

New cave-dwelling schizomids (Schizomida: Hubbardiidae) from Australia

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Abstract – Six new schizomid species are described from caves in Western Australia. *Draculoides julianneae* sp. nov. is restricted to a single cave on the western coastal regions of Cape Range peninsula, whereas *D. brooksi* sp. nov. is only known from a borehole driven into limestone below fixed red sand dunes on the northern side of the peninsula. *Bamazomus vespertinus* sp. nov. and *B. subsolanus* sp. nov. are sister-species found in caves on the coastal plain on the western and eastern side of Cape Range peninsula. *Bamazomus huntii* sp. nov. is described from The Tunnel, a cave in the Oscar Range in the southern Kimberley, whereas *Apozomus eberhardi* is described from Old Napier Downs Cave in the Napier Range, also in the southern Kimberley. Two further species of *Apozomus*, *A. howarthi* sp. nov. and *A. volschenki* sp. nov., are described from caves in the Chillagoe region of northern Queensland.

INTRODUCTION

Although the Australian schizomid fauna is now known to show considerable diversity at both the generic and specific level, with seven described genera and 38 described species (Harvey, 1988, 1992, 2000a, 2000b; Harvey and Humphreys, 1995), the vast majority of species have been collected in epigeal environments. In contrast, only three species have been recorded from cavernicolous habitats. The first was *Draculoides vinei* (Harvey) from Cape Range, Western Australia, which has the distinction of being the first described Australian schizomid (Harvey, 1988), although the presence of this species had been known for some time (Main, 1980). The second was *D. bramstokeri* Harvey and Humphreys which occurs in limestone caves on the coastal plain of Cape Range peninsula and on nearby Barrow Island (Harvey and Humphreys, 1995). The third was *Attenuizomus cuttacutta* Harvey from Cutta Cutta Cave, situated near Katherine, Northern Territory (Harvey, 2000a). It possessed very few features which were indicative of a subterranean existence, and a related epigeal species was found nearby, suggesting that *A. cuttacutta* may be a troglophile.

Amongst recent collections of Australian cave-dwelling schizomids kindly made available to me by various colleagues are several new species that are described here. These include two new species of *Draculoides* from Cape Range peninsula, three new species of *Bamazomus* and three new species of *Apozomus* from different caves in Western Australia

and Queensland. This brings the total number of described Australian schizomids to 46 species, with 11 of these recorded from cavernicolous habitats. Although most of these cave-dwelling species are thus far known from single caves and are allopatric from other species, it is worth noting here that some species are sympatric with each other. This includes *Draculoides julianneae* sp. nov. and *Bamazomus vespertinus* sp. nov. that coexist in Cape Range cave C-215.

Specimens are lodged in the Western Australian Museum, Perth (WAM), the Queensland Museum, Brisbane (QM) and the Bernice P. Bishop Museum, Honolulu (BPBM). Methods and terminology follow Harvey (1992) and Reddell and Cokendolpher (1995).

This paper is dedicated to the memory of Glenn Hunt (1944–1999), a wonderful friend, an arachnological enthusiast, and a pot-holer from way back.

SYSTEMATICS

Family Hubbardiidae Cook

Genus *Draculoides* Harvey

Draculoides Harvey, 1992: 82–83; Harvey and Humphreys, 1995: 183–184; Reddell and Cokendolpher, 1995: 69.

Type Species

Schizomus vinei Harvey, 1988, by original designation.

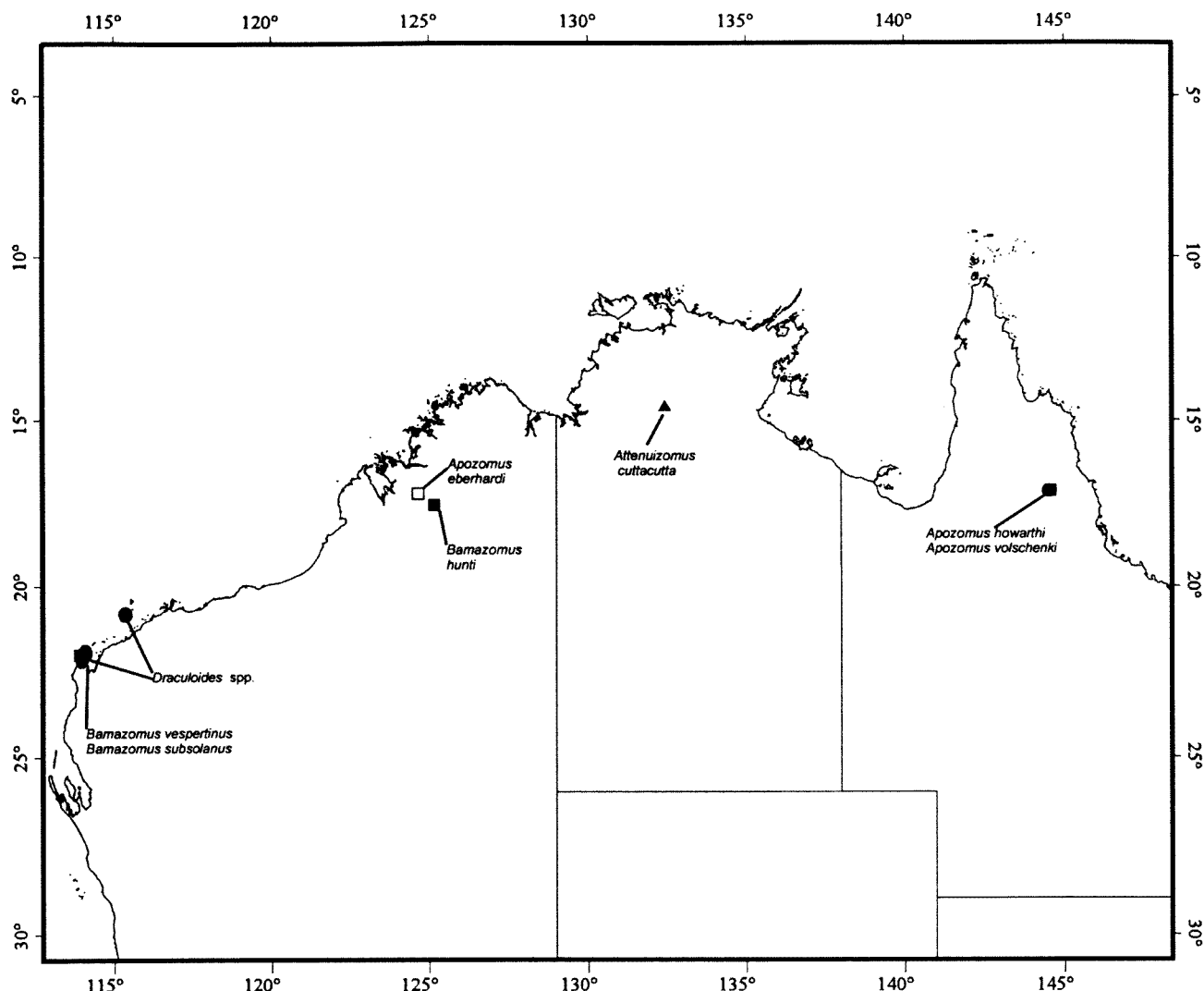


Figure 1 Map showing known distributions of cave-dwelling schizomids in Australia. Unidentified juveniles not shown.

Remarks

The addition of two new species of *Draculoides* from Cape Range peninsula is a noteworthy extension of this compact genus. The new key presented below will facilitate identification of the known species.

Key to species of *Draculoides*

1. Males (those of *D. julianneae* unknown) 2
Females (those of *D. brooksi* unknown) 4
2. Flagellum constricted posteriorly in dorsal and ventral views; flagellar seta dl1 very small; flagellar seta vm1 on same level as vm2
..... *Draculoides vinei* (Harvey)
Flagellum not constricted posteriorly in dorsal and ventral views; flagellar seta dl1 large; flagellar seta vm1 anterior to vm2 3
3. Flagellar seta dl1 small; seta vm2 situated anterior to vm1 *Draculoides brooksi* sp. nov.
Flagellar seta dl1 large; seta vm2 situated posterior to vm1 *Draculoides bramstokeri* Harvey and Humphreys
4. Gonopod absent *Draculoides vinei* (Harvey)
Gonopod present 5
5. Flagellar seta dm1 situated on same level as vm2; propeltidium 1.99 mm in length
..... *Draculoides julianneae* sp. nov.
Flagellar seta dm1 situated slightly posterior to vm2; propeltidium 1.26–1.47 mm in length
..... *Draculoides bramstokeri* Harvey and Humphreys

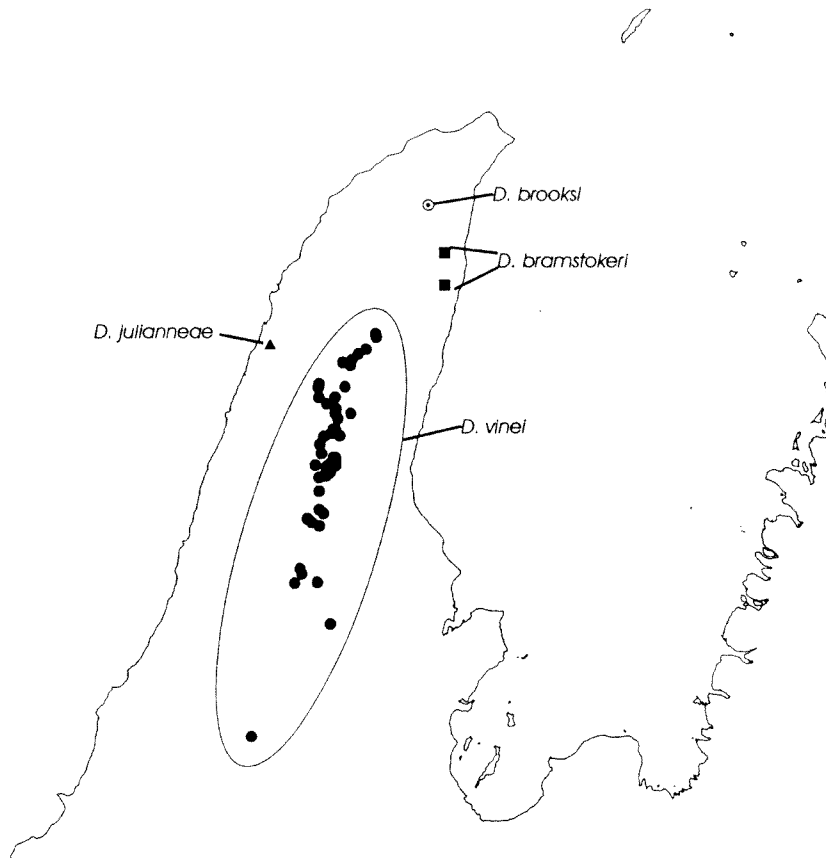


Figure 2 Map showing known distributions of *Draculoides* species on Cape Range peninsula (*Draculoides bramstokeri* also occurs on Barrow Island to the northeast).

***Draculoides julianneae* sp. nov.**

Figures 2–3

Draculoides vinei (Harvey): Harvey and Humphreys, 1995: 184–185 (misidentification, in part; specimens from cave C-215).

Material Examined

Holotype

♀, cave C-215, Cape Range peninsula, Western Australia, Australia, 22°02'S, 113°56'E, 19 May 1995, B. Vine, J.M. Waldock (WAM 98/1553).

Paratypes

Australia: Western Australia: 4 ♀, same data as holotype (WAM 98/1549–1552); 1 ♀, same data as holotype (WAM 98/1585).

Other Material

Australia: Western Australia: all from Cape Range peninsula, cave C-215, 22°02'S, 113°56'E: 1 ♀, 27 April 1996, W.F. Humphreys (WAM 98/1554); 4 juveniles, 4 December 1996, R.D. Brooks (WAM 98/1555–1558); 2 juveniles, 19 July 1991, R.D. Brooks (WAM 98/1576–1577); 1 juvenile, 8 August 1993, W.F. Humphreys, R.D. Brooks (WAM T40827); 1 ♀, 2 juveniles, 25 June 1999, W.F. Humphreys (WAM T40847).

Diagnosis

Females of *Draculoides julianneae* differ from those of *D. vinei* by the presence of a gonopod, and from *D. bramstokeri* by their larger size (e.g. propeltidium length 1.99 mm in *D. julianneae*, and 1.26–1.47 mm in *D. bramstokeri*), and the position of flagellar seta dm1 which is situated on the same level as vm2 in *D. julianneae*, but is situated slightly posterior to vm2 in *D. bramstokeri*. Males are unknown.

Description

Adult Female

Colour yellow-brown. Propeltidium with 9 setae, arranged 2: 1: 2: 2: 2; anterior margin drawn to a sharply downturned point between chelicerae; eye spots absent. Mesopeltidia widely separated. Metapeltidium divided. Anterior sternum with 15 setae, including 2 sternapophysial setae; posterior sternum triangular, with 6 setae. Chaetotaxy of tergites I–IX: 2+4 (microsetae diagonal): 2+6 (microsetae in column): 2: 2: 2: 2: 2: 4: 4; segment XII without dorsal process. Flagellum 3 segmented, first segment slightly longer than second, third longest; seta dm1 on same level as vm2. Genitalia (Figure 3): 4 spermathecae, each pair connected basally before connection with bursa; evenly covered with small

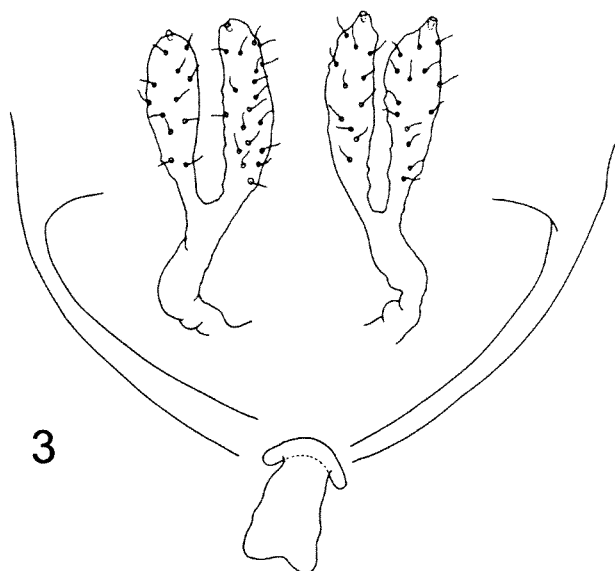


Figure 3 *Draculoides julianneae* sp. nov., holotype ♀, spermathecae, dorsal.

pores; small gonopod present, distally bifurcate. Pedipalp: without apophyses; trochanter with sharply produced distal extension, ventral margin with stout setae, without mesal spur; tibia and tarsus lacking spines; tarsus with spurs; claw 0.50 length of tarsus. Chelicera: fixed finger with 2 large teeth plus 7 smaller teeth between these, basal tooth with 1–2 small, blunt, lateral teeth; brush at base of fixed finger composed of 11 setae, each densely pilose in distal half; lateral surface with 3 large, lanceolate, terminally pilose setae; movable finger file composed of 19 long lamellae, blunt guard tooth present subdistally, 1 large and several small accessory teeth present near subdistal end of file. Legs: tarsus I with 6 segments; femur IV 3.67 times longer than wide.

Dimensions (mm), holotype ♀: Body length 6.80. Propeltidium 1.99/1.16. Chelicera 1.46. Flagellum 0.61. Pedipalp: trochanter 1.07, femur 1.08, patella 1.10, tibia 1.02, tarsus 0.52, claw 0.26, total excluding claw 4.79. Leg I: trochanter 0.73, femur 2.61, patella 3.27, tibia 1.18, metatarsus 0.68, tarsus 0.99, total 9.46. Leg II: trochanter 0.43, femur 1.83, patella 0.95, tibia 1.45, metatarsus 0.87, tarsus 0.77, total 6.30. Leg III: trochanter 0.46, femur 1.61, patella 0.80, tibia 1.15, metatarsus 0.99, tarsus 0.77, total 5.78. Leg IV: trochanter 0.63, femur 2.31, patella 1.02, tibia 1.77, metatarsus 0.99, tarsus 0.93, total 7.65.

Variation (♀, n = 6): propeltidium length 1.91–2.23 mm.

Remarks

Harvey and Humphreys (1995) included in their review of *Draculoides* a single record of *D. vinei* based upon two juveniles from cave C-215 on the western edge of Cape Range (Harvey and Humphreys 1995, figure 1). The recent collection of

adults from this cave has now revealed that the specimens occurring in this cave are distinct from the other species of *Draculoides*, and that *D. vinei* does not occur on the coastal plain of the peninsula (Figure 2). This species only occurs in cave C-215 where it is sympatric with *Bamazomus vespertinus*. Adults and juveniles are easily distinguished from one another, as *D. julianneae* lacks a mesal spur on the pedipalpal trochanter.

Draculoides julianneae is currently listed as a threatened species under the Wildlife Conservation Act by the Western Australian Government, under the name "Western Cape Range *Draculoides*".

Etymology

This species is named for Julianne Waldock, who has collected large numbers of schizomids, including several specimens of this new species.

Draculoides brooksi sp. nov.

Figures 2, 4–6

Material Examined

Holotype

♂, Ampolex 'A' borehole, Cape Range area, Western Australia, Australia, 21°53'S, 114°06'E, litter trap in base of borehole, 28 April 1996, W.F. Humphreys, R.D. Brooks (WAM T40640).

Other Material (non-types)

Australia: Western Australia: 3 juveniles, same data as holotype (WAM T40641).

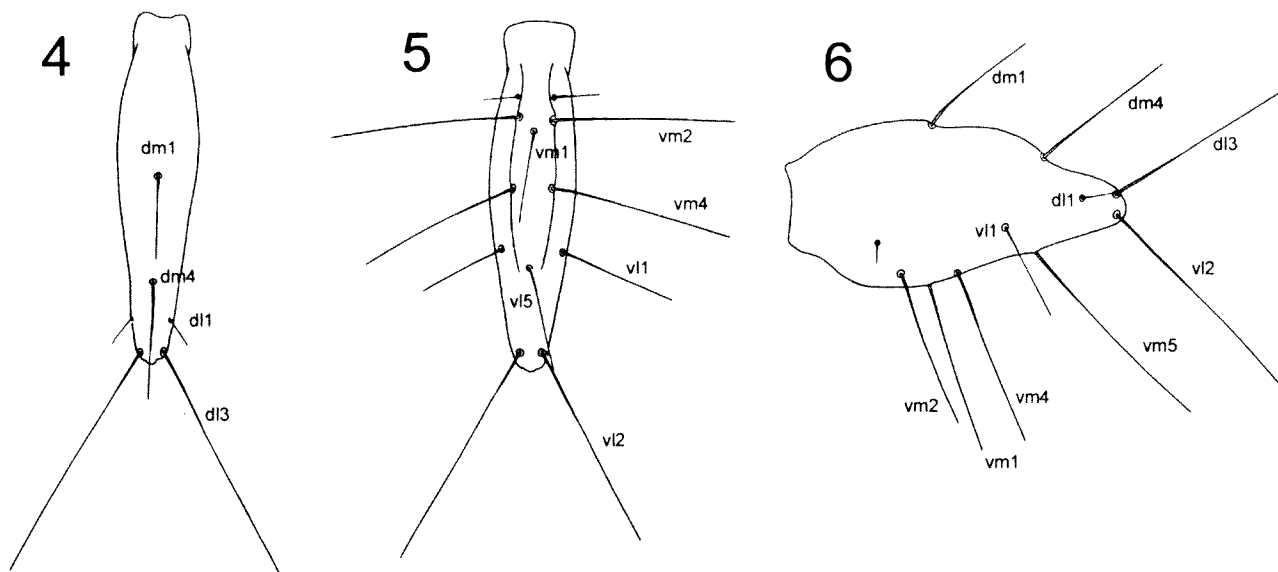
Diagnosis

Males of *Draculoides brooksi* differ from those of *D. vinei* by the lack of a posterior constriction on the flagellum, and from *D. bramstokeri* by the shape of the flagellum, the smaller size of flagellar seta dl1, and the position of vm2 which is situated anterior to vm1. Females are unknown.

Description

Adult Male

Colour very pale yellow-brown. Propeltidium with 9 setae, arranged 2: 1: 2: 2: 2; anterior margin drawn to a sharply downturned point between chelicerae; eye spots absent. Mesopeltidia widely separated. Metapeltidium divided. Anterior sternum with 12 setae, including 2 sternapophysial setae; posterior sternum triangular, with 6 setae. Chaetotaxy of tergites I–IX: 2+4 (microsetae diagonal): 2+6 (microsetae in column): 2: 2: 2: 2: 4: 4; segment XII without dorsal process. Flagellum (Figures 4–6) laterally compressed, seta dm4 situated slightly closer to end of flagellum than to dm1, dl1 small and situated postero-laterally, vm1



Figures 4–6 *Draculoides brooksi* sp. nov., holotype ♂: 4, flagellum, dorsal; 5, flagellum, ventral; 6, flagellum, lateral.

situated slightly posterior to vm2, and 3.77 times longer than broad. Pedipalp: without apophyses; trochanter with sharply produced distal extension, ventral margin with stout setae, without mesal spur; tibia and tarsus lacking spines; tarsus with spurs; claw 0.52 length of tarsus. Chelicera: fixed finger with 2 large teeth plus 5 smaller teeth between these, basal tooth with 1 small, blunt, lateral tooth; brush at base of fixed finger composed of 8 setae, each densely pilose in distal half; lateral surface with 3 large, lanceolate, terminally pilose setae; movable finger file composed of 20 long lamellae, blunt guard tooth present subdistally, 1 large and several small accessory teeth present near subdistal end of file. Legs: tarsus I with 6 segments; femur IV 3.54 times longer than wide.

Dimensions (mm), holotype ♂: Body length ca. 5.8. Propeltidium 1.62/0.88. Chelicera 1.18. Flagellum 0.49/0.13. Pedipalp: trochanter 0.84, femur 0.93, patella 0.96, tibia 0.84, tarsus 0.44, claw 0.23, total excluding claw 4.01. Leg I: trochanter 0.66, femur 2.45, patella 3.34, tibia 2.59, metatarsus 0.84, tarsus 0.81, total 10.69. Leg II: trochanter 0.37, femur 1.60, patella 0.75, tibia 1.28, metatarsus 0.91, tarsus 0.67, total 5.58. Leg III: trochanter 0.35, femur 1.39, patella 0.61, tibia 0.98, metatarsus 0.59, tarsus 0.64, total 4.56. Leg IV: trochanter 0.55, femur 2.02, patella 0.87, tibia 1.49, metatarsus 1.49, tarsus 0.79, total 7.21.

Remarks

The four known specimens of *D. brooksi* were taken from a leaf litter-baited trap placed at the bottom of a borehole which had been drilled through several metres of fixed red sand dunes to the base limestone. The sand dunes are of Pleistocene age (Wyrwoll *et al.*, 1993), and the

underlying limestone contains both troglobites and stygobites (Humphreys, 2000).

Etymology

This species is named for Darren Brooks, in recognition of his exemplary skills in collecting schizomids and other fascinating cave-dwelling creatures.

Genus *Bamazomus* Harvey

Bamazomus Harvey, 1992: 109–111; Reddell and Cokendolpher, 1995: 63–64.

Type Species

Bamazomus bamaga Harvey, 1992, by original designation.

Remarks

Although only four species of *Bamazomus* are currently described (Harvey, 1992, 2000a; Reddell and Cokendolpher, 1995), it is apparent that this genus is widespread throughout the Australasian region (Harvey, unpublished data). The three new species described below represent the only definitive records of the genus from Western Australia, but some of the unidentified juveniles of *Apozomus* collected in rainforest patches of the Kimberley District (Harvey, 1992) may represent specimens of this genus.

Two of the new species described below, *B. vespertinus* and *B. subsolanus*, are significantly different from all previously described species in that the male flagellum is shaped like an arrow-head with large lateral processes, with prominent dorsal keels, and with flagellar seta dl1 situated far

posteriorly than in any other described species (Figures 7, 13). A full review of the genus is clearly desirable, but it appears that these two species represent a divergent clade within *Bamazomus*.

***Bamazomus vespertinus* sp. nov.**

Figures 7–12

Material Examined

Holotype

♂, cave C-215, Cape Range, Western Australia, Australia, 22°02'S, 113°56'E, 19 May 1995, from roots in canal area, R.D. Brooks (WAM 95/748).

Paratypes

Australia: Western Australia: all from cave C-215, 22°02'S, 113°56'E, Cape Range: 4 ♀, 2 juveniles, 19 May 1995, B. Vine, J.M. Waldock (WAM 98/

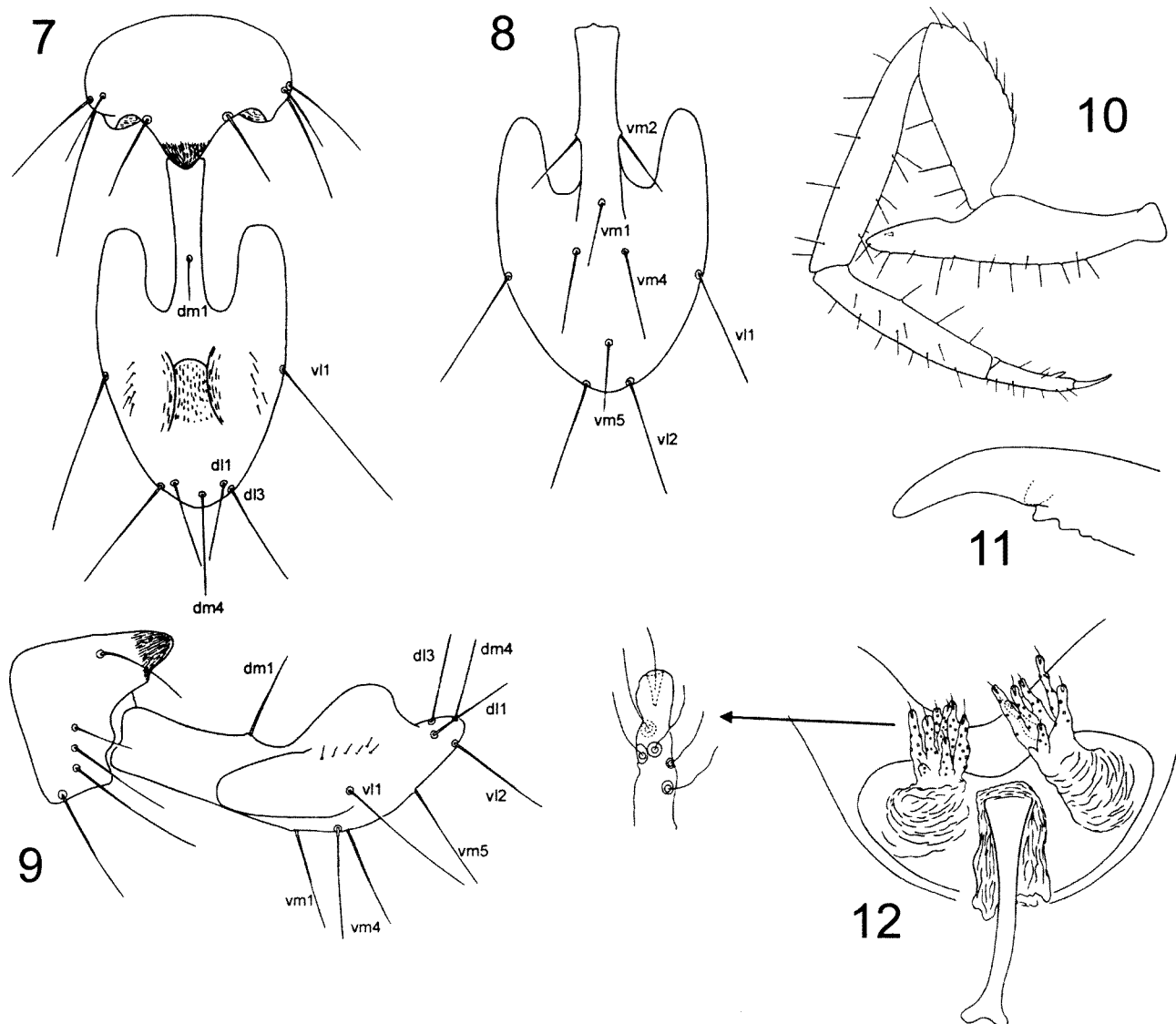
1527-1532); 1 ♂, canal area, 19 May 1995, B. Vine, J.M. Waldock (WAM 95/755); 1 ♀, canal area, 19 May 1995, B. Vine, J.M. Waldock (WAM T40848).

Other Material

Australia: Western Australia: all from cave C-215, 22°02'S, 113°56'E, Cape Range: 2 ♀, 3 juveniles, 17 May 1995, R.D. Brooks (WAM 95/750-754); 1 juvenile, litter in entrance chamber, 17 May 1995, B. Vine (WAM 95/749); 1 juvenile, 19 July 1991, W.F. Humphreys (WAM 98/1578).

Diagnosis

Bamazomus vespertinus can be distinguished from *B. subsolanus* by the shape of the male flagellum in which the keels of the former are more rounded, and by the position of flagellar seta dl1 which is situated posteriorly near dm4 in *B. vespertinus*, but is further anterior in *B. subsolanus*.



Figures 7–12 *Bamazomus vespertinus* sp. nov., 7–11, holotype m: 7, flagellum and segment XII, dorsal; 8, flagellum, ventral; 9, flagellum and segment XII, lateral; 10, left pedipalp; 11, movable cheliceral finger; 12, paratype female (WAM 95/756), spermathecae with detail, dorsal.

Description

Adults

Colour pale yellow-brown. Propeltidium with 9 setae, arranged 2: 1: 2: 2: 2; anterior margin drawn to a sharply downturned point between chelicerae; eye spots absent. Mesopeltidia widely separated. Metapeltidium fully divided in ♀, but divided anteriorly and posteriorly but fused medially in ♂. Anterior sternum with 14 (♂), 15 (♀) setae, including 2 sternapophysial setae; posterior sternum triangular, with 6 (♂, ♀) setae. Chaetotaxy of tergites I-IX: 2+4 (microsetae diagonal): 2+6 (microsetae in column): 2: 2: 2: 2: 4: 7-8: 6; segment XII of male with distinct dorsal process (Figures 7, 9). Flagellum of male (Figures 7-9) somewhat arrow-head shaped with rounded posterior margin and prominent lateral processes, dorsally with two prominent keels situated either side of a moderate dorsal depression; seta vm1 situated mid-way between vm2 and vm4; seta vm5 situated slightly anterior to vl2; dl1 situated adjacent to dl3 and dm4; dorsally with 6 pairs of small accessory setae in straight line; 1.60 times longer than broad. Flagellum of ♀ 3 segmented, first segment slightly longer than second, third longest. Female genitalia (Figure 12): with 7 pairs of receptacula, most without side branches; receptacula with external pores, each apparently bearing a thin duct which is anteriorly directed; gonopod long and distally bifurcate. Pedipalps displaying significant sexual dimorphism with that of ♂ elongate and with long distal extension of trochanter (Figure 10), that of ♀ not modified; pedipalps without apophyses; ventral trochanteral margin with stout setae, with mesal spur situated subdistally; tibia and tarsus lacking spines; tarsus with spurs; claw 0.40 (♂, ♀) length of tarsus. Chelicera: fixed finger with 2 large teeth plus 5 smaller teeth between these, basal tooth with 1-2 small, blunt, lateral teeth; brush at base of fixed finger composed of 6 setae, each densely pilose in distal half; lateral surface with 3 large, lanceolate, terminally pilose setae; movable finger file composed of 17 (♂), 20 (♀) long lamellae, blunt guard tooth present subdistally, with 3 (♂), 6 (♀) prominent accessory tooth near subdistal end of file (Figure 11). Legs: tarsus I with 6 segments; femur IV 2.48 (♂), 2.44 (♀) times longer than wide.

Dimensions (mm), holotype ♂ (paratype ♀, WAM 95/756): Body length 3.50 (3.10). Propeltidium 1.19/0.78 (1.34/0.78). Chelicera 0.84 (0.95). Flagellum 0.56/0.35 (0.33). Pedipalp: trochanter 1.00 (0.70), femur 0.67 (0.61), patella 0.92 (0.73), tibia 0.71 (0.64), tarsus 0.35 (0.35), claw 0.14 (0.14), total excluding claw 3.65 (3.03). Leg I: trochanter 0.38 (0.38), femur 1.27 (1.22), patella 1.57 (1.45), tibia 1.19 (1.13), metatarsus 0.37 (0.34), tarsus 0.55 (0.54), total 5.33 (5.06). Leg II: trochanter 0.29 (0.26), femur 0.92 (0.94), patella 0.55 (0.57), tibia 0.66

(0.64), metatarsus 0.47 (0.47), tarsus 0.39 (0.35), total 3.28 (3.23). Leg III: trochanter 0.26 (0.25), femur 0.75 (0.81), patella 0.41 (0.40), tibia 0.45 (0.44), metatarsus 0.47 (0.52), tarsus 0.43 (0.39), total 2.77 (2.81). Leg IV: trochanter 0.39 (0.38), femur 1.19 (1.22), patella 0.77 (0.55), tibia 0.91 (0.87), metatarsus 0.77 (0.77), tarsus 0.45 (0.46), total 4.48 (4.25).

Remarks

Bamazomus vespertinus and *B. subsolanus* are extremely unusual species with distinctive features including the greatly elongate male pedipalpal trochanter, and a male flagellum with a deeply incised anterior margin and strong dorsal keels. They form a sister-species pair, but are easily separated as indicated above in the diagnosis. The lack of eye spots in both species indicates strong adaptations to the cave environment which is elsewhere paralleled in the genus by the blind *B. pileti* (Brignoli) from Batu Caves, Malaysia (Brignoli, 1974). This species only occurs in cave C-215 where it is sympatric with *Draculoides julianneae*. Adults and juveniles are easily distinguished from one another, as *D. julianneae* lacks a mesal spur on the pedipalpal trochanter.

Bamazomus vespertinus is currently listed as a threatened species under the Wildlife Conservation Act by the Western Australian Government, under the name "Western Cape Range *Bamazomus*".

Etymology

The specific epithet refers to the occurrence of this species on the western side of Cape Range peninsula (*vespertinus*, Latin, of the evening).

Bamazomus subsolanus sp. nov.

Figures 13-16

Material Examined

Holotype

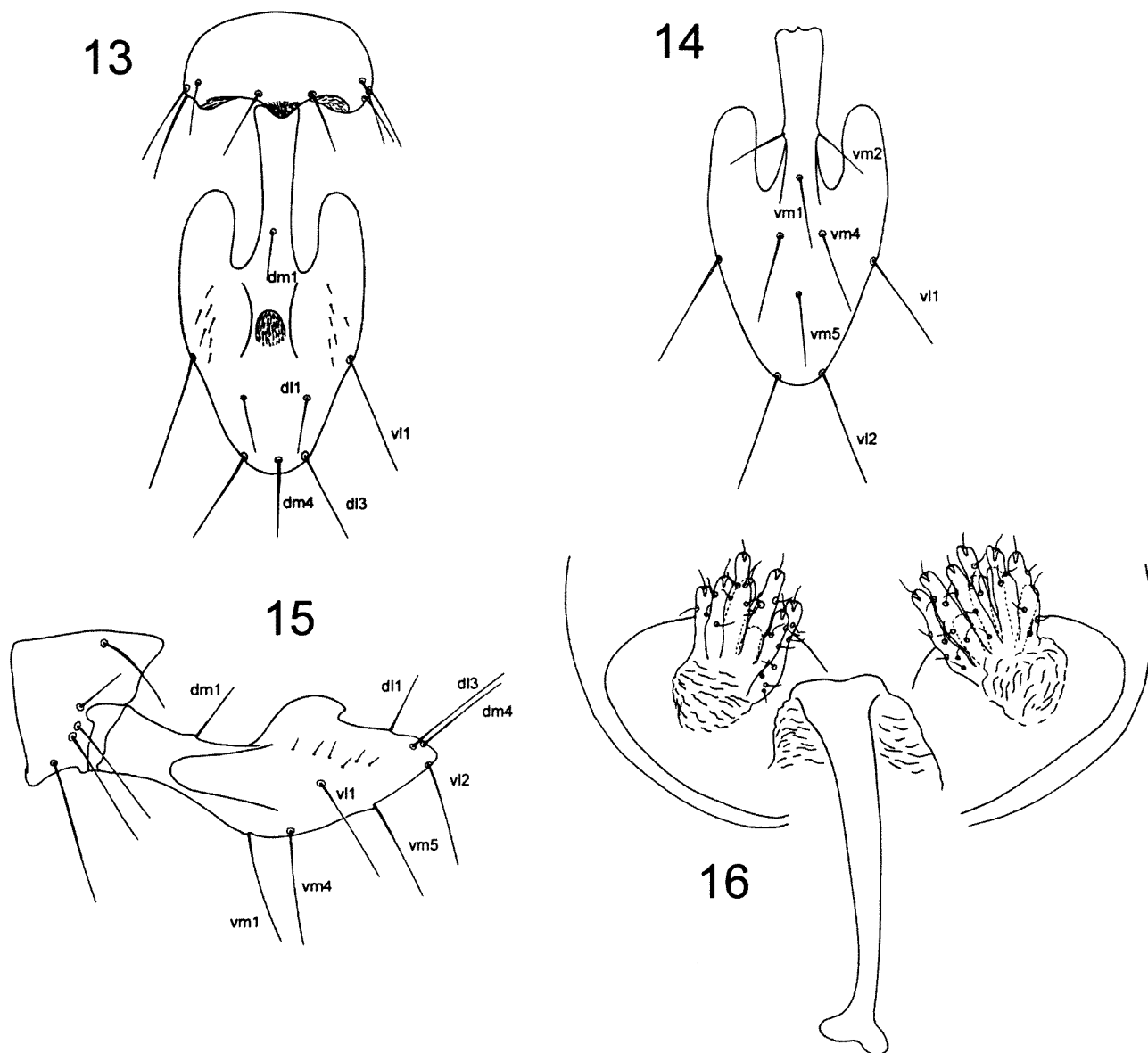
♂, unnamed limestone quarry, Cape Range peninsula, Western Australia, Australia, 22°00'S, 114°05'E, 31 January 1998, R.D. Brooks (WAM 98/1540).

Paratypes

Australia: Western Australia: all from unnamed limestone quarry, Cape Range peninsula, 22°00'S, 114°05'E, R.D. Brooks: 1 ♀, 2 juveniles, 3 February 1998 (WAM 98/1545-1547); 1 ♀, 1 juvenile, 15 October 1996 (WAM 98/1533-1534); 1 ♀, 15 April 1998, under rock on surface in swirl hole (WAM 98/1559).

Other Material

Australia: Western Australia: all from unnamed



Figures 13–16 *Bamazomus subsolanus* sp. nov., 13–15, holotype m: 13, flagellum and segment XII, dorsal; 14, flagellum, ventral; 15, flagellum and segment XII, lateral; 16, paratype female (WAM 98/1533), spermathecae, dorsal.

limestone quarry, Cape Range peninsula, 22°00'S, 114°05'E, R.D. Brooks: 1 juvenile, 18 October 1996 (WAM 98/1535); 1 juvenile, 21 October 1996 (WAM 98/1536); 1 juvenile, 24 October 1996 (WAM 98/1537); 1 juvenile, 28 January 1998 (WAM 98/1538); 1 juvenile, 29 January 1998 (WAM 98/1539); 2 juveniles, 1 February 1998 (WAM 98/1541-1542); 2 juveniles, 3 February 1998 (WAM 98/1543-1544).

Diagnosis

Bamazomus subsolanus can be distinguished from *B. vespertinus* by the shape of the male flagellum in which the keels of the former possess a posterior kink, and by the position of flagellar seta dl1 which is situated anteriorly in *B. subsolanus*, but is situated posteriorly near dm4 in *B. vespertinus*.

Description

Adults

Colour yellow-brown. Propeltidium with 9 setae, arranged 2: 1: 2: 2: 2; anterior margin drawn to a sharply downturned point between chelicerae; eye spots absent. Mesopeltidia widely separated. Metapeltidium fully divided in ♀, but undivided in ♂. Anterior sternum with 15 (♂), 13 (♀) setae, including 2 sternapophysial setae; posterior sternum triangular, with 6 (♂, ♀) setae. Chaetotaxy of tergites I-IX: 2+4 (microsetae diagonal): 2+6 (microsetae in column): 2: 2: 2: 2: 4: 6–8: 7–8; segment XII of male with distinct dorsal process (Figures 13, 15). Flagellum of male (Figures 13–15) somewhat arrow-head shaped with rounded

posterior margin and prominent lateral processes, dorsally with two prominent keels situated either side of a moderate dorsal depression; seta vm1 situated mid-way between vm2 and vm4; seta vm5 situated midway between vl1 and vl2; dl1 situated midway between vl1 and dl3; dorsally with 7–8 pairs of small accessory setae in straight line; 1.69 times longer than broad. Flagellum of ♀ 3 segmented, first segment slightly longer than second, third longest. Female genitalia (Figure 16): with 6–10 pairs of receptacula, without side branches; receptacula with external pores, each apparently bearing a thin duct which is anteriorly directed; gonopod long and distally bifurcate. Pedipalps displaying significant sexual dimorphism with that of ♂ elongate and with long distal extension of trochanter, that of ♀ not modified; pedipalps without apophyses; ventral trochanteral margin with stout setae, with mesal spur situated subdistally; tibia and tarsus lacking spines; tarsus with spurs; claw 0.40 (♂), 0.36 (♀) length of tarsus. Chelicera: fixed finger with 2 large teeth plus 6 smaller teeth between these, distal tooth with 1–2 small, blunt, lateral teeth; brush at base of fixed finger composed of 6 setae, each densely pilose in distal half; lateral surface with 3 large, lanceolate, terminally pilose setae; movable finger file composed of 18 long lamellae, blunt guard tooth present subdistally, with 4 accessory teeth present near subdistal end of file. Legs: tarsus I with 6 segments; femur IV 2.53 (♂), 2.51 (♀) times longer than wide.

Dimensions (mm), holotype ♂ (paratype ♀, WAM 98/1533): Body length 4.00 (4.10). Propeltidium 1.13/0.64 (1.21/0.71). Chelicera 0.75 (0.83). Flagellum 0.54/0.32 (0.40). Pedipalp: trochanter 0.70 (0.61), femur 0.51 (0.53), patella 0.67 (0.62), tibia 0.59 (0.55), tarsus 0.30 (0.28), claw 0.12 (0.10), total excluding claw 2.77 (2.59). Leg I: trochanter 0.37 (0.38), femur 1.25 (1.20), patella 1.52 (1.44), tibia 1.16 (1.10), metatarsus 0.35 (0.34), tarsus 0.55 (0.48), total 5.20 (4.94). Leg II: trochanter 0.22 (0.23), femur 0.84 (0.84), patella 0.51 (0.52), tibia 0.61 (0.61), metatarsus 0.46 (0.47), tarsus 0.38 (0.35), total 3.02 (3.02). Leg III: trochanter 0.20 (0.24), femur 0.70 (0.70), patella 0.24 (0.38), tibia 0.43 (0.44), metatarsus 0.49 (0.49), tarsus 0.37 (0.37), total 2.43 (2.62). Leg IV: trochanter 0.34 (0.32), femur 1.10 (1.13), patella 0.51 (0.52), tibia 0.83 (0.84), metatarsus 0.70 (0.70), tarsus 0.43 (0.42), total 3.91 (3.93).

Remarks

Bamazomus subsolanus is extremely similar to *B. vespertinus* and they only differ in the setation and shape of the male flagellum, a feature regarded by Harvey (1992) and other authors to be of great significance in distinguishing schizomid species. Females of the two species are less easily

distinguished, as there is some overlap in details of the genitalia. Indeed, one female of *B. subsolanus* (WAM 98/1533) possesses 8 spermathecal lobes on one side and 10 on the other, whereas another female (WAM 98/1559) bears only 6 lobes on each side.

Etymology

The specific epithet refers to the occurrence of this species on the eastern side of Cape Range peninsula (*subsolanus*, Latin, eastern).

Bamazomus hunti sp. nov.

Figure 17

Material Examined

Holotype

♀, The Tunnel, cave KO-1, Western Australia, Australia, 17°35'S, 125°10'E, 7 July 1994, R.D. Brooks, W.F. Humphreys (WAM T40602).

Other Material

Australia: Western Australia: 1 juvenile, same data as holotype except 8 July 1994, W.F. Humphreys (WAM T40603).

Diagnosis

Females of *Bamazomus hunti* differ from those of *B. siamensis* (Hansen) in possessing longer spermathecae and a somewhat shorter gonopod (see Cokendolpher and Reddell, 1986), and from *B. bamaga*, *B. vespertinus* and *B. subsolanus* in the presence of a deeply incised gonopod. It is not possible to compare *B. hunti* with *B. pileti* (Brignoli)

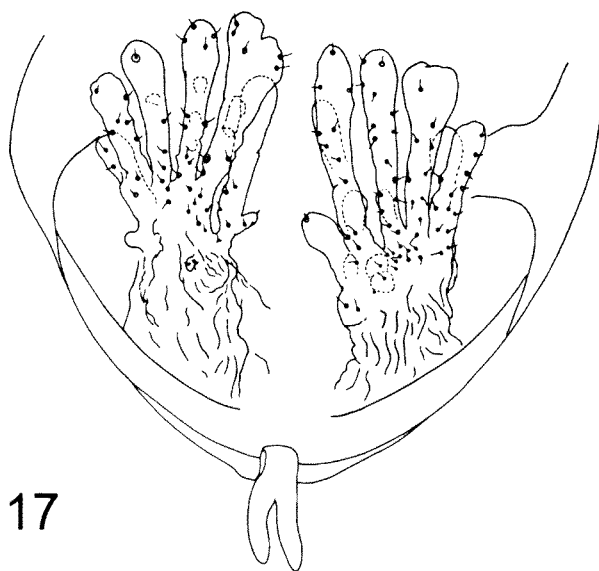


Figure 17 *Bamazomus hunti* sp. nov., holotype ♀, spermathecae, dorsal.

from Batu Caves in Malaysia, which is known only from a single male (Brignoli, 1974). *B. hunti* is also unusual in possessing only three teeth between the exterior teeth of the fixed cheliceral finger; all other known species possess four such teeth. Males are unknown.

Description

Adult female

Colour pale yellow-brown. Propeltidium with 11 setae, arranged 2 (in row): 1: 2: 2: 2: 2; anterior margin drawn to a sharply downturned point between chelicerae; eye spots present, but small. Mesopeltidia widely separated. Metapeltidium divided. Anterior sternum with 18 setae, including 2 sternapophysial setae; posterior sternum triangular, with 6 setae. Chaetotaxy of tergites I-IX: 2+4 (4 microsetae diagonal): 2+6 (6 microsetae in column): 4: 4: 4: 4: 4: 4: 6; segment XII without dorsal process. Flagellum 3 segmented, first segment approximately same length as second, third longest. Genitalia (Figure 17): with 4–5 major pairs of receptacula, many with one or more side branches; receptacula with external pores; gonopod not extremely long, and with a deep distal bifurcation. Pedipalp: without apophyses; trochanter without sharply produced distal extension, ventral margin with stout setae, with mesal spur; tibia and tarsus lacking spines; tarsus with spurs; claw 0.41 length of tarsus. Chelicera: fixed finger with 2 large teeth plus 3 smaller teeth between these, basal tooth with 1 small, blunt, lateral tooth; brush at base of fixed finger composed of 12 setae, each densely pilose in distal half; lateral surface with 3 large, lanceolate, terminally pilose setae; movable finger file composed of 18 long lamellae, blunt guard tooth present subdistally, accessory tooth present near middle of file. Legs: tarsus I with 6 segments; femur IV 2.67 times longer than wide.

Dimensions (mm): Body length 4.20. Propeltidium 1.26/0.77. Chelicera 0.97. Flagellum 0.35. Pedipalp: trochanter 0.55, femur 0.60, patella 0.57, tibia 0.56, tarsus 0.27, claw 0.11, total excluding claw 2.55. Leg I: trochanter 0.44, femur 1.38, patella 1.67, tibia 1.28, metatarsus 0.41, tarsus 0.58, total 5.76. Leg II: trochanter 0.26, femur 0.95, patella 0.56, tibia 0.61, metatarsus 0.54, tarsus 0.43, total 3.35. Leg III: trochanter 0.29, femur 0.85, patella 0.42, tibia 0.41, metatarsus 0.57, tarsus 0.44, total 2.98. Leg IV: trochanter 0.46, femur 1.28, patella 0.63, tibia 0.96, metatarsus 0.84, tarsus 0.52, total 4.69.

Remarks

Bamazomus hunti is known only from The Tunnel, a cave in the Oscar Range, western Kimberley. It exhibits very few adaptations to a cave environment, and the eye-spots, although present,

appear to be only barely reduced in size compared with epigean species of the genus.

Etymology

This species is named for the late Glenn Hunt, whose enthusiasm for opilionids, mites and life was contagious.

Genus *Apozomus* Harvey

Apozomus Harvey, 1992: 85; Reddell and Cokendolpher, 1995: 58.

Type Species

Apozomus watsoni Harvey, 1992, by original designation.

Remarks

The three species described below represent the first Australian cave-dwelling members of the genus, although two Asian species, *A. daitoensis* (Shimojana) from Japan and *A. yamasakii* (Cokendolpher) from Taiwan, are found in cave environments (Cokendolpher, 1988; Shimojana, 1981).

The species described below from caves in the Chillagoe region, *A. howarthi* and *A. volschenki*, lack any close relationship with any other described Australian schizomid, but appear to be most similar to *A. brignolii* Cokendolpher and Reddell from the Marshall Islands. Males of *A. brignolii* and *A. howarthi* possess a flagellum and segment XII morphology that is typical of members of the genus *Bamazomus*, but the morphology of the female genitalia is typical of the genus *Apozomus*. I here follow Cokendolpher and Reddell (2000) is ascribing these species to the genus *Apozomus*, but acknowledge that further work on the relationships of the species currently attributed to *Apozomus*, *Bamazomus* and related genera may significantly alter the generic definitions currently employed.

Apozomus eberhardi sp. nov.

Figures 18–20

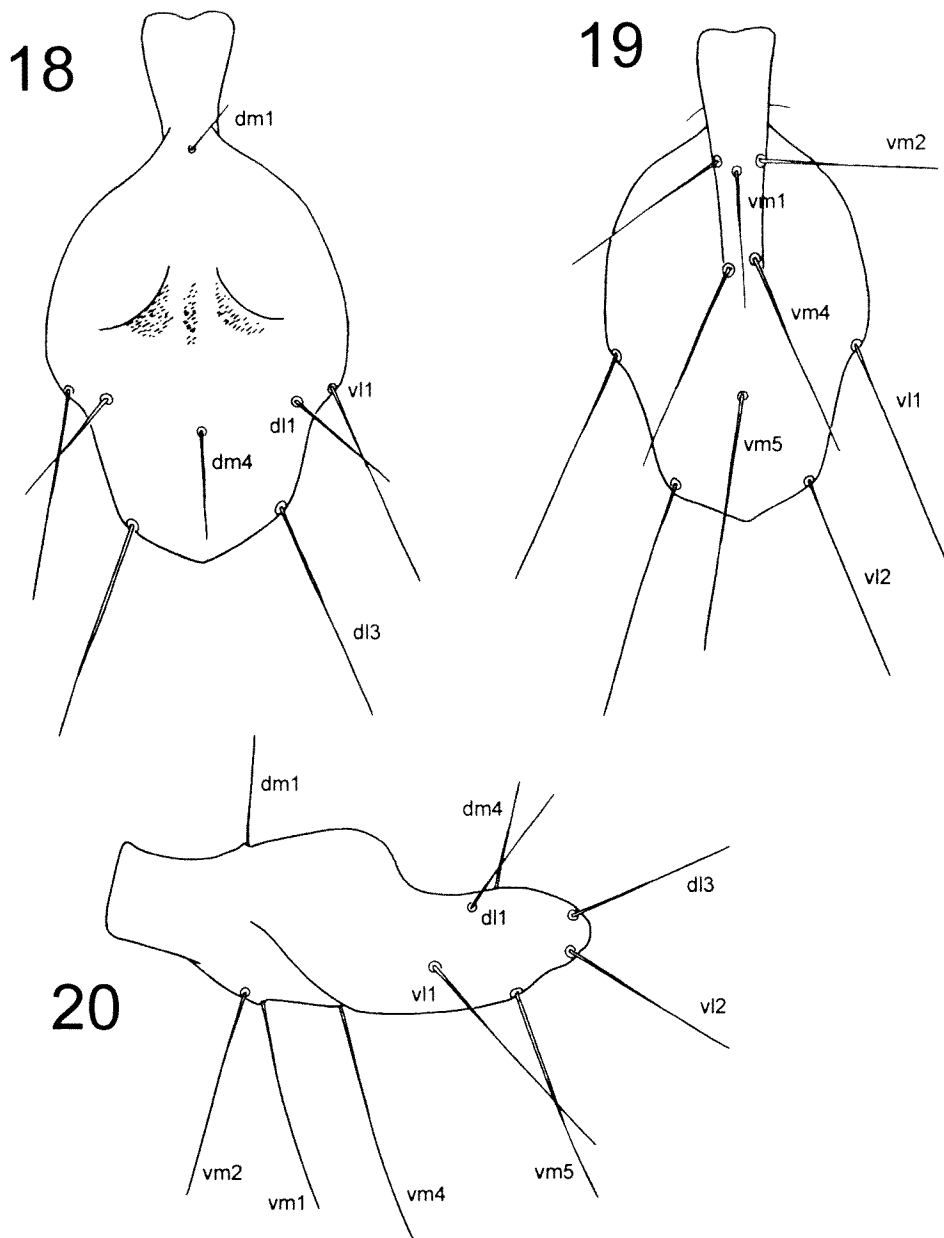
Material Examined

Holotype

♂, Old Napier Downs Cave, cave KN-1, Napier Range, Western Australia, Australia, 17°14'35"S, 124°39'10"E, 23 July 1998, S.M. Eberhard (WAM T40604).

Diagnosis

Males differ from other *Apozomus* species by the position of flagellar setae dm4 which is situated just posterior to the level of dl1. In all other species dm4 is situated closer to dl3. Females are unknown.



Figures 18–20 *Apozomus eberhardi* sp. nov., holotype m: 21, flagellum, dorsal; 22, flagellum, ventral; 23, flagellum, lateral.

Description

Adult male

Colour yellow-brown. Propeltidium with 10 setae, arranged 2: 1: 2: 1: 2: 2; anterior margin drawn to a sharply downturned point between chelicerae; eye spots present. Mesopeltidia widely separated. Metapeltidium divided. Anterior sternum with 14 setae, including 2 sternapophysial setae; posterior sternum triangular, with 6 setae. Chaetotaxy of tergites I–IX: 2+4 (microsetae diagonal): 2+6 (microsetae in column): 1: 2: 2: 2: 2: 4: 6; segment XII with small dorsal process. Flagellum (Figures 18–20) without lateral processes or dorsal keels, posterior margin somewhat angular, seta dm4 situated slightly

posterior to dl1, seta vm5 situated somewhat medial between levels of vl1 and same level as vl2, dl1 slightly shorter and situated slightly medial than usual; 1.64 times longer than broad. Pedipalp: without apophyses; trochanter without sharply produced distal extension, ventral margin with stout setae, with mesal spur; tibia and tarsus lacking spines; tarsus with spurs; claw 0.44 length of tarsus. Chelicera: fixed finger with 2 large teeth plus 4 smaller teeth between these, basal tooth with 1 small, blunt, lateral tooth; brush at base of fixed finger composed of 11 setae, each densely pilose in distal half; lateral surface with 3 large, lanceolate, terminally pilose setae; movable finger file composed of 19 long lamellae, blunt guard tooth present subdistally, very large accessory

tooth present near subdistal end of file. Legs: tarsus I with 6 segments; femur IV 3.68 times longer than wide.

Dimensions (mm): Body length *ca.* 4.3. Propeltidium 1.31/0.76. Chelicera 1.01. Flagellum 0.46/0.28. Pedipalp: trochanter 0.70, femur 0.40, patella 0.67, tibia 0.66, tarsus 0.32, claw 0.14, total excluding claw 2.75. Leg I: trochanter 0.58, femur 2.00, patella 2.60, tibia 2.10, metatarsus 0.59, tarsus 0.87, total 8.74. Leg II: trochanter 0.31, femur 1.19, patella 0.68, tibia 0.90, metatarsus 0.66, tarsus 0.46, total 4.20. Leg III: trochanter 0.30, femur 1.05, patella 0.49, tibia 0.70, metatarsus 0.70, tarsus 0.49, total 3.73. Leg IV: trochanter 0.53, femur 1.62, patella 0.70, tibia 1.91, metatarsus 1.04, tarsus 0.64, total 6.44.

Remarks

Apozomus eberhardi is known from only a single male from Old Napier Downs Cave (KN-1).

Etymology

This species is named for Stefan Eberhard, who valiantly collected the sole specimen.

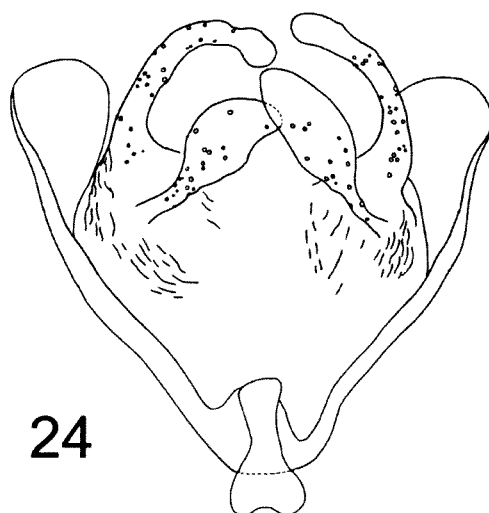
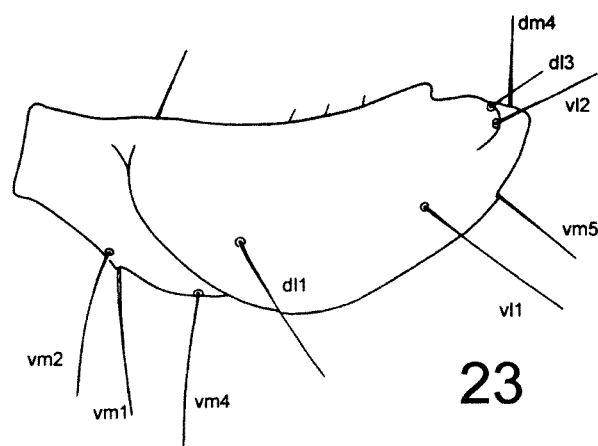
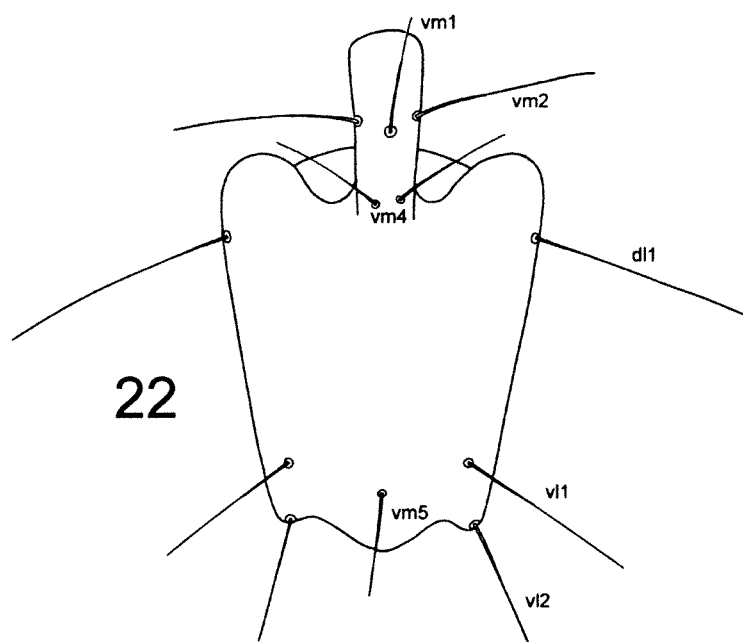
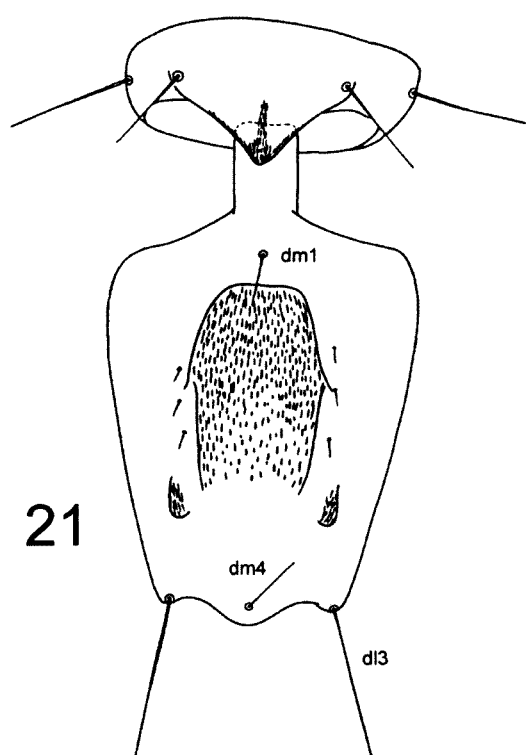
Apozomus howarthi sp. nov.

Figures 21–24

Material Examined

Holotype

♂, Tea Tree Cave, CH-43, Chillagoe, Queensland,



Figures 21–24 *Apozomus howarthi* sp. nov., 21–23, holotype m: 18, flagellum and segment XII, dorsal; 19, flagellum, ventral; 20, flagellum and segment XII, lateral; 24, paratype ♀, spermathecae, dorsal.

Australia, 17°10'S, 144°35'E, 24 June 1984, TT4C, F.G. Howarth (QM S52327 ex BPBM).

Paratypes

Australia: Queensland: 1 ♀, same data as holotype except TT5G, F.D. Stone (QM S52328 ex BPBM); 1 ♂, same data as holotype except 29 June 1984, TT28B, F.D. Stone, F.G. Howarth (BPBM); 1 ♂, same data as holotype except 2 July 1984, TT20C, F.G. Howarth (BPBM); 1 ♀, same data as holotype except under stone, 5 February 1996, E.S. Volschenk and D. Slaney (WAM T40642).

Diagnosis

Apozomus howarthi closely resembles *A. brignolii* from the Marshall Islands in the possession of a distinct dorsal process on segment XII, in the shape of the flagellum, and in the possession of dorsal flagellar keels, along with the presence of two pairs of spermathecae, the medial pair of which are enlarged. Males differ from *A. brignolii* by the shape of the flagellum in which the dorsal keels are more widely spaced; females differ from *A. brignolii* by the enlarged medial spermathecae. Females of *A. howarthi* also resemble those of *A. volschenki* from nearby Surprise Packet Cave, but they differ in the shape of the medial spermathecae.

Description

Adults

Colour dark yellow-brown. Propeltidium with 9 setae, arranged 2: 1: 2: 2: 2; anterior margin drawn to a sharply downturned point between chelicerae; eye spots present. Mesopeltidia widely separated. Metapeltidium divided. Anterior sternum with 15 (♂), 14 (♀) setae, including 2 sternapophysial setae; posterior sternum triangular, with 6 setae. Chaetotaxy of tergites I-IX: 2+4 (microsetae diagonal): 2+6 (microsetae in column): 2: 2: 2: 2: 2: 4: 6-7; segment XII of male with distinct dorsal process (Figures 21, 23); segment XII of female without dorsal process. Flagellum of male (Figures 21-23) with posterior margin rounded with 2 lateral rounded processes, dorsally with two small keels situated postero-laterally of a moderate dorsal depression; seta dm4 situated at distal end of flagellum, on same level as dl3; dl1 situated anteriorly, well forward of vl1; vl1 situated posteriorly; dm4 situated near posterior margin of flagellum, on same level as dl3; vm5 situated midway between vl1 and vl2; several pairs of small setae on dorsal surface; 1.56 times longer than broad. Flagellum of female 3 segmented, first segment slightly longer than second, third longest. Female genitalia (Figure 24): 4 spermathecae, each pair connected basally before connection with bursa; medial spermathecae enlarged, lateral spermathecae slightly enlarged distally, without

lobes; covered with small pores which are more abundant basally; small gonopod present, distally bifurcate. Pedipalps without apophyses; ventral trochanteral margin with very few stout setae, with mesal spur; tibia and tarsus lacking spines; tarsus with spurs; claw 0.39 (♂), 0.46 (♀) length of tarsus. Chelicera: fixed finger with 2 large teeth plus 4-5 smaller teeth between these, basal tooth with 1 small, blunt, lateral tooth; brush at base of fixed finger composed of 9-10 setae, each densely pilose in distal half; lateral surface with 3 large, lanceolate, terminally pilose setae; movable finger file composed of 19 (♂), 17 (♀) long lamellae, blunt guard tooth present subdistally, with 1 accessory tooth present near subdistal end of file. Legs: tarsus I with 6 segments; femur IV 3.41 (♂), 2.65 (♀) times longer than wide.

Dimensions (mm), holotype ♂ (paratype ♀): Body length 3.80 (4.00). Propeltidium 1.33/0.74 (1.31/0.81). Chelicera 0.97 (0.95). Flagellum 0.61/0.39 (0.34). Pedipalp: trochanter 0.58 (0.55), femur 0.57 (0.53), patella 0.57 (0.54), tibia 0.54 (0.50), tarsus 0.28 (0.26), claw 0.11 (0.12), total excluding claw 2.54 (2.38). Leg I: trochanter 0.55 (0.38), femur 1.89 (1.20), patella 2.45 (1.47), tibia 1.88 (1.11), metatarsus 0.49 (0.34), tarsus 0.70 (0.54), total 7.96 (5.04). Leg II: trochanter 0.26 (0.30), femur 1.09 (0.90), patella 0.63 (0.52), tibia 0.73 (0.60), metatarsus 0.61 (0.49), tarsus 0.46 (0.39), total 3.78 (3.20). Leg III: trochanter 0.29 (0.26), femur 0.96 (0.78), patella 0.41 (0.40), tibia 0.54 (0.40), metatarsus 0.61 (0.52), tarsus 0.49 (0.41), total 3.30 (2.77). Leg IV: trochanter 0.52 (0.35), femur 1.57 (1.22), patella 0.73 (0.55), tibia 1.23 (0.90), metatarsus 1.03 (0.78), tarsus 0.63 (0.49), total 5.71 (4.29).

Remarks

Apozomus howarthi has only been collected in Tea Tree Cave, situated near Chillagoe, northern Queensland. It appears to lack any morphological modifications to the cave environment, despite being collected from a cave.

Etymology

This species is named for Frank Howarth, collector of some of the type specimens, in recognition of his research into the Chillagoe cave systems.

Apozomus volschenki sp. nov.

Figure 25

Material Examined

Holotype

♀, near entrance to Surprise Packet Cave, Chillagoe, Queensland, Australia, 17°17'S, 144°25'E, under stones, 6 February 1996, E.S. Volschenk and D. Slaney (QM S52329).

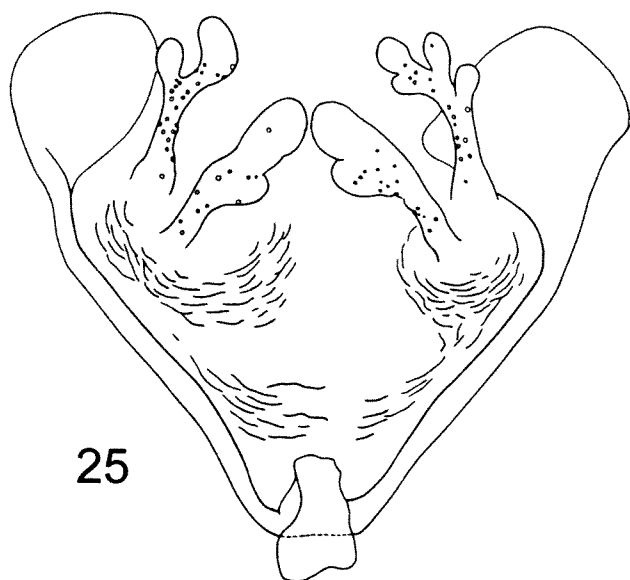


Figure 25 *Apozomus volschenki* sp. nov., holotype ♀, spermathecae, dorsal.

Other Material (non-types)

Australia: Queensland: 3 juveniles, same data as holotype (QM S52330).

Diagnosis

Females differ from those of *A. howarthi* by the bifurcate median spermathecae and the lobate lateral spermathecae. Males are unknown.

Description

Adult female

Colour yellow-brown. Propeltidium with 9 setae, arranged 2: 1: 2: 2: 2; anterior margin drawn to a sharply downturned point between chelicerae; eye spots present. Mesopeltidia widely separated. Metapeltidium divided. Anterior sternum with 15 setae, including 2 sternapophysial setae; posterior sternum triangular, with 6 setae. Chaetotaxy of tergites I-IX: 2+4 (microsetae diagonal): 2+6 (microsetae in column): 2: 2: 2: 2: 2: 4: 6; segment XII without dorsal process. Flagellum 3 segmented, first segment slightly longer than second, third longest. Genitalia (Figure 25): 4 spermathecae, each pair connected basally before connection with bursa; medial spermathecae enlarged and with sub-basal lobe, lateral spermathecae with several lobes; covered with small pores; small gonopod present, distally slightly bifurcate. Pedipalp: without apophyses; trochanter without sharply produced distal extension, ventral margin with stout setae, with mesal spur; tibia and tarsus lacking spines; tarsus with spurs; claw 0.32 length of tarsus. Chelicera: fixed finger with 2 large teeth plus 4 smaller teeth between these, basal tooth with 1 small, blunt, lateral tooth; brush at base of fixed

finger composed of 7 setae, each densely pilose in distal half; lateral surface with 3 large, lanceolate, terminally pilose setae; movable finger file composed of 16 long lamellae, blunt guard tooth present subdistally, large accessory tooth present near middle of file. Legs: tarsus I with 6 segments; femur IV 2.79 times longer than wide.

Dimensions (mm): Body length *ca.* 4.4. Propeltidium 1.30/0.79. Chelicera 0.93. Flagellum 0.38. Pedipalp: trochanter 0.60, femur 0.56, patella 0.56, tibia 0.52, tarsus 0.38, claw 0.12, total excluding claw 2.06. Leg I: trochanter 0.41, femur 1.39, patella 1.68, tibia 1.30, metatarsus 0.38, tarsus 0.57, total 5.73. Leg II: trochanter 0.19, femur 0.93, patella 0.54, tibia 0.64, metatarsus 0.52, tarsus 0.41, total 3.23. Leg III: trochanter 0.26, femur 0.84, patella 0.41, tibia 0.46, metatarsus 0.55, tarsus 0.41, total 2.93. Leg IV: trochanter 0.44, femur 1.31, patella 0.61, tibia 0.99, metatarsus 0.57, tarsus 0.49, total 4.41.

Remarks

Despite the close proximity of Surprise Packet Cave to Tea Tree Cave, the differences between the female genitalia of *A. volschenki* and *A. howarthi* appear to be sufficient to regard them as different species. *Apozomus volschenki* appears to lack any morphological modifications to the cave environment, despite being collected from a cave.

Etymology

This species is named for Erich Volschenk, one of the collectors of the type specimens.

Unidentified juveniles

Material Examined

Australia: Queensland: 1 juvenile, Barkers Cave, Rosella Plains Station, Mt Surprise [18°15'S, 114°30'E], dark zone, 600 m, 23 May 1985, F.G. Howarth, F.D. Stone, D. Irwin (BPBM); 1 juvenile, Kiwi Cave, Chillagoe [17°10'S, 144°25'E], 5 February 1996, under stone, E. Volschenk (WAM); 1 juvenile, entrance of Kiwi Cave, Chillagoe [17°10'S, 144°25'E], 7 February 1996, under stone, E. Volschenk (WAM); 1 juvenile, Rope Ladder Cave, Fanning River Station, Mingela, 19°45'S, 146°28'E, 18 April 1995, E.S. Volschenk (WAM); 1 juvenile, Spring Cave, CH-12, Chillagoe, 19 March 1997, F.D. Stone (WAM). **Western Australia:** 1 juvenile, Nefetiti's Palace Cave, KNI-41, 15°11'S, 128°38'E, 20 June 1994, R.D. Brooks (WAM, BES 3190); 1 juvenile, Ningbing Range, KNI-19, 15°18'S, 128°37'E, 5 June 1994, R.D. Brooks (WAM, BES 2992).

Remarks

It is not possible to identify these juveniles to generic or species level, but it is possible that many

of them represent undescribed species of either *Apozomus* or *Bamazomus*. The two specimens from Western Australia were found in giant grikes within the limestone substrate which are intermittently open to the air (W.F. Humphreys, personal communication).

DISCUSSION

The cavernicolous schizomid fauna of Australia is now known to consist of 11 species, including four species of *Draculoides*, three *Bamazomus*, three *Apozomus* and one *Attenuizomus*. However, the degree of specialization which can be attributed to the cave environment differs between species. Each of the *Draculoides* species are the most specialized, with large body sizes, long legs and a complete lack of eye spots. *Bamazomus vespertinus* and *B. subsolanus* also lack eye spots, and males of both species possess enlarged pedipalps which are quite different to that of the females. Yet one specimen of *B. subsolanus* was taken from "under rock on surface in swirl hole", indicating that some contact with the surface by at least some specimens of this species. *Apozomus eberhardi* and *B. huntii* possess eye spots, and it is possible that they inhabit sheltered environments within the gorges which abound in the Oscar and Napier Ranges. Similarly, *Apozomus howarthi*, *A. volschenki* and *Attenuizomus cuttcutta* appear to lack any specializations for the cave environment, with full retention of eye spots, and seemingly unmodified appendages. Indeed, the only known specimens of *Apozomus volschenki* were taken from near the entrance of Surprise Packet Cave, and it is possible that these three species may eventually be found in suitable mesic surface environments.

The discovery of further populations of schizomids from caves in both northern Western Australia and northern Queensland indicates that more species await description. Unfortunately, adults are not yet available from these sites.

ACKNOWLEDGEMENTS

I am deeply grateful to Bill Humphreys of the Western Australian Museum for the vast number of interesting creatures he regularly dispatches into my office. I am also indebted to Brenton Knott (University of Western Australia), Sabina Swift (Bernice P. Bishop Museum) and Erich Volschenk (Curtin University of Technology) for access to the remaining specimens described in this paper.

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