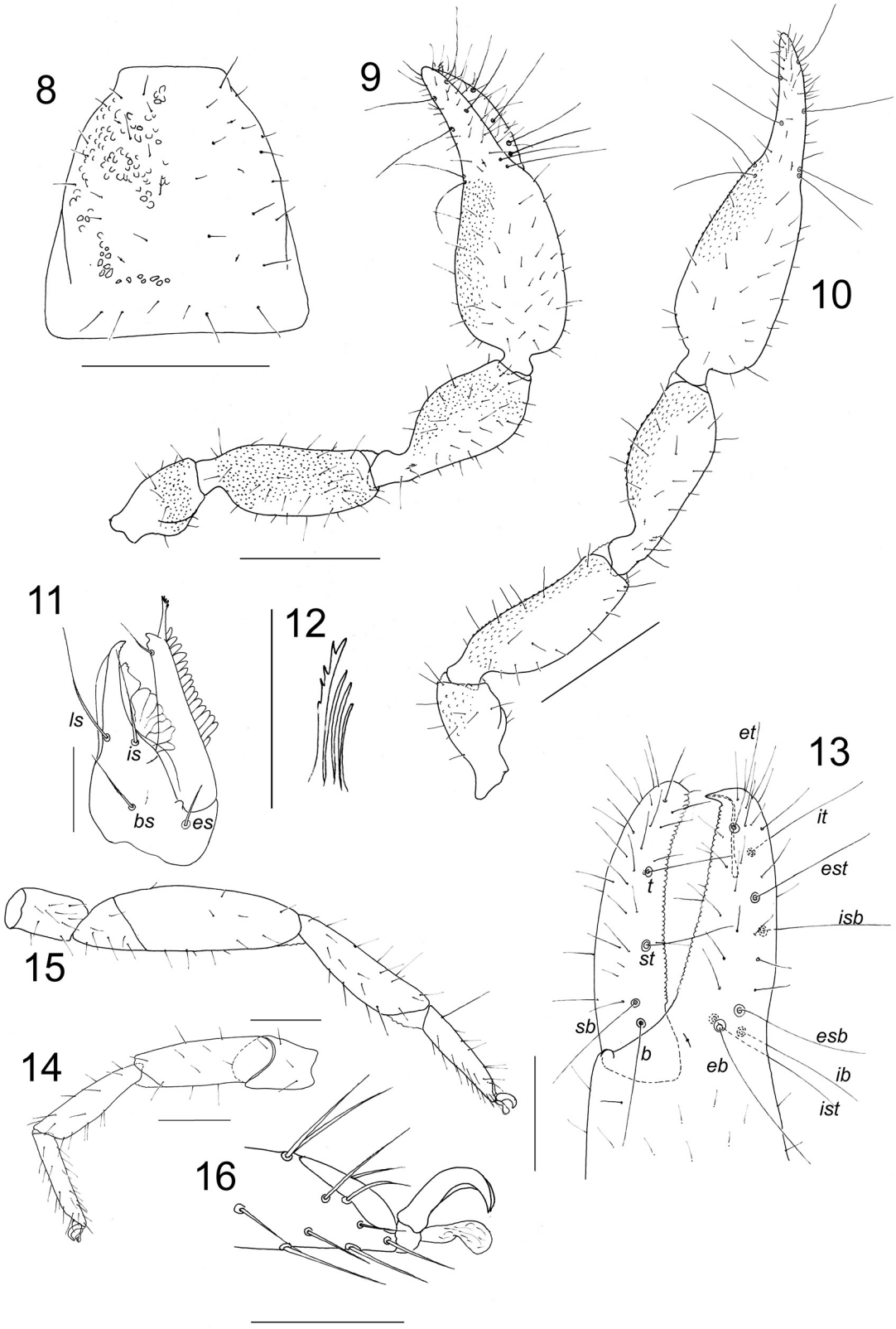
*Setae and cuticl*e: setae long, mostly straight and acicular; most cuticular surfaces smooth and glossy, with exception of pedipalps, which are finely granulate.

Chelicera (Figure 11): much smaller than carapace length; surface smooth; cheliceral hand with 4 setae (*sbs* absent); movable finger with 1 sub-distal seta; all setae acuminate; seta *bs* shorter than others; galea present, with several distal to sub-distal rami; with 2 dorsal and 1 ventral lyrifissures present; exterior condylar lyrifissure situated near exterior condyle; serrula interior connected to the cheliceral fixed finger for entire length, proximally modified to form velum; serrula exterior with 16 (♂), 17 (♀) blades; lamina exterior present; rallum (Figure 12) with 4 blades, first two blades with anterior spinules, remainder smooth; rallum with basal and sub-basal blades shorter than others.

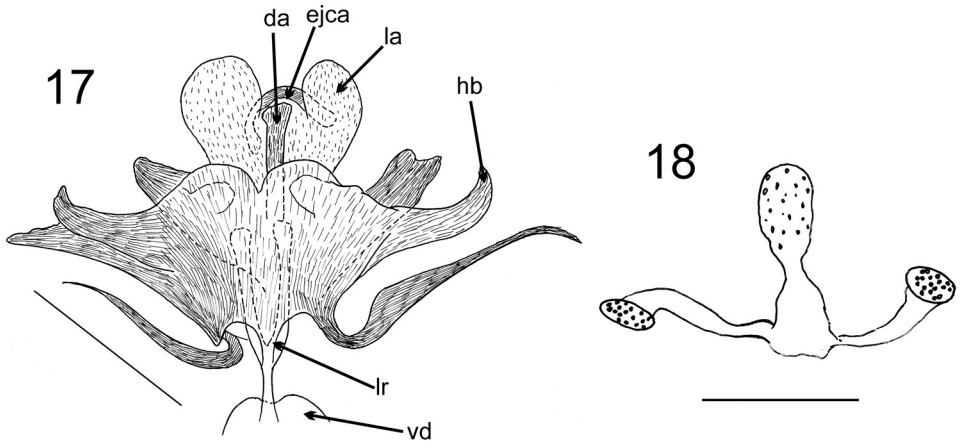
Pedipalps (Figures 9, 10): stout; lightly granulate on femur, patella, and at base of chelal fingers on prolateral face; setae acicular, straight or nearly so; trochanter with anterior margin rounded, with unmodified dorsal tubercle, 1.66–1.78 (♂), 1.79 (♀) x; femur cylindrical, robust, with 1 small trichobothrium on dorsal surface, situated near basal margin, 2.62–2.97 (♂), 2.72 (♀) x; patella cylindrical, robust, with narrow pedicel, with several small lyrifissures situated basally on dorsal surface, 2.11–2.44 (♂), 2.58 (♀) x; chelal hand cylindrical, external and internal chelal condyles small and rounded, chela (with pedicel) 2.97–3.21 (♂) longer than broad, 3.55 (♀) x, chela (without pedicel) 2.78–2.96 (♂), 3.38 (♀) x; hand (without pedicel) 1.50–1.84 (♂), 2.03 (♀) x;



FIGURES 2–7 *Anatemnus subvastus* sp. nov.: 2–4, male holotype (WAM T119416): 2, body, dorsal; 3, body, ventral; 4, carapace, dorsal; 5–7, female paratype (WAM T119417): 5, body, dorsal; 6, body, ventral; 7, carapace, dorsal.



FIGURES 8–16 *Anatemnus subvastus* sp. nov., male holotype (WAM T119416), unless stated otherwise: 8, carapace, dorsal; 9, right pedipalp, dorsal; 10, right pedipalp, dorsal, female paratype (WAM T119417); 11, right chelicera, dorsal; 12, rallum; 13, left chelal fingers, lateral; 14, left leg I, lateral; 15, left leg IV, lateral; 16, tip of tarsus IV, lateral. Scale lines = 0.5 mm (Figures 8–10), 0.2 mm (Figure 13), 0.2 mm (Figures 14–15), 0.1 mm (Figures 11–12, 16).



FIGURES 17–18 *Anatemnus subvastus* sp. nov.: 17, genitalia, ventral, male holotype (WAM T119416); 18, genitalia, ventral, female paratype (WAM T119417). Abbreviations: da, dorsal apodeme; ejca, ejaculatory canal atrium; hb, hooked branches; la, lateral apodemes; lr, lateral rod; vd, ventral diverticulum. Scale lines = 0.1 mm.

movable finger 0.75–0.95 (♂), 0.68 (♀) x longer than hand (without pedicel). Fixed finger with 8 trichobothria; movable finger with 4 trichobothria (Figure 13); *eb* and *esb* situated at base of fixed finger on retrolateral face; *ib* and *ist* situated at base of fixed finger on prolateral face; *isb* slightly proximad to *est*; *it* midway between *et* and *est*; *et* slightly distad to *it*; *sb* much closer to *b* than to *st*; *st* midway between *sb* and *t*; *t* acuminate. Both fingers straight in lateral view; chelal teeth juxtadentate; fixed finger with 37 (♂), 42 (♀) rounded teeth; movable finger with 46 (♂), 49 (♀) rounded teeth; accessory chelal teeth absent; venom apparatus present only in fixed chelal finger; venom duct long, terminating in nodus ramosus between *et* and *est*; nodus ramosus inflated; sense spots absent.

Cephalothorax: carapace (Figure 8) sub-rectangular; anterior margin medially indented; epistome absent; lateral margins evenly convex; 1.29–1.37 (♂), 1.36 (♀) x longer than broad, with 23–25 (♂), 23 (♀) setae including 4 on anterior margin and 4 on posterior margin; furrows absent; eyes absent. Manducatory process somewhat pointed, with 2 apical setae and 1 sub-oral seta; maxilla with 20 (♂), 16 (♀) other setae; maxillary shoulder absent; median maxillary lyrifissure present, situated medially, strongly curved, U-shaped; posterior maxillary lyrifissure present, strongly curved. Coxa I about same width as coxa IV; coxae I-IV setal formula: ♂, 8: 6: 5: 10; ♀, 7: 7: 5: 14.

Legs (Figures 14, 15): femora I and II about same size as patellae I and II, respectively; junction between anterior femora and patellae oblique; junction between posterior femora and patellae strongly angulate; femora III and IV much smaller than patellae III and IV, respectively; femur + patella IV 3.48–3.86 (♂), 4.14 (♀) x longer than broad; tibiae III and IV without tactile seta; tarsi III and IV with long tactile seta, situated basally; tarsal lyrifissure lying flush with tarsal surface; subterminal tarsal seta curved; claws smooth; arolium slightly shorter than claws; arolium not divided (Figure 16).

Abdomen: tergites straight; not divided; tergites, setal formula ♂, 6: 6: 6: 9: 10: 8: 9: 10: 11: 13: 12: 2; ♀, 5: 4: 6: 7: 8: 9: 8: 8: 10: 12: 15: 2; arranged in single rows; lateral margin of tergites not modified; sternites, setal formula ♂, 11: (1) 6 (1): (1) 6 (1): 9: 9: 10: 10: 10: 10: 13: 2; sternites, setal formula ♀, 11: (1) 7 (1): (1) 6 (1): 10: 10: 9: 10: 10: 11: 13: 2; glandular setae absent; medial sternites without suture line; pleural membrane uniformly longitudinally striate; without setae; stigmatic helix present; anus (tergite XII and sternite XII) without raised rim; anus situated between tergite XI and sternite XI.

Genitalia: male: dorsal apodeme long with rounded apex, ejaculatory canal atrium broad, lateral apodemes spherical, lateral rods Y-shaped with rounded apices, hooked branches wide (Figure 17), genital atrium without glandular setae; female (Figure 18): with single anteriorly directed spermathecal lobes, and 1 pair of small lateral cribriform plates.

Dimensions (mm): Males: holotype followed by other males (where applicable): Body length 2.58 (2.24–2.66). Chelicera 0.241/0.152; movable finger length 0.195. Pedipalp: trochanter 0.385/0.218 (0.371–0.382/0.215–0.223); femur 0.652/0.248 (0.589–0.712/0.225–0.240); patella 0.650/0.289 (0.637–0.662/0.271–0.302); chela (with pedicel) 1.139/0.382 (1.132–1.162/0.362–0.381); chela (without pedicel) length 1.066 (1.058–1.072); chelal hand (without pedicel) length 0.704 (0.573–0.595);

movable finger length 0.531 (0.470–0.542). Carapace 0.715/0.543 (0.710–0.742/0.518–0.576). Leg I: femur 0.228/0.144; patella 0.376/0.127; tibia 0.323/0.084; tarsus 0.296/0.052. Leg IV: femur + patella 0.637/0.183 (0.571–0.618/0.153–0.160); tibia 0.458/0.118; tarsus 0.309/0.072.

Female: paratype (WAM T119417): Body length 2.83. Chelicera 0.261/0.133; movable finger length 0.185. Pedipalp: trochanter 0.377/0.211; femur 0.642/0.236; patella 0.680/0.264; chela (with pedicel) 1.264/0.356; chela (without pedicel) 1.208; hand (without pedicel) 0.724; movable finger length 0.495. Carapace 0.778/0.572. Leg I: femur 0.212/0.123; patella 0.353/0.097; tibia 0.328/0.051; tarsus 0.295/0.049. Leg IV: femur + patella 0.633/0.153; tibia 0.459/0.085; tarsus 0.315/0.063.

REMARKS

Anatemnus subvastus has been collected from a very small area of the central Pilbara in the Hamersley Range, less than 20 km^2. All four specimens were collected from subterranean environments either using baited subterranean fauna traps, or by scraping the sides of the boreholes with a net. The specimens lack eye spots and are notably paler than epigean species of the genus (M. Burger, M. Harvey, personal observations). There is some notable variation in the size and proportions of the pedipalps and legs between the samples collected. For example, the pedipalpal femur is 0.59–0.71 (♂), 0.64 (♀) mm in length and 2.62–2.97 (♂), 2.72 (♀) x longer than broad, the pedipalpal patella is 0.64–0.66 (♂), 0.68 (♀) mm in length and 2.11–2.44 (♂), 2.58 (♀) x longer than broad, and the chela (without pedicel) is 1.13–1.16 (♂), 1.21 (♀) mm in length and 2.78–2.96 (♂), 3.38 (♀) x longer than broad. However, as the specimens come from a small area, we prefer to attribute this to intraspecific variation.

This species represents only the second troglobitic species of the genus. The first, *A. cavernicola*, from Jump Up Cave, in the Grey Range in north-western New South Wales, is substantially larger than *A. subvastus*, with a pedipalpal femur length of 1.25 mm (Beier 1976).

The subterranean fauna of the immediate area contains several other confirmed troglobites, including undescribed species of *Draculoides* and *Paradraculoides* (Schizomida, Hubbardiidae), *Lagynochthonius* and *Tyrannochthonius* (Pseudoscorpiones, Chthoniidae), Dalodesmidae (Diplopoda, Polydesmida) (C.A. Car, personal communication) and *Cormocephalus* (Scolopendrida, Scolopendridae) (J.M. Waldock, personal communication).

ETYMOLOGY

The species name refers to the presence of this species in subterranean environments in the semi-arid Pilbara region of Western Australia (*sub*-, Latin, under; *vastus*, Latin, waste, desert).

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