

# The millipede genus *Antichiropus* (Diplopoda: Polydesmida: Paradoxosomatidae), part 2: species of the Great Western Woodlands region of Western Australia

Catherine A. Car<sup>1,3</sup> and Mark S. Harvey<sup>1,2</sup>

<sup>1</sup> Department of Terrestrial Zoology, Western Australian Museum, Locked Bag 49, Welshpool DC, Western Australia 6986, Australia.

<sup>2</sup> Research Associate, Division of Invertebrate Zoology, American Museum of Natural History, New York, U.S.A.; Research Associate, Department of Entomology, California Academy of Sciences, San Francisco, California, U.S.A.; School of Animal Biology, University of Western Australia, Crawley, Western Australia 6009, Australia; School of Natural Sciences, Edith Cowan University, Joondalup, Western Australia 6027, Australia.

<sup>3</sup> Corresponding author: catherine.ann.car@gmail.com

**ABSTRACT** – The species of the millipede genus *Antichiropus* found in the Great Western Woodlands region of southern Western Australia are reviewed, and 30 new species are described. The new species are: *A. alastairi*, *A. alatus*, *A. anconus*, *A. axicius*, *A. baudini*, *A. buchanoorum*, *A. cavernus*, *A. cincinnus*, *A. cuspis*, *A. digitatus*, *A. equinus*, *A. exclamatus*, *A. framenau*, *A. giganteus*, *A. howardi*, *A. incomptus*, *A. inflatus*, *A. inopinatus*, *A. kealleyi*, *A. lacustrinus*, *A. laticlavus*, *A. nadineae*, *A. paracalothamnus*, *A. rex*, *A. sagittulus*, *A. saxatilis*, *A. serratus*, *A. simpulus*, *A. succedaneus* and *A. westi*. This raises the number of known species in the genus to 39, with most of the new species having ranges less than 10,000 km<sup>2</sup>, thus qualifying as short-range endemics.

**KEYWORDS:** new species, taxonomy, biodiversity, short-range endemics

## INTRODUCTION

The Great Western Woodlands is unique because it is the largest area of relatively undisturbed Mediterranean climate woodlands in the world, occupying c. 160,000 km<sup>2</sup> in the south west region of Western Australia (Watson et al. 2008) (Figure 1). The region supports extraordinary species richness and may be considered a so-called biodiversity ‘hotspot’. Field studies have shown that although insects and arachnids are the most numerous and diverse of the invertebrate groups in the area, millipedes, and in particular, species belonging to the paradoxosomatid genus *Antichiropus* Attems, 1911, are a remarkably diverse group in the region.

The taxonomic history of the genus *Antichiropus* is surprisingly short (Nguyen and Sierwald 2013). The genus was described by Attems (1911) for seven species collected in southwestern Australia by W. Michaelsen and R. Hartmeyer during the Hamburger südwest-australischen Forschungsreise of 1905. The descriptions and the accompanying illustrations of the gonopods

were quite detailed, and sufficient to recognise each taxon. Verhoeff (1924) added the subgenus *Antichiropus* (*Solaenodolichopus*) (spelled *Solänodolichopus*) for three Queensland taxa, *A. (S.) teres* Verhoeff, 1924, *A. (S.) vittatus* Verhoeff, 1924, and *A. (S.) vittatus dorsalis* Verhoeff, 1924, but *Solaenodolichopus* was later recognised as a distinct genus by Verhoeff (1928). Another subgenus, *Antichiropus* (*Haplochiropus*) was proposed by Attems (1944) for *A. (H.) pustulosus* Attems, 1944 from New Guinea, but it too was raised to generic level by Jeekel (1968).

The next *Antichiropus* species wasn’t described until nearly 70 years after Attems’ pioneering work, with the establishment of *A. mammillifer* Jeekel, 1982 from the Eyre Peninsula, in South Australia (Jeekel 1982). This was followed a decade later by *A. humphreysi* Shear, 1992 from cave habitats in North West Cape, Western Australia (Shear 1992). The most recent publication – the first part of this series – included a new diagnosis of the genus and redescriptions of the nine previously named species (Car et al. 2013).

Despite the fact that, to date, only nine species have been formally described, the genus has been extensively collected and examined, and is known to consist of c. 160 species, ranging across most of Western Australia south of the Kimberley region, from 22° to 33°S and from 117° to 127°E. This paper describes 30 new species of the genus *Antichiropus*, from the Great Western Woodlands region, and the area between its southern boundary and the south coast of Western Australia: the named fauna of the genus is thus increased to 39 species.

## MATERIALS AND METHODS

All material examined for this study is preserved in 75% ethanol and lodged in the Western Australian Museum, Perth, Australia (WAM). Specimens were examined with Leica MZ6 and MZ16A stereo microscopes and the images generated with a Leica MZ16A automontage imaging system using Leica Application Suite Version 3.7.0 software. The method of image capture follows that of Car et al. (2013): images of whole specimens were generally captured first and then various body parts were removed for further imaging. As before, a set of images of each gonopod from four orientations was captured but, in this study, there are additional images for some species showing detail of

the solenomere tip. Usually the holotype or paratype material was used to generate images. Descriptions were compiled with the software package DELTA (Dallwitz et al. 1999). Car et al. (2013) published a revised description of the genus *Antichiropus* in part 1 of this series: characters that define the genus are, therefore, excluded from species' descriptions, unless the characters of the species under consideration differ from the general generic description. The maps were generated with ArcMap version 9.3 (ESRI Inc.).

## GONOPOD MORPHOLOGY

The labelling of the processes on the gonopod follows that adopted by Car et al. (2013) and, as before, has been undertaken for convenience, and not to suggest homologies with podomeres. For clarity, labelling has been standardized across all species in the genus. With this in mind, we have decided to re-label what was called the prolongation of the femur (prof) on *A. mammillifer* Jeekel, 1982 in Car et al. (2013) as a femoral process (fp1) separate from the main femoral process, in an attempt to simplify the comparison of *A. mammillifer* with other similar species from the Great Western Woodlands. If the prolongation of the femur is present, it occurs as an upright, pointed structure on the femorite

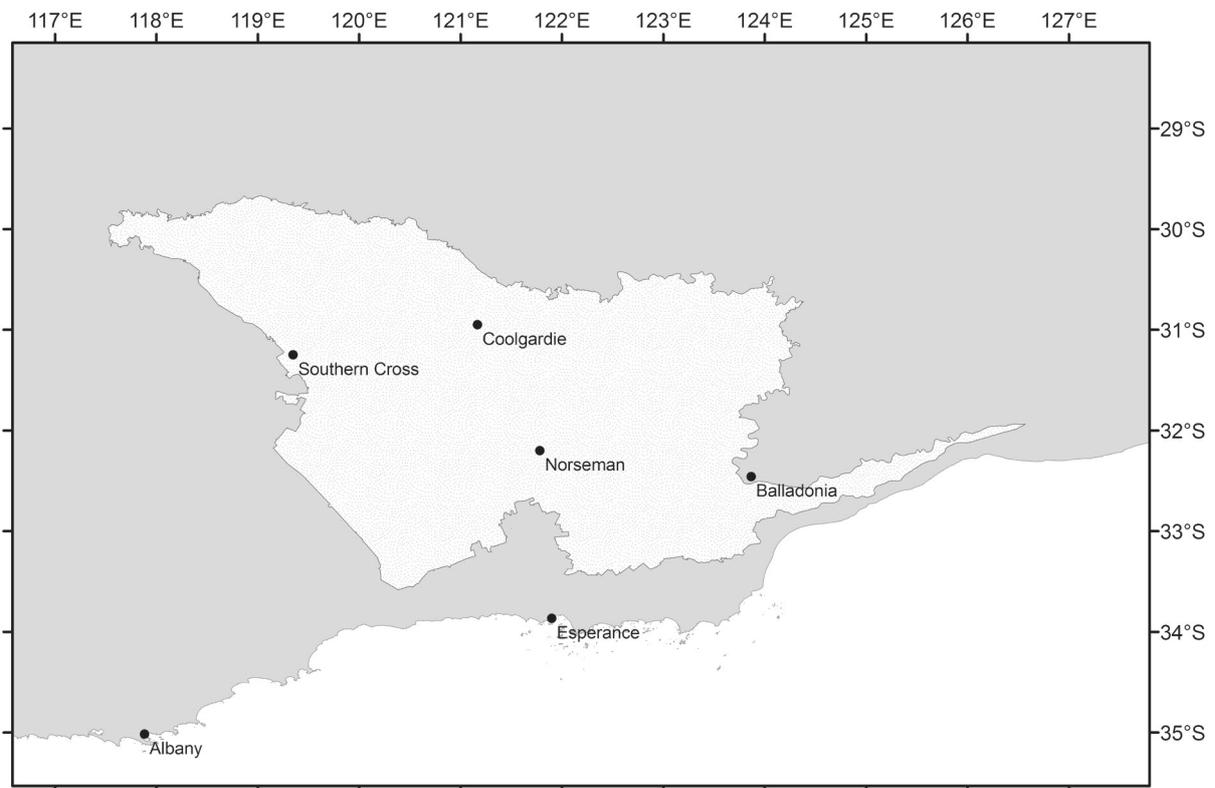
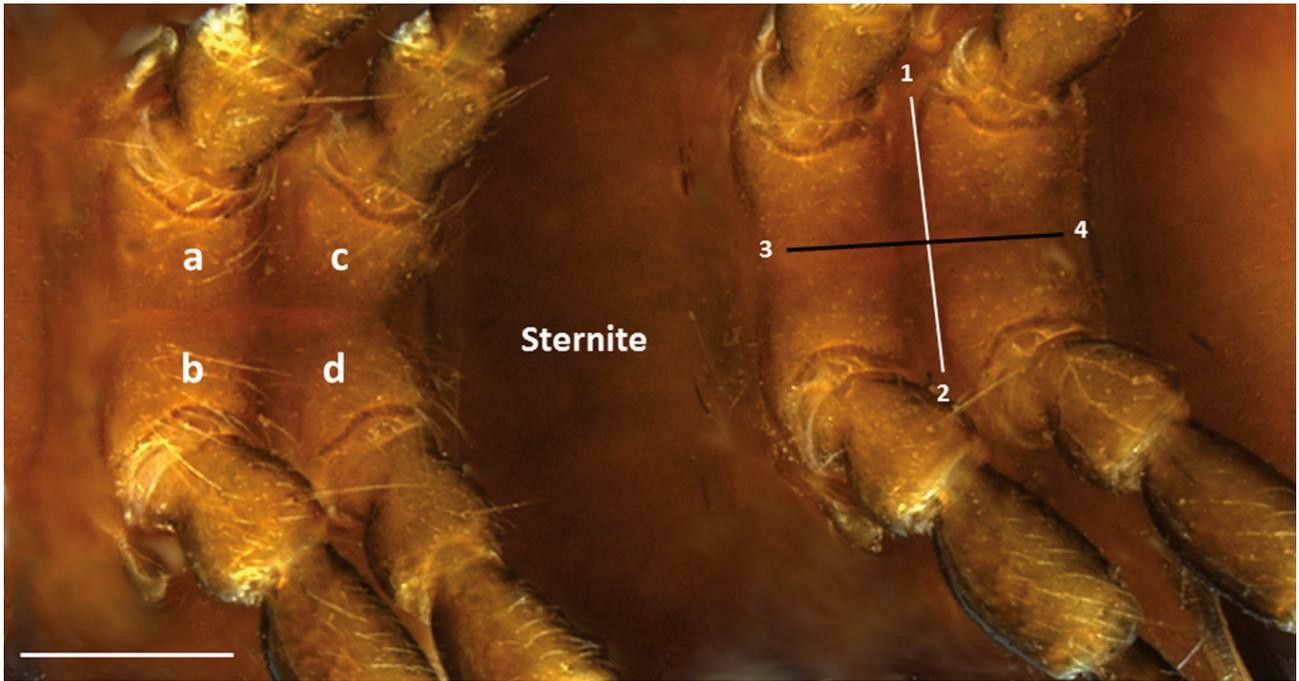
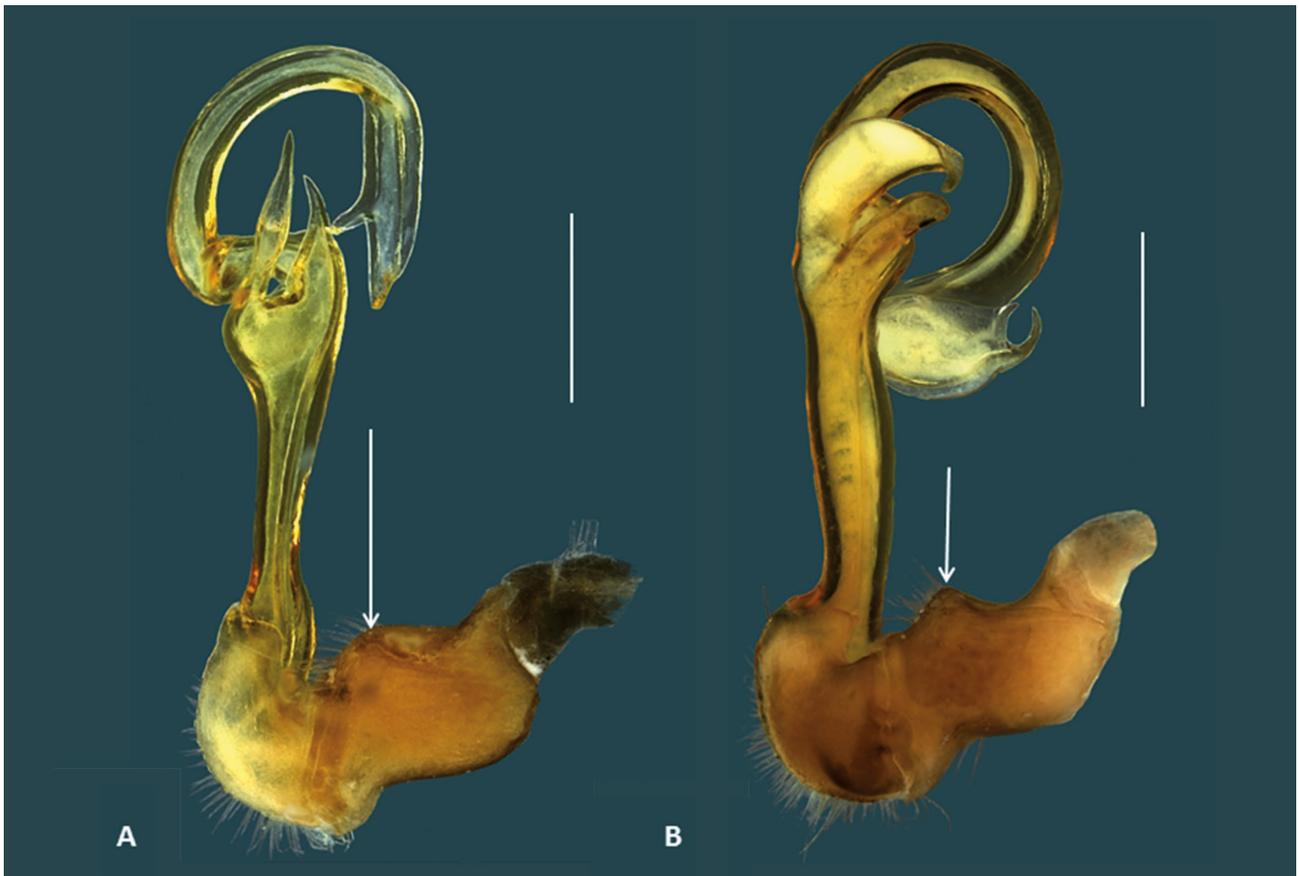


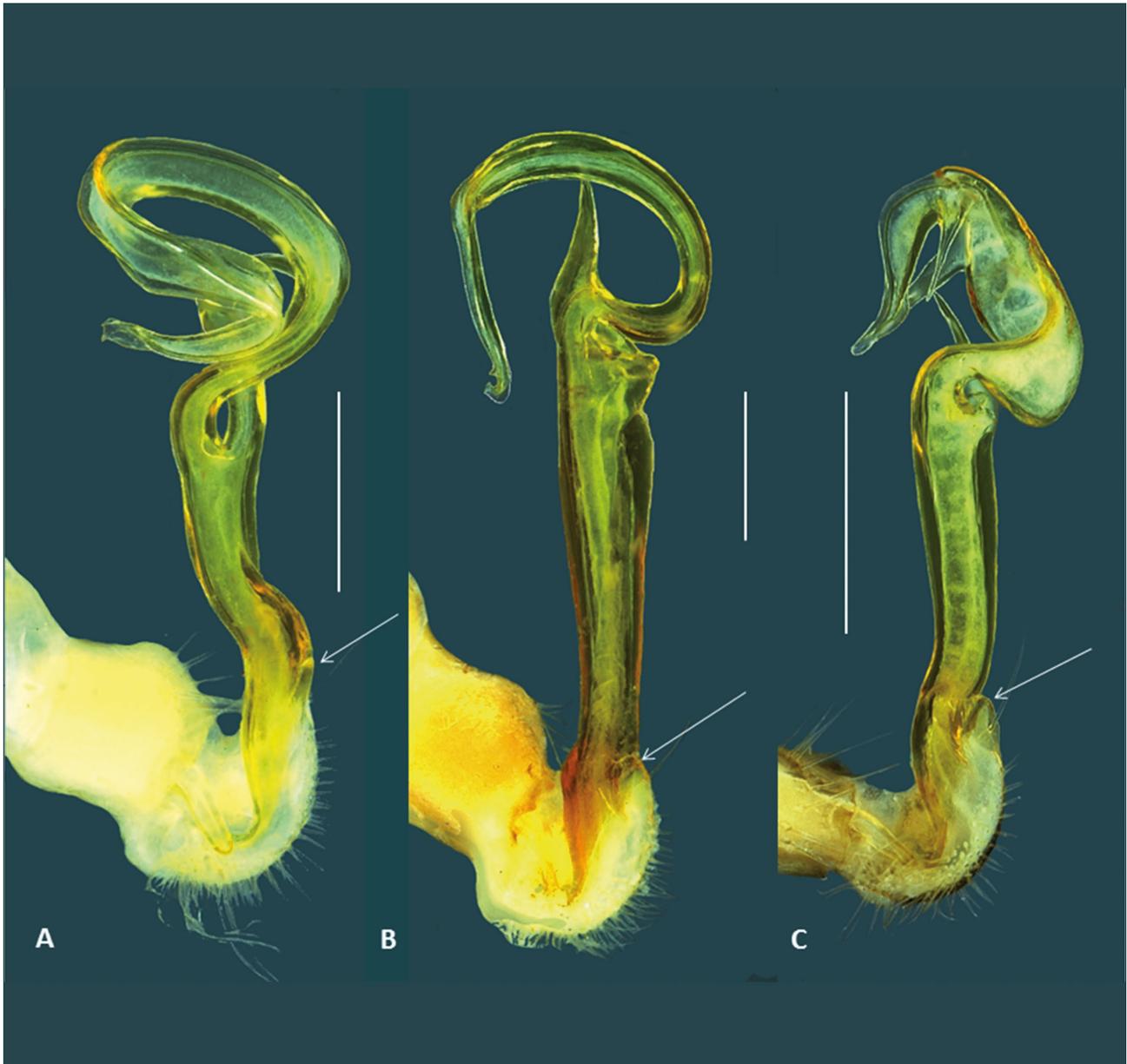
FIGURE 1 The Great Western Woodlands region of Western Australia.



**FIGURE 2** Midbody sternites of *Antichiropus exclamatus* sp. nov. (WAM T112932) showing cross impressions. Abbreviations: a–d, coxae of two pairs of legs. Line 1–2 transverse cross impression; line 3–4 longitudinal cross impression. Scale bar = 0.5 mm.



**FIGURE 3** Lateral view of the left gonopods of two different *Antichiropus* species showing the coxal ridge on each (indicated by arrows): A, *Antichiropus axicius* sp. nov. (WAM T71835); B, *A. cavernus* sp. nov. (WAM T72020). Scale bars = 0.5 mm.



**FIGURE 4** Medial view of the left gonopods of three different *Antichiropus* species showing the prefemoral lip on each (indicated by arrows): A, *Antichiropus cincinnus* sp. nov. (WAM T72055) showing virtually no lip; B, *A. alastairi* sp. nov. (WAM T42304) showing slight lip; C, *A. buchanorum* sp. nov. (WAM T115034) showing noticeable lip. Scale bars = 0.5 mm.

apex, just basal to the gonopod bending at right angles into the solenomere: the prof is best seen in medial view. It must be also noted that, as before, the main femoral process (MFP) is not numbered. Subsequent femoral processes are numbered fp1, fp2 etc. Thus, what is referred to in the text as fp1 is called the second femoral process.

It is also often difficult to decide how many processes are present on the solenomere of any species, particularly at the solenomere tip, where damage from

mating or from collecting of specimens is common. There may be differing views on what constitutes a ‘process’ on the solenomere, but again, we have identified processes solely to assist with species identification and separation and, as before, have numbered them from solenomere tip to base.

For a full explanation of the labelling of the gonopods and explanatory diagrams of body parts refer to Car et al. (2013). In this paper, we have added a comparison of the distance between antennal sockets with the

widest part of the millipede face. We have also included explanatory diagrams of the following characters: sternal cross impressions (Figure 2); the gonopodal coxal ridge (Figure 3) as compared with the species *Antichiropus humphreysi* Shear, which has a prominent ridge (Shear 1992); and the gonopodal prefemoral lip (Figure 4). We have also added two more labels to those already used in identifying gonopod parts: stip = solenomere tip; and serr = serrations on the gonopod.

Females could only be identified positively as the same species as males in any area if they were collected with those males.

## TAXONOMY

### Order Polydesmida Pocock, 1887

### Suborder Strongylosomatidea Brölemann, 1916

### Family Paradoxosomatidae Daday, 1889

### Tribe Antichiropodini Brölemann, 1916

### Genus *Antichiropus* Attems, 1911

*Antichiropus* Attems 1911: 168.

#### TYPE SPECIES

*Antichiropus variabilis* Attems, 1911, by subsequent designation of Brölemann (1916).

#### DIAGNOSIS

See Car et al. (2013).

#### REMARKS

The new species described in this paper conform quite closely to the diagnosis of the genus *Antichiropus* recently presented by Car et al. (2013), and no change to the diagnosis is necessary.

### *Antichiropus alastairi* sp. nov.

Figures 4B, 5, 35

<http://www.zoobank.org/urn:lsid:zoobank.org:act:03ECB41F-EBC4-4463-9A78-1511F2266589>

#### MATERIAL EXAMINED

##### *Holotype*

**Australia: Western Australia:** ♂, Askew Road, site BE 6, 30°35'46"S, 117°54'28"E, 15 September 1998–8 April and 25 October 1999, wet pitfall traps, L. King (WAM T71834).

##### *Paratypes*

**Australia: Western Australia:** 1 ♂, Bunce Bin, 2 km N of Beacon, 30°27'S, 117°52'E, 28 June–26 July 1985, pitfall trap, B.Y. Main (WAM T42304).

#### *Other material*

**Australia: Western Australia:** 1 ♀, 2 juveniles, Mungarri Nature Reserve North, Beacon, site BE 12, 30°19'51"S, 117°45'12"E, 15 September 1998–8 April and 25 October 1999, P. Van Heurck (WAM T71863).

#### DIAGNOSIS

Gonopod: *Antichiropus alastairi* is similar to *A. framenau* and *A. alatus* because each has an elongate ribbon-like solenomere carrying a small short process near its tip, and a long pointed second process in the apical third (Figures 5, 6 and 17). In addition, each has a conspicuous, large, pointed prolongation of the femorite. *A. alastairi* can, however, be distinguished by a relatively slender femorite and the irregular shape of the main femoral process (Figures 5C, D).

#### DESCRIPTION

##### *Male holotype*

Body c. 20 mm long; midbody ring c. 2 mm wide, with distinct waist, prozonite and metazonite of similar width. Colour chestnut brown overall (Figure 5A); leg colour as for body. No paranota on posterior rings (Figure 5B). Sternites without obvious processes/tubercles, sternal lamella broad, square. Anterior spiracles at midbody flat, folded. Head smooth, without noticeable sculpturing; frons smooth, with some setae; face broad, cheeks at least partially obscuring cardines when viewed face-on, maximum width c. 3.4 x the distance between antennal sockets; sockets separated by c. 2 x width of socket. Antennae of moderate length, reaching to ring 2, not obviously clavate, antennomeres 5 and 6 only slightly wider than proximal ones and relatively slender. Collum 1 x as long as head (in lateral view) (Figure 5A). Gonopod of medium length, reaching posterior edge of ring 5; coxa (C) similar in length to but more robust and thicker than femorite, with slight ridge on anterior surface; prefemur (PF) considerably shorter than femorite, ovoid, appearing to hug femorite base; femorite (F) c. 2/3 of acropodite length in situ, upright, becoming thicker towards apex; main femoral process (MFP) long (to c. 1/4 solenomere length), pointed, but not spine-like, irregularly shaped with a sharp point; second femoral process (fp1) absent; prolongation of femorite apex (prof) present, mainly upright, long, slender and sharply pointed; solenomere (S) long, forming >1 loop/circle, much more slender than femorite, and stoutest in basal half; solenomere tip with single flattened end and no serrations; solenomere process (sp1) near solenomere tip, small, pointed, upright, slender; second solenomere process (sp2) positioned c. halfway along solenomere, prominent, pointed (Figures 5C–F).

*Female*

The female specimen cannot positively be identified as *A. alastairi* as it was collected from a slightly different locality. It seems likely, however, that it is *A. alastairi* because it was collected very close by, is similar in colour to the male (chestnut brown) and of similar length, but slightly broader (c. 3 mm) when viewed dorsally (WAM T71863).

## DISTRIBUTION

This species is known only from the Beacon area of the Great Western Woodlands (Figure 35).

## ETYMOLOGY

This species is named in honour of Alastair Buchan, a person deeply dedicated to environmental protection.

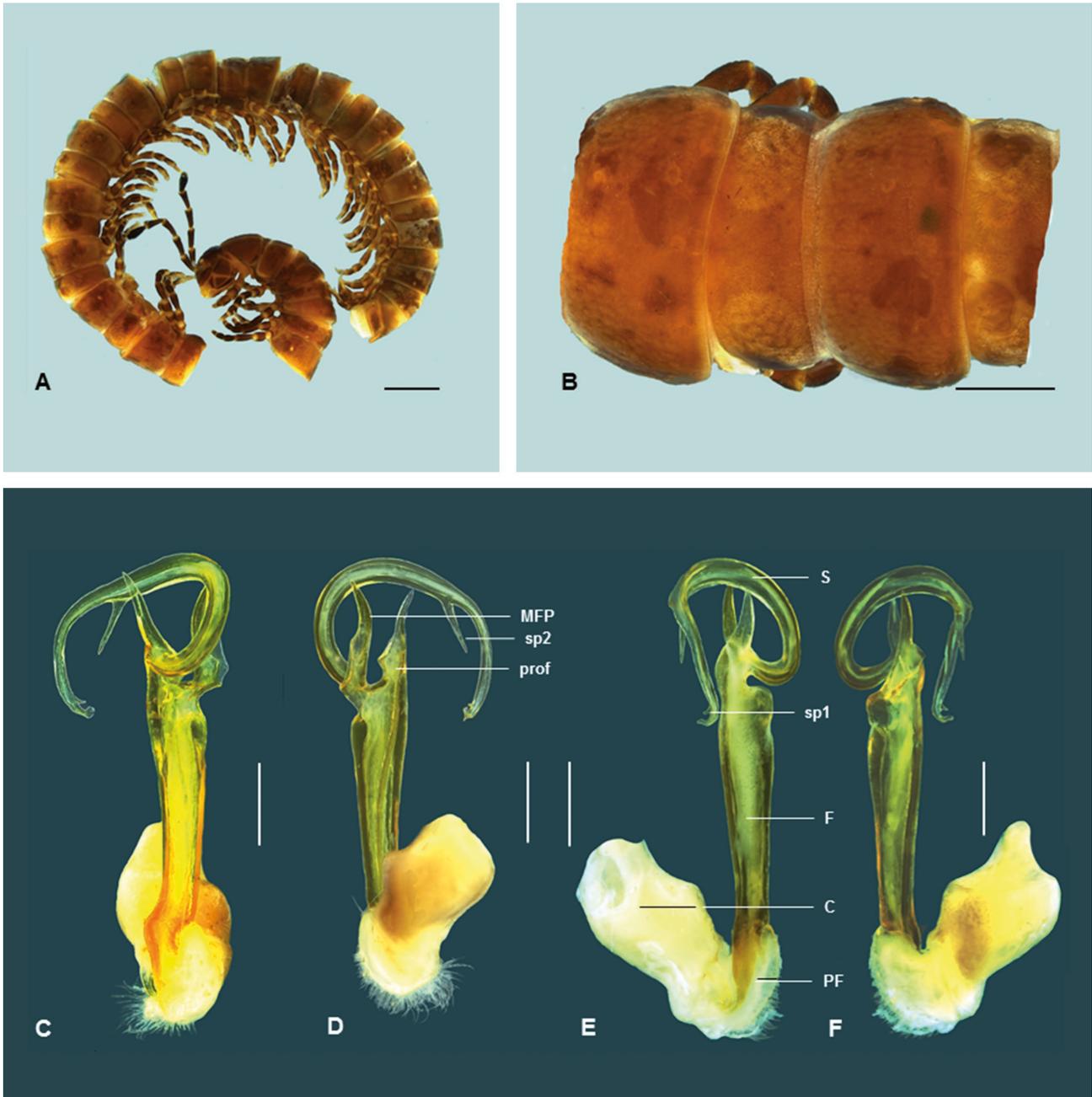


FIGURE 5

*Antichiropus alastairi* sp. nov.: A–B, paratype male (WAMT42304) habitus: A, lateral view; B, dorsal view; C–D, paratype male (WAMT42304), left gonopod: C, posterior view; D, anterior view; E–F, holotype male (WAMT71834); E, medial view; F, lateral view. Abbreviations: C, coxa; F, femorite; MFP, main femoral process; PF, prefemur; prof, prolongation of femorite; S, solenomere; sp1 and sp2, solenomere processes 1 and 2. Scale bars: A = 2 mm; B = 1 mm; C–F = 0.5 mm.

***Antichiropus alatus* sp. nov.**

Figures 6, 35

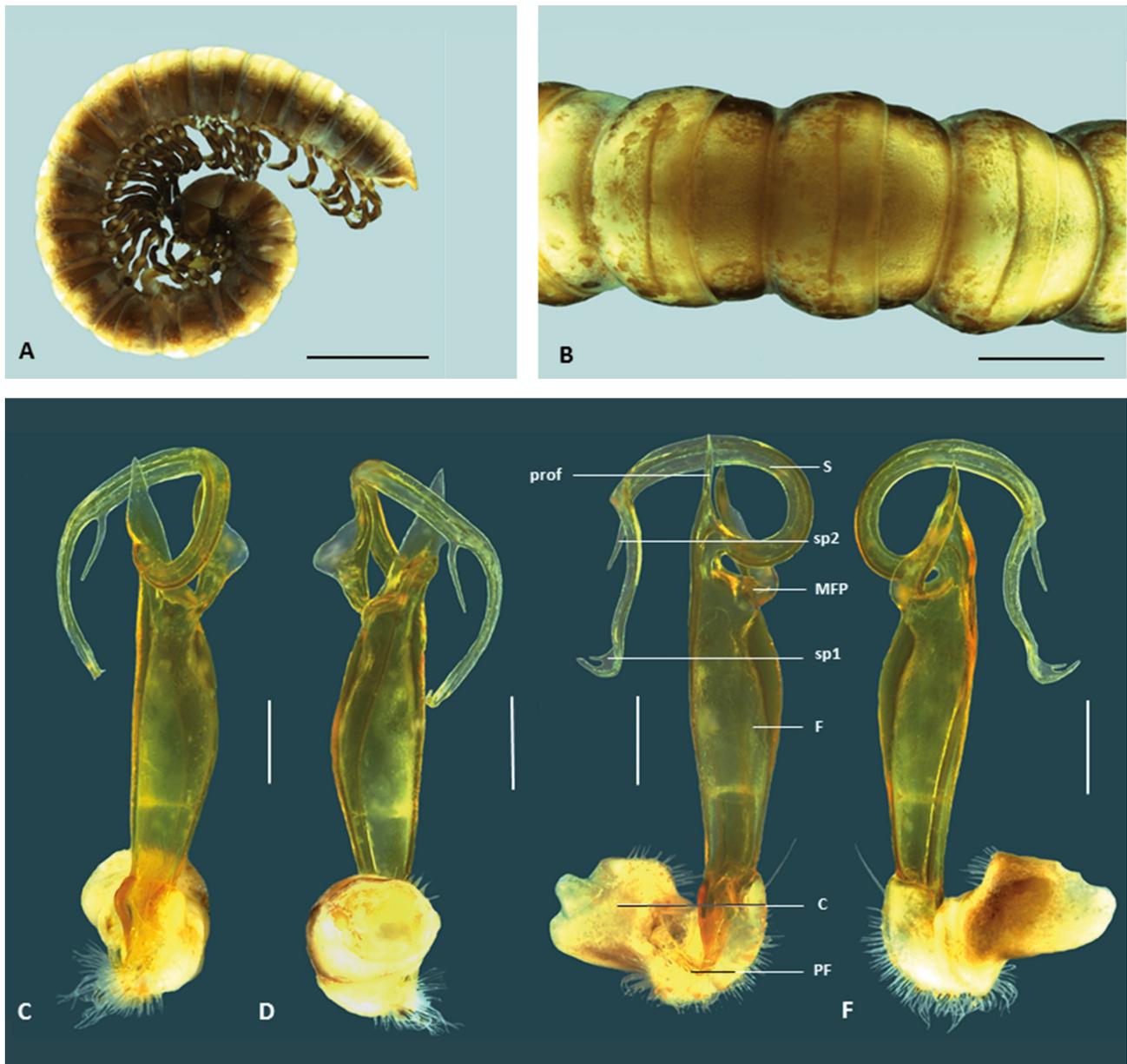
<http://www.zoobank.org/urn:lsid:zoobank.org:act:ED207C3C-DB56-4A24-81D3-5BAF140B679D>

**MATERIAL EXAMINED****Holotype**

**Australia: Western Australia:** ♂, Mt Gibson Station, site 6, 29°43'35"S, 117°18'28"E, 20–31 August 2001, dry pitfall traps, bowgada/*Melaleuca* shrubland on deep red sands, Biological Survey (WAM T65516).

**Paratypes**

**Australia: Western Australia:** 1 ♂, 1 ♀, Mt Gibson Station, site 9, 29°41'13"S, 117°21'37"E, 20–31 August 2001, dry pitfall traps, mallee woodland on rocky red loamy clay, Biological Survey (WAM T65500); 1 ♂, Mt Gibson Station, site B, 29°41'58"S, 117°24'11"E, 20–31 August 2001, dry pitfall traps, mallee woodland on white sandy clay, Biological Survey (WAM T65517); 1 ♂, 1 ♀, Mt Gibson Station, site 10, 29°41'07"S, 117°23'43"E, 20–31 August 2001, dry pitfall traps, York gum woodland on red loamy clay, Biological Survey (WAM T65518).

**FIGURE 6**

*Antichiropus alatus* sp. nov.: paratype male (WAM T65500) habitus: A, lateral view; B, dorsal view; C–F, left gonopod: C, posterior view; D, anterior view; E, medial view; F, lateral view. Abbreviations: C, coxa; F, femorite; MFP, main femoral process; PF, prefemur; prof, prolongation of femorite; S, solenomere; sp1 and sp2, solenomere processes 1 and 2. Scale bars: A = 5 mm; B = 2 mm; C–F = 0.5 mm.

*Other material*

**Australia: Western Australia:** 1 ♂, Mt Gibson Station at 29°37'12"S, 117°10'24"E, 27 September 2001, dead on ground, M.S. Harvey and B.Y. Main (WAM T65525); 1 ♂, Mt Gibson Station at 29°36'38"S, 117°10'53"E, 27 September 2001, dead on ground, M.S. Harvey and B.Y. Main (WAM T65526); 1 ♂, Mt Gibson iron ore mine at 29°35'59"S, 117°11'51"E, 10 May 2005, M.S. Harvey and S. Thompson (WAM T65527); 1 ♂, Mt Gibson iron ore mine at 29°34'33"S, 117°09'38"E, 9 May 2005, under rock, M.S. Harvey and S. Thompson (WAM T65528); 1 ♂, 1 ♀, 1 juvenile, Mt Gibson iron ore mine at 29°34'33"S, 117°09'38"E, 10 May 2005, under rock, M.S. Harvey and S. Thompson (WAM T65529); 1 ♂, Mt Gibson iron ore mine, banded ironstone ridge, Extension Hill west facing, 29°34'33"S, 117°09'38"E, 31 May–11 June 2005, wet pitfall traps, S. Thompson (WAM T65532); 1 ♂, Mt Gibson iron ore mine, banded ironstone ridge, Extension Hill west facing, 29°35'43"S, 117°11'14"E, 1–11 June 2005, wet pitfall traps, S. Thompson (WAM T65534); 1 ♂, Mt Gibson iron ore mine, ironstone slopes, Extension Hill, east facing, 29°34'32"S, 117°09'49"E, 1–11 June 2005, wet pitfall traps, S. Thompson (WAM T65538); 1 ♂, 3 juveniles, Mt Gibson Station, 29°26'18.4"S, 117°10'23.1"E, 21 August 2001, A. Baynes and R.D. Foster (WAM T73425); 1 ♂, 1 ♀, 2 juveniles, Mummaloo, c. 76 km NE. of Wubin, 29°40'16.00"S, 117°13'40.50"E, 4 July 2012, hand foraging, *Eucalyptus* and *Acacia* leaf litter, M.K. Curran and S.R. Bennett (WAM T125761).

## DIAGNOSIS

Gonopod: *Antichiropus alatus* is most similar to *A. alastairi* and *A. framenau*, but *A. alatus* can be recognised by the very stout, almost urn-shaped femorite (Figures 6C–F), the very long slender solenomere (Figures 6E, F) and by far the most robust and longest prolongation of the femorite, arising from a thick base (Figures 6C–F). The main femoral process is distinctly hatchet-shaped when viewed anteriorly (Figure 6D).

## DESCRIPTION

*Male holotype*

Body c. 25 mm long; midbody ring c. 2.5 mm wide, with less pronounced waist, prozonite and metazonite of similar width. Colour chestnut brown overall (Figure 6A), with broad pale dorsal stripe running full length of body (Figure 6B); leg colour as for body. No paranota on posterior rings. Sternites without obvious processes/tubercles, sternal lamella broad, square. Anterior spiracles at midbody flat, erect. Head smooth, without noticeable sculpturing; frons smooth, with some setae; face narrow, the cardines and stipites clearly visible when the animal is viewed face-on, maximum width c. 3 x the distance between antennal sockets; sockets separated by c. 2 x width of socket. Antennae of moderate length, reaching to ring 2, not obviously clavate, antennomeres 5 and 6 only slightly wider than

proximal ones and relatively robust. Collum 1 x as long as head (in lateral view). Gonopod of medium length, reaching posterior edge of ring 5; coxa (C) similar in thickness to but shorter than femorite, with noticeable ridge on anterior surface; prefemur (PF) considerably shorter than femorite, ovoid, appearing to hug femorite base; femorite (F) c. 2/3 of acropodite length in situ, upright, thickest midway along its length, becoming slightly thinner towards its apex; main femoral process (MFP) stout and long (to c. 1/4 solenomere length), pointed, but not spine-like, broadly hatchet-shaped but with extended apex; second femoral process (fp1) absent; prolongation of femorite apex (prof) present, broad at base, long and pointed; solenomere (S) very long, extending in situ to 1/2 acropodite length, much more slender than femorite, generally tapering towards tip; solenomere tip with single slightly flattened end and no serrations; solenomere process (sp1) near solenomere tip, small, pointed, upright; second solenomere process (sp2) positioned c. halfway along solenomere, prominent, pointed, long and slender (Figures 6C–F).

*Female*

Of similar colour and general appearance to the male but slightly broader (c. 3 mm) when viewed dorsally (WAM T65500).

## DISTRIBUTION

This species has been collected only from Mt Gibson Station (Figure 35).

## ETYMOLOGY

This species' name refers to the greatly enlarged prolongation of the femorite on the male gonopod (Latin, adjective, *alatus*, winged).

***Antichiropus anconus* sp. nov.**

Figures 7, 35

<http://www.zoobank.org/urn:lsid:zoobank.org:act:FFB4C798-E678-4518-AE29-2849AEF77EF4>

## MATERIAL EXAMINED

*Holotype*

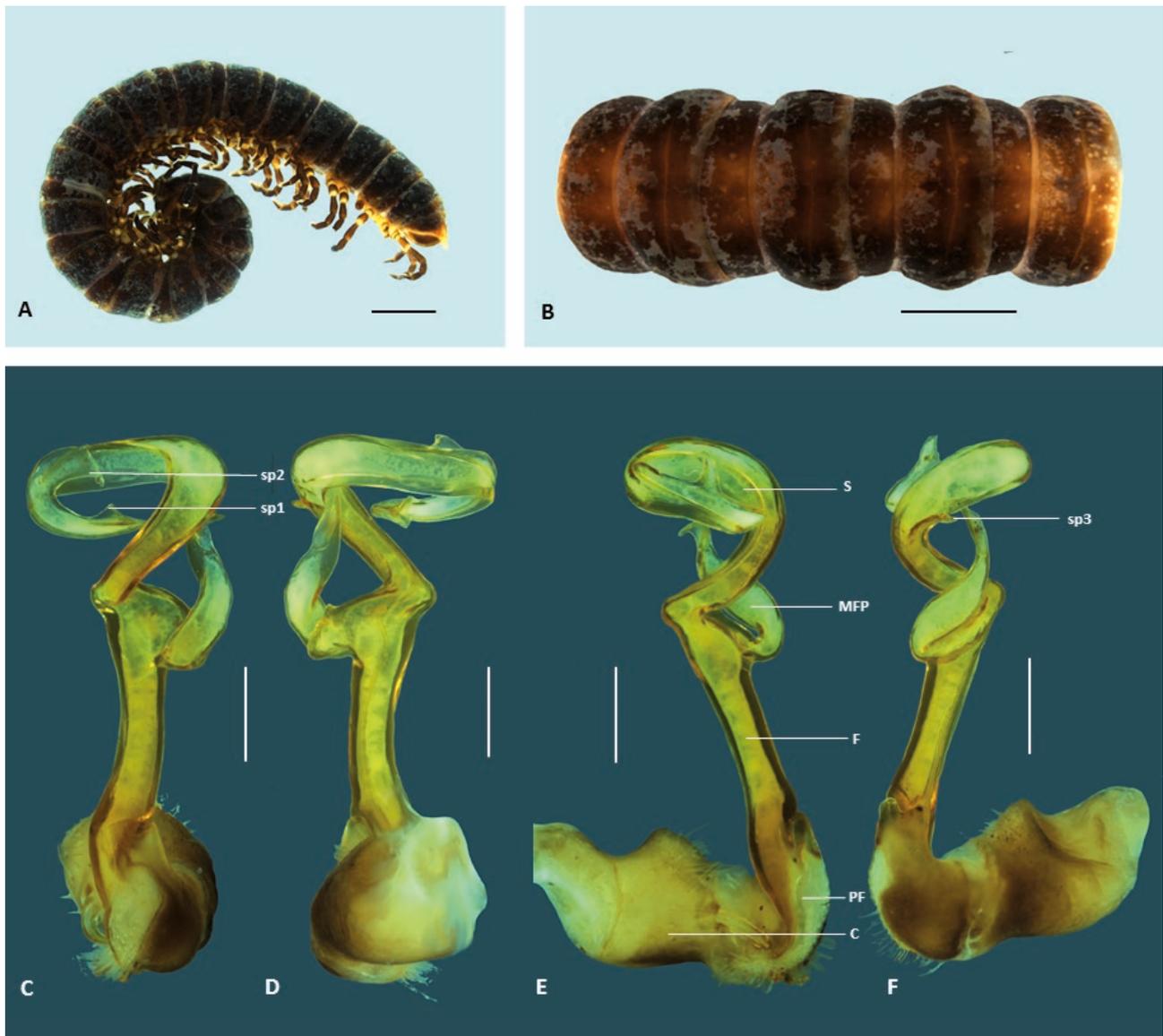
**Australia: Western Australia:** ♂, Buldania Rocks, Eyre Highway, 32°04'43.4"S, 122°02'02.8"E, 2 August 2012, under rocks on granite outcrop, J.M. Waldoek (WAM T126106).

*Paratypes*

**Australia: Western Australia:** 1 ♂, National Highway, 110 km NW of Balladonia, 32°01'08"S, 122°50'14"E, 23 July 2007, in damp mallee litter, C.A. Car (WAM T112937); 1 ♀, collected with paratype (WAM T112938).

*Other material*

**Australia: Western Australia:** 3 juveniles, National Highway, 110 km NW of Balladonia, 32°01'08"S,



**FIGURE 7** *Antichiropus anconus* sp. nov.: paratype male (WAMT112937) habitus: A, lateral view; B, dorsal view; C-F, left gonopod holotype male (WAMT126106): C, posterior view; D, anterior view; E, medial view; F, lateral view. Abbreviations: C, coxa; F, femurite; MFP, main femoral process; PF, prefemur; S, solenomere; sp1, sp2 and sp3, solenomere processes 1, 2 and 3. Scale bars: A = 2 mm; B = 1 mm; C-F = 0.5 mm.

122°50'14"E, 23 July 2007, in damp mallee litter, C.A. Car (WAM T54244); 1 ♂, Woodline, 31°48'S, 122°19'E, 1 August 1980, mallee/*Triodia*, debris, W.F. Humphreys (WAM T71828); 2 ♂, remains, Buldania Rocks, c. 27 km NE of Norseman, N of Eyre Highway, 32°04'45.8"S, 122°02'16.0"E, 16 November 2011, under granite rocks in *Acacia* woodland, C.A. Car and J.M. Waldoock (WAM T119062, T119063).

#### DIAGNOSIS

Gonopod: *Antichiropus anconus* may be separated from two other similar species, namely *A. inopinatus* (Figure 22) and *A. equinus* (Figure 15), by a distinctively shaped main femoral process, the lack of a second femoral process, the presence of three solenomere processes and

lack of serrations on the solenomere, either at its base or tip. In addition, the second solenomere process has a distinctive L-shape (Figures 7C–F).

#### DESCRIPTION

##### *Male holotype*

Body c. 25 mm long; midbody ring c. 2.5 mm wide, with distinct waist, prozonite and metazonite of similar width. Colour dark brown, almost black (Figure 7A); leg colour as for body. No paranota on posterior rings (Figure 7B). Sternites without obvious processes/tubercles, sternal lamella broad, square. Anterior spiracles at midbody flat, folded. Head smooth, without noticeable sculpturing; frons smooth, with some setae;

face broad, cheeks at least partially obscuring cardines, when viewed face-on, maximum width c. 3.5 x the distance between antennal sockets; sockets separated by c. 2 x width of socket. Antennae of moderate length, reaching to ring 2, not obviously clavate, antennomeres 5 and 6 only slightly wider than the proximal ones, and relatively robust. Collum 1 x as long as head (in lateral view). Gonopod of medium length, reaching posterior edge of ring 5; coxa (C) similar in length but more robust and thicker than femorite, with noticeable ridge on anterior surface; prefemur (PF) somewhat shorter than femorite, with distinct process at clearly demarcated join of prefemur and femorite, noticeable prefemoral lip; femorite (F) contributing to c. 1/2 acropodite length in situ, upright, of similar thickness along length; main femoral process (MFP) stout, pointed, carried on large femoral protuberance at right angles to femorite, irregularly shaped; second femoral process (fp1) absent; prolongation of femorite apex (prof) absent; solenomere (S) held in different plane from femorite, i.e. in Figure 7C, femorite is shown as vertical and solenomere appears orientated horizontally, long, forming >1 loop/circle, generally thicker than femorite, of variable thickness, thickest midway along length; solenomere tip with single flattened end and no serrations; solenomere process (sp1) near solenomere tip, small, pointed, triangular; second solenomere process (sp2) positioned c. halfway along solenomere, prominent, not pointed, L-shaped; third solenomere process (sp3) near solenomere base, small, pointed (Figures 7C–F).

#### Female

Of similar length, but slightly broader when viewed dorsally (c. 3 mm). The only female is, however, chestnut brown in colour with a broad, pale, dorsal stripe, which may be due to discoloration (WAM T112938).

#### DISTRIBUTION

This species has been hand collected from several sites along the edge of the Eyre Highway near Balladonia (Figure 35).

#### ETYMOLOGY

This species is named for the elbow-like shape of the main femoral process (Latin, noun, *anconus*, bend in the arm).

#### ***Antichiropus axicius* sp. nov.**

Figures 3A, 8, 36

<http://www.zoobank.org/urn:lsid:zoobank.org:act:0EE6D464-D9BE-4302-B787-4A0AD7C7CA10>

#### MATERIAL EXAMINED

##### *Holotype*

**Australia: Western Australia:** ♂, Mungarri Nature

Reserve North, Beacon, site BE 12, 30°19'51"S, 117°45'12"E, wet pitfall trap, 15 September 1998–25 October 1999, P. Van Heurck (WAM T71835).

##### *Other material*

None.

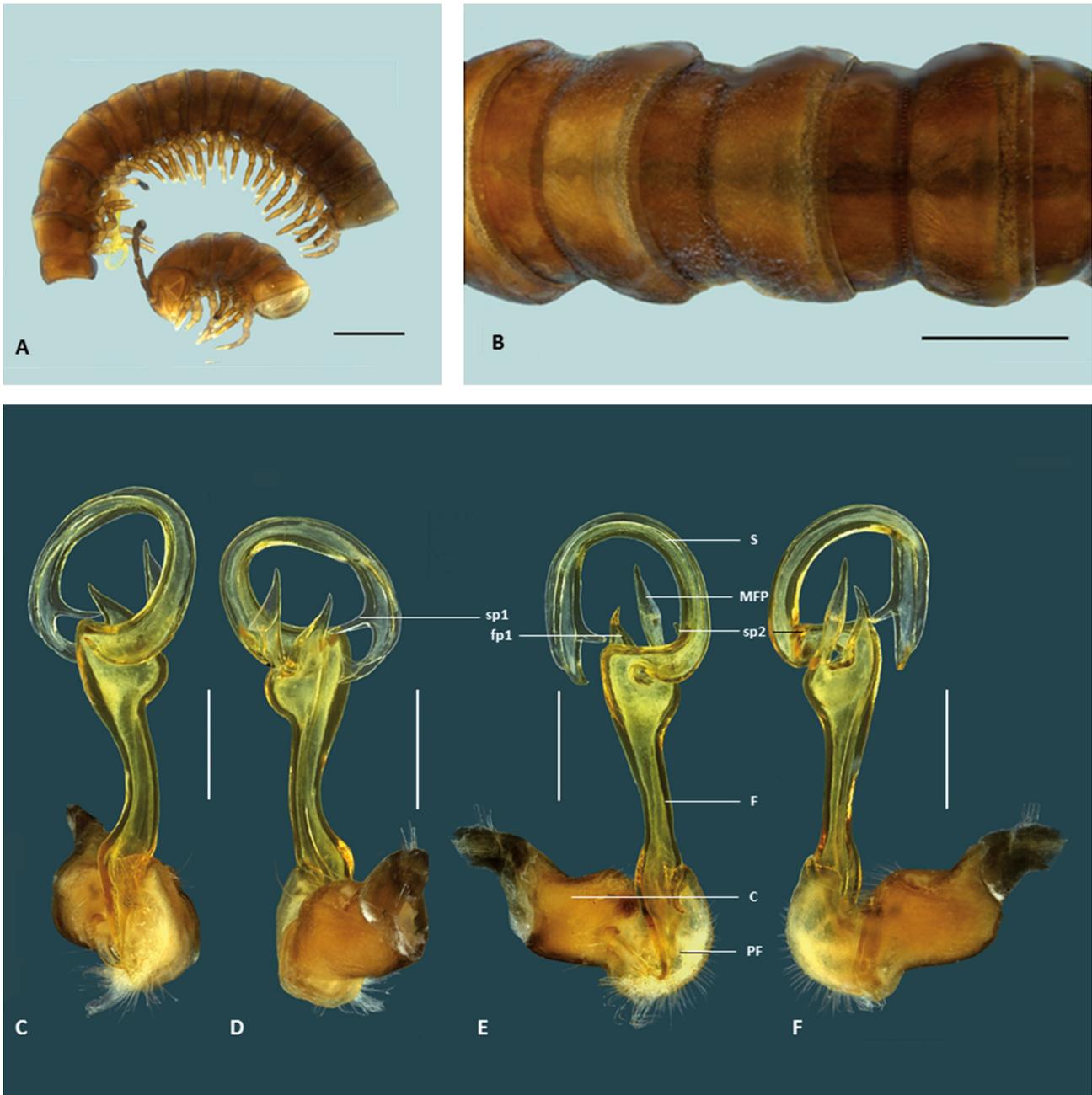
#### DIAGNOSIS

Gonopod: both *Antichiropus axicius* and *A. lacustrinus* have noticeably short femorites and the main femoral process of each arises from a prominent broadening of the distal femorite. *A. axicius* has however, a longer less curved femorite than *A. lacustrinus*, a second femoral process that is roughly triangular when viewed anteriorly and of similar shape to the main femoral process (Figures 8C–F): *A. lacustrinus* has a much longer, more slender second femoral process and a more bulbous main femoral process (Figures 24C–F). The first solenomere process of *A. axicius* is large and prominent. *A. axicius* may also appear similar to *A. equinus* but has a much more noticeable thickening of the distal femorite and has femoral processes shaped differently from *A. equinus* (Figure 15).

#### DESCRIPTION

##### *Male holotype*

Body c. 20 mm long; midbody ring c. 1.5 mm wide, with distinct beaded waist, metazonite slightly wider than prozonite. Colour chestnut brown overall (Figure 8A); legs noticeably paler than general body colour. No paranota on posterior rings (Figure 8B). Sternites without obvious processes/tubercles, sternal lamella broad, helmet-shaped. Anterior spiracles at midbody flat, erect. Head smooth, without noticeable sculpturing; frons smooth, with some setae; face broad, cheeks partially obscuring cardines, when viewed face-on, maximum width c. 3.4 x the distance between antennal sockets; sockets separated by c. 2 x width of socket. Antennae of moderate length, reaching to ring 2, not obviously clavate, antennomeres 5 and 6 only slightly wider than proximal ones and relatively robust. Collum 0.8 x as long as head (in lateral view). Gonopod of medium length, reaching posterior edge of ring 5; coxa (C) similar in length to but more robust and thicker than femorite, with slight ridge on anterior surface; prefemur (PF) somewhat shorter than femorite, appearing to hug femorite base, a small prefemoral lip; femorite (F) c. 1/2 of acropodite length in situ, slightly curved when viewed anteriorly, broadening into large rounded protuberance from which the MFP arises; main femoral process (MFP) short, <1/4 solenomere length, stout, pointed, hatchet-shaped; second femoral process (fp1) present, arising close to solenomere base, upright, pointed, short, triangular; prolongation of femorite apex (prof) absent; solenomere (S) relatively short, forming circle, generally as thick as femorite,



**FIGURE 8** *Antichiropus axicius* sp. nov.: holotype male (WAMT71835) habitus: A, lateral view; B, dorsal view; C–F, left gonopod: C, posterior view; D, anterior view; E, medial view; F, lateral view. Abbreviations: C, coxa; F, femorite; fp1, second femoral process; MFP, main femoral process; PF, prefemur; S, solenomere; sp1 and sp2, solenomere processes 1 and 2. Scale bars: A = 2 mm; B = 1 mm; C–F = 0.5 mm.

thick at base, becoming thinner midlength, thickening again at tip; solenomere tip single, square or flattened, with no serrations; solenomere process (sp1) in apical 1/3 of solenomere, prominent, pointed, upright, slender; second solenomere process (sp2) near solenomere base, prominent, pointed (Figures 8C–F).

#### Female

No females have been collected.

#### DISTRIBUTION

This species is known only from Mungarri Nature Reserve, but as only one specimen has been collected, its range is unknown (Figure 36).

#### ETYMOLOGY

This species is named for the shape made by the femorite processes when viewed anteriorly (Latin, noun, *axicia*, shears).

***Antichiropus baudini* sp. nov.**

Figures 9, 35

<http://www.zoobank.org/urn:lsid:zoobank.org:act:B0C2FD43-BBDD-41CB-BA01-C01F3C384F36>

## MATERIAL EXAMINED

*Male holotype*

**Australia: Western Australia:** ♂, Esperance, Wireless Hill, 33°52'44"S, 121°53'24"E, 3 June 2007, hand collected under rocks, M.L. Moir and K.E.C. Brennan (WAM T80691).

*Paratypes*

**Australia: Western Australia:** 6 ♂, 3 ♀, Duke of Orleans Bay, Mt Belches southern side, site 4, 33°56'36"S, 122°33'42"E, 2 June 2007, hand collected under granite rocks, M.L. Moir and A. Longbottom (WAM T80694); 5 ♂, 6 ♀, Duke of Orleans Bay, Mt Belches near summit, site 1, 33°56'26"S, 122°34'31"E, 2 June 2007, hand collected under granite rocks, M.L. Moir and A. Longbottom (WAM T80703).

*Other material*

**Australia: Western Australia:** 1 ♂, Cape Arid National Park, Thomas River, 33°51'11"S, 123°01'00"E, 8

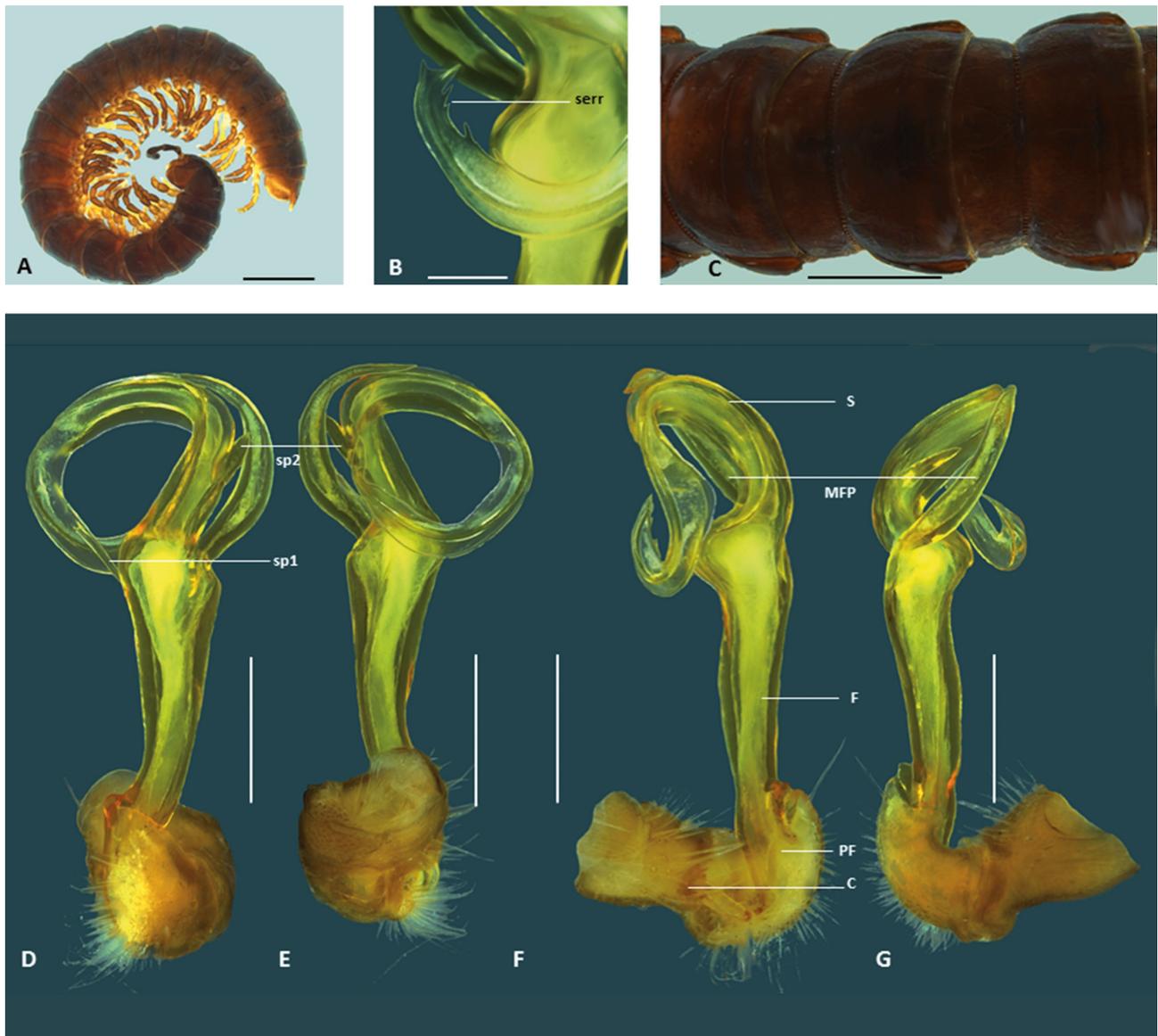


FIGURE 9

*Antichiropus baudini* sp. nov. male from Wittenoom (WAM T71874) A and C habitus: A, lateral view; C, dorsal view; B, holotype male (WAM T80691) left gonopod anterior view solenomere tip; D–G, left gonopod: D, posterior view; E, anterior view; F, medial view; G, lateral view. Abbreviations: C, coxa; F, femorite; MFP, main femoral process; serr, serrations; S, solenomere; sp1 and sp2, solenomere processes 1 and 2. Scale bars: A = 2 mm; B = 0.2 mm; C = 1 mm; D–G = 0.5 mm.

June 2012, K.E.C. Brennan et al. (WAM T124575); 1 ♂, 5 ♀, 1 juvenile, Wittenoom, near junction with Dempster Road, site ES 4, 33°38'18"S, 122°00'50"E, 15 October 1999–1 November 2000, wet pitfall, P. Van Heurck et al. (WAM T71874, T71875); 1 ♂, Backmans Road, near Burdett Road junction, SE. of Mt Burdett, site ES 9, 33°29'05"S, 122°14'27"E, 15 October 1999–1 November 2000, wet pitfall, P. Van Heurck et al. (WAM T71876); 16 ♂, 7 ♀, 4 juveniles, Brockway Rd, Helms Arboretum Reserve, site ES 2, 33°43'42"S, 121°47'50"E, 15 October 1999–1 November 2000, wet pitfall, P. Van Heurck et al. (WAM T71877); 1 ♂, Shark Lake Rd, Helms Arboretum Reserve, site ES 1, 33°44'49"S, 121°48'55"E, 15 October 1999–1 November 2000, pitfall, P. Van Heurck et al. (WAM T71878); 4 ♂, 1 ♀, Coolinup Nature Reserve, South, Esperance, site ES 12, 33°43'53"S, 122°17'59"E, trap closed 2 May 2000 and 29 November 2000, pitfall trap, P. Van Heurck (WAM T71879); 4 ♂, 3 ♀, 5 juveniles, Coolinup Nature Reserve, SW, Esperance, site ES 13, 33°44'09"S, 122°17'29"E, trap closed 2 May 2000 and 29 November 2000, pitfall trap, P. Van Heurck (WAM T71880); 9 ♂, 3 ♀, 1 juvenile, Shark Lake Rd, Helms Arboretum Reserve, site ES 1, 33°44'49"S, 121°48'55"E, 15 October 1999–1 November 2000, pitfall, P. Van Heurck et al. (WAM T71881); 1 ♂, Coolinup Nature Reserve, North, site ES 10, 33°34'02"S, 122°17'55"E, 15 October 1999–1 November 2000, pitfall, P. Van Heurck et al. (WAM T71882); 93 ♂, 13 ♀, 29 juveniles, Lake Morgan, Helms Arboretum Reserve, site ES 3, 33°43'09"S, 121°48'29"E, 15 October 1999–1 November 2000, wet pitfall, P. Van Heurck et al. (WAM T71883); remains only, Duke of Orleans Bay, Mt Belches near summit, site 1, 33°56'26"S, 122°34'31"E, 2 June 2007, hand collected under granite rocks M.L. Moir and A. Longbottom (WAM T80704); 1 ♂, Cape Arid National Park, Seal Creek, 33°54'22"S, 123°30'35"E, 9 April 2007, *Banksia speciosa* woodland, G. Byrne (WAM T85346); 1 ♂, Cape Arid National Park, Thomas River, 33°51'11"S, 123°01'00"E, 8 June 2012, K.E.C. Brennan et al. (WAM T124575).

## DIAGNOSIS

Gonopod: *Antichiropus baudini* may be distinguished by the shape of the main femoral process: it is noticeably long and slender and follows the curve of the solenomere. In addition, there is a process near the base of the solenomere that is short, rounded and almost leaf-like in appearance (Figures 9D–G).

## DESCRIPTION

### *Male holotype*

Body c. 24 mm long; midbody ring c. 1.75 mm wide, with distinct beaded waist, prozonite and metazonite of similar width. Colour chestnut brown overall (Figure 9A); legs slightly paler than body. Paranota small but distinct (Figure 9C). I. Sternites without obvious processes/tubercles, sternal lamella broad, with rounded edge. Anterior spiracles at midbody flat, folded. Head smooth, without noticeable sculpturing; frons smooth, with some setae; face broad, cheeks at

least partially obscuring cardines, when viewed face-on, maximum width face c. 3.4 x the distance between antennal sockets; sockets separated by c. 2 x width of socket. Antennae of moderate length, reaching to ring 2, distinctly clavate, antennomeres relatively robust. Collum 0.6 x as long as head (in lateral view). Gonopod of medium length, reaching posterior edge of ring 5; coxa (C) thicker and shorter than femorite, with slight ridge on anterior surface (not obvious in Figure 9); prefemur (PF) somewhat shorter than femorite, a noticeable prefemoral lip; femorite (F) c. 2/3 of acropodite length in situ, slightly curved when viewed anteriorly, upright, becoming thicker towards apex; main femoral process (MFP) long (to c. 1/4 solenomere length), pointed, but not spine-like, banana-shaped and following solenomere curve; second femoral process (fpl) absent; prolongation of femorite apex (prof) absent; solenomere (S) long enough to form more than one loop or circle, generally more slender than femorite, and of similar thickness along length; solenomere tip pointed, with serrations (Figure 9B); solenomere process (sp1) closer to solenomere tip than base, prominent, pointed, upright, slender; second solenomere process (sp2) near solenomere base, small and leaf-shaped (Figures 9D–G).

### *Female*

Similar to male but slightly broader (c. 2 mm) when viewed dorsally (WAM T80694).

## DISTRIBUTION

Many specimens of this species were collected from Esperance (33°52'S, 121°53'E) in the west to Cape Arid National Park (33°58'S, 123°10'E) the most easterly point, just south of the Great Western Woodlands (Figure 35).

## ETYMOLOGY

The species name is in honour of Nicolas Baudin (1754–1803), who led an expedition from France to Australia and was the first European explorer to chart the Western Australian coastline.

### *Antichiropus buchianorum* sp. nov.

Figures 4C, 10, 36

<http://www.zoobank.org/urn:lsid:zoobank.org:act:6F28338B-A623-4FF1-A113-511575057359>

## MATERIAL EXAMINED

### *Holotype*

**Australia: Western Australia:** ♂, Dundas Rocks, Coolgardie-Esperance Highway, 32°23'27.4"S, 121°46'22.3"E, 22 September 2011, damp litter at base of dam walls, J.M. Waldock and C.A. Car (WAM T121012).

### *Paratypes*

**Australia: Western Australia:** 5 ♂, 6 ♀, collected with holotype (WAM T115034).



**FIGURE 10** *Antichiropus buchianorum* sp. nov.: paratype male (WAM T115034) habitus: A, lateral view; B, dorsal view; C–F, left gonopod: C, posterior view; D, anterior view; E, medial view; F, lateral view. Abbreviations: C, coxa; F, femorite; MFP, main femoral process; PF, prefemur; S, solenomere; sp1 and sp2, solenomere processes 1 and 2. Scale bars: A = 2 mm; B = 1 mm; C–F = 0.5 mm.

#### Other material

**Australia: Western Australia:** 1 ♂, 1 ♀, details as for type specimens, but collected dead under granite rock on outcrop, J.M. Waldock and C.A. Car (WAM T115035).

#### DIAGNOSIS

**General:** this is the smallest species found in the Great Western Woodlands, with two distinctive pale dorsal stripes (Figures 10A, B). Gonopod: *Antichiropus buchianorum* may be distinguished further by the shape of the solenomere which is very stout and rounded midway along its length, and has the appearance of

being folded over the basal third, and by the shape of two processes on the solenomere: the first is noticeably long, reaching almost to the solenomere tip while the second arises from the thick central section of the solenomere and is distinctly forked at its tip (Figures 10C–F).

#### DESCRIPTION

##### *Male holotype*

Body c. 15 mm long; midbody ring c. 1.0 mm wide, with distinct waist, prozonite and metazonite of similar width. Colour dark brown overall (Figure 10A), with

two pale dorsal stripes, running full length of body: legs noticeably paler than general body colour. No paranota on posterior rings (Figure 10B). Sternites without obvious processes/tubercles, sternal lamella broad, with rounded edge. Anterior spiracles at midbody flat, erect. Head smooth, without noticeable sculpturing; frons smooth, with some setae; face narrow, cardines and stipites clearly visible when animal is viewed face-on, maximum width c. 3.5 x the distance between antennal sockets; sockets separated by c. 2 x width of socket. Antennae of moderate length, reaching to ring 2, distinctly clavate, antennomeres relatively robust. Collum 0.75 x as long as head (in lateral view). Gonopod of medium length, reaching posterior edge of ring 5; coxa (C) more robust, thicker and shorter than femorite, with slight ridge on anterior surface (damaged in Figures 10C–F); prefemur (PF) somewhat shorter than femorite, appearing to hug femorite base, noticeable prefemoral lip; femorite (F) contributing to c. 2/3 of acropodite length in situ, slightly curved when viewed anteriorly, becoming thicker towards apex; main femoral process (MFP) long (to c. 1/4 solenomere length), narrow, pointed, finger-like; second femoral process (fp1) present, arising close to solenomere base, rounded, short, triangular; prolongation of femorite apex (prof) absent; solenomere (S) relatively short, forming circle, thicker than femorite at least in part, and much thicker midway along length; solenomere tip with single flattened end and no serrations; solenomere process (sp1) near solenomere tip, prominent, pointed, upright, slender; second solenomere process (sp2) positioned halfway along solenomere, prominent, pointed with 2 branches (Figures 10C–F).

#### Female

Similar to male, but slightly larger and noticeably broader (c. 2 mm) (WAM T115034).

#### DISTRIBUTION

This species is known only from the granite outcrops known as Dundas Rocks, c. 25 km south of Norseman (Figure 36).

#### ETYMOLOGY

The species epithet is a patronym in honour of the senior author's parents, Terry and Kathy Buchan, who fostered her life long interest in terrestrial invertebrates.

#### *Antichiropus cavernus* sp. nov.

Figures 3B, 11, 35

<http://www.zoobank.org/urn:lsid:zoobank.org:act:6C039B59-BDD5-4AAD-9BF1-EA31CF97D917>

#### MATERIAL EXAMINED

##### Holotype

**Australia: Western Australia:** ♂, N of Madura, Mullamullang Cave (6N–37), doline, 31°43'S, 127°13'E, 4 September 1985, B. Knott (WAM T78708).

##### Paratypes

**Australia: Western Australia:** 2 ♂, collected with holotype (WAM T72020).

##### Other material

**Australia: Western Australia:** 1 ♂, Fern Cave doline, 6N-747, Nullarbor region, 31°50'S, 126°40'E, 2 October 1994, R. Foulds (WAM T42305); 1 ♂, Mullamullang Cave (6N–37), doline, 31°43'S, 127°13'E, 4 September 1985, B. Knott (WAM T112939).

#### DIAGNOSIS

General: *Antichiropus cavernus* is similar in many aspects to *A. mammillifer*. Both have small distinctive protuberances on the sternites of the fifth body ring, posterior to the sternal lamella (Figure 11B), presumably the feature after which *A. mammillifer* was named. *A. cavernus*, however, has been found only on the eastern edge of Western Australia and *A. mammillifer* only on the Eyre Peninsula of South Australia. *A. cavernus* is also considerably smaller than *A. mammillifer* (Figure 11A). Gonopod: each species has a large spoon-shaped tip to the solenomere, a slender, pointed, serrated main femoral process that curves tightly towards the solenomere and a large, bulbous, pointed second femoral process (see Remarks). *A. cavernus* lacks the protuberance on the femur as shown by *A. mammillifer* in posterior view and has a shorter, relatively slender main femoral process. In addition, both the main femoral process and the second femoral process in *A. cavernus* are held horizontally in relation to the vertical femur whereas in *A. mammillifer*, they are both held at a 45° angle. *A. cavernus* is similar also to *A. rex* (Figures 28D–G) and *A. simpulus* (Figures 32D–G) but is distinguishable by its bulbous second femoral process (Figures 11D–G).

#### DESCRIPTION

##### Male holotype

Body c. 25 mm long; midbody ring c. 2.5 mm wide, with distinct waist, prozonite and metazonite of similar width. Legs relatively longer than in other species from the region, c. length of 2 midbody rings. Colour dark brown overall (Figure 11A); leg colour as for body. Paranota on posterior body rings present as slight protuberances (Figure 11C). Sternites, except ring 5, with protuberances on some, sternite of ring 5 with processes pointing anteriorly (Figure 11B), sternal lamella narrow, with rounded edge. Anterior spiracles at midbody flat, folded. Head smooth, without noticeable sculpturing; frons smooth, with some setae; face broad, cheeks partially obscuring cardines, when viewed face-on, maximum width c. 3 x the distance between antennal sockets; sockets separated by c. 2 x width of socket. Antennae of moderate length, reaching to ring 2, distinctly clavate, antennomeres relatively robust. Collum 0.75 x as long as head (in lateral view). Gonopod of medium length, reaching posterior edge of ring 5; coxa (C) more robust, thicker than and slightly shorter than femorite, with noticeable ridge

on anterior surface; prefemur (PF) somewhat shorter than femorite, appearing to hug femorite base, a small prefemoral lip; femorite (F) contributing to c. 1/2 of acropodite length in situ, upright, of similar thickness along length; main femoral process (MFP) long (to c. 1/4 solenomere length), narrow, pointed, serrated on one edge, spear-shaped; second femoral process (fp1) curved, pointed, stout, bulbous; prolongation of femur (prof) absent; solenomere (S) very long extending in situ to 1/2 acropodite length, thicker than femorite at least in part, thickest nearer tip; solenomere tip flattened, with no serrations, distinctive spoon-shaped apex (Figures 11D–G); solenomere process (sp1) near solenomere tip, tiny ridge-like, not seen in Figure 11, but very similar to that of *A. simpulus* (Figure 32B).

#### Female

No female specimens have been collected.

#### REMARKS

With regards to the species from the Great Western Woodlands that possess large ‘spoon-shaped’ tips to their solenomeres, there is some difficulty in assigning the various femoral processes to the categories established in Car et al. (2013). As before, the main femoral process is recognised as that process which arises on the lateral surface of the femorite. Each of three species, *A. cavernus*, *A. rex* and *A. simpulus* carries a second femoral process, labelled here fp1. For consistency, what was labelled as a prolongation of the femur in *A. mammillifer* (Car et al. 2013) is here relabelled the fp1 for easier comparison.

#### DISTRIBUTION

This species has been found only on the extreme eastern edge of the Great Western Woodlands, and is the most

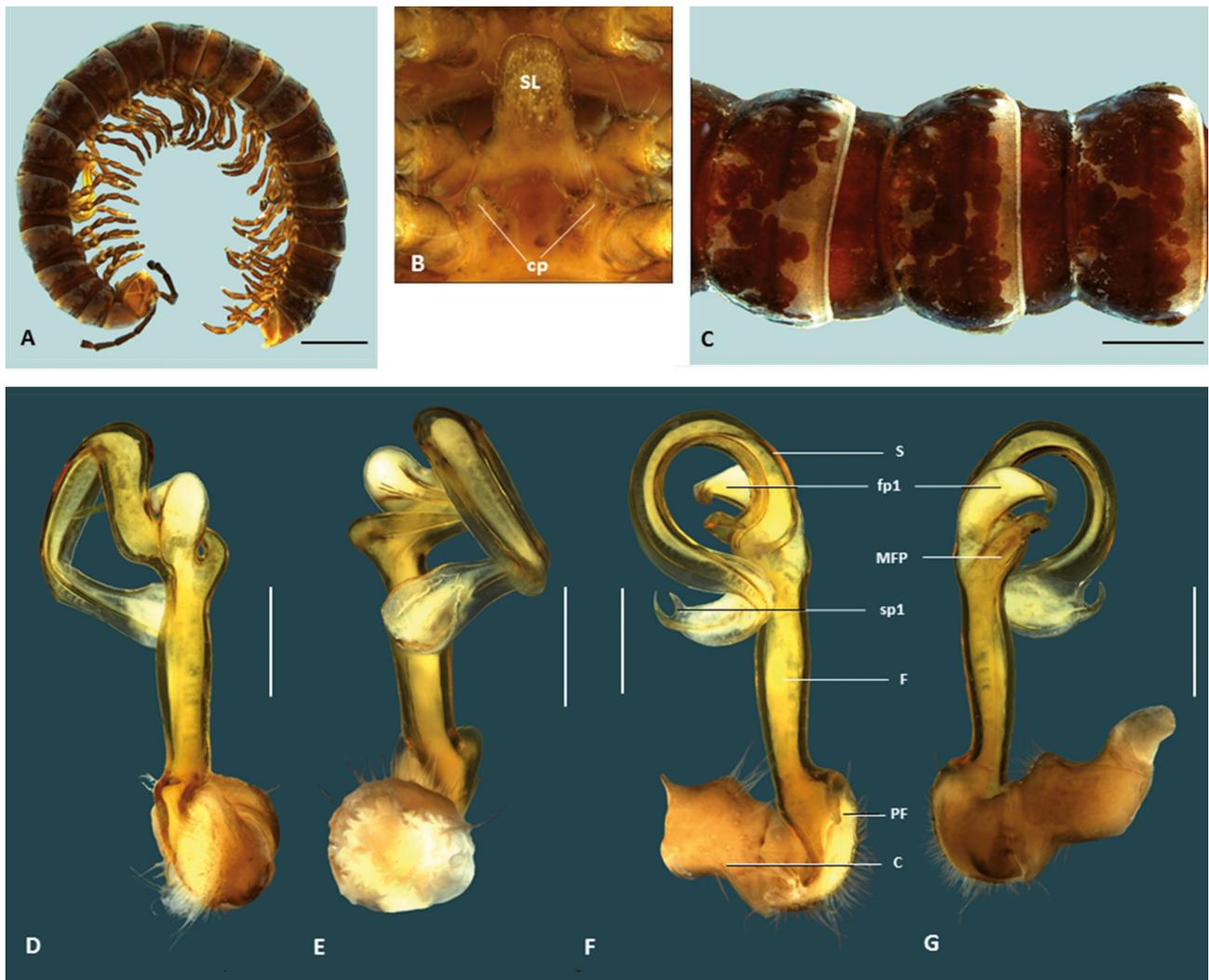


FIGURE 11

*Antichiropus cavernus* sp. nov.: A and C male (WAM T112939) habitus: A, lateral view; C, dorsal view; B, male (WAM T112939) sternal view of fifth body ring; D–G, paratype male (WAM T72020) left gonopod: D, posterior view; E, anterior view; F, medial view; G, lateral view. Abbreviations: C, coxa; cp, coxal processes; F, femorite; fp1, second femoral process; MFP, main femoral process; PF, prefemur; S, solenomere; SL, sternal lamella; sp1, solenomere process 1. Scale bars: A = 2 mm; B = 0.2 mm; C = 1 mm; D–G = 0.5 mm.

easterly species found in Western Australia (Figure 35).

#### ETYMOLOGY

This species is named for the fact that it has been found only in caves (Latin, noun, *caverna*, cave).

#### *Antichiropus cincinnus* sp. nov.

Figures 4A, 12, 36

<http://www.zoobank.org/urn:lsid:zoobank.org:act:6F4A20C7-7B24-4E94-8D53-16B23E482AA4>

#### MATERIAL EXAMINED

##### *Holotype*

**Australia: Western Australia:** ♂, McDermid Rock, site MRR 4, 32°01'40"S, 120°44'45"E, *Eucalyptus salmonophloia* woodland, 1981, W.F. Humphreys (WAM T72055).

#### *Other material*

None

#### DIAGNOSIS

Gonopod: *Antichiropus cincinnus* is recognised by the extremely short, bent femorite and by what appears to be a fusion of two femoral processes to form a large distinctive two-headed main femoral process (Figures 12C–F).

#### DESCRIPTION

##### *Male holotype*

Body damaged, length not determined; midbody ring c. 2 mm; with distinct waist, metazonite distinctly wider than prozonite. Colour bleached in alcohol (Figure 12A, B). No paranota on posterior rings (Figure 12B). Pore formula difficult to determine. Sternites, except ring 5, with protuberances on some, long setae

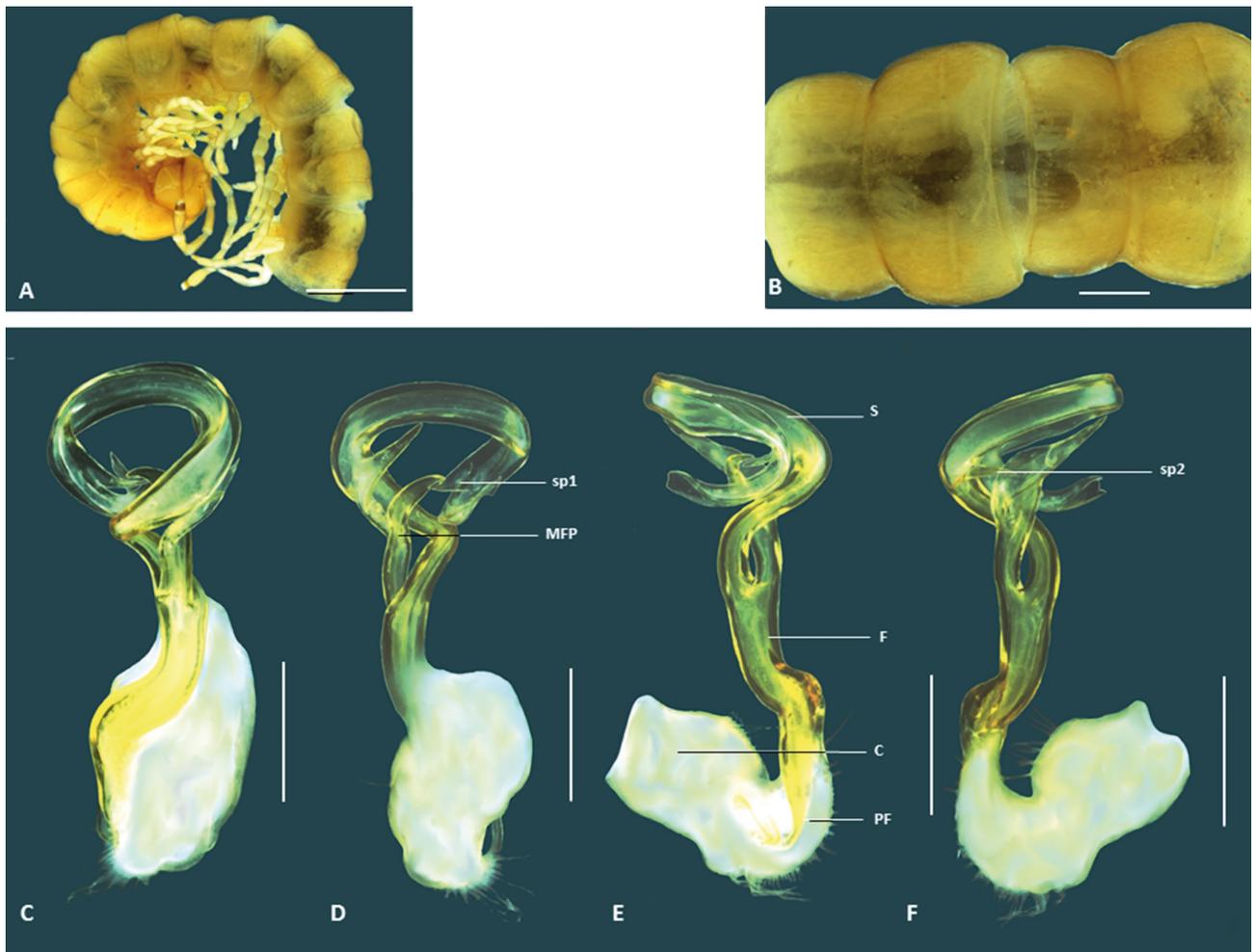


FIGURE 12

*Antichiropus cincinnus* sp. nov.: holotype male (WAM T72055) habitus: A, lateral view; B, dorsal view; C–F, left gonopod: C, posterior view; D, anterior view; E, medial view; F, lateral view. Abbreviations: C, coxa; F, femorite; MFP, main femoral process; PF, prefemur; S, solenomere; sp1 and sp2 solenomere processes 1 and 2. Scale bars: A = 2 mm; B–F = 0.5 mm.

on protuberances, sternites of ring 5 without obvious processes/tubercles, sternal lamella broad, with rounded edge. Anterior spiracles at midbody flat, erect. Head smooth, without noticeable sculpturing; frons smooth, with some setae; face narrow, cardines and stipites clearly visible when animal is viewed face-on, maximum width c. 4 x the distance between antennal sockets; sockets separated by c. 1.5 x width of socket. Antennae of moderate length, reaching to ring 2, not obviously clavate, antennomeres relatively robust. Collum 1 x as long as head (in lateral view). Gonopod short, reaching to ring 6; coxa (C) more robust, thicker and longer than femorite, with no noticeable ridge; prefemur (PF) longer than femorite (Figure 4); femorite (F) less than 1/2 acropodite length in situ, bent when viewed medially, becoming thicker towards apex; main femoral process (MFP) very long, to 1/2 solenomere length, pointed, but not spine-like, irregularly shaped, comprising 2 pointed processes; prolongation of femorite apex (prof) absent; solenomere (S) held in different plane from femorite, i.e. in Figure 12E, femorite is shown as vertical and solenomere appears orientated horizontally, relatively short, forming circle, generally same thickness as femorite, of similar thickness along length but thinner at tip; solenomere tip flattened, with no serrations, indeterminate; solenomere process (spl) prominent, pointed, triangular; second solenomere process (sp2) positioned c. halfway along solenomere, prominent, pointed (Figures 12C–F).

#### Female

No female known.

#### DISTRIBUTION

Only one specimen has ever been collected and that from woodlands at the base of McDermid Rock in the Great Western Woodlands (Figure 36). Interestingly, another species, *A. paracalothamnus* was collected on the granite surface of McDermid Rock.

#### REMARKS

The only specimen used for montage images and scanning electron microscopy.

#### ETYMOLOGY

The species name refers to the shape of the male gonopod (Latin, noun, *cincinnus*, lock of hair).

#### ***Antichiropus cuspis* sp. nov.**

Figures 13, 36

<http://www.zoobank.org/urn:lsid:zoobank.org:act:117B9177-7B39-4C19-9A53-54C5EAB8BAF5>

#### MATERIAL EXAMINED

##### *Holotype*

**Australia: Western Australia:** ♂, Ravensthorpe Range South (site WAM 22), 33°38'31.00"S,

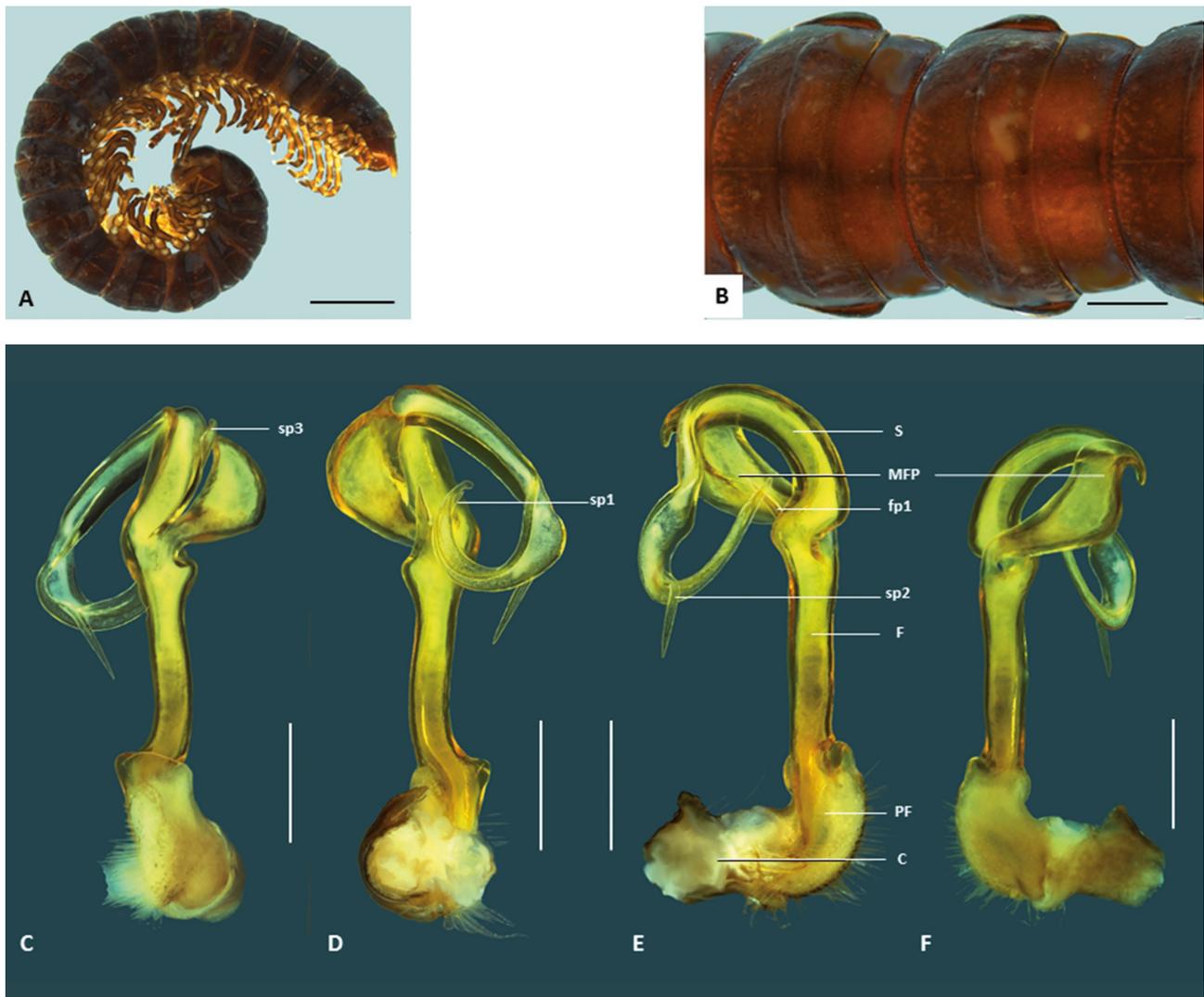
120°13'50.00"E, 96 m, 16 September 2007, hand collected under rock, M.C. Leng and J. Newell (WAM T81288).

##### *Paratypes*

**Australia: Western Australia:** 5 ♂, 3 ♀, 8 juveniles, Ravensthorpe Range South (site WAM 22), 33°38'31.06"S, 120°13'50.00"E, 130 m, 19 May 2007, hand collected under rock, M.C. Leng and M.L. Moir (WAM T80844).

##### *Other material*

**Australia: Western Australia:** 1 ♂, 34.2 km E of Ravensthorpe, 33°39'47"S, 120°24'01"E, 24 August 2005, R. Teale and Z. Hamilton (WAM T66416); 3 ♂, 2 juveniles, 24.4 km E of Ravensthorpe, 33°34'22"S, 120°18'28"E, 26–27 August 2005, R. Teale and Z. Hamilton (WAM T66417); 1 ♂, 24.4 km E. of Ravensthorpe, site RNOCTS2, 33°34'22"S, 120°18'28"E, 26–27 August 2005, dry pitfall, R. Teale and Z. Hamilton (WAM T78187); 3 ♂, 4 ♀, 3 juveniles, Bremer Bay, Peppermint Beach, southern end, 34°23'37"S, 119°29'32"E, 7 June 2007, hand collected under granite rocks, M.C. Leng and M.L. Moir (WAM T80655); 1 ♀, Bremer Bay, Peppermint Beach, southern end, 34°23'37"S, 119°29'32"E, 7 June 2007, hand collected under granite rocks, M.C. Leng and M.L. Moir (WAM T80656); 1 ♂, 1 juvenile, Fitzgerald River National Park, Eyre Range, rock outcrop, unburnt, site 3, 33°51'11"S, 119°57'58"E, 30 May 2007 hand collected under rock, M.C. Leng and M.L. Moir (WAM T80792); 1 ♂, Fitzgerald River National Park, Eyre Range, gully, unburnt, site 1, 33°50'50"S, 119°57'07"E, 30 May 2007, hand collected under rock, M.C. Leng and M.L. Moir (WAM T80810); 1 ♂, Fitzgerald River National Park, Eyre Range, rock outcrop, unburnt, site 2, 33°51'01"S, 119°57'32"E, 30 May 2007, hand collected under rock, M.C. Leng and M.L. Moir (WAM T80811); 1 ♀, Ravensthorpe Range South (site WAM 22), 33°38'31.06"S, 120°13'50.00"E, 130 m, 19 May 2007, hand collected under rock, M.C. Leng and M.L. Moir (WAM T80845); 1 ♀, Ravensthorpe Range South (site WAM 14), 33°41'53.07"S, 120°18'00.02"E, 115 m, 18 May 2007, hand collected under rock, M.C. Leng and M.L. Moir (WAM T80890); 2 ♂, 3 juveniles, Ravensthorpe Range South (site WAM 17), 33°40'35.02"S, 120°17'59.08"E, 81 m, 18 May 2007, hand collected under rock, M.C. Leng and M.L. Moir (WAM T80900); 1 ♂, 5 juveniles, Ravensthorpe Range North (site WAM 27), 33°27'38.09"S, 120°00'00.00"E, 358 m, 20 May 2007, hand collected under rock, M.C. Leng and M.L. Moir (WAM T80932); 1 ♂, 2 ♀, 6 juveniles, Ravensthorpe Range North (Site WAM 30), 33°32'58.03"S, 120°06'12.01"E, 226 m, 21 May 2007, hand collected under rock, M.C. Leng and M.L. Moir (WAM T80949); 1 ♂, Ravensthorpe Range North (site WAM 34), 33°33'06.01"S, 120°08'48.06"E, 150 m, 22 May 2007 hand collected under rock,



**FIGURE 13** *Antichiropus cuspis* sp. nov.: A-B, male (WAM T80810) habitus: A, lateral view; B, dorsal view; C-F, holotype male (WAM T81288) left gonopod: C, posterior view; D, anterior view; E, medial view; F, lateral view. Abbreviations: C, coxa; F, femorite; fp1, second femoral process; MFP, main femoral process; PF, prefemur; S, solenomere; sp1, sp2 and sp3, solenomere processes 1, 2 and 3. Scale bars: A = 2 mm; B = 1 mm; C-F = 0.5 mm.

M.C. Leng and M.L. Moir (WAM T80968); 4 ♂, 4 juveniles, Ravensthorpe Range North (site WAM 36), 33°31'13.09"S, 120°03'34.01"E, 379 m, 23 May 2007, hand collected under rock, M.C. Leng and M.L. Moir (WAM T80977); 1 juvenile, Ravensthorpe Range North, Mt McMahon area (site WAM 38), 33°33'18.05"S, 120°06'46.04"E, 266 m, 23 May 2007, hand collected under rock, M.C. Leng and M.L. Moir (WAM T80983); 3 ♂, 2 juveniles, Ravensthorpe Range Middle, near townsite (site WAM 48), 33°34'04.09"S, 120°02'51.05"E, 210 m, 28 May 2007, hand collected under rock, M.C. Leng and M.L. Moir (WAM T81020); 1 ♂, 1 juvenile, Ravensthorpe Range Middle (Site WAM 49), 33°34'59.08"S, 120°07'36.07"E, 201 m, 28 May 2007, hand collected under rock, M.C. Leng and M.L.

Moir (WAM T81029); 2 ♂, 8 juveniles, Ravensthorpe Range, Bandalup Hill (site WAM 51), 33°40'16.01"S, 120°24'35.05"E, 153 m, 29 May 2007, hand collected under rock, M.C. Leng and M.L. Moir (WAM T81034); 2 ♂, Ravensthorpe Range, Bandalup Hill (site WAM 52), 33°40'34.01"S, 120°23'59.04"E, 163 m, 29 May 2007, hand collected under rock, M.C. Leng and M.L. Moir (WAM T81039); 6 ♂, 1 ♀, 1 juvenile, Ravensthorpe Range, Bandalup Hill (site WAM 54), 33°39'40.06"S, 120°23'02.09"E, 148 m, 29 May 2007, hand collected under rock, M.C. Leng and M.L. Moir (WAM T81045); 1 ♂, Calyerup Rocks, 33°54'40.1"S, 119°06'02.5"E, 23 October 2008, dead on sand track near rocks, J.M. Waldoock, S. Crews, F. Stone and D. Ward (WAM T94019); 1 ♀, Ravensthorpe Range, Bandalup Hill (site

WAM 54), 33°39'40.06"S, 120°23'02.09"E, 148 m, 29 May 2007, hand collected under rock, M.C. Leng and M.L. Moir (WAM T112943).

#### DIAGNOSIS

Gonopod: *Antichiropus cuspis* has a noticeably large, very broad, uniquely shaped femoral process and three solenomere processes, the most prominent of which is highly visible and positioned c. two-thirds of the way from the base of the long, looping solenomere towards its tip (Figures 13C–F).

#### DESCRIPTION

##### *Holotype male*

Body c. 20 mm long; midbody ring c. 1.75 mm wide, with distinct waist, prozonite and metazonite of similar width. Colour dark brown overall (Figure 13A); leg colour as for body. Paranota on posterior rings small, distinct (Figure 13B). Sternites, except ring 5, with no noticeable features, sternite of ring 5 with slight processes, pointing anteriorly, sternal lamella relatively narrow, with rounded edge. Anterior spiracles at midbody flat, folded. Head smooth, without noticeable sculpturing; frons setose; face broad, cheeks partially obscuring cardines, when viewed face-on, maximum width c. 3.3 x the distance between antennal sockets; sockets separated by c. 2 x width of socket. Antennae of moderate length, reaching to ring 2, not obviously clavate, antennomeres relatively robust. Collum 0.8 x as long as head (in lateral view). Gonopod of medium length, reaching posterior edge of ring 5; coxa (C) more robust, thicker and shorter than femorite; prefemur (PF) of similar length to femorite, ovoid, a noticeable prefemoral lip; femorite (F) c. 1/2 of acropodite length in situ, upright, with noticeable 'elbow' at femorite base when viewed anteriorly, of similar thickness along length; main femoral process (MFP) very long, broad, c. 1/2 of solenomere length, pointed, irregularly shaped; second femoral process (fp1) present, arising close to solenomere base, upright, pointed, short, triangular; prolongation of femorite apex (prof) absent; solenomere (S) very long, extending to prefemur, thicker than femorite in part, thickest midway along length; solenomere tip pointed, with no serrations; solenomere process (sp1) near solenomere tip, small, pointed, slender; second solenomere process (sp2) in apical 1/3 of solenomere, long, prominent, pointed; third solenomere process (sp3) near solenomere base, prominent, broadly pointed (Figures 13 C–F).

##### *Female*

Similar to male, but slightly broader (dorsal width c. 2.5 mm) (WAM T112943).

#### DISTRIBUTION

This species has been collected from a number of localities from under rocks in the granite outcrops of

the Fitzgerald River National Park and the Ravensthorpe Range (Figure 36).

#### ETYMOLOGY

The species name refers to the several pointed processes on the solenomere of the male gonopod (Latin, noun, *cuspis*, the pointed end of anything).

#### ***Antichiropus digitatus* sp. nov.**

Figures 14, 36

<http://www.zoobank.org/urn:lsid:zoobank.org:act:66141F0E-5527-4560-98C1-C475AE65AE18>

#### MATERIAL EXAMINED

##### *Holotype*

**Australia: Western Australia:** ♂, Dongolocking Spring Reserve, site DU 02, 33°05'19"S, 117°41'29"E, 15 October 1999–1 November 2000, wet pitfall, P. Van Heurck et al. (WAM T132357).

##### *Paratypes*

**Australia: Western Australia:** 10 ♂, 8 ♀, collected with holotype (WAM T71992, T71993).

##### *Other material*

None.

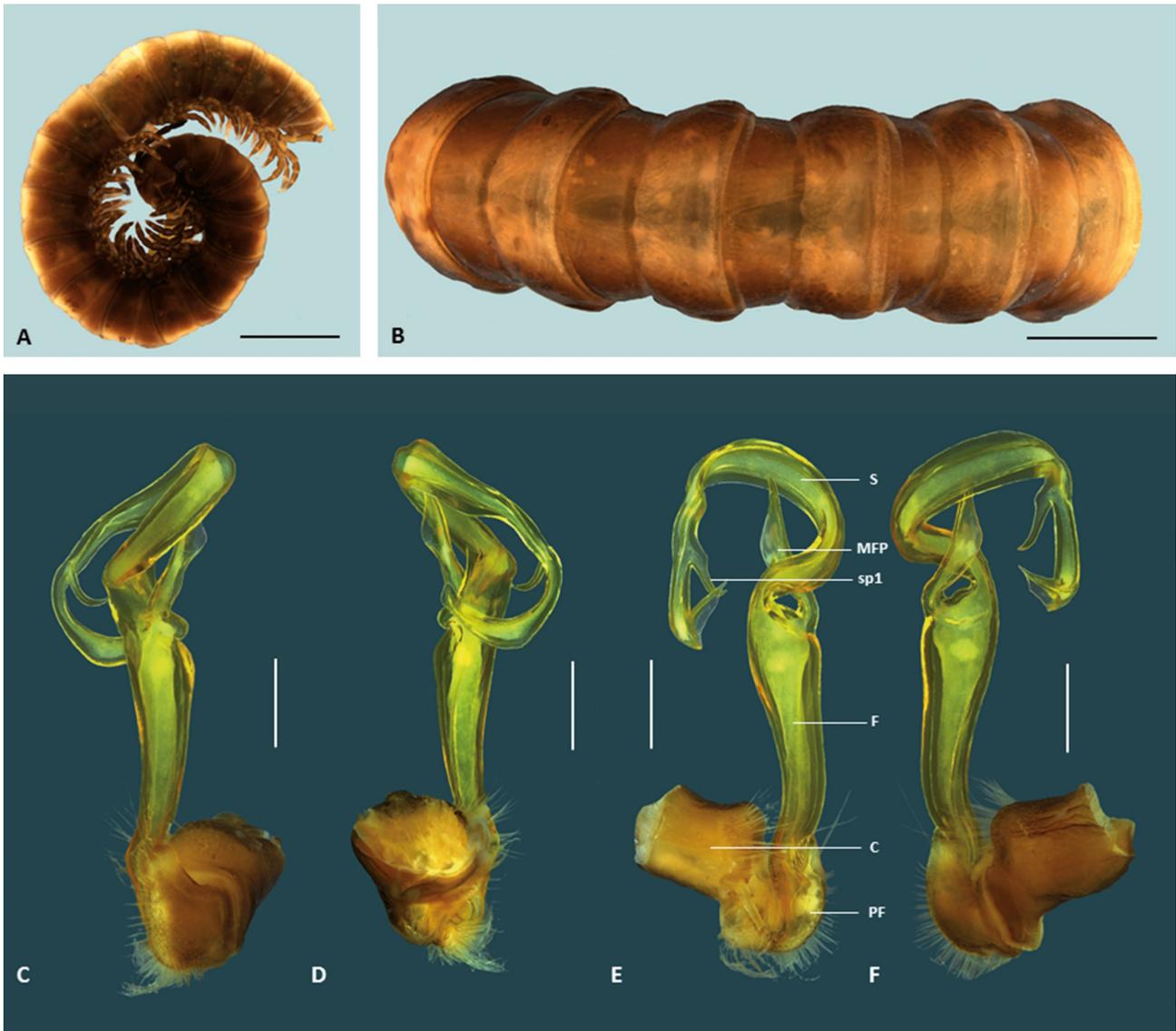
#### DIAGNOSIS

Gonopod: the most striking diagnostic feature of *Antichiropus digitatus* is the large process on the solenomere which is almost long enough to reach the tip of the solenomere. This process and the tip together give the impression of a finger and thumb when viewed medially (Figure 14E). The gonopod is relatively simple with few processes.

#### DESCRIPTION

##### *Male holotype*

Body c. 27 mm long; midbody ring c. 2.5 mm wide, with distinct beaded waist, prozonite and metazonite of similar width. Colour chestnut brown overall with broad, pale, dorsal stripe running full length of body (Figure 14A); leg colour as for body. No paranota on posterior rings (Figure 14B). Sternites without obvious processes/tubercles, sternal lamella broad, with rounded edge. Anterior spiracles at midbody flat, folded. Head smooth, without noticeable sculpturing; frons smooth, with some setae; face broad, cheeks partially obscuring cardines, when viewed face-on, maximum width 2.9 x the distance between antennal sockets; sockets separated by c. 2.5 x width of socket. Antennae of moderate length, reaching to ring 2, not obviously clavate, antennomeres relatively robust. Collum 0.75 x as long as head (in lateral view). Gonopod of medium length, reaching to posterior edge of ring 5; coxa (C)



**FIGURE 14** *Antichiropus digitatus* sp. nov.: A–B, holotype male (WAM T71993) habitus: A, lateral view; B, dorsal view; C–F, paratype male (WAM T71992) right gonopod image flipped: C, posterior view; D, anterior view; E, medial view; F, lateral view. Abbreviations: C, coxa; F, femorite; MFP, main femoral process; PF, prefemur; S, solenomere; sp1, solenomere process 1. Scale bars: A = 2 mm; B = 1 mm; C–F = 0.5 mm.

more robust, thicker, of similar length to femorite, with noticeable ridge on anterior surface; prefemur (PF) somewhat shorter than femorite; femorite (F) contributing to c. 1/2 acropodite length in situ, upright, becoming thicker towards apex; main femoral process (MFP) long (to c. 1/4 solenomere length), pointed, but not spine-like, spear or flame-shaped; second femoral process (fp1) absent; prolongation of femorite apex (prof) absent; solenomere (S) long enough to form more than 1 loop or circle, generally more slender than femorite, thickest midway along length, narrowing abruptly in apical 1/3; solenomere tip broadly pointed, with no serrations, single flattened end; solenomere

process (sp1) in apical 1/3 of solenomere, prominent, pointed, upright, thumb-like and slender (Figures 14 C–F).

Female (WAM T71993) similar in colour and length to male, but slightly broader (c. 3 mm).

#### DISTRIBUTION

This species is only known from specimens collected at Dongolocking Spring Reserve (Figure 36).

#### ETYMOLOGY

This species is named for the distinctive shape of the solenomere tip (Latin, *digitatus*, having fingers).

***Antichiropus equinus* sp. nov.**

Figures 15, 38

<http://www.zoobank.org/urn:lsid:zoobank.org:act:21994AFE-007B-4027-816B-EC5779CFF1F1>

## MATERIAL EXAMINED

*Holotype*

**Australia: Western Australia:** ♂, Lake King-Norseman Road, site LK13, 33°04'54"S, 119°59'53"E, 15 October 1999–25 October 2000, wet pitfall, N. Guthrie (WAM T124608).

*Paratypes*

**Australia: Western Australia:** 43 ♂, 26 ♀, 8 juveniles, collected with holotype (WAM T72616, T72617, T72618, T112942).

*Other material*

None.

## DIAGNOSIS

**Gonopod:** *Antichiropus equinus* is distinguishable from other similar species, namely *A. anconus*, by a combination of gonopodal features. The main femoral process is of a distinctive shape: large and very stout,



FIGURE 15

*Antichiropus equinus* sp. nov.: paratype male (WAM T72616) habitus: A, lateral view; B, dorsal view; C–F, left gonopod: C, posterior view; D, anterior view; E, medial view; F, lateral view. Abbreviations: C, coxa; F, femorite; MFP, main femoral process; PF, prefemur; S, solenomere; sp1, solenomere process 1. Scale bars: A = 2 mm; B = 1 mm; C–F = 0.5 mm.

with a transparent flange running along its pointed tip. The second femoral process is broad, short and triangular and more prominent than that of *A. anconus* (Figures 7D, 15D). The solenomere ends in a spatulate, slightly bilobed tip which, under high magnification, reveals serrations. There is a single, prominent, pointed process that arises c. two-thirds along the length of the solenomere from its base: *A. anconus* has three distinct solenomere processes.

## DESCRIPTION

### *Male holotype*

Body c. 25 mm long; midbody ring c. 2.5 mm wide, with distinct waist, prozonite and metazonite of similar width. Colour chestnut brown overall (Figure 15A); leg colour as for body. No paranota on posterior rings (Figure 15C). Sternites without obvious processes/tubercles, sternal lamella broad, heart-shaped. Anterior spiracles at midbody flat, folded. Head smooth, without noticeable sculpturing; frons smooth, with some setae; face broad, cheeks partially obscuring cardines, when viewed face-on, maximum width c. 3.7 x the distance between antennal sockets; sockets separated by c. 1.5 x width of socket. Antennae of moderate length, reaching to ring 2, not obviously clavate, antennomeres 5 and 6 only slightly wider than proximal ones. Collum 0.75 x as long as head (in lateral view). Gonopod of medium length, reaching posterior edge of ring 5; coxa (C) more robust, thicker and of similar length to femorite, with noticeable ridge on anterior surface; prefemur (PF) of similar length to femorite, ovoid, appearing to hug femorite base, small prefemoral lip; femorite (F) contributing to c. 1/2 of acropodite length in situ, upright, slightly curved when viewed anteriorly, becoming thicker towards apex; main femoral process (MFP) long (to c. 1/4 solenomere length), relatively stout with pointed tip, transparent flange at tip, irregularly shaped; second femoral process (fp1) present, arising close to solenomere base, curved, pointed, short, broadly triangular; prolongation of femorite apex (prof) absent; solenomere (S) relatively short, forming circle, generally thicker than femorite, thickest midway along length; solenomere tip flattened, with serrations and several lobes; solenomere process (spl) positioned c. halfway along solenomere, prominent, pointed, upright, slender (Figures 15B, D–G).

### *Female*

Similar to the male but slightly broader, width c. 3 mm (WAM T112942).

## DISTRIBUTION

This species is known only from specimens collected from a wet pitfall trap set near the edge of the Lake King-Norseman Road (Figure 38).

## ETYMOLOGY

The species name refers to a town in the area,

Norseman, that was named after a horse (Latin, *equinus*, of horses).

## *Antichiropus exclamatus* sp. nov.

Figures 2, 16, 37

<http://www.zoobank.org/urn:lsid:zoobank.org:act:F5006273-D1B6-4221-BFE4-48CC97CF1B39>

## MATERIAL EXAMINED

### *Holotype*

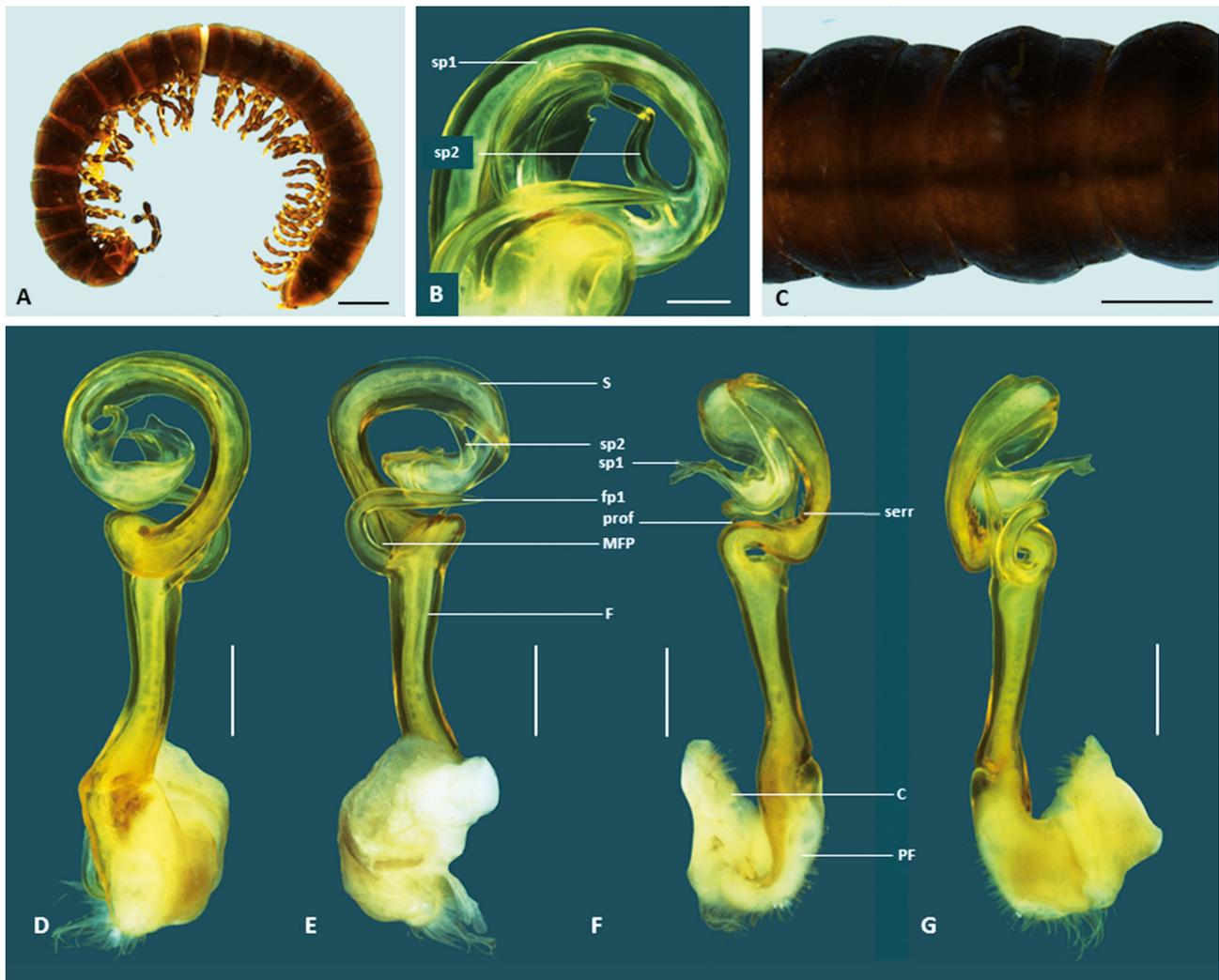
**Australia: Western Australia:** ♂, Exclamation Lake, site SG 06A, 32°46'22"S, 121°23'52"E, 23–29 April 2002, pitfall, R. Teale, G. Harold, A. Sanders and P. Higgs (WAM T71927).

### *Paratypes*

**Australia: Western Australia:** 1 ♂, Exclamation Lake, site SG 05B, 32°49'18"S, 121°24'45"E, 29 April 2002, dry pitfall, R. Teale, G. Harold, A. Sanders and P. Higgs (WAM T71928); 4 ♂, 5 ♀, Exclamation Lake, site SG 01A, 32°48'26"S, 121°26'49"E, 23–29 April 2002, dry pitfall, R. Teale, G. Harold, A. Sanders and P. Higgs (WAM T71930).

### *Other material*

**Australia: Western Australia:** 7 ♂, 2 ♀, 1 juvenile, Salmon Gums, 32°58'59"S, 121°38'42"E, 23 July 2007, in mallee litter under logs, C.A. Car (WAM T54242); 1 ♂, Norseman, 32°09'47"S, 121°47'50"E, 23 July 2007, in mallee litter, C.A. Car (WAM T54243); 1 ♂, N of Mt Dean (via Norseman), 32°17'23"S, 121°26'03"E, 12 May 2005, open saltbush, eucalypts on limestone soil under log, A.F. Longbottom (WAM T66523); 3 ♂, Exclamation Lake, site SG 08B, 32°41'48"S, 121°26'31"E, 23–29 April 2002, dry pitfall, R. Teale, G. Harold, A. Sanders and P. Higgs (WAM T71917); 1 ♂, Exclamation Lake, site SG 08A, 32°41'48"S, 121°26'31"E, 23–29 April 2002 dry pitfall, R. Teale, G. Harold, A. Sanders and P. Higgs (WAM T71919); 2 ♂, Exclamation Lake, site SG 09B, 32°42'26"S, 121°29'31"E, 23–29 April 2002, pitfall, R. Teale, G. Harold, A. Sanders and P. Higgs (WAM T71920); 1 ♂, Pyramid Lake, East, site GP 04, 33°09'31"S, 120°00'03"E, 15 October 1999–26 November 2000, wet pitfall, B. Durrant (WAM T71921); 3 ♂, Pyramid Lake, East, site GP 04, 33°09'31"S, 120°00'03"E, 15 October 1999–26 November 2000, wet pitfall, B. Durrant (WAM T71922); 1 ♀, 1 juvenile, Exclamation Lake, site SG 10B, 32°41'55"S, 121°29'11"E, 23–29 April 2002, dry pitfall, R. Teale, G. Harold, A. Sanders and P. Higgs (WAM T71925); 2 ♀, Exclamation Lake, site SG 07B, 32°49'59"S, 121°24'50"E, 23–29 April 2002, dry pitfall, R. Teale, G. Harold, A. Sanders and P. Higgs (WAM T71926); 2 ♀, Exclamation Lake, site SG 03B, 32°47'51"S, 121°24'09"E, 23–29 April 2002, dry pitfall, R. Teale, G. Harold, A. Sanders and



**FIGURE 16** *Antichiropus exclamatus* sp. nov. A, C paratype male (WAM T71928) habitus: A, lateral view; C, dorsal view; B, D–G holotype male (WAM T71927) left gonopod: B, anterior view, detail of solenomere tip; D, posterior view; E, anterior view; F, medial view; G, lateral view. Abbreviations: C, coxa; F, femorite; fp1, second femoral process; MFP, main femoral process; PF, prefemur; prof, prolongation of femorite; S, solenomere; serr, serrations; sp1 and sp2, solenomere processes 1 and 2. Scale bars: A = 2 mm; B = 0.2 mm; C = 1 mm; D–G = 0.5 mm.

P. Higgs (WAM T71929); 1 ♂, 4 ♀, Exclamation Lake, site SG 12, 32°51'43"S, 121°24'04"E, 23–29 April 2002, dry pitfall, R. Teale, G. Harold, A. Sanders and P. Higgs (WAM T71940); 2 ♂, 1 ♀, Pine Hill, 33°18'S, 123°23'E, 24 May 1986, B. Y. Main (WAM T72536); 2 ♂, 2 ♀, c. 32 km NW of Salmon Gums, 32°46'35"S, 121°23'46"E, September 2008, opportunistic, K. George and M. Peterson (WAM T95225); 1 ♀, c. 35 km NW of Salmon Gums, Rapallo site 4A, 32°43'02"S, 121°25'00"E, October–November 2008 pitfall trap, K. George and M. Peterson (WAM T95226); 2 ♂, c. 28 km NW of Salmon Gums, Rapallo site 7A, 32°45'55"S, 121°25'36"E, October–November 2008, pitfall trap, K. George and M. Peterson (WAM T95229); 1 ♂, c. 28 km NW of Salmon Gums, Rapallo site 7, 32°45'55"S, 121°25'36"E, October–November 2008, night forage, K. George and

M. Peterson (WAM T95230); 1 ♀, c. 28 km NW of Salmon Gums, Rapallo site 7B, 32°45'58"S, 121°25'36"E, October–November 2008 day forage, K. George and M. Peterson (WAM T95231); 1 ♂, Exclamation Lake, site SG 05B, 32°49'18"S, 121°24'45"E, 23–29 April 2002, dry pitfall, R. Teale, G. Harold, A. Sanders and P. Higgs (WAM T112932); 1 ♀, Exclamation Lake, site SG 12, 32°51'43"S, 121°24'04"E, 23–29 April 2002, dry pitfall, R. Teale, G. Harold, A. Sanders and P. Higgs (WAM T112933); 2 ♂, 2 ♀, Newman Rocks, 32°06'50.9"S, 123°10'22.6"E, 3 August 2012 by hand, under rocks in gully below large pool, J.M. Waldock (WAM T126101).

#### DIAGNOSIS

Gonopod: *Antichiropus exclamatus* is recognisable by a combination of characters in a telopodite that is the

most complex looking of all those in the Great Western Woodland species: the solenomere is thickest midlength and carries a large L-shaped process, and the second femoral process is slender, pointed and curves into a C-shape (Figures 16D–G).

## DESCRIPTION

### *Male holotype*

Body c. 25 mm long; midbody ring c. 2.5 mm wide, with less pronounced waist, prozonite and metazonite of similar width. Colour chestnut brown overall (Figure 16A); leg colour as for body. No paranota on posterior rings (Figure 16C). Sternites without obvious processes/tubercles, transverse sternal cross impressions not noticeably different from longitudinal, sternal lamella broad, with rounded edge. Anterior spiracles at midbody flat, folded. Head smooth, without noticeable sculpturing; frons smooth, with some setae; face broad, cheeks partially obscuring cardines, when viewed face-on, maximum width c. 3.1 x the distance between antennal sockets; sockets separated by c. 2 x width of socket. Antennae of moderate length, reaching to ring 2, distinctly clavate, antennomeres relatively robust. Collum 1 x as long as head (in lateral view). Gonopod of medium length, reaching posterior edge of ring 5; coxa (C) thicker, but similar length to femorite, with noticeable ridge on anterior surface; prefemur (PF) of similar length to femorite, ovoid; femorite (F) contributing to c. 1/2 of acropodite length in situ, of similar thickness along length; main femoral process (MFP) long (to c. 1/4 solenomere length), narrow, pointed, spear or flame-shaped; second femoral process (fp1) present, arising close to solenomere base, curved, pointed, slender along length; prolongation of femorite apex (prof) present as slight projection, orientated anteriorly; solenomere (S) long, forming >1 loop/circle, thicker than femorite in part, thickest nearer tip; solenomere tip flattened, with no serrations, ribbon like; solenomere process (sp1) at tip, small pointed; solenomere process (sp2) near solenomere tip, prominent, curved, L-shaped (Figures B, D–G).

### *Female*

Similar to male in length, but slightly broader (slightly less than 3 mm wide) (WAM T71930).

## DISTRIBUTION

This species is remarkable as one of those from the Great Western Woodlands that has a relatively broad distribution, stretching from Pyramid Lake (33°09'31"S, 120°00'03"E) to Newman Rocks (32°06'50.9"S, 123°10'22.6"E) (Figure 37).

## ETYMOLOGY

This species was named for the type locality, Exclamation Lake, and is derived from the Latin word *clamatus* (Latin, cry out, shout, call).

## *Antichiropus framenai* sp. nov.

Figures 17, 37

<http://www.zoobank.org/urn:Isid:zoobank.org:act:3E02AA85-C85C-405F-9209-2B2CA9F256C6>

## MATERIAL EXAMINED

### *Holotype*

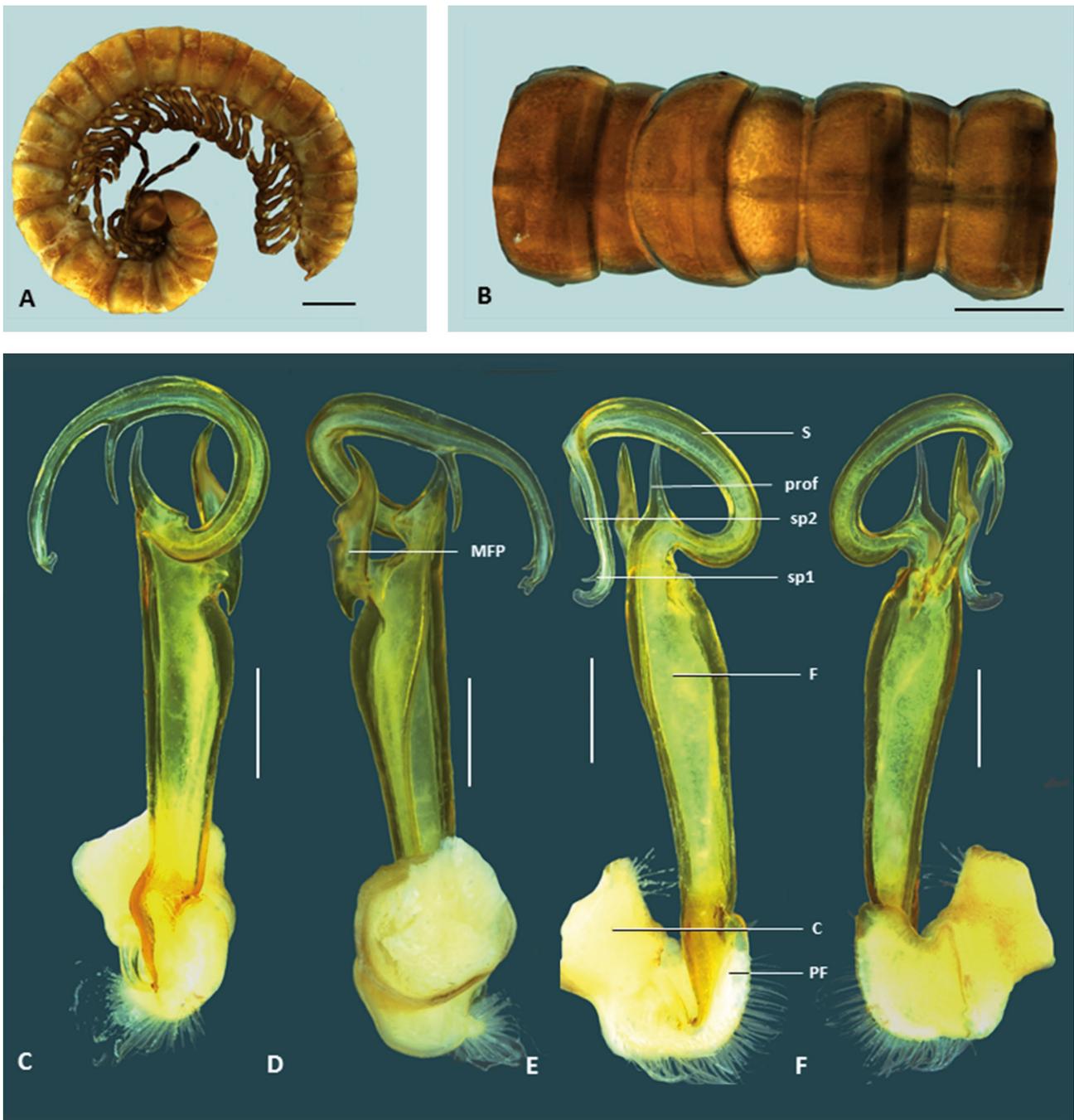
**Australia: Western Australia:** ♂, Mt Jackson area, site MJ07, 30°13'30"S, 119°09'40"E, 18 August 2006, under leaf litter, W. Bancroft and B. Metcalf (WAM T98571).

### *Paratypes*

**Australia: Western Australia:** 2 ♂, 1 ♀, 1 juvenile, Bungalbin Hill, 49 km NNE of Koolyanobbing, 30°23'32.03"S, 119°37'47.10"E, 3–11 April 2013, leaf litter, S. White, A. Heidrich, A. Nowicki, J. Vos and F. Bokhari (WAM T130657); 2 ♂, 1 juvenile, Bungalbin Hill, 53 km N of Koolyanobbing, 30°21'42.27"S, 119°37'06.48"E, 3–11 April 2013, leaf litter, S. White, A. Heidrich, A. Nowicki, J. Vos and F. Bokhari (WAM T130663).

### *Other material*

**Australia: Western Australia:** 1 ♂, 13.2 km SE of Koolyanobbing, 30°53'06.97"S, 119°37'59.66"E, 20 August 2009, leaf litter, R. Teale (WAM T99029); 1 ♂, 13.2 km SE of Koolyanobbing, 30°53'06.97"S, 119°37'59.66"E, 20 August 2009, leaf litter, R. Teale (WAM T99037); 1 ♂, 10.0 km SE of Koolyanobbing, 30°52'16.66"S, 119°36'16.70"E, 22 August 2009, leaf litter, R. Teale (WAM T99084); 1 ♂, Deception, 108.8 km N of Koolyanobbing, 29°51'30"S, 119°16'12"E, 30 June 2010, leaf litter, Z. Hamilton and J. Cairnes (WAM T104622); 1 ♂, Windarling, 92.5 km N of Koolyanobbing, 30°00'44"S, 119°15'32"E, 7 July 2010, leaf litter, Z. Hamilton and J. Cairnes (WAM T104661); 1 ♂, Windarling, 93.3 km N of Koolyanobbing, 30°00'26"S, 119°14'49"E, 4 July 2010, leaf litter, Z. Hamilton and J. Cairnes (WAM T104673); 1 ♂, 1 juvenile, c. 39 km W of Wallaroo, 30°23'54.31"S, 119°56'45.51"E, 17–24 May 2013, leaf litter, dense bushland, K. Bankin (WAM T128589); 1 ♂, 1 juvenile, c. 39 km W of Wallaroo, 30°22'41.78"S, 119°55'17.47"E, 17–24 May 2013, leaf litter, open woodland, K. Bankin (WAM T128590); 1 ♂, 1 juvenile, Bungalbin Hill, 53 km NNE of Koolyanobbing, 30°22'42.62"S, 119°41'56.69"E, 3–11 April 2013, leaf litter, S. White, A. Heidrich, A. Nowicki, J. Vos and F. Bokhari (WAM T130647); 3 ♀, 1 juvenile, Bungalbin Hill, 53 km N of, 30°21'43.17"S, 119°37'12.31"E, 3–11 April 2013, leaf litter, S. White, A. Heidrich, A. Nowicki, J. Vos and F. Bokhari (WAM T130649); 1 ♂, 1 ♀, 3 juveniles, Bungalbin Hill, 53 km N of Koolyanobbing, 30°21'44.77"S, 119°37'17.51"E, 3–11 April 2013, leaf



**FIGURE 17** *Antichiropus framenaui* sp. nov.: A-B paratype male (WAM T130663) habitus: A, lateral view; B, dorsal view; C-F, holotype male (WAM T98571) left gonopod: C, posterior view; D, anterior view; E, medial view; F, lateral view. Abbreviations: C, coxa; F, femorite; MFP, main femoral process; PF, prefemur; prof, prolongation of femorite; S, solenomere; sp1 and sp2, solenomere processes 1 and 2. Scale bars: A = 2 mm; B = 1 mm; C-F = 0.5 mm.

litter, S. White, A. Heidrich, A. Nowicki, J. Vos and F. Bokhari (WAM T130659).

#### DIAGNOSIS

**Gonopod:** *Antichiropus framenaui* can be characterised by a combination of features: a long, upright, robust femorite, an elongate slender solenomere

which carries a short process at its tip and a long pointed second process in the apical third, as well as a well developed large pointed prolongation of the femorite. It may be distinguished from similar species such as *A. alastairi* (Figures 5C-F) by the unusual shape of the main femoral process which is pointed both anteriorly and posteriorly (Figure 17D). *A. giganteus*

(Figure 18D) has a similarly pointed main femoral process but of a noticeably different shape and this species lacks the femoral prolongation present in *A. framenau*.

## DESCRIPTION

### *Male holotype*

Body c. 25 mm long; midbody ring c. 2.5 mm wide, with less pronounced waist, prozonite and metazonite of similar width. Colour chestnut brown overall (Figure 17A); leg colour as for body. No paranota on posterior rings (Figure 17B). Sternites without obvious processes/tubercles, sternal lamella broad, helmet-shaped. Anterior spiracles at midbody flat, folded. Head smooth, without noticeable sculpturing; frons smooth, with some setae; face narrow, cardines and stipites clearly visible when animal is viewed face-on, maximum width c. 3.6 x the distance between antennal sockets, sockets separated by c. 2 x width of socket. Antennae of moderate length, reaching to ring 2, not obviously clavate, antennomeres 5 and 6 only slightly wider than proximal ones and relatively slender. Collum 1 x as long as head (in lateral view). Gonopod of medium length, reaching posterior edge of ring 5; coxa (C) thicker, shorter than femorite, with slight ridge on anterior surface; prefemur (PF) considerably shorter than femorite, ovoid, slight prefemoral lip; femorite (F) contributing to c. 2/3 of acropodite length in situ, upright, robust, thickest midway along length, becoming slightly thinner towards apex; main femoral process (MFP) long (to c. 1/4 solenomere length), pointed, but not spine-like, irregularly shaped, pointed at both ends; second femoral process (fp1) absent; prolongation of femorite apex (prof) present, long, sharply pointed; solenomere (S) long, forming >1 loop/circle, much more slender than femorite, generally slender, tapering towards tip; solenomere tip with single flattened end and no serrations; solenomere process (sp1) near solenomere tip, small, pointed; second solenomere process (sp2) in apical 1/3 of solenomere, prominent, pointed (Figures 17C–F).

### *Female*

Of similar length and colour to male but broader (at least 3 mm wide) (WAM T130657).

## DISTRIBUTION

This species has been collected from the Mt Jackson area, Windjarling, near Koolyanobbing, and Deception (Figure 37).

## ETYMOLOGY

The specific epithet is a patronym in honour of Volker Framenau in appreciation of his research on terrestrial invertebrates.

## *Antichiropus giganteus* sp. nov.

Figures 18, 37

<http://www.zoobank.org/urn:lsid:zoobank.org:act:A9AEE3D0-CB66-4E4A-A11E-BF70E55170C4>

## MATERIAL EXAMINED

### *Holotype*

**Australia: Western Australia:** ♂, Jouerdine Nature Reserve, site BE 3, 30°38'11"S, 118°25'39"E, wet pitfall trap, 15 September 1998–25 October 1999, L. King (WAM T72232).

### *Other material*

None.

## DIAGNOSIS

Gonopod: *Antichiropus giganteus* is distinguishable by its relatively large, robust gonopod with a long, thick femorite and a broad flattened tip to the solenomere (Figures 18C–F). The femorite carries only one process which, like that of *A. framenau*, is pointed both anteriorly and posteriorly, but in this species is very long and slender. *A. giganteus* can be separated from the superficially similar *A. sagittulus* (Figure 29C–F) by its solenomere lacking obvious processes.

## DESCRIPTION

### *Male holotype*

Body length c. 35 mm; midbody ring c. 2.5 mm wide, with distinct waist, prozonite and metazonite of similar width. Colour bleached in alcohol (Figure 18A). No paranota on posterior rings (Figure 18B). Sternites without obvious processes/tubercles, sternal lamella broad, helmet-shaped. Anterior spiracles at midbody flat, folded. Head smooth, without noticeable sculpturing; frons smooth, with some setae; face broad, cheeks partially obscuring cardines, when viewed face-on, maximum width c. 3.6 x the distance between antennal sockets; sockets separated by c. 2.5 x width of socket. Antennae of moderate length, reaching to ring 2 collum, distinctly clavate, antennomeres relatively robust. Collum 0.75 x as long as head (in lateral view). Gonopod long, reaching well into ring 5; coxa (C) robust, thicker and shorter than femorite, with slight ridge (not seen in Figure 18); prefemur (PF) considerably shorter than femorite, ovoid, a noticeable prefemoral lip; femorite (F) contributing to c. 2/3 of acropodite length in situ, upright, becoming thicker towards apex; main femoral process (MFP) long (to 1/4 solenomere length), narrow, pointed, irregularly shaped; second femoral process (fp1) absent; prolongation of femorite apex (prof) absent; solenomere (S) relatively short, forming circle, much more slender than femorite, thick at base, becoming thinner midlength, thickening again at tip; solenomere tip with single flattened end and no

serrations; solenomere process (sp1) near solenomere tip, tiny, pointed, slender (Figures 18C–F).

#### Female

No female specimens have been collected.

#### DISTRIBUTION

This species is known from a single male collected in

a wet pitfall trap in Jouerdine Nature Reserve (Figure 37).

#### ETYMOLOGY

This species was named for the relatively large size of the male gonopods (Latin, adjective, *giganteus*, very large, gigantic).



**FIGURE 18** *Antichiropus giganteus* sp. nov.: holotype male (WAMT72232) habitus: A, lateral view; B, dorsal view; C–F, left gonopod: C, posterior view; D, anterior view; E, medial view; F, lateral view. Abbreviations: F, femorite; MFP, main femoral process; PF, prefemur; S, solenomere; sp1 and sp2, solenomere processes 1 and 2. Scale bars: A = 5 mm; B–F = 1 mm.

***Antichiropus howardi* sp. nov.**

Figures 19, 37

<http://www.zoobank.org/urn:lsid:zoobank.org:act:B791EA60-2B44-48B8-8DF5-2A54398F921C>

## MATERIAL EXAMINED

*Holotype*

**Australia: Western Australia:** ♂, Marvel Loch, St Barbara Operation, 31°10'10.56"S, 119°18'16.05"E, 3 August 2008, under rock, P. Cullen and P. Langlands (WAM T132358).

*Paratypes*

**Australia: Western Australia:** 2 ♂, 3 juveniles, collected with holotype (WAM T96079).

*Other material*

None.

## DIAGNOSIS

Gonopod: *Antichiropus howardi* is most similar to *A. incomptus* (Figures 20C–F), both possessing a very simple gonopod, but the species may be separated by several gonopodal features: *A. howardi* has a more robust femorite, a longer solenomere that tends to dip down towards the coxa in lateral view, and a larger solenomere process (Figures 19C–F).

## DESCRIPTION

*Male holotype*

Body c. 25 mm long; midbody ring c. 2 mm wide, with distinct waist, prozonite and metazonite of similar

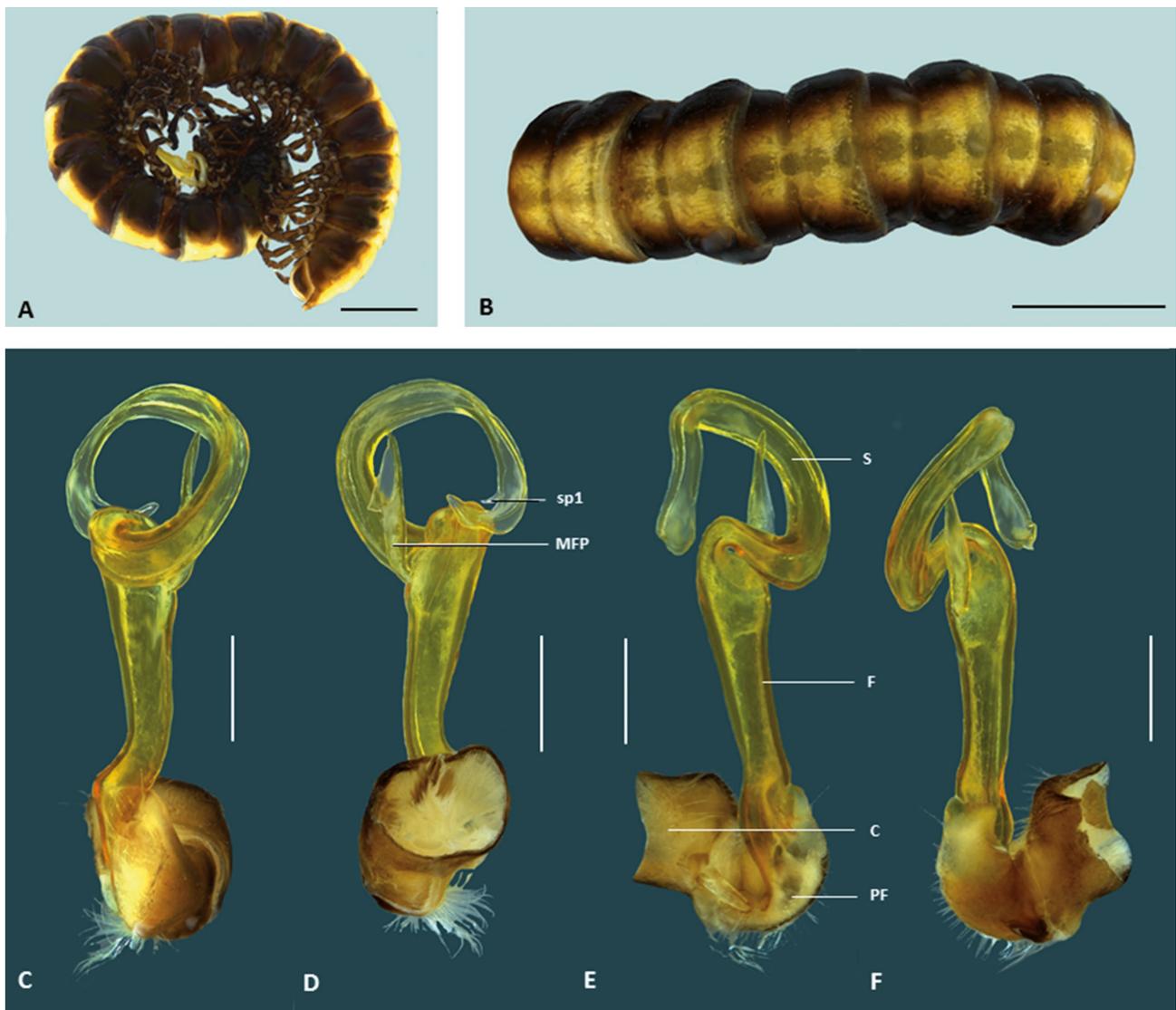


FIGURE 19

*Antichiropus howardi* sp. nov.: paratype male (WAM T96079) habitus: A, lateral view; B, dorsal view; C–F left gonopod: C, posterior view; D, anterior view; E, medial view; F, lateral view. Abbreviations: C, coxa; F, femorite; MFP, main femoral process; PF, prefemur; S, solenomere; sp1, solenomere process 1. Scale bars: A = 2 mm; B = 2 mm; C–F = 0.5 mm.

width. Colour dark brown overall (Figure 19A), with broad, pale, dorsal stripe running full length of body; leg colour as for body. Paranota on posterior rings present as slight protuberances (Figure 19B). Sternites without obvious processes/tubercles, sternal lamella broad, with rounded edge. Anterior spiracles at midbody flat, folded. Head smooth, without noticeable sculpturing; frons smooth, with some setae; face narrow, cardines and stipites clearly visible when animal is viewed face-on, maximum width c. 3.4 x the distance between antennal sockets; sockets separated by c. 2 x width of socket. Antennae of moderate length, reaching to ring 2, not obviously clavate, antennomeres 5 and 6 only slightly wider than proximal ones and relatively robust. Collum 0.75 x as long as head (in lateral view). Gonopod of medium length, reaching posterior edge of ring 5; coxa (C) more robust, thicker and of similar length to femorite, with noticeable ridge on anterior surface; prefemur (PF) of similar length to femorite, ovoid, small prefemoral lip; femorite (F) contributing to c. 1/2 acropodite length in situ, slightly curved when viewed anteriorly, upright and becoming thicker towards apex; main femoral process (MFP): long (to c. 1/4 solenomere length), pointed, but not spine-like, hatchet-shaped; second femoral process (fp1) absent; prolongation of femorite apex (prof) absent; solenomere (S) relatively short, forming circle, generally more slender than femorite but of variable thickness; solenomere tip with single flattened end, broadly pointed, with no serrations; solenomere process (sp1); near solenomere tip, small, pointed, upright, slender (Figures 19C–F).

#### Female

No female specimens have been collected.

#### DISTRIBUTION

This species has been collected only from the Marvel Loch area (Figure 37).

#### ETYMOLOGY

This species is named for Robert Howard of Cliffs Natural Resources in appreciation of his support for this research project.

#### *Antichiropus incomptus* sp. nov.

Figures 20, 37

<http://www.zoobank.org/urn:lsid:zoobank.org:act:B8040C9C-4D46-4B3F-B277-AF022CA15E0B>

#### MATERIAL EXAMINED

##### *Holotype*

**Australia: Western Australia:** ♂, S of Kambalda, 31°34'03"S, 121°44'42"E, April 2006, S. Thompson (WAM T124577).

##### *Paratypes*

**Australia: Western Australia:** 21 ♂, 6 ♀, 3 juveniles, S of Kambalda, 31°34'03"S, 121°44'42"E, April 2006, S. Thompson (WAM T99989).

##### *Other material*

**Australia: Western Australia:** 1 ♂, Woodline, 31°57'S, 122°24'E, August 1980, pitfall trap, mallee/shrubs, W.F. Humphreys et al. (WAM T71829); 1 ♂, 1 ♀, S of Kambalda, 31°34'03"S, 121°44'42"E, April 2006, S. Thompson (WAM T112935); Bedourie Hill, c. 47 km NE of Norseman, N of Eyre Highway, 32°03'20.0"S, 122°15'31.1"E, 16 November 2011, under disturbed rocks, remains only, C.A. Car and J.M. Waldoock (WAM T119065); Bedourie Hill, c. 47 km NE of Norseman, N of Eyre Highway, 32°03'20.0"S, 122°15'31.1"E, 16 November 2011, under disturbed rocks, remains only, C.A. Car and J.M. Waldoock (WAM T119066); 1 ♂ (remains only), Bedourie Hill, c. 47 km NE of Norseman, N of Eyre Highway, 32°03'20.0"S, 122°15'31.1"E, 16 November 2011, under disturbed rocks, C.A. Car and J.M. Waldoock (WAM T119067); 1 ♂ (remains only), Bedourie Hill, c. 47 km NE of Norseman, N of Eyre Highway, 32°03'20.0"S, 122°15'31.1"E, 16 November 2011, under disturbed rocks, C.A. Car and J.M. Waldoock (WAM T119068).

#### DIAGNOSIS

Gonopod: *Antichiropus incomptus* is recognisable by its simple gonopod, with a relatively long femorite. There are no obvious solenomere processes, just one tiny spine near the solenomere tip. This species is most similar to *A. howardi*, but has a relatively slender femorite and short solenomere as well as a differently shaped femoral process (Figures 20C–F).

#### DESCRIPTION

##### *Male holotype*

Body c. 24 mm long; midbody ring c. 2.75 mm wide, with distinct waist, prozonite and metazonite of similar width. Colour dark brown overall (Figure 20A), with pale paramedian spots on dorsal metazonites, giving a banded appearance; leg colour as for body. Paranota on posterior rings present as slight protuberances (Figure 20B). Some sternites, except ring 5, with posteriorly pointing, setose protuberances, sternite of ring 5 without obvious processes/tubercles, sternal lamella broad, mushroom-shaped. Anterior spiracles at midbody flat, erect. Head smooth, without noticeable sculpturing; frons smooth, with some setae; face broad, cheeks at least partially obscuring cardines, when viewed face-on, maximum width c. 3.8 x the distance between antennal sockets; sockets separated by c. 2 x width of socket. Antennae of moderate length, reaching to ring 2, distinctly clavate, antennomeres relatively robust. Collum 1 x as long as head (in lateral view). Gonopod of medium length, reaching posterior edge of ring 5; coxa (C) more robust, thicker and shorter than femorite, with noticeable ridge on



**FIGURE 20** *Antichiropus incomptus* sp. nov.: A-C, male (WAM T112935) A, B, habitus: A, lateral view; C, dorsal view; B, sternites showing posteriorly pointing processes (indicated by arrows); D-G, paratype male (WAM T99989) left gonopod: D, posterior view; E, anterior view; F, medial view; G, lateral view. Abbreviations: C, coxa; F, femorite; MFP, main femoral process; PF, prefemur; S, solenomere; sp1, solenomere process 1. Scale bars: A = 2 mm; B = 0.5 mm; C = 1 mm; D-G = 0.5 mm.

anterior surface; prefemur (PF) considerably shorter than femorite, ovoid; femorite (F) contributing to c. 2/3 of acropodite length in situ, upright, of similar thickness along length; main femoral process (MFP) long (to c. 1/4 solenomere length), pointed, but not spine-like, spear or flame-shaped; femoral process (fp1) absent; prolongation of femorite apex (prof) absent; solenomere (S) relatively short, forming circle, generally more slender than femorite, and thickest midway along length; solenomere tip with single, flattened end, with no serrations; solenomere process (sp1): near solenomere tip, small, pointed, slender (Figures 20C–F).

#### *Female*

Similar to male, but slightly wider dorsally (c. 3 mm wide) (WAM T112936)

#### DISTRIBUTION

This species has been collected mainly from rocky outcrops, c. 50 km east of Norseman and from mallee country in Kambalda (Figure 37).

#### ETYMOLOGY

The species name describes the relatively simple configuration of the male gonopod (Latin, adjective, *incomptus*, unadorned).

***Antichiropus inflatus* sp. nov.**

Figures 21, 38

<http://www.zoobank.org/urn:lsid:zoobank.org:act:F69CB601-E70E-4291-8E4E-9BA5AE1C332A>

## MATERIAL EXAMINED

*Holotype*

**Australia: Western Australia:** ♂, Mt Hampton Nature Reserve Dam, site MN 6, 31°45'40"S, 119°04'21"E, wet pitfall trap, closed 22 September 1998, N. Guthrie (WAM T72056).

*Other material*

None.

## DIAGNOSIS

Gonopod: *Antichiropus inflatus* is characterised by a short solenomere with a broad paddle-like tip in close association with a noticeably long solenomere process. In addition, the main femoral process is large and swollen and bulb-like in appearance (Figures 21C–F). This species is very similar to *A. succedaneus* (Figure 33D) but the solenomere tips differ markedly between the species.

## DESCRIPTION

*Male holotype*

Body length c. 30 mm, appearing slightly rugose laterally; midbody ring c. 2.5 mm wide, with distinct waist, prozonite and metazonite of similar width. Colour

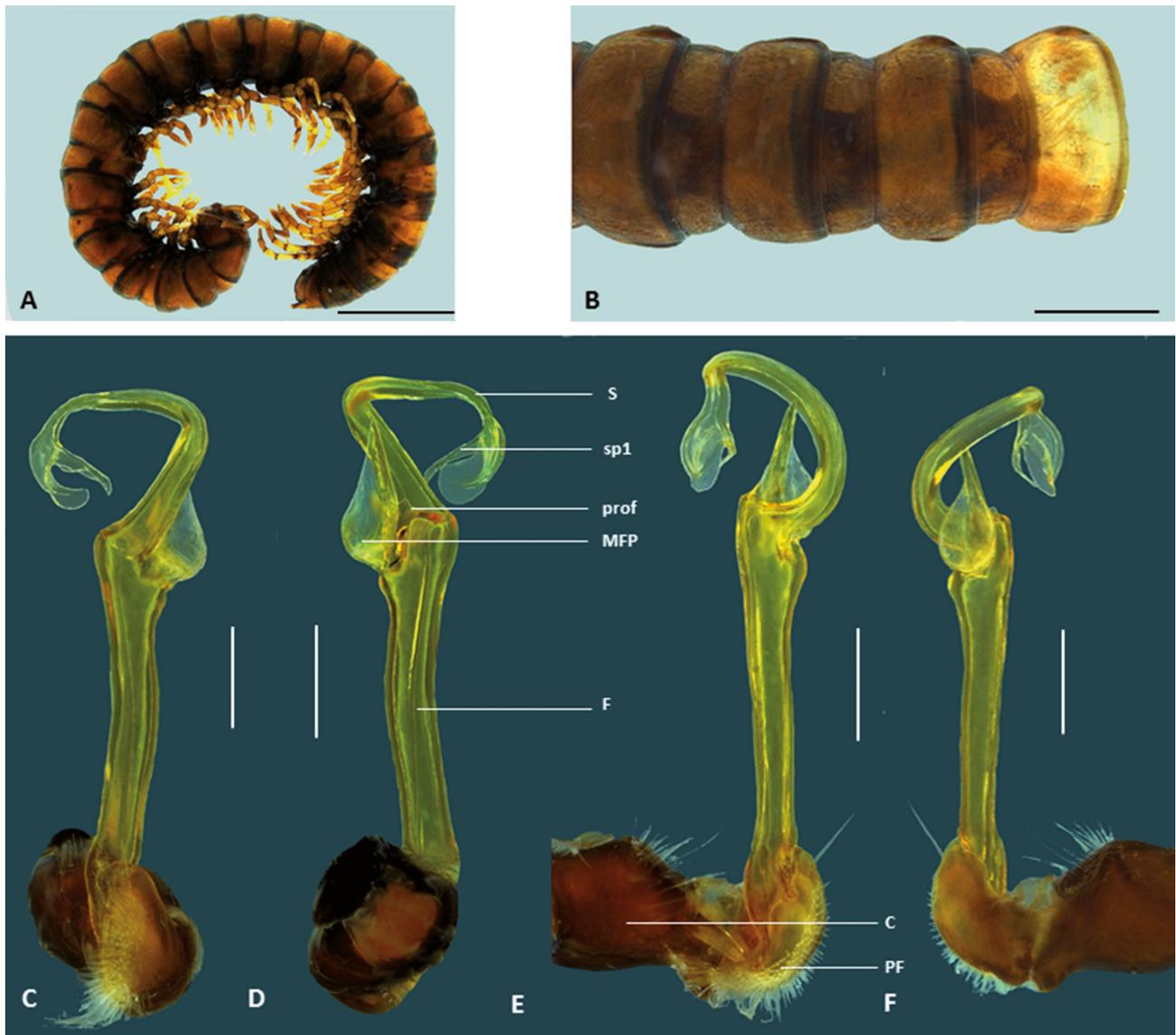


FIGURE 21

*Antichiropus inflatus* sp. nov.: holotype male (WAM T72056) habitus: A, lateral view; B, dorsal view; C–F, left gonopod: C, posterior view; D, anterior view; E, medial view; F, lateral view. Abbreviations: C, coxa; F, femurite; MFP, main femoral process; PF, prefemur; prof, prolongation of femurite; S, solenomere; sp1, solenomere process 1. Scale bars: A = 5 mm; B = 2 mm; C–F = 0.5 mm.

chestnut brown overall (Figure 21A), with transverse bands; legs noticeably paler than body. Paranota on posterior rings present as slight protuberances (Figure 21B). Sternites, except ring 5, with no noticeable features, sternite of ring 5 with slight protuberances, sternal lamella broad, helmet-shaped. Anterior spiracles at midbody protuberant, folded. Head smooth, without noticeable sculpturing; frons smooth, with some setae; face narrow, cardines and stipites clearly visible when animal is viewed face-on, maximum width c. 3.5 x the distance between antennal sockets; sockets separated by c. 1.5 x width of socket. Antennae of moderate length, reaching to ring 2, distinctly clavate, antennomeres relatively robust. Collum 1 x as long as head (in lateral view). Gonopod of medium length, reaching posterior edge ring 5; coxa (C) more robust, thicker, shorter than femorite, with noticeable ridge on anterior surface; prefemur (PF) considerably shorter than femorite, ovoid; femorite (F) c. 2/3 of acropodite length in situ, upright, of similar thickness along length; main femoral process (MFP) stout, very long, to c. 1/2 solenomere length, pointed, bulbous; second femoral process (fp1) absent; prolongation of femorite apex (prof) present as tiny spine; solenomere (S) relatively short, forming circle, generally more slender than femorite, thick at base, becoming thinner midlength, thickening again at tip; solenomere tip broadly flattened and rounded, with no serrations; solenomere process (sp1) near solenomere tip, prominent, pointed, curved, slender (Figures 21C–F).

#### Female

Females of this species are unknown.

#### DISTRIBUTION

This species is known from only one male specimen collected from Mt Hampden Nature Reserve (Figure 38)

#### ETYMOLOGY

The species name describes the appearance of the main femoral process on the male gonopod of this species (Latin, adjective, *inflatus*, swollen).

#### ***Antichiropus inopinatus* sp. nov.**

Figures 22, 38

<http://www.zoobank.org/urn:lsid:zoobank.org:act:885F0DB0-C4D1-4DB7-A902-043F5D7B74DE>

#### MATERIAL EXAMINED

##### *Holotype*

**Australia: Western Australia:** ♂, Fraser Range Station, water tank hill behind old homestead, 32°01'55.1"S, 122°48'09.5"E, 2 August 2012, J.M. Waldock (WAM T132359).

##### *Paratypes*

**Australia: Western Australia:** 1 ♂, 1 ♀, 1 juvenile, Fraser Range Station, collected with holotype, female and juvenile in eucalypt litter in small gully with mallee, male among rocks near water tank, J.M. Waldock (WAM T126105).

##### *Other material*

**Australia: Western Australia:** 1 ♂, 1 ♀, Fraser Range, 31°57'S, 122°53'E, 1 June 1914, collector unknown (WAM T347; old number 14/1006); 3 ♂, Fraser Range Station, 32°04'S, 122°48'E, 22 April 1995, under rocks, A.F. Longbottom (WAM T71974, T112934); 3 specimens, fragmented remains only (not males), Fraser Range Station, hill behind old homestead, 32°02'59.1"S, 122°48'06.7"E, 16 November 2011, under granite rocks and litter, C.A. Car and J.M. Waldock (WAM T119060, T119061).

#### DIAGNOSIS

Gonopod: in *Antichiropus inopinatus*, the main femoral process is carried on a shelf-like protuberance on the femorite, similar to those found in *A. anconus* (Figure 7D) and *A. equinus* (Figure 15D), but, in contrast with those two species, the process in this species is uniquely long and slender. The solenomere tip is markedly broad and flat and there are serrations along one edge of the solenomere, closer to its base (Figures 22C–F).

#### DESCRIPTION

##### *Male holotype*

Body c. 25 mm long; midbody ring c. 2 mm wide, with less pronounced waist, prozonite and metazonite of similar width. Colour dark brown with pale dorsal stripe (Figure 22A); leg colour as for body. No paranota on posterior rings (Figure 22C). Sternites without obvious processes/tubercles, sternal lamella broad, mushroom-shaped. Anterior spiracles at midbody flat, folded. Head smooth, without noticeable sculpturing; frons smooth, with some setae; face broad, cheeks partially obscuring cardines, when viewed face-on, maximum width c. 3.3 x the distance between antennal sockets; sockets separated by c. 2 x width of socket. Antennae of moderate length, reaching to ring 2, not obviously clavate, antennomeres 5 and 6 only slightly wider than the proximal ones and relatively slender. Collum 0.75 x as long as head (in lateral view). Gonopod of medium length, reaching posterior edge of ring 5; coxa (C) more robust and thicker than femorite, with slight ridge; prefemur (PF) of similar length to femorite, ovoid, a noticeable prefemoral lip; femorite (F) contributing to c. 1/2 acropodite length in situ, slightly curved when viewed anteriorly, becoming thicker towards apex; main femoral process (MFP) long (to c. 1/4 solenomere length), narrow, pointed, curved; second femoral process (fp1) present, arising close to solenomere base, curved, pointed, short,



**FIGURE 22** *Antichiropus inopinatus* sp. nov. A and C, paratype male (WAM T126105) habitus: A, lateral view; C, dorsal view; B, D and E, holotype male (WAM T132359) left gonopod: B, solenomere tip; D, posterior view; E, anterior view; F and G, male (WAM T112934) left gonopod: F, medial view; G, lateral view. Abbreviations: C, coxa; F, femorite; fp1, second femoral process; MFP, main femoral process; PF, prefemur; S, solenomere; sp1, sp2 and sp3, solenomere processes 1, 2 and 3. Scale bars: A = 5 mm; B = 0.2 mm; C = 2 mm; D–G = 0.5 mm.

triangular; prolongation of femorite apex (prof) absent; solenomere (S) relatively short, forming circle, mainly thicker than femorite, thinnest at base, then thicker, small serrations near base; solenomere with single slightly ridged flattened tip and minute process (sp1) (Figure 22B); second solenomere process (sp2) closer to solenomere tip than base, prominent, pointed, upright, slender; third solenomere process (sp3) in basal third of solenomere, prominent, pointed (Figures 22D–G).

#### Female

Of similar length and colour to male but broader, c.

2.5 mm wide dorsally (WAM T126105).

#### DISTRIBUTION

This species is known only from a hill behind the old homestead on Fraser Range Station, east of Norseman (Figure 38).

#### ETYMOLOGY

This species is named for its being found on an exposed hillside in semi-arid country (Latin, adjective, *inopinatus*, unexpected).

***Antichiropus kealleyi* sp. nov.**

Figures 23, 38

<http://www.zoobank.org/urn:lsid:zoobank.org:act:94EBED04-A789-440C-AAA8-AC8CFE6FACF1>

## MATERIAL EXAMINED

*Holotype*

**Australia: Western Australia:** ♂, Koolyanobbing Range, 30°48'S, 119°35'E, 31 July 2007, beneath rocks of ironstone hills, M. Bamford (WAM T82459).

*Paratypes*

**Australia: Western Australia:** 1 ♂, 3 ♀, collected with holotype (WAM T67126).

*Other material*

**Australia: Western Australia:** 2 ♂, 3.4 km SE of Koolyanobbing, 30°50'27.49"S, 119°32'27.56"E, 23 August 2009, leaf litter, R. Teale (WAM T99038, T99055); 1 ♂, 2 ♀, 11.0 km SE of Koolyanobbing, 30°52'29.68"S, 119°36'37.01"E, 22 August 2009, leaf litter, R. Teale (WAM T99073, T112940).

## DIAGNOSIS

**Gonopod:** *Antichiropus kealleyi* may be easily recognised by the shape of the two femoral processes on the short squat gonopod femorite: the processes are very similar in length, thickness, shape and orientation to each other (Figure 23E). The femorite prolongation consists of two tiny sub-equal spines (Figures 23B).

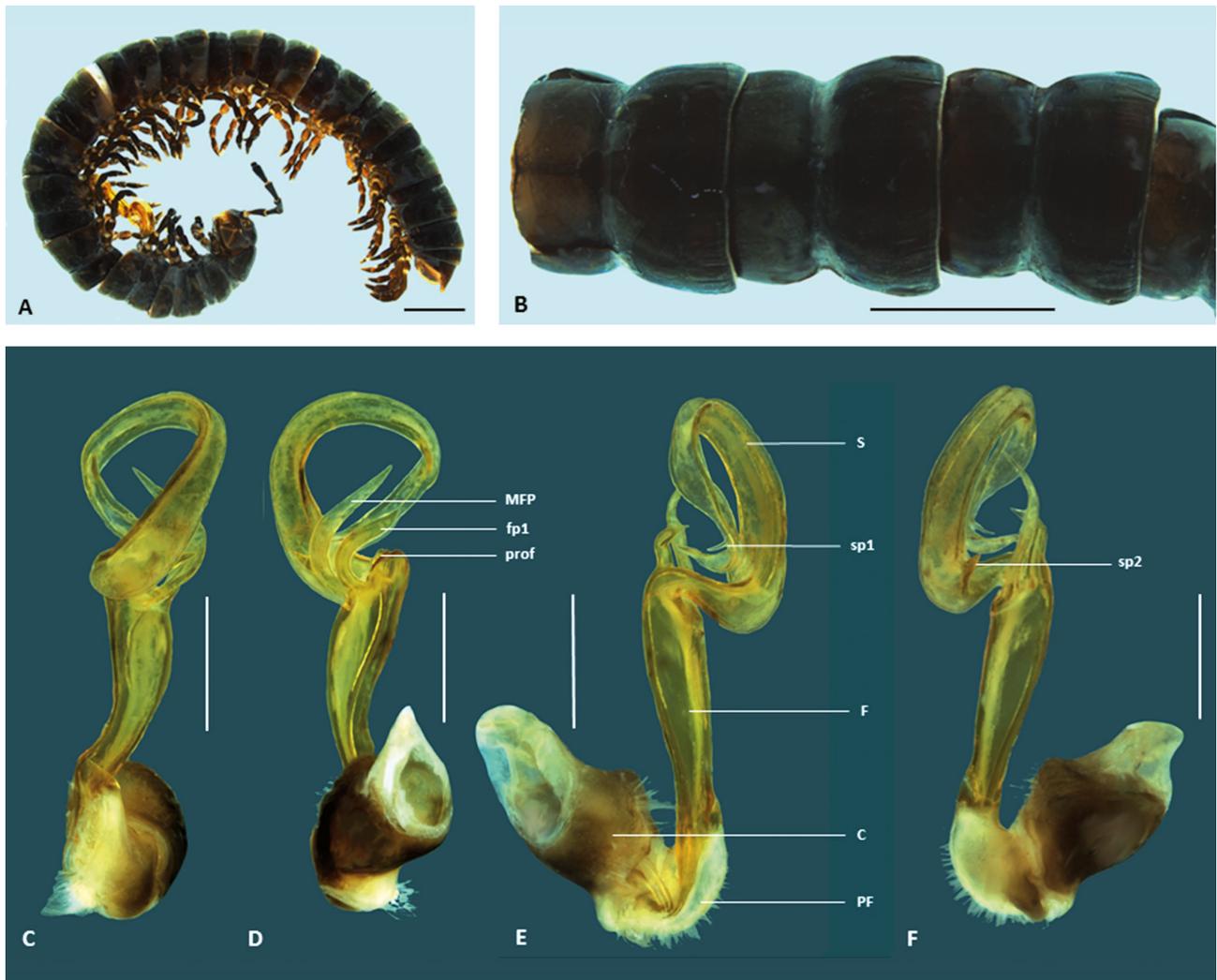


FIGURE 23

*Antichiropus kealleyi* sp. nov.: male (WAM T99055) habitus: A, lateral view; B, dorsal view; C–F, holotype male (WAM T82459) left gonopod: C, posterior view; D, anterior view; E, medial view; F, lateral view. Abbreviations: C, coxa; F, femorite; fp1, second femoral process; MFP, main femoral process; PF, prefemur; prof, prolongation of femorite; S, solenomere; sp1 and sp2, solenomere processes 1 and 2. Scale bars: A = 2 mm; B = 1 mm; C–F = 1 mm.

## DESCRIPTION

*Male holotype*

Body c. 25 mm long; midbody ring c. 2 mm wide, with distinct waist, prozonite and metazonite of similar width. Colour dark brown, almost black (Figure 23A); leg colour as for body. No paranota on posterior rings (Figure 23C). Sternites, except ring 5, with slight protuberances carrying long setae on some, sternite of ring 5 with processes, sternal lamella broad, heart-shaped. Anterior spiracles at midbody flat, folded. Head smooth, without noticeable sculpturing; frons smooth, with some setae; face narrow, cardines and stipites clearly visible when animal is viewed face-on, maximum width c. 3.6 x the distance between antennal sockets; sockets separated by c. 2 x width of socket. Antennae of moderate length, reaching to ring 2, distinctly clavate, antennomeres relatively robust. Collum 1 x as long as head (in lateral view). Gonopod relatively longer, reaching anterior edge of ring 5; coxa (C) more robust, thicker, of similar length to femorite, with noticeable ridge on anterior surface; prefemur (PF) somewhat shorter than femorite; femorite (F) contributing to c. 1/2 acropodite length in situ, curved, robust, and becoming thicker towards apex; main femoral process (MFP) long (to c. 1/4 solenomere length), narrow, pointed; second femoral process (fp1) present, arising close to solenomere base, following curve of MFP, pointed, slender along its length; prolongation of femorite apex (prof) present as two tiny spines; solenomere (S) long, forming >1 loop/circle, generally more slender than femorite, thick at base, thin at tip; solenomere tip pointed, with no serrations; solenomere process (sp1) near solenomere tip, small, pointed, slender; second solenomere process (sp2) near solenomere base, prominent, pointed, triangular (Figures 23C–F).

*Female*

Of similar length and colour to the male but noticeably broader, c. 3 mm wide dorsally (WAM T67126).

## DISTRIBUTION

All specimens of this species were collected from Koolyanobbing, from under rocks or in leaf litter (Figure 38).

## ETYMOLOGY

This species is named for Ian Kealley, Regional Manager of the Department of Parks and Wildlife's Goldfields Region, in recognition of his ongoing efforts to support biodiversity research in Western Australia.

*Antichiropus lacustrinus* sp. nov.

Figures 24, 38

<http://www.zoobank.org/urn:Isid:zoobank.org:act:851FFC20-597A-4CFF-B5EE-47B2893A5546>

## MATERIAL EXAMINED

*Holotype*

**Australia: Western Australia:** ♂, Lake King-Norseman Road, site LK13, 33°04'54"S, 119°59'53"E, 15 October 1999–25 October 2000, wet pitfall trap, N. Guthrie (WAM T124607).

*Paratypes*

**Australia: Western Australia:** 1 ♂, Bungalbin Hill, 37 km N of Koolyanobbing, 30°30'28.92"S, 119°35'47.31"E, 3–11 April 2013, litter, S. White, A. Heidrich, A. Nowicki, J. Vos, F. Bokhari (WAM T130686).

*Other material*

None.

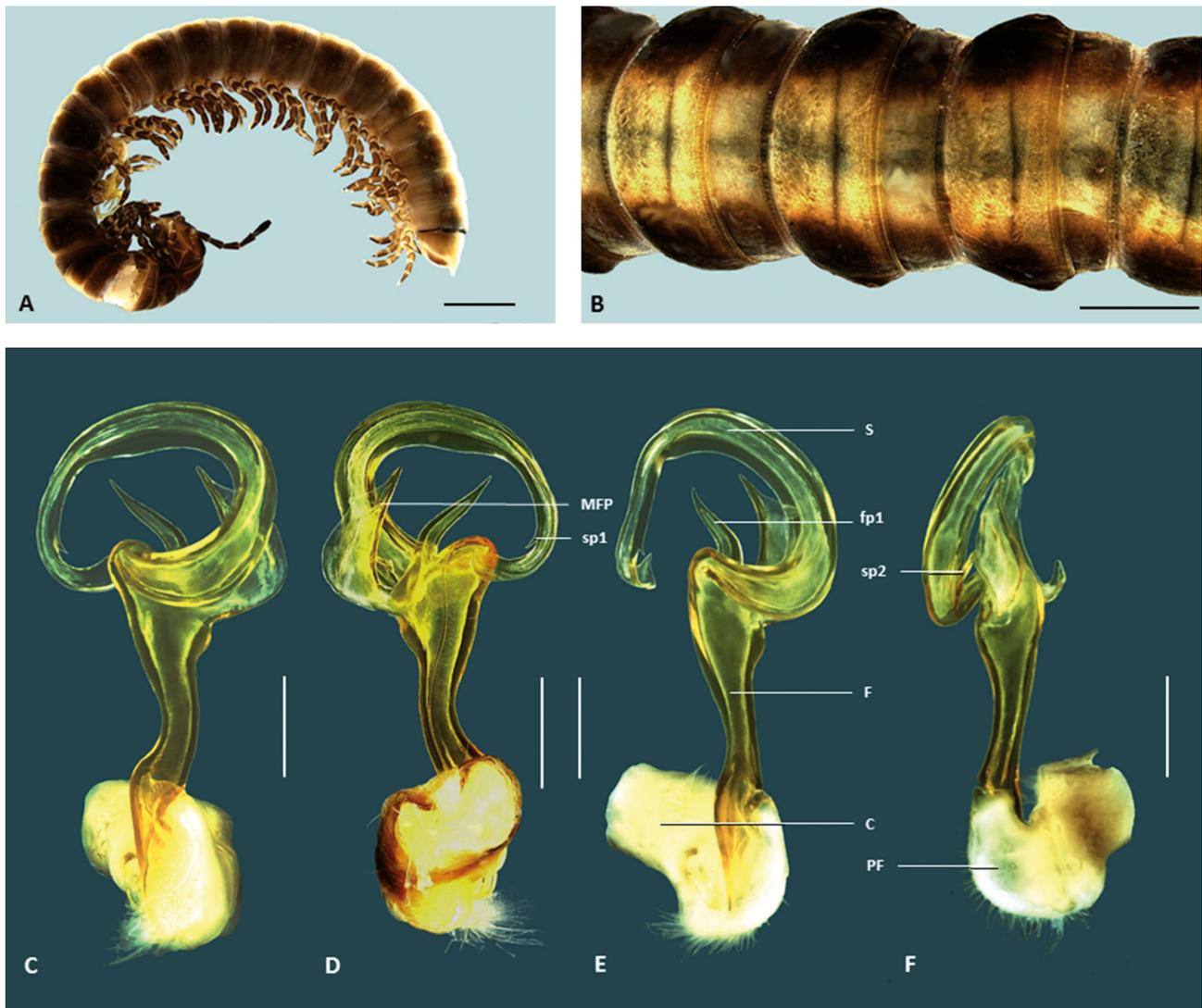
## DIAGNOSIS

Gonopod: *Antichiropus lacustrinus* is most similar to *A. axicius* (Figure 8C–F), both with a noticeably short squat femorite, but that of *A. lacustrinus* is shorter and more curved when viewed anteriorly and its solenomere is relatively thicker at the base than that of *A. axicius*. The shape of the main femoral process differs noticeably in the two species (Figures 24C–F).

## DESCRIPTION

*Male holotype*

Body c. 25 mm long; midbody ring with distinct waist, prozonite and metazonite of similar width. Colour dark brown overall (Figure 24A), with 2 pale dorsal stripes, running full length of body; legs with coloration similar to that of main body. No paranota on posterior rings (Figure 24B). Sternites, except ring 5, with setose protuberances on some, setae long; sternite of ring 5 without obvious processes/tubercles, sternal cross impressions of similar depth, sternal lamella broad, with rounded edge. Anterior spiracles at midbody flat, folded. Head smooth, without noticeable sculpturing; frons smooth, with some setae; face narrow, cardines and stipites clearly visible when animal is viewed face-on, maximum width c. 3.4 x the distance between antennal sockets; sockets separated by c. 2.5 x width of socket. Antennae distinctly clavate, antennomeres relatively robust. Collum 0.75 x as long as head (in lateral view). Gonopod of medium length, reaching posterior edge of ring 5; coxa (C) more robust, thicker, of similar length to femorite; Prefemur (PF) of similar length to femorite,



**FIGURE 24** *Antichiropus lacustrinus* sp. nov.: holotype male (WAM T124607) habitus: A, lateral view; B, dorsal view; C–F, left gonopod: C, posterior view; D, anterior view; E, medial view; F, lateral view. Abbreviations: C, coxa; F, femorite; fp1, second femoral process; MFP, main femoral process; PF, prefemur; S, solenomere; sp1 and sp2, solenomere processes 1 and 2. Scale bars: A = 2 mm; B = 1 mm; C–F = 0.5 mm.

ovoid, small prefemoral lip; femorite (F) contributing to c. 1/2 acropodite length in situ, curved, broadening into large rounded protuberance from which main femoral process (MFP) arises, becoming thicker towards apex; main femoral process (MFP) long (to c. 1/4 solenomere length), pointed, but not spine-like, carried on large femoral protuberance held at right angles to femorite; second femoral process (fp1) absent; prolongation of femorite apex (prof) absent; solenomere (S) relatively short, forming circle, of variable thickness, thick at base, becoming thinner mid-length, thickening again at tip; solenomere tip broadly pointed, with no serrations, single flattened end; solenomere process (sp1) near solenomere tip, small, pointed; second solenomere

process (sp2) near solenomere base, prominent, pointed (Figures 24C–F).

#### *Female*

No female specimens have been collected.

#### DISTRIBUTION

Only three males and three juveniles of this species have been collected from Marvel Loch (Figure 38).

#### ETYMOLOGY

This species is named for its occurrence near a lake (Latin, *lacustrinus*, of lakes).

***Antichiropus laticlavus* sp. nov.**

Figures 25, 39

<http://www.zoobank.org/urn:lsid:zoobank.org:act:C14632B1-DF05-455D-A786-BB74D1853E6D>

## MATERIAL EXAMINED

*Holotype*

**Australia: Western Australia:** ♂, McDougall Nature Reserve, site DU 09, 33°27'08"S, 118°06'57"E, 15 October 1999–1 November 2000, wet pitfall, P. Van Heurck et al. (WAM T72007).

*Paratypes*

**Australia: Western Australia:** 4 ♂, 2 ♀, Dunn Rock Nature Reserve, N of farm, site LK 5, 33°14'49"S, 119°33'04"E, 15 October 1999–1 November 2000, wet

pitfall, P. Van Heurck et al. (WAM T72005).

*Other material*

**Australia: Western Australia:** 1 ♂, collected with paratypes (WAM T72006); 1 ♂, 2 juveniles, adjacent to Holland Rock Nature Reserve, site PI 5, 33°21'35"S, 118°44'50"E, 15 October 1999–1 November 2000, wet pitfall, P. Van Heurck et al. (WAM T72008); 1 ♀, granite rock N of Koorda-Bullfinch Road, W of Warrachuppin Road, 31°00'35"S, 118°42'02"E, 25 June 2006, under granite rocks on outcrop, J.M. Waldock, R. Engel, R and R. Morritt (WAM T74820); 1 ♂, as above (WAM T76739); 1 ♂, Baladjie Rock, western slopes, 30°57'13.2"S, 118°52'33.5"E, 3 June 2007, under granite rocks along edge, J.M. Waldock (WAM T85344); 1 ♂, 1 ♀, as above (WAM T85345); 1 ♀, N of farm, Dunn Rock nature Reserve, site LK5, 33°14'49"S, 119°33'04"E, 15 October 1999–1 November 2000, wet pitfalls, P. Van Heurck et al. (WAM T114009).

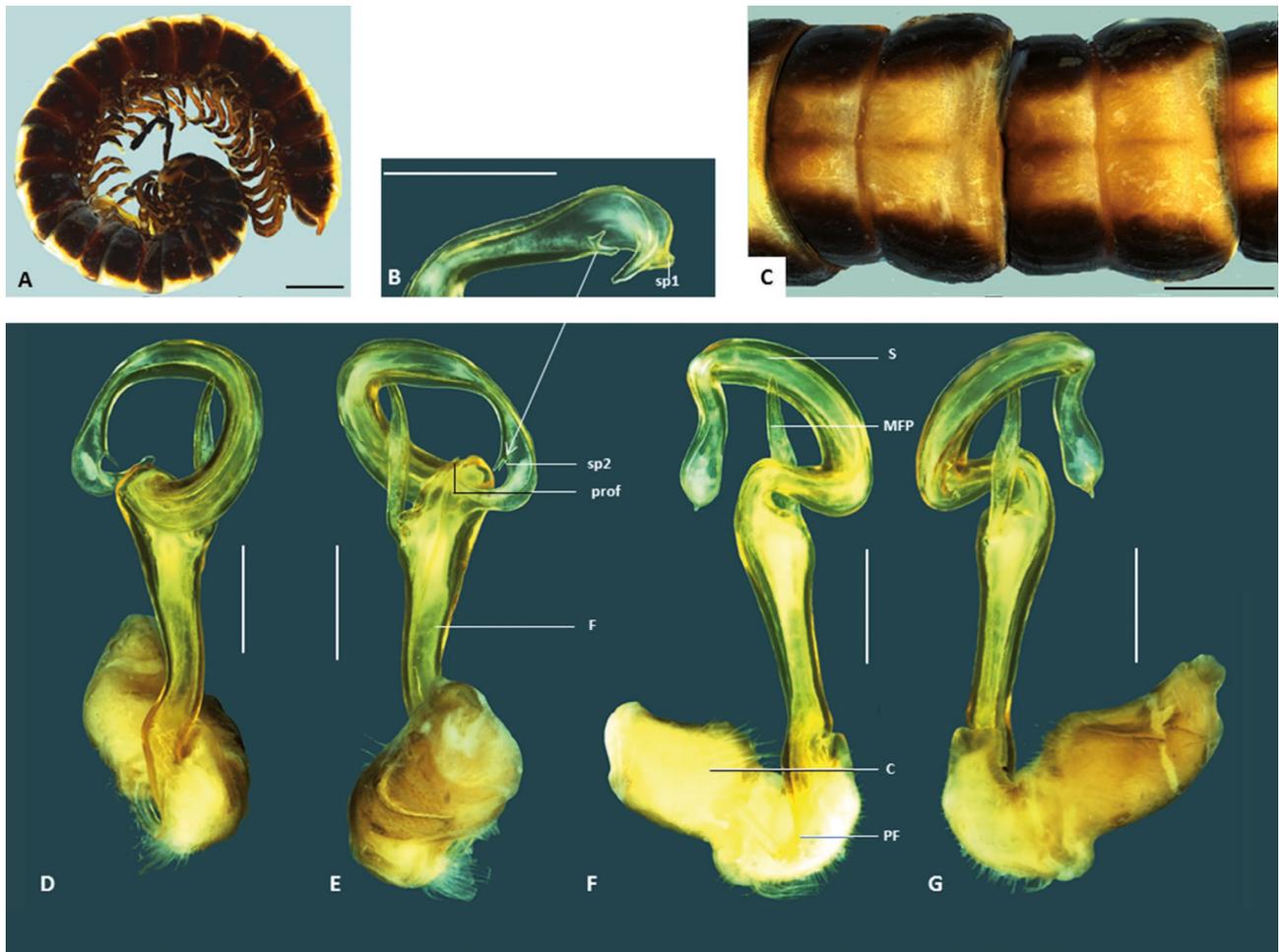


FIGURE 25

*Antichiropus laticlavus* sp. nov.: A and C male from west of Warrachuppin Rd (WAM T76739) habitus: A, lateral view; C, dorsal view; B and D–G, holotype male (WAM T72007) left gonopod: B, solenomere tip; D, posterior view; E, anterior view; F, medial view; G, lateral view. Abbreviations: C, coxa; F, femorite; MFP, main femoral process; PF, prefemur; prof, prolongation of femorite; S, solenomere; sp1 and sp2, solenomere processes 1 and 2. Scale bars: A = 2 mm; B = 0.5 mm; C = 1 mm; D–G = 0.5 mm.

## DIAGNOSIS

General: the broad dorsal stripe on this species assists in its identification (Figure 25C).

Gonopod: *Antichiropus laticlavus* has a robust solenomere with a combination of two features making identification relatively simple, namely, the presence of small serrations near the base of the solenomere and a distinctive two-pronged second process near the tip of the solenomere (Figures 25B, D–G).

## DESCRIPTION

### *Male holotype*

Body c. 25 mm long, slightly rugose laterally; midbody ring c. 2.5 mm wide, with less pronounced waist, prozonite and metazonite of similar width. Colour dark brown overall (Figure 25A), with broad, pale, dorsal stripe running full length of body (Figure 25C); leg colour as for body. No paranota on posterior rings. Some sternites, except ring 5, with slight protuberances bearing long setae, sternite of ring 5 without obvious processes/tubercles, sternal lamella broad, with rounded edge. Anterior spiracles at midbody flat, folded. Head smooth, without noticeable sculpturing; frons smooth, with some setae; face broad, cheeks at least partially obscuring cardines, when viewed face-on; maximum width c. 3.4 x the distance between antennal sockets; sockets separated by c. 2 x width of socket. Antennae of moderate length, reaching to ring 2, clavate, antennomeres relatively robust. Collum 0.75 x as long as head (in lateral view). Gonopod of medium length, reaching posterior edge of ring 5; coxa (C) more robust, thicker, of similar length to femorite, with slight ridge on anterior surface; prefemur (PF) of similar length to femorite, ovoid, appearing to hug femorite base; femorite (F) contributing to c. 1/2 acropodite length in situ, slightly curved when viewed anteriorly, broadening into large, rounded protuberance from which main femoral process arises, becoming thicker towards apex; main femoral process (MFP) long (to c. 1/4 solenomere length), pointed, spear or flame-shaped; second femoral process (fp1) absent; prolongation of femorite apex (prof) present as tiny spine; solenomere (S) long, forming >1 loop/circle, mainly thicker than femorite, thick at base, becoming thinner mid-length, thickening again at tip; solenomere tip broadly pointed, with no serrations; solenomere process (sp1) near solenomere tip, tiny, pointed, triangular; second solenomere process (sp2) in apical 1/3 of solenomere, small, pointed with two branches (Figures B, D–G).

### *Female*

Similar to male but more robust, midbody dorsal width c. 3 mm (WAM T72005).

## DISTRIBUTION

This species is known from several localities on the western edge of the Great Western Woodlands, ranging from c. 31° to 33°S (Figure 39).

## ETYMOLOGY

This species is named for its longitudinal dorsal stripe (Latin, *laticlavus*, having a broad stripe).

### *Antichiropus nadineae* sp. nov.

Figures 26, 39

<http://www.zoobank.org/urn:lsid:zoobank.org:act:0D0B3B4F-A8EF-4189-B762-428DCF41EA7D>

## MATERIAL EXAMINED

### *Holotype*

**Australia: Western Australia:** ♂, Credo Station, c. 17 km NW of Homestead, 30°20'47.7"S, 120°42'23.2"E, 3 September 2011, M.S. Harvey et al. (WAM T119044).

### *Other material*

**Australia: Western Australia:** 1 ♀, Credo Station c. 55 km NNW of Homestead, 29°58'59.3"S, 120°40'19.4"E, 3 September 2011, M.S. Harvey (WAM T118635).

## DIAGNOSIS

Gonopod: the two species most similar to *Antichiropus nadineae* are *A. serratus* (Figures 31C–F) and *A. westi* (Figures 34C–F) with both the main and second femoral processes being similar in configuration in all three species. *A. serratus* may, however, be separated by its prominent serrations at the base of the broad based solenomere and its short squat femur: both *A. nadineae* and *A. westi* have solenomeres with no serrations and with slender bases, but may be determined from each other by the shape of the femur, the main femoral process and the length of the second femoral process. *A. nadineae* also has a small prolongation of the femur, lacking in *A. westi* (Figure 26F).

## DESCRIPTION

### *Male holotype*

Body c. 20 mm long; midbody ring c. 2 mm wide, with less pronounced waist, prozonite and metazonite of similar width. Colour dark brown, almost black (Figure 26A); leg colour as for body. No paranota on posterior rings (Figure 26B). Sternites without obvious processes/tubercles, sternal lamella broad, with straight edge. Anterior spiracles at midbody flat, erect. Head smooth, without noticeable sculpturing; frons smooth, with some setae; face narrow, cardines and stipites clearly visible when animal is viewed face-on; maximum width c. 3.7 x the distance between antennal sockets; sockets separated by c. 1.6 x width of socket. Antennae of moderate length, reaching to ring 2, not obviously clavate, antennomeres 5 and 6 only slightly wider than proximal ones, relatively slender. Collum 1 x as long as head (in lateral view). Gonopod of medium length, reaching posterior edge of ring 5; coxa (C) more robust, thicker, of similar length to



**FIGURE 26** *Antichiropus nadineae* sp. nov.: holotype male (WAM T119044) habitus: A, lateral view; B, dorsal view; C–F, left gonopod: C, posterior view; D, anterior view; E, medial view; F, lateral view. Abbreviations: C, coxa; F, femorite; fp1, second femoral process; MFP, main femoral process; PF, prefemur; prof, prolongation of femorite; S, solenomere; sp1, solenomere process 1; stip, solenomere tip. Scale bars: A = 2 mm; B = 1 mm; C–F = 0.5 mm.

femorite, with slight ridge on anterior surface; prefemur (PF) of similar length to femorite, ovoid, appearing to hug femorite base; femorite (F) c. 1/2 acropodite length in situ, slightly curved when viewed anteriorly, upright, of similar thickness along length; main femoral process (MFP) long (to c. 1/4 solenomere length), pointed, but not spine-like, hatchet-shaped; second femoral process (fp1) present, arising close to solenomere base, curved, pointed, slender along length; prolongation of femorite apex (prof) present, small, triangular and sharply pointed; solenomere (S) long, forming >1 loop/circle, generally more slender than femorite, of variable thickness; solenomere tip broadly flattened, with no serrations; solenomere process (sp1) near solenomere tip, prominent, pointed, upright, slender (Figures 26C–F).

#### Female

Similar to male in colour and length but broader, c. 2.5 mm wide dorsally (WAM T118635).

#### DISTRIBUTION

The species is known from just one male and one female collected from the base of a tree at Credo Station, 70 km north of Coolgardie (Figure 39).

#### ETYMOLOGY

The species epithet is a patronym in honour of Nadine Guthrie who has collected numerous *Antichiropus* specimens.

***Antichiropus paracalothamnus* sp. nov.**

Figures 27, 39

<http://www.zoobank.org/urn:lsid:zoobank.org:act:92D58326-3C9E-4947-A750-920C27849032>

**MATERIAL EXAMINED****Holotype**

**Australia: Western Australia:** ♂, McDermid Rock, Hyden-Norseman Road, 32°01'12.5"S, 120°44'23.3"E, 21 September 2011, in deep damp *Calothamnus tuberosus* litter on outcrop, J.M. Waldock and C.A. Car (WAM T124574).

**Paratypes**

**Australia: Western Australia:** 2 ♂, 1 juvenile, collected with holotype (WAM T115026)

**Other material**

**Australia: Western Australia:** 1 ♀, McDermid Rock, Hyden-Norseman Road, 32°01'12.5"S, 120°44'23.3"E, 21 September 2011, in deep damp *Calothamnus tuberosus* litter on outcrop, J.M. Waldock and C.A. Car (WAM T115036); 1 ♀, 2 juveniles, Disappointment Rock, Hyden-Norseman Road, 32°07'49.7"S, 120°55'40.6"E, 21 September 2011, in deep damp *Calothamnus tuberosus* litter on outcrop, J.M. Waldock and C.A. Car (WAM T115128); 1 ♂, McDermid Rock, Hyden-Norseman Road, 32°01'12.5"S, 120°44'23.3"E, 21 September 2011,

**FIGURE 27**

*Antichiropus paracalothamnus* sp. nov.: paratype male (WAM T115026) habitus: A, lateral view; B, dorsal view; C–F, left gonopod: C, posterior view; D, anterior view; E, medial view; F, lateral view. Abbreviations: C, coxa; F, femorite; fp1, second femoral process; MFP, main femoral process; PF, prefemur; S, solenomere; serr, serrations; sp1, solenomere process 1. Scale bars: A = 2 mm; B = 1 mm; C–F = 0.5 mm.

in deep damp *Calothamnus tuberosus* litter on outcrop, J.M. Waldoock and C.A. Car (WAM T115130); 3 ♂, 2 ♀, 3 juveniles, Disappointment Rock, Hyden-Norseman Road, 32°07'49.7"S, 120°55'40.6"E, 21 September 2011, in deep damp *Calothamnus tuberosus* litter on outcrop, J.M. Waldoock and C.A. Car (WAM T115141, T115143, T115144).

#### DIAGNOSIS

Gonopod: *Antichiropus paracalothamnus* is unmistakable. The most remarkable feature of the gonopod is the cowl-like appearance of the solenomere midway along its length: it then thins abruptly towards the tip where it expands again into a tongue-like structure (Figures 27C–F).

#### DESCRIPTION

##### *Male holotype*

Body c. 25 mm long; midbody ring c. 2.5 mm wide, with distinct waist, prozonite and metazonite of similar width. Colour dark brown, almost black (Figure 27A); leg colour as for body. Paranota on posterior rings present as slight protuberances (Figure 27B). Sternites without obvious processes/tubercles, sternal lamella broad, heart-shaped. Anterior spiracles at midbody flat, folded. Head smooth, without noticeable sculpturing; frons smooth, with some setae; face narrow, cardines and stipites clearly visible when animal is viewed face-on, maximum width c. 3.5 x the distance between antennal sockets; sockets separated by c. 2 x width of socket. Antennae of moderate length, reaching to ring 2, not obviously clavate, antennomeres 5 and 6 only slightly wider than proximal ones and relatively slender. Collum 1 x as long as head (in lateral view). Gonopod of medium length, reaching posterior edge of ring 5; coxa (C) more robust, thicker, shorter than femorite, with slight ridge; prefemur (PF) somewhat shorter than femorite, appearing to hug femorite base; femorite (F) c. 2/3 of acropodite length in situ, upright, of similar thickness along length; main femoral process (MFP) long (to c. 1/4 solenomere length), narrow, pointed; second femoral process (fpl) present, arising close to solenomere base, curved, pointed, slender along length; prolongation of femorite apex (prof) absent; solenomere (S) held in different plane from femorite i.e. in Figure 27D, femorite is shown as vertical and solenomere appears orientated horizontally; long, forming >1 loop/circle, mainly thicker than femorite, thickest midway along length, slight serrations near base; solenomere tip flattened, with no serrations, tongue-like; solenomere process (spl) positioned c. halfway along solenomere, small, pointed, upright, slender (Figures 27C–F).

##### *Female*

Similar to male, but slightly broader, slightly less than 3 mm wide dorsally (WAM T115144).

#### DISTRIBUTION

This species was collected at two sites, both granite

outcrops, known as Disappointment Rock and McDermid Rock, in the south west corner of the Goldfields. All specimens were found hidden in the damp leaf litter at the base of the shrub *Calothamnus tuberosus*, clinging to granite outcrops and well known for the water retaining capabilities of its roots (Figure 39).

#### ETYMOLOGY

As this species was collected only from the leaf litter at the bases of *Calothamnus tuberosus* shrubs it was named accordingly (Greek, prefix, *para*, next to; adjective, *kalos*, beautiful; noun, *thamnus*, shrub).

#### ***Antichiropus rex* sp. nov.**

Figures 28, 40

<http://www.zoobank.org/urn:lsid:zoobank>.

org:act:629C70AF-112E-41DE-9168-77A1F56D2341

#### MATERIAL EXAMINED

##### *Holotype*

**Australia: Western Australia:** ♂, N of Edwards Road, SE of Lake King, site GP 2, 33°22'01"S, 120°59'43"E, 15 October 1999–1 November 2000, wet pitfall, P. Van Heurck et al. (WAM T80933).

##### *Paratypes*

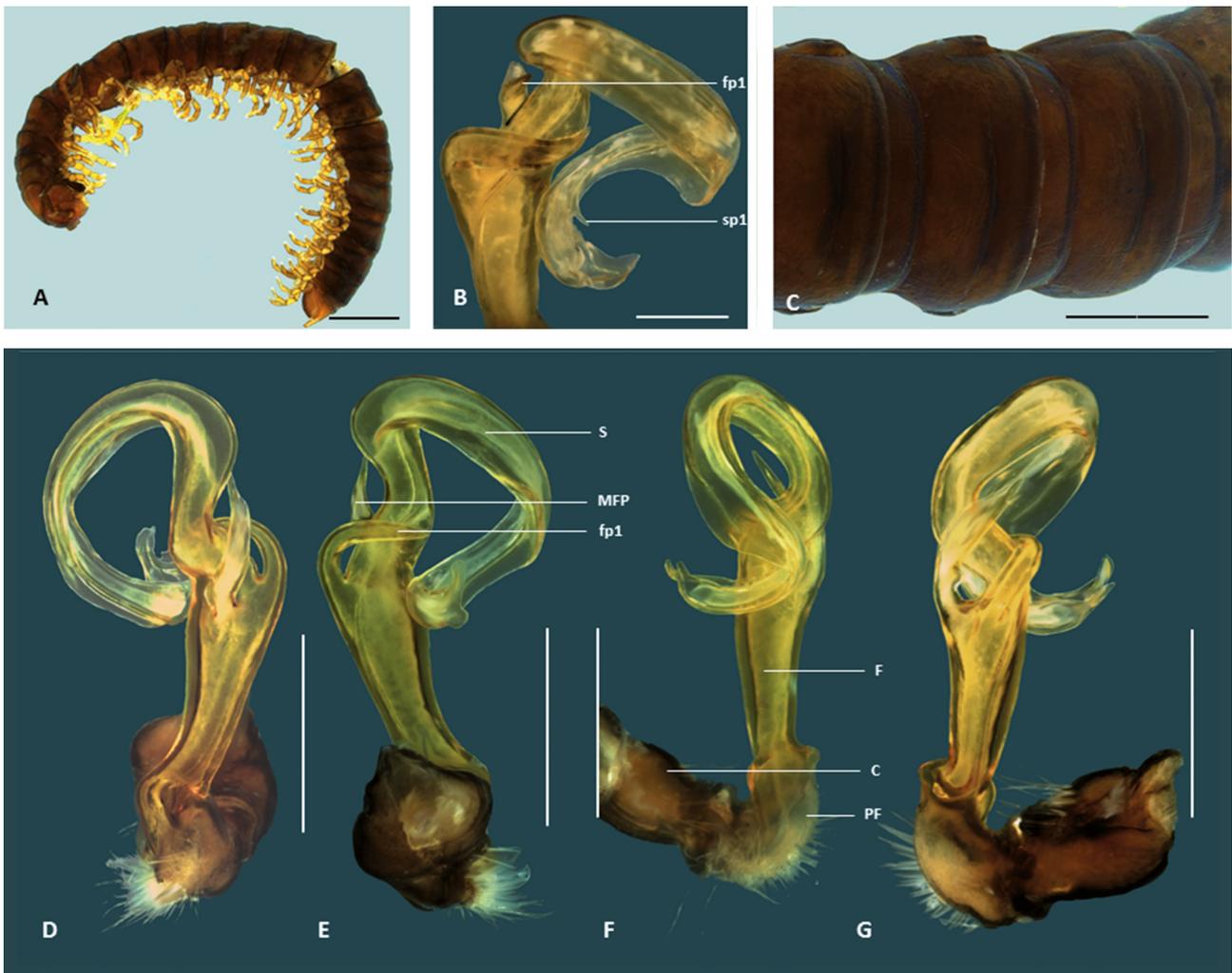
**Australia: Western Australia:** 1 ♂, collected with holotype (WAM T72564); 4 ♂, remains only collected with holotype (WAM T72565).

##### *Other material*

**Australia: Western Australia:** 1 ♂, 2 ♀, 1 juvenile, 'Sieda', E of Grass Patch, 33°14'S, 121°46'E, 8 May 2005, E of '10 Bugger' dam, in heavy, damp litter, mallee bush, A.F. Longbottom (WAM T66526, T66527); 1 ♂, 'Sieda' (Fitz. Loc. 41), E of Grass Patch, 33°14'S, 121°46'E, 24 April 2006, in litter at rubbish tip, A.F. Longbottom (WAM T66711); 2 ♀, 5 juveniles, N of Edwards Road, SE of Lake King, site GP 2, 33°22'01"S, 120°59'43"E, 15 October 1999–1 November 2000, wet pitfall, P. Van Heurck et al. (WAM T72563); 4 ♂, 8 ♀, 10 juveniles (damaged specimens), W of Dalyup Road, W of Scaddan, site GP 8, 33°23'09"S, 121°34'56"E, 15 October 1999–1 November 2000, wet pitfall, P. Van Heurck et al. (WAM T72566).

#### DIAGNOSIS

Gonopod: *Antichiropus rex* is similar to others that have a large spoon-shaped apex to the solenomere: *A. cavernus* (Figures 11C–F), *A. simpulus* (Figures 32D–G) and *A. mammillifer*. It is easily distinguished from *A. cavernus* and *A. mammillifer* by lacking the bulbous second femoral process they carry, and from *A. simpulus* by the lack of serrations on the main femoral process. In addition, *A. rex* has a very short, thick femorite and the solenomere becomes very stout before it extends into the spoon-shaped apex (Figures 28C–F).



**FIGURE 28** *Antichiropus rex* sp. nov.: A and C paratype male (WAM T72564) habitus: A, lateral view; C, dorsal view; B and D–G, paratype male (WAM T72565) left gonopod: B, solenomere tip; D, posterior view; E, anterior view; F, medial view; G, lateral view. Abbreviations: C, coxa; F, femorite; fp1, second femoral process; MFP, main femoral process; PF, prefemur; S, solenomere; sp1, solenomere process 1. Scale bars: A = 2 mm; B = 0.2 mm; C = 1 mm; D–G = 0.5 mm.

## DESCRIPTION

### *Male holotype*

Body c. 25 mm long; midbody ring c. 2 mm wide, with less pronounced waist, prozonite and metazonite of similar width. Colour dark brown overall (Figure 28A); legs noticeably paler than body. Paranota on posterior rings present as slight protuberances (Figure 28C). Sternites without obvious processes/tubercles, transverse and longitudinal cross impressions of similar depth, sternal lamella relatively narrow, with rounded edge. Anterior spiracles at midbody flat, erect. Head smooth, without noticeable sculpturing; frons smooth, with some setae; face narrow, cardines and stipites clearly visible when animal is viewed face-on, maximum width c. 3.6 x the distance between antennal sockets; sockets separated by c. 1.5 x width of socket. Antennae of moderate length, reaching to ring

2, distinctly clavate, antennomeres relatively robust. Gonopod of medium length, reaching posterior edge of ring 5; coxa (C) similar in thickness and length to femorite, with slight ridge on anterior surface; prefemur (PF) of similar length to femorite, ovoid, appearing to hug femorite base; femorite (F) c. 1/2 acropodite length in situ, curved, becoming thicker towards apex; main femoral process (MFP) long (to c. 1/4 solenomere length), pointed, but not spine-like, spear or flame-shaped; second femoral process (fp1) present, arising close to solenomere base, curved, pointed, slender along length; prolongation of femorite apex (prof) absent; solenomere (S) long, forming >1 loop/circle, generally as thick as femorite, of similar thickness along length but thickest nearer tip; solenomere tip flattened, with no serrations, distinctive spoon-shaped apex; solenomere process (sp1) near solenomere tip, tiny, pointed, upright, slender (Figures 28B, D–G).

*Female*

Similar to male in length, but the specimen examined (WAM T66527) was much paler in colour with dark legs and was much wider (c. 3 mm wide).

## DISTRIBUTION

This species has been collected by hand from damp leaf litter at Grass Patch and in wet pitfall traps near Lake King (Figure 40).

## ETYMOLOGY

This species name reflects the fact that specimens were first found at Lake King (Latin, noun, *rex*, king).

*Antichiropus sagittulus* sp. nov.

Figures 29, 39

<http://www.zoobank.org/urn:lsid:zoobank.org:act:C79FDE8D-B0F3-44C8-81E2-694D9C5B19E8>

## MATERIAL EXAMINED

*Holotype*

**Australia: Western Australia:** ♂, Mt Gibson Station, site 11, 29°34'52"S, 117°24'15"E, 20–31 August 2001, dry pitfall traps, Biological Survey (WAM T65497).

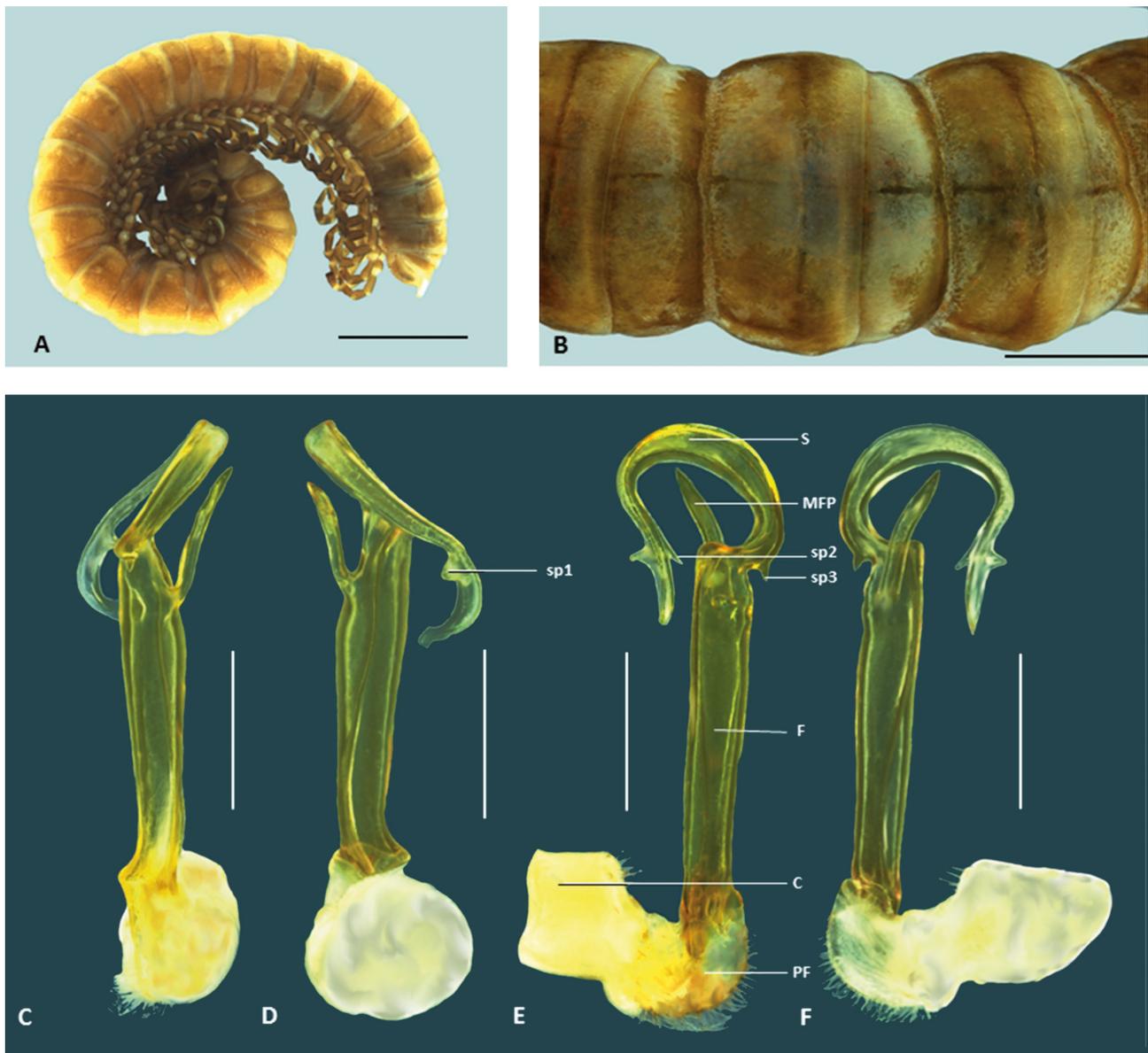


FIGURE 29

*Antichiropus sagittulus* sp. nov.: paratype male (WAM T65498) habitus: A, lateral view; B, dorsal view; C–F, holotype male (WAM T65497) left gonopod: C, posterior view; D, anterior view; E, medial view; F, lateral view. Abbreviations: C, coxa; F, femorite; MFP, main femoral process; PF, prefemur; S, solenomere; sp1, sp2 and sp3, solenomere processes 1, 2 and 3. Scale bars: A = 5 mm; B = 1 mm; C–F = 0.5 mm.

*Paratypes*

**Australia: Western Australia:** 2 ♂, collected with holotype (WAM T65498).

*Other material*

**Australia: Western Australia:** 1 ♂, Mt Gibson Station at 29°38'07"S, 117°29'38"E, 28 August 2001, sheoak/wattle woodland, found dead on rocky slope, A. Baynes (WAM T65499); 4 ♂, 3 ♀, Mt Gibson Station at 29°34'52"S, 117°24'15"E, 15 November 2001, dead at base of pitline 11 fence, J. Mead and A. Baynes (WAM T65524).

## DIAGNOSIS

General: this millipede is notably large (Figure 29A). Gonopod: *Antichiropus sagittulus* is characterised by the relatively long, straight-sided femorite of its gonopod which immediately separates it from the similar *A. giganteus* (Figure 18), by the small posteriorly facing triangular process at the base of the solenomere and by two processes on opposite sides of the solenomere near its tip (Figure 29E).

## DESCRIPTION

*Male holotype*

Body c. 2.5 mm long; midbody ring slightly less than 3 mm wide dorsally, with distinct waist, prozonite and metazonite of similar width. Colour uniformly pale (Figure 29A); leg colour as for body. No paranota on posterior rings (Figure 29B). Sternites without obvious processes/tubercles, sternal lamella broad, square. Head smooth, without noticeable sculpturing; frons smooth, with some setae; face narrow, cardines and stipites clearly visible when animal is viewed face-on; maximum width c. 3.5 x the distance between antennal sockets; sockets separated by c. 1.6 x width of socket. Antennae of moderate length, reaching to ring 2, distinctly clavate. Gonopod of medium length, reaching posterior edge of ring 5; coxa (C) more robust, thicker and shorter than femorite, with slight ridge on anterior surface; prefemur (PF) considerably shorter than femorite, ovoid, appearing to hug femorite base; femorite (F) c. 2/3 of acropodite length in situ, upright, of similar thickness along length; main femoral process (MFP) long (to c. 1/4 solenomere length), narrow, pointed, finger-like; second femoral process (fp1) absent; prolongation of femorite apex (prof) absent; solenomere (S) long, forming >1 loop/circle, generally more slender than femorite, thickest midway along length; solenomere tip with single flattened end and no serrations; solenomere process (sp1) closer to solenomere tip than base, small, pointed, upright, slender; second solenomere process (sp2) in apical third of solenomere, small, pointed; third solenomere process (sp3) near solenomere base, small, pointed (Figures 29C–F).

*Female*

Similar to the male in colour and length but broader, c. 3 mm wide dorsally (WAM T65498).

## DISTRIBUTION

Several specimens of this species have been collected in dry pitfall traps from Mt Gibson Station only (Figure 39).

## ETYMOLOGY

This species name refers to the shape of the solenomere tip on the gonopod (Latin, noun, *sagittulus*, little arrow).

***Antichiropus saxatilis* sp. nov.**

Figures 30, 39

<http://www.zoobank.org/urn:lsid:zoobank.org:act:69DBD14E-CD19-4181-AFF6-27903FB4A568>

## MATERIAL EXAMINED

*Holotype*

**Australia: Western Australia:** ♂, Boorabbin National Park, Boorabbin Rock at dam wall, 31°12'17.7"S, 119°17'22.7"E, 23 September 2011, damp she oak litter, J.M. Waldock and C.A. Car (WAM T124576).

*Paratypes*

**Australia: Western Australia:** 3 ♂, collected with holotype (WAM T115021); 1 ♂, Boorabbin, BNR 1, *Callitris* heath isolate, 31°15'S, 120°04'E, July 1980, pitfall trap, W.F. Humphreys et al. (WAM T71811).

*Other material*

**Australia: Western Australia:** 1 ♂, Boorabbin, BNR 1, *Callitris* heath isolate, 31°15'S, 120°04'E, July 1980, pitfall trap, A1 debris, W.F. Humphreys et al. (WAM T71812); 1 ♀, as above (WAM T71813); 1 ♀, Boorabbin, BNR 3, samphire-lithic complex, 31°14'S, 120°19'E, July 1980, debris, W.F. Humphreys et al. (WAM T71814) 2 ♀, 1 juvenile, Boorabbin, BNR 5, lithic complex, 31°13'S, 120°19'E, July 1980, debris, W.F. Humphreys et al. (WAM T71815, T112929) 1 ♂, Boondi Rock, Goldfields Woodlands National Park, Great Eastern Highway, 31°10'48.8"S, 120°22'58.7"E, 19 September 2011, J.M. Waldock and C.A. Car (WAM T115001); 1 ♂, Boondi Rock, as above collected dead in litter at base of rock (WAM T115155); 1 ♂, Boorabbin National Park, Boorabbin Rock at dam wall, 31°12'17.7"S, 119°17'22.7"E, 19 September 2011, damp she oak litter, J.M. Waldock and C.A. Car (WAM T115022).

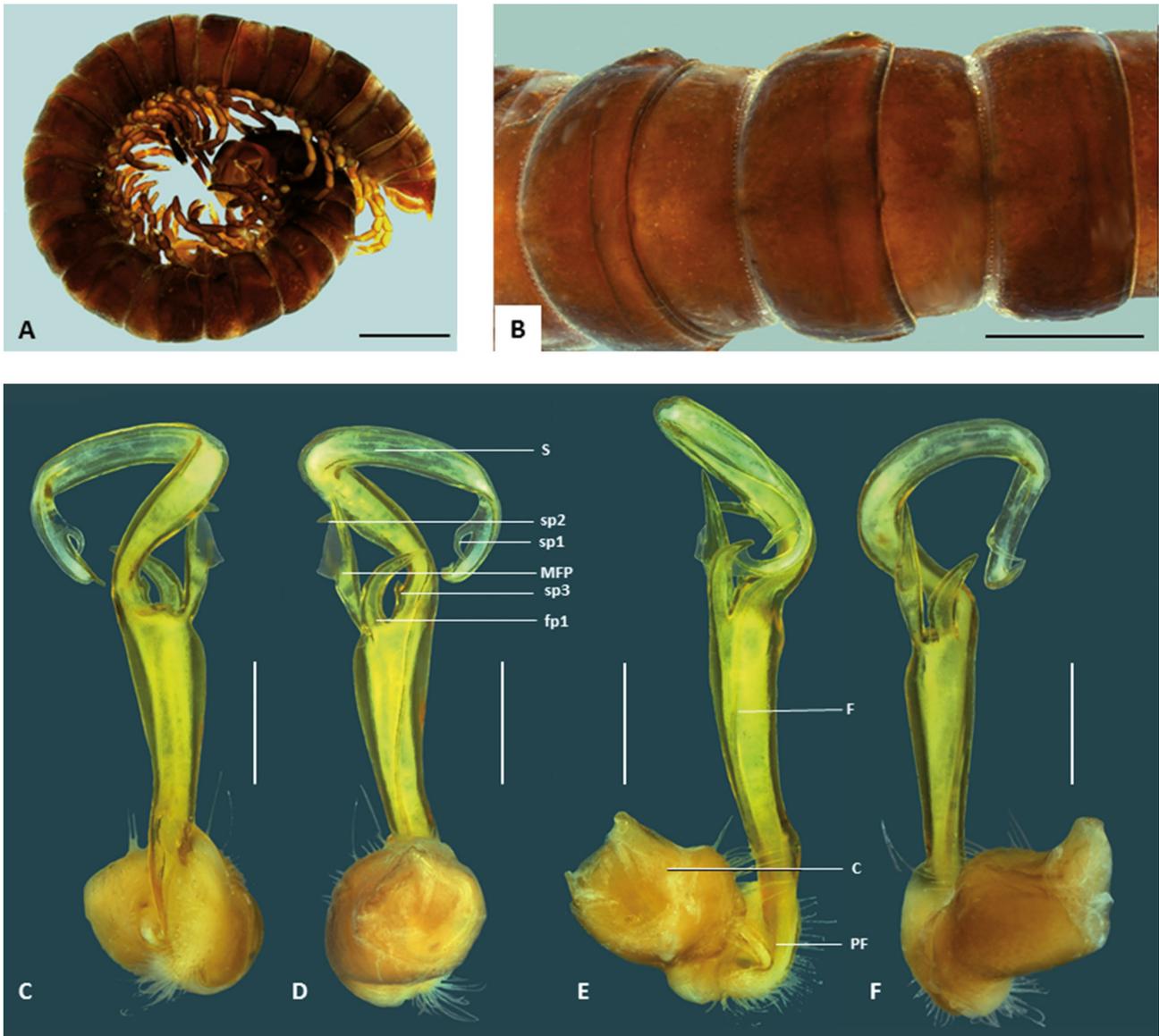
## DIAGNOSIS

Gonopod: *Antichiropus saxatilis* is similar to that of *A. westi* (Figures 34C–F) and *A. serratus* (Figures 31C–F) but has three solenomere processes, compared with two and one respectively in the other species. The process nearest the tip is relatively large and curved and the third process is a short, pointed spine found in the basal third of the solenomere (Figures 30C–F).

## DESCRIPTION

*Male holotype*

Body c. 2.2 mm long; midbody ring c. 2 mm wide,



**FIGURE 30** *Antichiropus saxatilis* sp. nov.: paratype male (WAMT71811) habitus: A, lateral view; B, dorsal view; C–F, left gonopod: C, posterior view; D, anterior view; E, medial view; F, lateral view. Abbreviations: C, coxa; F, femorite; fp1, second femoral process; MFP, main femoral process; PF, prefemur; S, solenomere; sp1, sp2 and sp3, solenomere processes 1, 2 and 3. Scale bars: A = 2 mm; B = 1 mm; C–F = 0.5 mm.

with distinct beaded waist, prozonite and metazonite of similar width. Colour dark brown overall (Figure 30A); leg colour as for body. Paranota on posterior rings present as slight protuberances (Figure 30B). Sternites, without obvious processes/tubercles, sternal lamella broad, with rounded edge. Anterior spiracles at midbody flat, erect. Head smooth, without noticeable sculpturing; frons smooth, with some setae; face narrow, cardines and stipites clearly visible when animal is viewed face-on; maximum width c. 3 x the distance between antennal sockets; sockets separated by c. 2.5 x width of socket. Antennae of moderate length, reaching to body ring 2, distinctly clavate. Collum 1 x as long as head (in lateral view). Gonopod of medium length, reaching posterior edge of ring 5; coxa (C) more robust, thicker,

shorter than femorite, with slight ridge on anterior surface; prefemur (PF) somewhat shorter than femorite; femorite (F) c. 1/2 acropodite length in situ, upright, becoming thicker towards apex; main femoral process (MFP) long (to c. 1/4 solenomere length), pointed, but not spine-like, hatchet-shaped; second femoral process (fp1) present, arising close to solenomere base, curved, pointed, banana-shaped; prolongation of femorite apex (prof) absent; solenomere (S) long, forming >1 loop/circle, generally more slender than femorite, thickest midway along length; solenomere tip pointed, with no serrations; solenomere process (sp1) near solenomere tip, prominent, pointed, curved, slender; second solenomere process (sp2) positioned in basal 1/3 of solenomere, prominent, pointed; third solenomere process (sp3) near

solenomere base, small, pointed (Figures 30C–F).

#### Female

Similar to male, but slightly larger and noticeably broader (2.5 mm) (WAM T112929)

#### DISTRIBUTION

This species has been collected from Boondi Rock and Boorabbin Rock, large granite outcrops on the edge of the Great Eastern highway between Southern Cross and Coolgardie. All specimens were collected by hand either at the base of the rock in damp litter or in the litter of the woodlands growing at the base of the rocks (Figure 39).

#### REMARKS

The small process near the base of the solenomere appears to vary in size and is more pronounced in some specimens than that shown (Figures 30C–F).

#### ETYMOLOGY

This species has been found only in association with

granite outcrops and its name reflects this association (Latin, *saxatilis*, found among rocks).

#### *Antichiropus serratus* sp. nov.

Figures 31, 40

<http://www.zoobank.org/urn:lsid:zoobank.org:act:C872CC57-A7AC-4C02-A2B0-9569DCD29FAF>

#### MATERIAL EXAMINED

##### Holotype

**Australia: Western Australia:** ♂, Marvel Loch, St Barbara Operation, Burbidge area, site 9, 31°33'33"S, 119°34'06"E, 30 July 2008, leaf litter, P. Cullen and P. Langlands (WAM T96076).

##### Paratypes

**Australia: Western Australia:** 2 ♂, 1 ♀, Marvel Loch, St Barbara Operation, Edwards Find, site 12, 31°34'35"S, 119°24'09"E, 2 August 2008, under rock, P. Cullen and

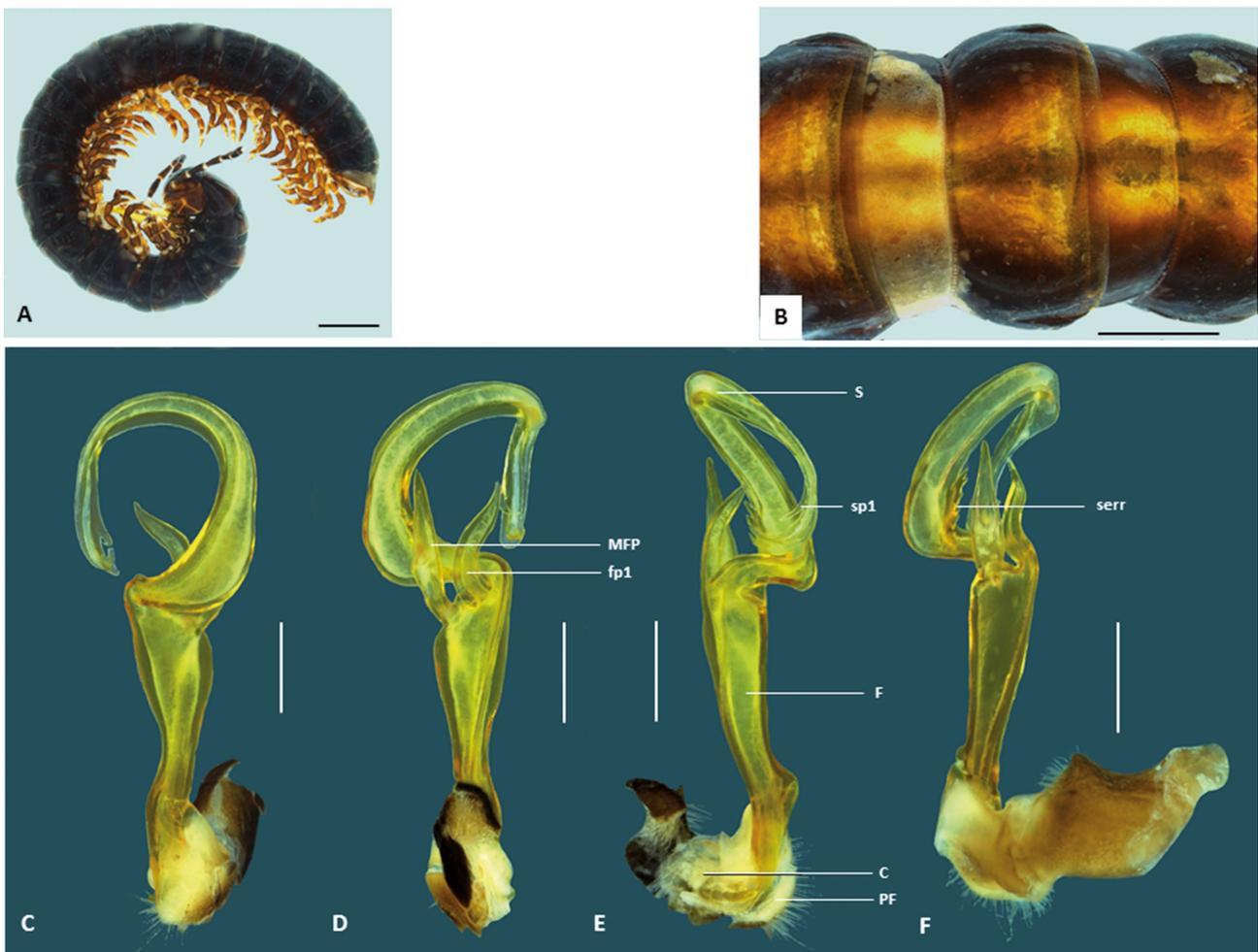


FIGURE 31

*Antichiropus serratus* sp. nov. holotype male (WAM T96076) habitus: A, lateral view; B, dorsal view; C–E, left gonopod: C, posterior view; D, anterior view; E, medial view; F, right gonopod [flipped image] (WAM T96078) lateral view. Abbreviations: C, coxa; F, femurite; fp1, second femoral process; MFP, main femoral process; PF, prefemur; S, solenomere; serr, serrations; sp1, solenomere process 1. Scale bars: A = 2 mm; B = 1 mm; C–F = 0.5 mm

P. Langlands (WAM T96082).

#### *Other material*

**Australia: Western Australia:** 1 ♂, Marvel Loch, St Barbara Operation, Transvaal area, site 6, 31°15'15"S, 119°18'49"E, 28 July 2008, under log, P. Cullen and P. Langlands (WAM T96071); 1 ♂, Marvel Loch, St Barbara Operation, Edwards Find, site 14, 31°33'33"S, 119°23'50"E, 2 August 2008, under rock, P. Cullen and P. Langlands (WAM T96074); 1 ♂ (gonopods damaged), Marvel Loch, St Barbara Operation, Transvaal area, site 6, 31°15'15"S, 119°18'48"E, 29 July 2008, leaf litter, P. Cullen and P. Langlands (WAM T96078).

#### DIAGNOSIS

Gonopod: the diagnostic feature of *Antichiropus serratus* is a noticeable serrated process (Figure 31F) at the thickest section of the solenomere, close to its base. The species is similar to *A. westi* but aside from serrations, it has a shorter and more robust femorite, and a thicker solenomere base than *A. westi*.

#### DESCRIPTION

##### *Male holotype*

Body c. 25 mm long; midbody ring c. 2.5 mm wide, with distinct beaded waist, prozonite and metazonite of similar width. Colour dark brown overall (Figure 31A), with 2 pale, dorsal stripes, running full length of body; leg colour as for body. Paranota on posterior rings present as slight protuberances (Figure 31B). Sternites without obvious processes/tubercles, sternal lamella broad, with rounded edge. Anterior spiracles at midbody flat, erect. Head smooth, without noticeable sculpturing; frons with some setae; face narrow, cardines and stipites clearly visible when animal is viewed face-on; maximum width c. 3.3 x the distance between antennal sockets; sockets separated by c. 2.2 x width of socket. Antennae of moderate length, reaching to ring 2, distinctly clavate, antennomeres relatively robust. Collum 1 x as long as head (in lateral view). Gonopod of medium length, reaching posterior edge of ring 5; coxa (C) thicker, but of similar length to femorite; prefemur (PF) considerably shorter than femorite, ovoid, appearing to hug femorite; femorite (F) c. 1/2 acropodite length in situ, upright, becoming much thicker towards apex; main femoral process (MFP) long (to c. 1/4 solenomere length), pointed, but not spine-like, spear or flame-shaped; second femoral process (fp1) present, arising close to solenomere base, curved, pointed, banana-shaped; prolongation of femorite apex (prof) absent; solenomere (S) long, forming >1 loop/circle, generally more slender than femorite, thick at base, thinner at tip; solenomere tip pointed, with no serrations; solenomere process (sp1) near solenomere tip, small, pointed, upright, slender; second solenomere process (sp2) near solenomere base, prominent, not pointed, serrated and saw-like (Figures 31C–F).

##### *Female*

Similar to male but broader (midbody width c. 3 mm) (WAM T96075).

#### DISTRIBUTION

All specimens were collected from the Marvel Loch area by hand from under rocks, logs and leaf litter (Figure 40).

#### ETYMOLOGY

The species is named for the prominent serrations at the base of the solenomere on the gonopod (Latin, *serratus*, toothed like a saw).

#### *Antichiropus simpulus* sp. nov.

Figures 32, 40

<http://www.zoobank.org/urn:lsid:zoobank.org:act:6F54FB79-EA7B-42E9-96DB-63169C040513>

#### MATERIAL EXAMINED

##### *Holotype*

**Australia: Western Australia:** ♂, N of Mt Dean, 32°13'19"S, 123°38'41"E, 15 April 2001, under limestone rocks, open flat, A. Baynes, L.M. Hatcher, M.R. Norton and R.E. Webb (WAM T112931).

##### *Paratypes*

**Australia: Western Australia:** 6 ♂, 1 ♀, collected with holotype (WAM T72602). 1 ♂, collected with holotype (WAM T112930).

##### *Other material*

**Australia: Western Australia:** 4 ♂, 3 ♀ (specimens in pieces), Cardanumbi, 32°17'S, 125°, 36'E, 1 June 1914, W.B. Alexander (WAM T349, old number 14/1010); 6 ♂, Kangawarie Clearing, c. 50 km NW of Israelite Bay, 33°13'36"S, 123°38'16"E, 7 August 2005, under limestone near sunken tank, A.F. Longbottom (WAM T66524, T66525, T112619); 2 ♂, Caiguna Blowhole, 5 km W of Caiguna, 32°16'S, 125°26'E, 29 August 1999, crawling down rim of blowhole, A.F. Longbottom (WAM T71975) 1 ♂, 4 ♀, 1 juvenile, Cocklebidy Cave (6N–48), doline, 31°57'59"S, 125°55'01"E, 16 November 2002, under limestone rocks, M.S. Harvey and M.E. Blosfelds (WAM T71976, T71977, T71978); 1 ♂, Twilight Cove, 32°16'S, 126°02'E, 26 September 1970, L.E. Koch and A.M. Douglas (WAM T71979); 1 remains, possibly ♀, Noondoonia Station, near homestead, 32°19'S, 123°43'E, 9 September 1999, under granite flake, A.F. Longbottom (WAM T72597); 1 ♂, 1 juvenile, Noondoonia Station, 250 m SE of homestead, 32°19'S, 123°43'E, 13 September 1999, in litter, A.F. Longbottom (WAM T72598); 2 ♂, 1 ♀, N of Mt Dean, 32°13'19"S, 123°38'41"E, 15 April 2001, under limestone rocks, open flat, A. Baynes, L.M. Hatcher, M.R. Norton and R.E. Webb (WAM T72599, T62601, T112930); 1 ♂, N of Mt Dean, 32°13'15"S, 123°38'46"E, 13 April 2001, under limestone rock, L.M. Hatcher and A. Baynes (WAM T72600); 1 ♂, 3 ♀, 3 juveniles, SE of Cocklebidy, on track to Eyre Bird Observatory, 32°03'50"S, 126°16'52"E, 31 January 2009, on ground, M.L. Moir and K.E.C. Brennan (WAM T109762).



**FIGURE 32** *Antichiropus simpulus* sp. nov.: A and C holotype male (WAMT112931) habitus: A, lateral view; C, dorsal view; B, male (WAMT72599) left gonopod, solenomere tip; D–G paratype male (WAMT112930) left gonopod: D posterior view; E, anterior view; F, medial view; G, lateral view. Abbreviations: C, coxa; F, femorite; fp1, second femoral process; MFP, main femoral process; PF, prefemur; S, solenomere; serr, serrations; sp1, solenomere process 1. Scale bars: A = 2 mm; B = 0.2 mm; C = 2 mm; D–G = 0.5 mm.

## DIAGNOSIS

Gonopod: *Antichiropus simpulus* has a relatively large spoon-like tip to the gonopod, a feature shared with *A. mammillifer*, *A. cavernus* and *A. rex* but it may be distinguished by the shapes of the main femoral process and the second femoral process, the former being noticeably serrated (Figures 32B, D–G).

## DESCRIPTION

### Male holotype

Body c. 25 mm long; midbody ring c. 2.5 mm wide, with distinct waist, prozonite and metazonite of similar width. Colour dark brown, almost black (Figure 32A); leg colour coloration as for body. No paranota on posterior rings (Figure 32C). Some sternites, except ring 5, with protuberances bearing long setae, sternite of ring 5 with obvious processes/tubercles projecting anteriorly, sternal lamella relatively narrow, with rounded edge. Anterior spiracles at midbody flat, folded. Head smooth, without noticeable sculpturing; frons smooth, with some setae; face broad, cheeks partially obscuring cardines, when viewed face-on, maximum width c. 3.9 x the distance

between antennal sockets; sockets separated by c. 1.6 x width of socket. Antennae of moderate length, reaching to ring 2, not obviously clavate, antennomeres 5 and 6 only slightly wider than proximal ones and relatively slender. Collum 1 x as long as head (in lateral view). Gonopod of medium length, reaching posterior edge of ring 5; coxa (C) more robust, thicker, and of similar length to femorite, with noticeable ridge on anterior surface; Prefemur (PF) somewhat shorter than femorite, appearing to hug femorite base; femorite (F) c. 1/2 acropodite length in situ, upright, of similar thickness along length; main femoral process (MFP) long (to c. 1/4 solenomere length), pointed, serrated on one edge; second femoral process (fp1) present, arising close solenomere base, long, upright, pointed; prolongation of femorite apex (prof) absent; solenomere (S) long, forming >1 loop/circle, generally as thick as femorite, thinnest at base, then thickening; solenomere tip flattened, with no serrations, distinctive spoon-shaped apex; solenomere process (sp1) at solenomere tip, tiny, ridge-like (Figures 32B, D–G).

### Female

Similar to male but slightly larger and noticeably

broader, midbody width c. 3 mm (WAM T73602).

#### DISTRIBUTION

This species is relatively widespread as it has been collected from a number of localities ranging from Kangawarie clearing, about 50 km north-west of Israelite Bay in the west to Cocklebiddy Cave on the Nullarbor in the east, a distance of c. 200 km (Figure 40).

#### ETYMOLOGY

The species name refers to the spoon-shaped tip to the male gonopod (Latin, noun, *simpulum*, small ladle).

#### *Antichiropus succedaneus* sp. nov.

Figures 33, 40

<http://www.zoobank.org/urn:lsid:zoobank.org:act:BE39AD86-B15D-4811-A201-82E18CADF93F>

#### MATERIAL EXAMINED

##### *Holotype*

**Australia: Western Australia:** ♂, King Rock, 29.4 km NE of Hyden, 32°18'46"S, 119°09'52"E, 18 July 2006, J.M. Waldoock and R. Engel (WAM T108898).



FIGURE 33

*Antichiropus succedaneus* sp. nov.: holotype male (WAM T108898) habitus: A, lateral view; B, dorsal view; C–F, left gonopod: C, posterior view; D, anterior view; E, medial view; F, lateral view. Abbreviations: C, coxa; F, femorite; MFP, main femoral process; PF, prefemur; prof, prolongation of femorite; S, solenomere; sp1, solenomere process 1. Scale bars: A = 2 mm; B = 1 mm; C–F = 0.5 mm.

*Paratype*

**Australia: Western Australia:** 1 ♀, collected with holotype (WAM T112946).

*Other material*

None.

## DIAGNOSIS

Gonopod: *Antichiropus succedaneus* is very similar to *A. inflatus* (Figures 21C–F) because each has a long solenomere process that forms a pincer shape with the solenomere tip, and a bulbous main femoral process arising from a relatively long slender femorite. *A. succedaneus* differs from *A. inflatus*, however, by its more curved femorite (anterior view), a less bulbous and longer main femoral process and a solenomere tip that is much less spatulate (Figures 33C–F).

## DESCRIPTION

*Male holotype*

Body c. 27 mm long; midbody ring c. 2.5 mm wide, with distinct beaded waist, prozonite and metazonite of similar width. Colour dark brown overall (Figure 33A); legs noticeably paler than body. Paranota on posterior rings small (Figure 33B). Sternites without obvious processes/tubercles, sternal lamella: broad, helmet-shaped. Anterior spiracles at midbody protuberant, folded. Head smooth, without noticeable sculpturing; frons smooth, with some setae; face narrow, cardines and stipites clearly visible when animal is viewed face-on, maximum width c. 3.4 x the distance between antennal sockets; sockets separated by c. 2 x width of socket. Antennae of moderate length, reaching to ring 2, distinctly clavate and antennomeres relatively robust. Collum 1 x as long as head (in lateral view). Gonopod of medium length, reaching posterior edge of ring 5; coxa (C) more robust, thicker and shorter than femorite, with slight ridge on anterior surface; prefemur (PF) considerably shorter than femorite, ovoid, appearing to hug femorite base; femorite (F) c. 2/3 of acropodite length in situ, slightly curved when viewed anteriorly or upright, and of similar thickness along length; main femoral process (MFP) stout and very long, at least 1/2 solenomere length, pointed, but not spine-like, bulbous; second femoral process (fp1) absent; prolongation of femorite apex (prof) present, small, triangular and pointed; solenomere (S) relatively short, forming circle, generally more slender than femorite, thick at base, becoming thinner midlength, thickening again at tip; solenomere tip with single, broadly flattened end and no serrations; solenomere process (sp1) near solenomere tip, prominent and extending beyond solenomere tip, pointed, upright, slender (Figures 33C–F).

## DISTRIBUTION

This species is known from only three specimens found on King Rock, a granite outcrop c. 30 km north-east of Hyden (Figure 40).

## ETYMOLOGY

The species name refers to the fact that this was the last species to be identified for this paper (Latin, *succedaneus*, following after).

***Antichiropus westi* sp. nov.**

Figures 34, 40

<http://www.zoobank.org/urn:lsid:zoobank.org:act:BC38A35C-876D-4ED5-8528-AA15036E6D31>

## MATERIAL EXAMINED

*Holotype*

**Australia: Western Australia:** ♂, Mt Gibson Station, site 6, 29°43'35"S, 117°18'28"E, 20–31 August 2001, dry pitfall traps, bowgada/*Melaleuca* shrubland on deep red sands, Biological Survey (WAM T78736).

*Paratypes*

**Australia: Western Australia:** 1 ♂, Mt Gibson iron ore mine, Iron Hill, 10 May 2005, under rock, M.S. Harvey and S. Thompson (WAM T65520); 2 ♂, 1 ♀, Mt Gibson Station, site 7, 29°42'09"S, 117°18'23"E, 20–31 August 2001, dry pitfall traps, mixed bowgada/*Allocasuarina* on yellow gravelly sand, Biological Survey (WAM T65522); 1 ♂, collected with holotype (WAM T65523).

*Other material*

**Australia: Western Australia:** 1 ♂, Mt Gibson iron ore mine, Banded Ironstone Ridge, Mt Gibson east facing (site 10), 29°35'38"S, 117°11'16"E, 30 April–11 May 2005, wet pitfall traps, M.S. Harvey and S. Thompson (WAM T65492); 1 ♂, 1 ♀, Mt Gibson iron ore mine, Banded Ironstone Ridge, Extension Hill east facing (site MTGIB2), 29°34'27"S, 117°09'39"E, 30 April–11 May 2005, wet pitfall traps, M.S. Harvey and S. Thompson (WAM T65493); 1 ♂, Mt Gibson iron ore mine, Ironstone Slope, Iron Hill west facing, 29°36'13"S, 117°10'17"E, 30 April–11 May 2005, wet pitfall traps, M.S. Harvey and S. Thompson (WAM T65494); 2 ♂, Mt Gibson iron ore mine, Banded Ironstone Ridge, Extension Hill west facing, 29°34'33"S, 117°09'38"E, 30 April–11 May 2005, wet pitfall traps, M.S. Harvey and S. Thompson (WAM T65495); 1 ♂, Mt Gibson Station at 29°47'00"S, 117°23'18"E, 24 August 2001, york gum woodland on yellow sandy loam, A. Baynes (WAM T65521); 2 ♂, Mt Gibson iron ore mine, Banded Ironstone Ridge, Extension Hill west facing, 29°34'33"S, 117°09'38"E, 31 May–11 June 2005, wet pitfall traps, S. Thompson (WAM T65531); 1 ♂, Mt Gibson iron ore mine, woodlands 1 (A) impact site, 29°34'09"S, 117°10'36"E, 30 May–11 June 2005, wet pitfall traps, S. Thompson (WAM T65533); 1 ♂, Mt Gibson iron ore mine, Banded Ironstone Range, Iron Hill west facing, 29°36'10"S, 117°10'20"E, 30 April–11 May 2005, wet pitfall traps, S. Thompson (WAM T65535); 2 ♂, Mt Gibson iron ore mine, Ironstone Slopes, Iron Hill east facing, 29°36'08"S, 117°10'27"E, 1–11 June 2005, wet



**FIGURE 34** *Antichiropus westi* sp. nov.: male A-B habitus: A (WAM T65495) lateral view; B (WAM T65520), dorsal view; C–F, paratype male left gonopod (WAM T65520): C, posterior view; D, anterior view; E, anteromedial view; F, lateral view. Abbreviations: C, coxa; F, femorite; fp1, second femoral process; MFP, main femoral process; PF; S, solenomere; sp1 and sp2, solenomere processes 1 and 2. Scale bars: A = 2 mm; B = 1 mm; C–F = 0.5 mm.

pitfall traps, S. Thompson (WAM T65536); 2 ♂, Mt Gibson iron ore mine, Ironstone Slopes, Extension Hill, east facing, 29°34'32"S, 117°09'49"E, 1–11 June 2005, wet pitfall traps, S. Thompson (WAM T65537); 2 ♂, Mt Gibson iron ore mine, Ironstone Slopes, Mt Gibson east facing, 29°34'38"S, 117°09'35"E, 31 May–11 June 2005, wet pitfall traps, S. Thompson (WAM T65539); 1 ♂, Mt Gibson iron ore mine, Ironstone Slopes, Mt Gibson west facing, 29°35'36"S, 117°10'55"E, 31 May–11 June 2005, wet pitfall traps, S. Thompson (WAM T65547); 1 ♂, Mt Gibson iron ore mine, Ironstone Slopes, Extension Hill, west facing, 29°34'38"S, 117°09'35"E, 31 May–11 June 2005, wet pitfall traps, S. Thompson (WAM T65548); 2 ♂, 1 ♀, Mt Gibson iron ore mine, Ironstone Slopes, Iron Hill east facing, 29°36'08"S, 117°10'27"E, 31 May–11 June 2005, wet pitfall traps, S. Thompson (WAM T65549); 1 ♂, 1 ♀, Mt Manning area, site CR3, 30°27'36.8"S, 120°00'09.5"E, 25 June

2008, open *Casuarina* woodland with mixed shrubs, J. Francesconi et al. (WAM T92078); 2 ♂, Mt Manning area, site CM5, 30°21'18.1"S, 119°53'45.2"E, 21 June 2008, open tall eucalypt woodland with *Eremophila* shrubs, J. Francesconi et al. (WAM T92094); 1 ♂, Mt Jackson, 106.5 km N of Southern Cross, 30°16'10"S, 119°14'09"E, 12 October 2008, soil and leaf litter, R. Teale and Z. Hamilton (WAM T93837); 1 ♂, 1 ♀, 2 juveniles, NE of Southern Cross, Helena and Aurora Ranges (Aurora Project), 30°21'28"S, 119°41'58"E, 9 May 2009, M. Bamford (WAM T98520); 1 ♂, Windarling, 92.0 km NNW of Koolyanobbing, 30°00'35.64"S, 119°18'22.03"E, 12 August 2009, leaf litter, R. Teale (WAM T99048); 1 ♂, Deception, 109.5 km N of Koolyanobbing, 29°51'00"S, 119°16'42"E, 29/06/2010, leaf litter, Z. Hamilton and J. Cairnes (WAM T104613); 1 ♂, Deception, 108.8 km N of Koolyanobbing, 29°51'30"S, 119°16'12"E, 30 June 2010,

leaf litter, Z. Hamilton and J. Cairnes (WAM T104620); 1 ♂, Deception, 108.8 km N of Koolyanobbing, 29°51'30"S, 119°16'12"E, 30 June 2010, leaf litter, Z. Hamilton and J. Cairnes (WAM T104621); 5 ♂, Deception, 109.5 km N of Koolyanobbing, 29°50'57"S, 119°16'59"E, 30 June 2010, leaf litter, Z. Hamilton and J. Cairnes (WAM T104627–T104630, T104632); 4 ♂, Deception, 102.5 km N of Koolyanobbing, 29°55'10"S, 119°15'26"E, 1 July 2010, leaf litter, Z. Hamilton and J. Cairnes (WAM T104634, T104635, T104637, T104638); 1 ♂, Deception, 89.6 km N of Koolyanobbing, 30°02'07"S, 119°16'29"E, 3 July 2010, leaf litter, Z. Hamilton and J. Cairnes (WAM T104653); 2 ♂, Windarling, 92.5 km N of Koolyanobbing, 30°00'44"S, 119°15'46"E, 7 July 2010, leaf litter, Z. Hamilton and J. Cairnes (WAM T104655, T104656); 1 ♂, 1 ♀, 2 juveniles, 190 km NW of Kalgoorlie, Lake Giles, site 09 - Snark, 29°49'08.95"S, 119°56'16.75"E, 15 June 2011, M.K. Curran and S.R. Bennett (WAM T114007); 1 ♂, Marda, 114 km N of Southern Cross, 30°11'53.22"S, 119°15'15.19"E, 22–23 September 2011, dry pitfall trap, north-facing slope, M. Peterson (WAM T116732); 3 ♂, 1 ♀, 6 juveniles, Mummaloo, c. 75 km NE of Wubin, 29°39'33.10"S, 117°13'51.90"E, 1 May 2012, hand foraging, under *Eucalyptus* tree, M.K. Curran and G.B. Pearson (WAM T125749); 2 ♂, 1 ♀, c. 7 km SW of Yandhanoo Hill, Bonneydoon, 29°53'00.00"S, 117°12'43.00"E, 15 August 2013, hand foraging, M. Bamford (WAM T128666); 1 ♂, 1 juvenile, Bungalbin Hill, 50 km N of Koolyanobbing, 30°23'45.57"S, 119°39'18.31"E, 3–11 April 2013, leaf litter, S. White, A. Heidrich, A. Nowicki, J. Vos and F. Bokhari (WAM T130656).

## DIAGNOSIS

Gonopod: the species *Antichiropus howardi* (Figures 19C–F), *A. incomptus* (Figures 20C–F) and *A. westi* each have a simple gonopod structure, but *A. westi* has two processes on the femorite whereas the other two species each have only the main femoral process on the femorite (Figures 34C–F).

## DESCRIPTION

### *Male holotype*

Body c. 25 mm long; midbody ring c. 2.5 mm wide, with less pronounced waist, prozonite and metazonite of similar width. Colour dark brown overall (Figure 34A); leg colour as for body. No paranota on posterior rings (Figure 34B). Sternites without obvious processes/tubercles, sternal lamella broad, helmet-shaped. Anterior spiracles at midbody flat, erect. Head smooth, without noticeable sculpturing; frons smooth, with some setae; face broad, cheeks at least partially obscuring cardines, when viewed face-on, maximum width c. 3.7 x the distance between antennal sockets; sockets separated by c. 1.7 x width of socket. Antennae of moderate length, reaching to ring 2, distinctly clavate, antennomeres relatively robust. Collum 0.6 x as long as head (in lateral view). Gonopod of medium length, reaching posterior edge of ring 5; coxa (C) thicker, of

similar length to femorite, with slight ridge on anterior surface; prefemur (PF) somewhat shorter than femorite; femorite (F) c. 1/2 acropodite length in situ, becoming thicker towards apex; main femoral process (MFP) long (to c. 1/4 solenomere length), pointed, hatchet-shaped; second femoral process (fp1) present, arising close to solenomere base, upright, pointed, banana-shaped; prolongation of femorite apex (prof) absent; solenomere (S) relatively short, forming circle, generally more slender than femorite; solenomere tip flattened, with no serrations, broadly arrow-shaped; solenomere process (sp1) closer to tip than base, small, pointed, upright (Figures 34C–F).

### *Female*

Similar to the male in length but generally broader, up to 3 mm wide dorsally. The females show the same colour variation as the males with dark brown forms (WAM T114007) and those with a broad pale dorsal stripe (WAM T65493). It appears that males and females of the same colour form occur together.

## DISTRIBUTION

This species has been collected from a number of localities in wet and dry pitfall traps and by hand from leaf litter at Mt Gibson station, Mt Jackson and Deception (100 km north of Koolyanobbing) (Figure 40) which makes it a relatively wide ranging species.

## REMARKS

Some *A. westi* specimens with no discernible differences in gonopod structure may show colour variation: some are uniformly dark brown in colour, while others have a noticeable lighter brown longitudinal dorsal stripe.

In addition, a number of specimens have gonopods that are similar in overall configuration but show small variations. For example, some specimens carry either a minute two-pronged process or a tiny triangular process at the distal end of the femorite, which could be considered a tiny prolongation of the femur: others show slight variation in the shape of the second femoral process. The species is relatively widespread but as yet, no pattern of variation due to geographical location has been discerned. Up to this point, species have been easily separable by gross differences in the structure of their gonopods. Consequently, despite these perceptible variations in structure, all specimens with gonopods of overall similar structure to *A. westi* have been included in this species. Further morphological, geographical and genetic studies are required to resolve the relative importance of these variations, as has been done for the marri millipede, *A. variabilis*, by Wojcieszek and Simmons (2009, 2011a, 2011b, 2013).

## ETYMOLOGY

This species is named in honour of Paul West of Cliffs Natural Resources whose support enabled this project to be undertaken.

**DISCUSSION**

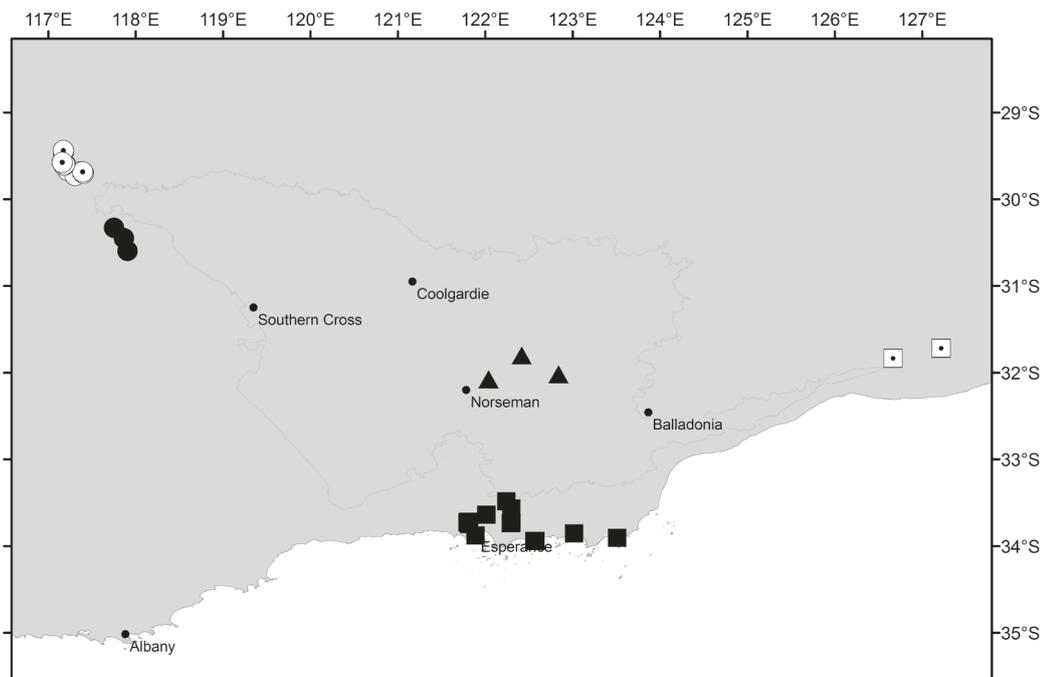
As litter dwellers, paradoxosomatids are generally susceptible to desiccation, but are able to survive in small localized areas of suitable microclimate (Sierwald and Bond 2007) even in semi-arid regions such as the Great Western Woodlands (Watson et al. 2008). Paradoxosomatid species are also vulnerable to disturbances in their habitat, such as land clearing and fragmentation (Car 2010) and are known to have poor dispersal ability (Harvey 2002). The Great Western Woodlands area is relatively undisturbed by human activity, due partly to an historical turn of events, and partly to unreliable and low rainfall, making agriculture difficult (Yates et al. 2000; Judd et al. 2008; Prober et al. 2012). This lack of disturbance in an area with abundant suitable microclimates has contributed to the diversity of the *Antichiropus* fauna.

In keeping with most paradoxosomatid species, it seems that nearly all of the *Antichiropus* species in the Great Western Woodlands may be characterised as short-range endemics (Harvey 2002). Some species described here, such as *A. axicius*, *A. cincinnus*, *A. giganteus* and *A. inflatus* are known only from single specimens (Figures 18, 36, 38). This rarity could be due to the difficulty of collecting specimens when they are active, but it is likely that they have genuinely restricted ranges which do not overlap at small ecological scales (Harvey et al. 2000). Several species, such as *A. buchianorum* and *A. saxatilis* were found in very localized areas (Figures 36, 39), associated only with granite outcrops, which seem to act as ‘islands’ of suitable habitat for millipedes (C. Car and J. Waldock,

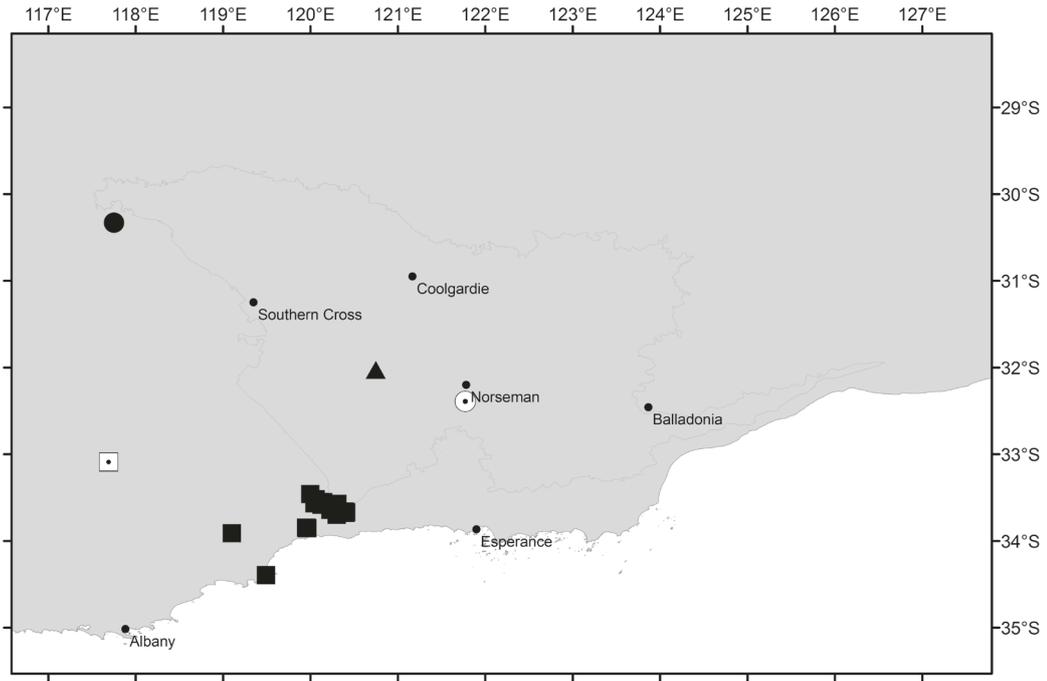
personal observations). Even well collected species such as *A. baudini* and *A. framenau* tend to have very limited distributions (Figures 35, 37). It is also common for millipede species’ distributions to form mosaic patterns in the landscape (Mesibov 2003) and those of the Great Western Woodlands area seem to follow this general pattern, for example, *A. exclamatus* (Figure 37).

The north-western region of the woodlands, the Mt Gibson area, appears to be particularly rich in *Antichiropus* species: five sympatric species occur there, namely, *A. alastairi*, *A. alatus*, *A. axicius*, *A. sagittulus* and *A. westi* (Figures 35, 36, 39, 40). Collecting effort was, however, much more intense in this particular area compared with others in the Great Western Woodlands. The results at Mt Gibson suggest that other areas of the Great Western Woodlands may yield more species and show similar species richness to Mt Gibson if targeted surveys were conducted on the infrequent occasions when millipedes are active above ground, i.e. after good rain (Car 2009).

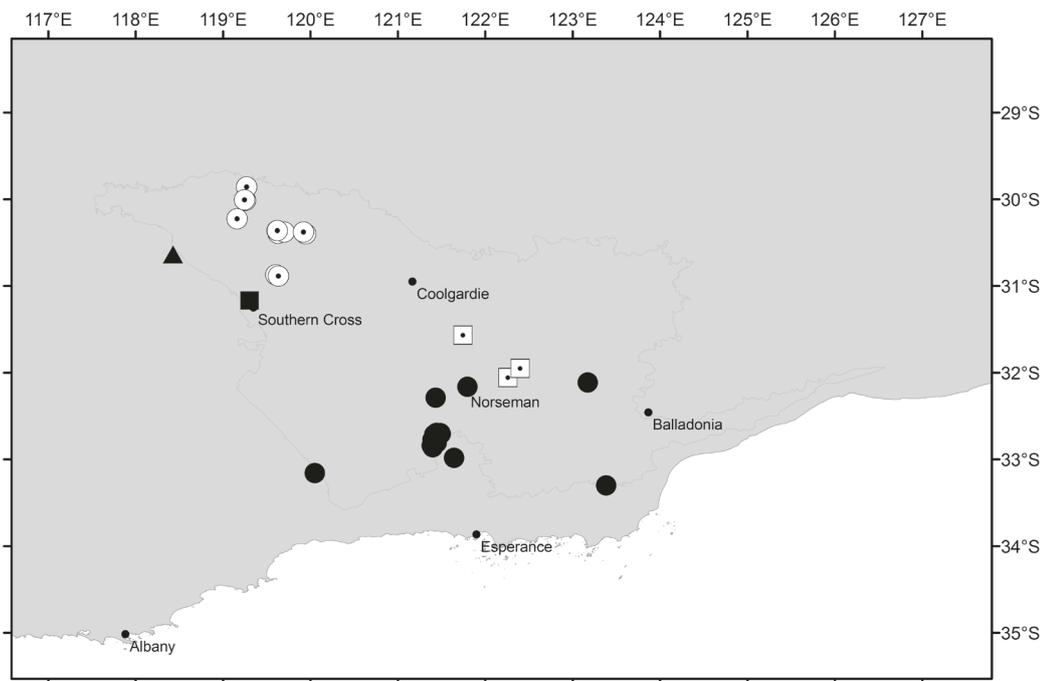
Several of the species in the area cannot be classed as short-range endemics as they have fairly broad ranges. These include *A. exclamatus*, *A. laticlavus*, *A. simpulus* and *A. westi* (Figures 37, 39, 40). The reasons for their wider distribution patterns are unknown, although there is some slight morphological and gonopodal variation apparent in at least one of these species, *A. westi*. Genetic studies may provide the answers to questions regarding these species’ ranges, along the lines of recent research into the marri millipede *A. variabilis* (Wojcieszek and Simmons 2009, 2011a, 2011b, 2013).



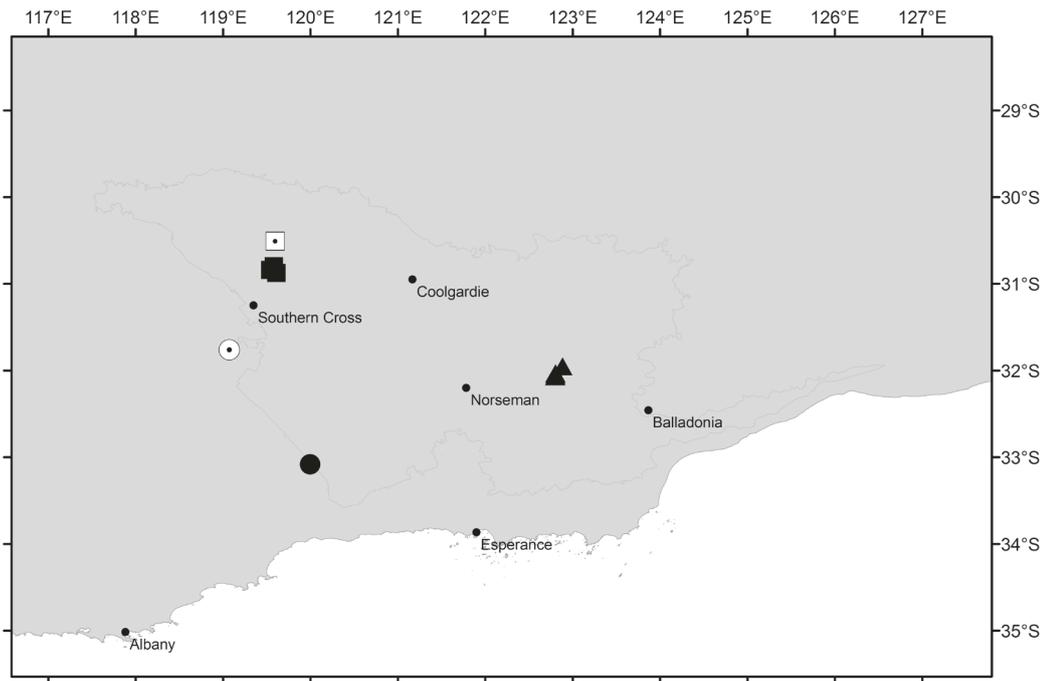
**FIGURE 35** Recorded distributions of *Antichiropus alastairi* (filled circles), *A. alatus* (dotted circles), *A. anconus* (filled triangles), *A. baudini* (filled squares) and *A. cavernus* (dotted squares).



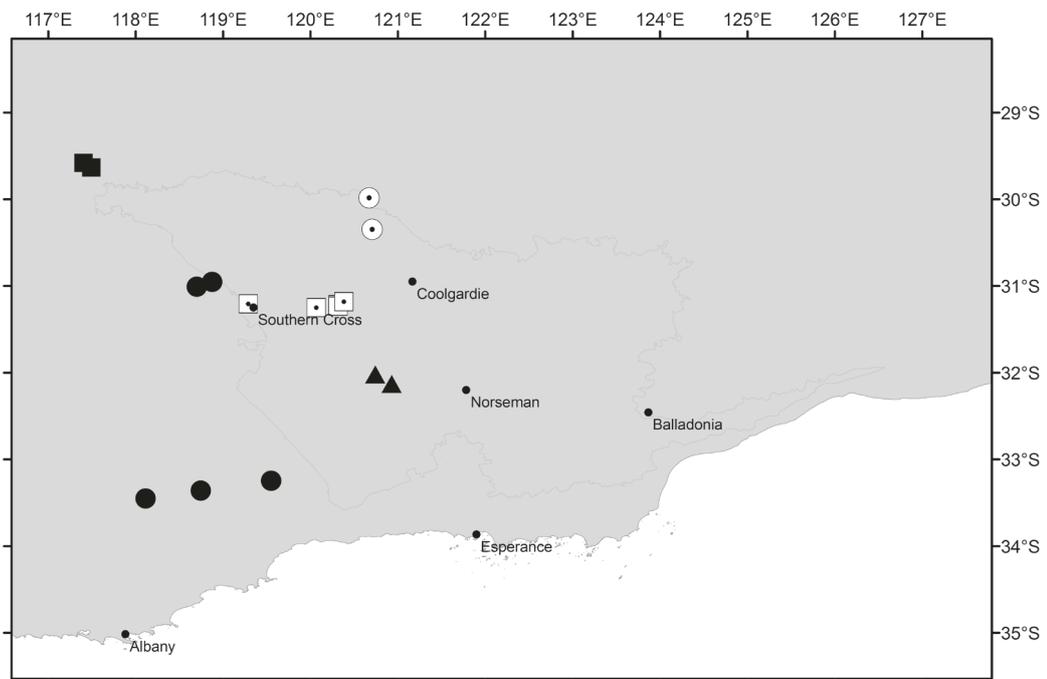
**FIGURE 36** Recorded distributions of *Antichiropus axicius* (filled circle), *A. buchianorum* (dotted circle), *A. cincinnus* (filled triangle), *A. cuspis* (filled squares) and *A. digitatus* (dotted square).



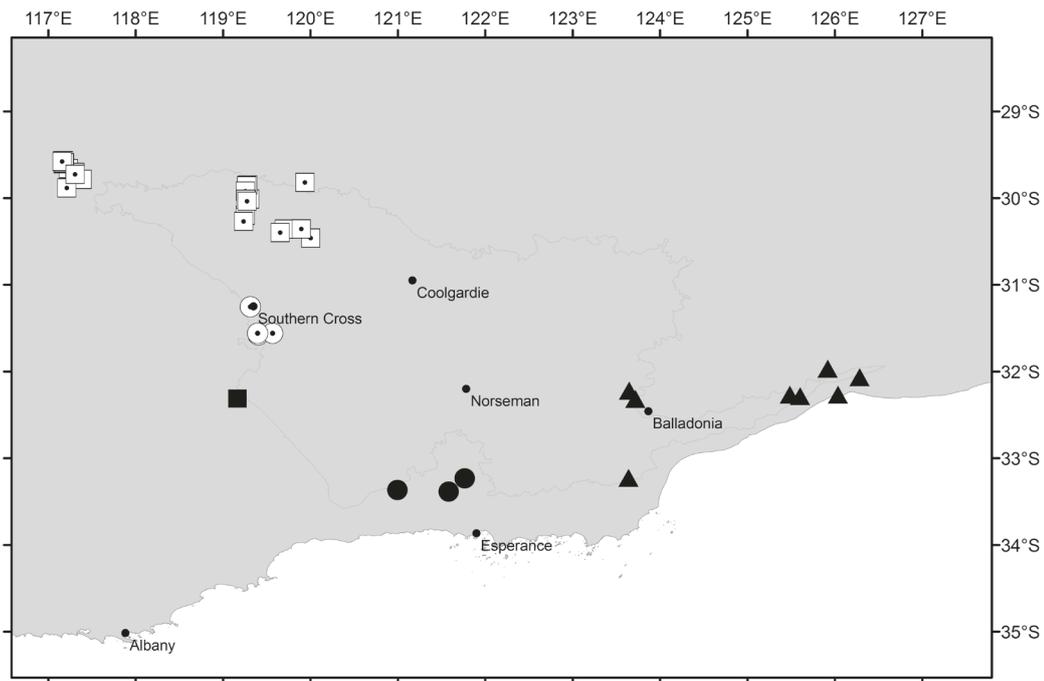
**FIGURE 37** Recorded distributions of *Antichiropus exclamatus* (filled circles), *A. framenau* (dotted circles), *A. giganteus* (filled triangle), *A. howardi* (filled square) and *A. incomptus* (dotted squares).



**FIGURE 38** Recorded distributions of *Antichiropus equinus* (filled circle), *A. inflatus* (dotted circle), *A. inopinatus* (filled triangles), *A. kealleyi* (filled squares) and *A. lacustrinus* (dotted square).



**FIGURE 39** Recorded distributions of *Antichiropus laticlavus* (filled circles), *A. nadineae* (dotted circles), *A. paracalothamnus* (filled triangles), *A. sagittulus* (filled squares) and *A. saxatilis* (dotted squares).



**FIGURE 36** Recorded distributions of *Antichiropus rex* (filled circles), *A. serratus* (dotted circles), *A. simpulus* (filled triangles), *A. succedaneus* (filled square) and *A. westi* (dotted squares).

### ACKNOWLEDGEMENTS

This project would not have been possible without the financial support of Cliffs Natural Resources, and we are sincerely grateful to Paul West for his support of this study. We are indebted to Julianne Waldock for her invaluable laboratory assistance, her field expertise and her unparalleled enthusiasm for collecting specimens that has remained constant over many years. Other notable collectors include former or current staff members of the Department of Parks and Wildlife (formerly Department of Environment and Conservation), Bradley Durrant, Nadine Guthrie and Paul van Heurck, as well as Jess Cairnes, Pat Cullen, Frances Leng, Peter Langlands, Alan Longbottom, Melinda Moir, Zoe Hamilton, Roy Teale and Scott Thompson, all of whom we gratefully acknowledge. We would also like to thank Bill Shear and Bob Mesibov for reviewing this paper: their detailed constructive comments have greatly improved the manuscript.

### REFERENCES

- Attems, C.G. (1911). Myriopoda exkl. Scolopendridae. In: Michaelsen, W. and Hartmeyer, R. (eds), *Die Fauna Südwest-Australiens*, volume 3: 147–204. Gustav Fischer: Jena.
- Attems, C. (1944). Neue Polydesmoidea. *Zoologischer Anzeiger* **144**: 223–251.
- Brölemann, H.W. (1916). Essai de classification des Polydesmiens (Myriapodes). *Annales de la Société Entomologique de France* **84**: 523–608.
- Car, C.A. (2009). Keeled millipedes (Diplopoda: Polydesmida: Paradoxosomatidae) in New South Wales. *General and Applied Entomology* **38**: 1–7.
- Car, C.A. (2010). Pine plantations and native millipedes (Diplopoda: Polydesmida: Paradoxosomatidae) in south-eastern New South Wales, Australia. *Australian Journal of Entomology* **49**: 317–323.
- Car, C.A., Wojcieszek, J.M. and Harvey, M.S. (2013). The millipede genus *Antichiropus* (Diplopoda: Polydesmida: Paradoxosomatidae), part 1: redefinition of the genus and redescription of existing species. *Records of the Western Australian Museum* **28**: 83–118.
- Dallwitz, M.J., Paine, T.A. and Zurcher, E.J. (1999). User's Guide to the DELTA Editor. <http://biodiversity.uno.edu/delta/>. Accessed 10 January 2012.
- Harvey, M.S. (2002). Short-range endemism in the Australian fauna: some examples from non-marine environments. *Invertebrate Systematics* **16**: 555–570.
- Harvey, M.S., Sampey, A., West, P.L.J. and Waldock, J.M. (2000). The Chilopoda and Diplopoda of the southern Carnarvon Basin, Western Australia. *Records of the Western Australian Museum, Supplement* **61**: 323–333.
- Jeekel, C.A.W. (1968). *On the Classification and Geographical Distribution of the Family Paradoxosomatidae (Diplopoda, Polydesmida)*. C.A.W. Jeekel: Rotterdam.
- Jeekel, C.A.W. (1982). Millipedes from Australia, 1: Antichiropodini from South Australia (Diplopoda, Polydesmida, Paradoxosomatidae). *Bulletin Zoologisch Museum, Universiteit van Amsterdam* **8**: 121–132.
- Judd, S., Watson, J.E.M. and Watson, A.W.T. (2008). Diversity

- of a semi-arid, intact Mediterranean ecosystem in south western Australia. *Web Ecology* **8**: 84–93.
- Mesibov, R. (2003). Lineage mosaics in millipedes. *African Invertebrates* **44**: 203–212.
- Nguyen, A.D. and Sierwald, P. (2013). A worldwide catalog of the family Paradoxosomatidae Daday, 1889 (Diplopoda: Polydesmida). *Check List* **9**: 1132–1353.
- Prober, S.M., Thiele, K.R., Rundel, P.W., Yates, C.J., Berry, S.L., Byrne, M., Christidis, L., Gosper, C.R., Grierson, P.F., Lemson, K., Lyons, T., Macfarlane, C., O'Connor, M.H., Scott, J.K., Standish, R.J., Stock, W.D., van Etten, E.J.B., Wardell-Johnson, G.W. and Watson, A. (2012). Facilitating adaptation of biodiversity to climate change: a conceptual framework applied to the world's largest mediterranean-climate woodland. *Climatic Change* **110**: 227–248.
- Shear, W.A. (1992). A new genus and two new species of millipedes from the Cape Range, Western Australia (Diplopoda, Polydesmida, Paradoxosomatidae). *Records of the Western Australian Museum* **15**: 777–784.
- Sierwald, P. and Bond, J.E. (2007). Current status of the myriapod class Diplopoda (millipedes): taxonomic diversity and phylogeny. *Annual Review of Entomology* **52**: 401–420.
- Verhoeff, K.W. (1924). Results of Dr. E. Mjöberg's Swedish Scientific Expeditions to Australia 1910–1913. 34. Myriapoda: Diplopoda. *Arkiv för Zoologi* **16**(5): 1–142.
- Verhoeff, K.W. (1928). On Diplopoda in the Australian Museum, Sydney. *Records of the Australian Museum* **16**: 79–115.
- Watson, A., Judd, S., Watson, J., Lam, A. and Mackenzie, D. (2008). *The Extraordinary Nature of the Great Western Woodlands*. The Wilderness Society: Perth.
- Wojcieszek, J.M. and Simmons, L.W. (2009). Isolation and characterization of 11 polymorphic microsatellite loci in the millipede *Antichiropus variabilis* Attems (Diplopoda: Polydesmida: Paradoxosomatidae). *Molecular Ecology Notes* **9**: 1208–1211.
- Wojcieszek, J.M. and Simmons, L.W. (2011a). Male genital morphology influences paternity success in the millipede *Antichiropus variabilis*. *Behavioral Ecology and Sociobiology* **65**(10): 1843–1856.
- Wojcieszek, J.M. and Simmons, L.W. (2011b). Evidence for stabilizing selection and slow divergent evolution of male genitalia in a millipede (*Antichiropus variabilis*). *Evolution* **66**: 1138–1153.
- Wojcieszek, J.M. and Simmons, L.W. (2013). Divergence in genital morphology may contribute to mechanical reproductive isolation in a millipede. *Ecology and Evolution* **3**: 334–343.
- Yates, C.J., Hobbs, R.J. and True, D.J. (2000). The distribution and status of eucalypt woodlands in Western Australia. In: Hobbs, R.J. and Yates, C.J. (eds), *Temperate Eucalypt Woodlands in Australia: Biology, Conservation, Management and Restoration*: 86–106. Sydney: Surrey Beatty and Sons.