

Bunderanthura bundera gen. et sp. nov. from Western Australia, first anchialine Leptanthuridae (Isopoda) from the Southern Hemisphere

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ABSTRACT – A new genus and species of leptanthurid isopod, *Bunderanthura bundera*, are described from a single individual from an anchialine environment in Western Australia. The new taxon differs from all species of *Leptanthura* in the elongate antennular and antennal peduncular articles (compact in *Leptanthura*), the presence of a strong thumb proximally on the palm of pereopod 1 (typically a square angle in *Leptanthura*), and on pereopod 2 (never seen in *Leptanthura*), an especially long pre-palm flexor margin on pereopod 3 (absent or short in *Leptanthura*), and a narrow uropodal exopod (few exceptions in *Leptanthura*). This is the first leptanthurid from non-marine environments outside the Atlantic.

KEYWORDS: Crustacea, isopod, Cape Range, stygobiont, new genus, new species

INTRODUCTION

Members of the crustacean suborder Isopoda have invaded fresh or brackish water many times. Representatives of freshwater taxa can be found among the Asellota (all species of Aselloidea in North America plus representatives of three other families), most Microcerberidea and Phreatoicoidea, all Tainisopidea, some Oniscidea, occasional species of at least nine families of Cymothoidea, plus few Idoteidae (Valvifera) and Sphaeromatidae (Sphaeromatidea) (Wilson 2008). Several species of *Cyathura* Norman and Stebbing, 1886 in the anthuroid family Anthuridae are found in brackish or fresh water (Frankenberg 1965; Negoescu 1981; Nunomura 1977; Poore and Lew Ton 1985) as are all 20 species of the related *Stygocyathura* (e.g. Andreev 1982a; Andreev 1982b; Botosaneanu and Sket 1999; Botosaneanu and Stock 1982; Nunomura 1992; Wägele et al. 1987). See Poore (2001) for lists of species. Among Paranthuridae, *Cruregens fontanus* Chilton, 1882 is interstitial in ground water in New Zealand (Wägele 1982) and the two Australian species of the three belonging to *Cruranthura* are estuarine (Poore 1984).

This is the first record of a stygobiont leptanthurid outside the Atlantic Ocean. The only other

stygobiontleptanthurids known are four species of *Curassanthura* Kensley, 1981. *Curassanthura halma* Kensley, 1981, *C. bermudensis* Wägele and Brandt, 1985 and *C. jamaicensis* Kensley, 1992 live interstitially on West Indian beaches and *C. canariensis* Wägele, 1985 in the Canary Islands. All tolerate brackish water, records ranging from 18 PSU to fully marine.

THE ENVIRONMENT

The specimen was collected from Bundera sinkhole, an isolated anchialine sinkhole on the coastal plain of Cape Range, 1.7 km inland of the Indian Ocean coast where it experiences 10% of oceanic tidal range. It was collected by drawing a small plankton net through the 4–8 m interval water depth in the cave accessed through a bore hole. The salinity varied from 20.3 to 25.5 PSU, temperature 22.3–24.8°C, pH 7.4–7.6, and dissolved oxygen 1.04–2.52 mg L⁻¹ (determined using a Quanta-G, Hydrolab Corporation, Austin, Texas). The sinkhole overall exhibits marked ecohydrogeochemical stratification, especially at water depths of 8–18 m (Humphreys 1999; Humphreys et al. 2012; Seymour et al. 2007).

ASSOCIATED FAUNA

The site is the main access to a rich anchialine (Stock et al. 1986) fauna including a core suite of species belonging to genera or higher taxa having a 'full Tethyan distribution' (Stock 1993: shown below with *) many of which are known elsewhere from Lanzarote (Canary Islands) and the Caribbean region (Humphreys 2000; Jaume and Humphreys 2001; Wilson and Humphreys 2001). The crustacean assemblage in these waters includes the remipede **Kumonga exleyi* (Yager and Humphreys, 1996); the thaumatocypridid ostracod* *Welesia kornickeri* (Danielopol, Baltanas and Humphreys, 2000); the paracypridine candonid *Phlyctenophora mesembria* Wouters, 1999; the epacteriscid calanoid copepod **Bunderia misophaga* Jaume and Humphreys, 2001; the pseudocyclopiid calanoid **Stygocyclopia australis* Jaume, Boxshall and Humphreys, 2001; the ridgewayiid calanoid **Stygoridgewayia trispinosa* Tang, Barron and Goater, 2008 the misophrioid copepod* *Speleophria bunderae* Jaume, Boxshall and Humphreys, 2001; the halicyclopine cyclopoids *Halicyclops spinifer* Kiefer, 1935 and *H. longifurnatus* Pesce, De Laurentiis and Humphreys, 1996; the laophontid harpacticoid *Onychocamptus bengalensis* (Sewell, 1934); the tetragnonicipitid harpacticoid *Phyllopodopsyllus wellsii* Karanovic et al., 2001; ameirid harpacticoids *Nitokra lacustris* (Schmankevitch, 1875), *N. fragilis* G.O. Sars, 1905 and *Nitokra humphreysi* Karanovic and Pesce, 2002; the atyid shrimps **Stygiocaris stylifera* Holthuis, 1959, **S. lancifera* Holthuis, 1959 and **Stygiocaris* sp. undescribed (Page et al. 2008); the thermosbaenacean **Halosbaena tulki* Poore and Humphreys, 1992; the hadziid amphipod **Hadzia branchialis* (Bradbury and Williams, 1996); the melitid amphipod *Nedsia douglasi* Barnard and Williams, 1995 and the cirolanid isopod **Haptolana pholeta* Bruce and Humphreys, 1993.

SYSTEMATICS

Family Leptanthuridae Poore, 2001

Bunderanthura gen. nov.

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TYPE SPECIES

Bunderanthura bundera sp. nov., herein designated.

DIAGNOSIS

Pereonite 7 about half length of pereonite 6. Pleonites 1–5 free and articulating; pleotelson with posterior margin of pleonite 6 indicated dorsally, delineated from telson. Eyes absent. Antenna peduncle articles longer than wide; flagellum elongate (of 9 articles), longer than last article of peduncle, articles cylindrical and

free. Mandibular palp of 3 articles, palp article 3 with 3 terminal setae. Maxillipedal endite obsolete; palp one-third as long as basis, free from basis, with articles 1–2 fused, articles 3–5 minute and free. Pereopod 7 present. Pereopod 1 carpus, flexor margin with simple setae; palm defined proximally by narrow thumb, palm with even marginal row of short complex robust setae along length, thumb bearing 1 robust seta. Pereopods 2 and 3 carpi flexor margins with slender flagellate seta and 2 simple setae. Pereopodal 2 propodus palm defined proximally by triangular thumb, palm with even marginal row of short complex robust setae along length, thumb with 2 robust setae. Pereopod 3 propodus longer than wide, palm oblique, with row of complex robust setae. Pereopods 4–7 carpi triangular, flexor margin with slender flagellate seta and 2 simple setae, enclosed anteriorly by surrounding articles; propodi elongate, flexor margin with flagellate setae. Uropodal exopod narrowly leaf-shaped, shorter than peduncle.

Male: unknown.

REMARKS

Bunderanthura most resembles *Leptanthura* Sars, 1897, a genus of 42 species and the largest genus of Leptanthuridae. Notable similarities are the presence of all seven pereonites and pairs of pereopods, free pleonites, differentiation of pereopods 2 and 3 from pereopods 4–7, all pereopods with triangular carpi, similar numbers of antennular and antennal flagellar articles, 3-articled mandibular palp, obsolete maxillipedal endite, and short maxillipedal palp with compressed distal articles. *Bunderanthura* differs from *Leptanthura* in the elongate first and second antennal peduncular articles (compact in *Leptanthura*), the presence of a strong thumb proximally on the palm of pereopod 1 (typically a square angle in *Leptanthura*), and on pereopod 2 (never seen in *Leptanthura*), an especially long pre-palm flexor margin on pereopod 3 (absent or short in *Leptanthura*), and with few exceptions a narrow uropodal exopod (broad and meeting in the middle in most species of *Leptanthura*).

Wägele (1989) believed *Leptanthura* to be a polyphyletic genus from which *Bulloanthura* Poore, 1978, *Ulakanthura* Poore, 1978 and *Psittanthura* Wägele, 1985[b] can be derived. It is not the intention or the place in this paper to undertake a cladistic analysis of this complex. All genera were said to share reduced maxillipedal endite and overlapping uropodal exopods (exopods secondarily smaller in few *Leptanthura*). All, except *Leptanthura*, have a reduced or no mandibular palp (also true of *L. apalpata*). Poore's (2001) phylogenetic analysis (that assumed these and all genera as monophyletic) was similar, recognising that these four genera shared the reduced maxillipedal endite, short maxillipedal palp and a robust seta on the margin of the carpus of pereopod 1. In his analysis, *Leptanthura* alone has about three terminal setae on

TABLE 1 Distribution and habitat of stygobiont leptanthurid isopods.

Species	Location	Salinity (PSU)	Habitat	Reference
<i>Curassanthura halma</i>	Curacao, West Indies, Caribbean, west Atlantic Ocean	18–33	coral rubble	Kensley 1981, 1992; Wägele 1985a
<i>C. bermudensis</i>	Bermuda, west Atlantic Ocean	15.54–26.06	anchialine: coarse sediments in cave pool	Wägele and Brandt 1985
<i>C. canariensis</i>	Lanzarote, Canary Islands, east Atlantic Ocean	34–35	anchialine: lava gravel in Jameos del Agua section of the Corona lava tube, Lanzarote	Wägele 1985a; Wilkens et al. 2009
<i>C. jamaicensis</i>	Jamaica, Caribbean, west Atlantic Ocean	14	anchialine: 1.5 m deep sinkhole, 100 m inland	Kensley 1992
<i>Bunderanthura bundera</i>	Cape Range peninsula, Western Australia, Indian Ocean	25.1–27.9	anchialine: cave, 1.7 km inland	this paper

the mandibular palp whereas the other genera have a uniarticulate palp or no palp at all. Some of the defining characters of the new genus are typical of hypogean species – attenuated limbs, reduced and narrow uropodal exopod, and reduced setation. *Bunderanthura bundera* may be like the others, derived from within *Leptanthura* sensu lato. All 42 species of *Leptanthura* are marine, ten are intertidal or subtidal but most are from shelf or bathyal environments (Müller 1992; Poore 2001).

Bunderanthura is superficially similar to species of *Curassanthura* from similar environments in the Atlantic (Table 1) but well-removed from *Leptanthura* in the cladistic analyses of Paranthuridae (sensu lato) (Wägele, 1989) and Leptanthuridae (Poore, 2001). While all share blindness and the attenuation of body and limbs associated with a hypogean environment, *Curassanthura* species lack pereopod 7, have elongate carpi on pereopods 2 and 3, have a prominent maxillipedal endite, long (yet plesiomorphically fully articulated) maxillipedal palp, and lack robust setae on the pereopodal carpi. These are the characters that separated *Curassanthura* from *Leptanthura* and other genera in earlier cladistic analyses.

ETYMOLOGY

From Bundera, type locality and *Anthura*, a genus

name commonly incorporated into generic names within Anthuroidea.

***Bunderanthura bundera* sp. nov.**

Figures 1–3

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MATERIAL EXAMINED

Holotype

Australia: Western Australia: Exmouth Region, Bundera, Bore S1, 22.41235°S, 113.76517°E, R.A. Young and W.F. Humphreys, 29 June 2012 (stn BES17421), Western Australian Museum (WAM C52568, juvenile, total length 7.1 mm, posterior section lost following dissection).

DESCRIPTION

Total length about 12 times width. Head as wide as its middorsal length, lateral lobes extending well beyond pseudorostrum. Pereonite 1–7 lengths with ratio 1:1.2:1.05:1.13:1.13:1:0.6. Pleonites 1–5 together as long as pereonite 7 middorsally, each with rounded epimera. Pleotelson 1.7 times as long as pereonite 7, 3 times as long as basal width of telson; telson parallel-sided

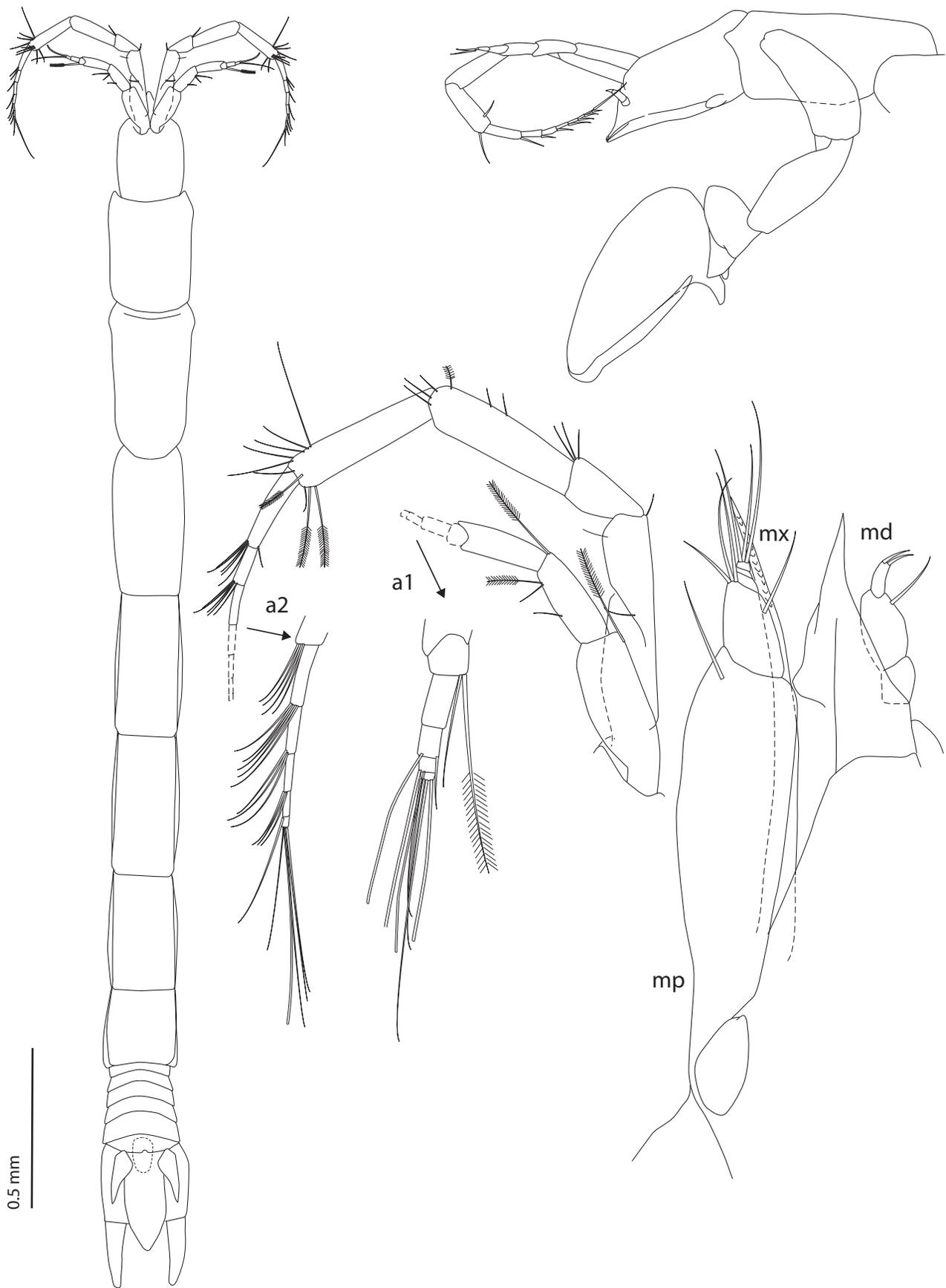


FIGURE 1 *Bundanthura bundera* gen. and sp. nov., holotype: Dorsal habitus, lateral view of head, pereonite 1 and pereonite 1. Left mouthparts in situ: mandible (md); maxillule style (mx), maxilliped (mp). Antennule (a1 with flagellum at greater magnification), antenna (a2 with distal flagellum at greater magnification) in situ. Scale bar refers to habitus only.

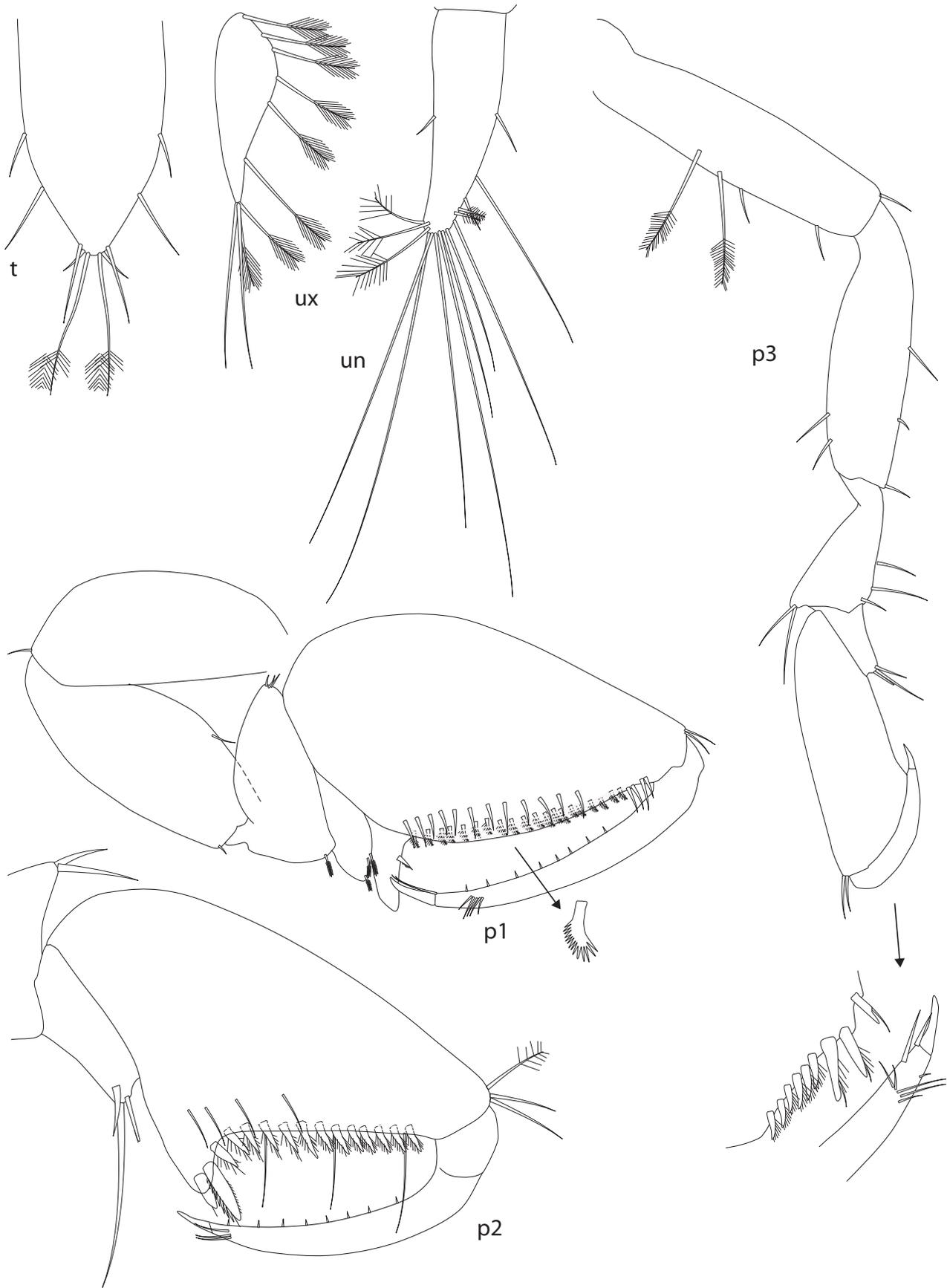


FIGURE 2 *Bundanthura bundera* gen. and sp. nov., holotype: Apex of telson (t); uropodal endopod and exopod (un, ux). Pereopods 1 (with lateral palm seta in detail), 2, 3 (with detail of propodal palm and dactylus apex). Pereopods to same scale, detail excepted.

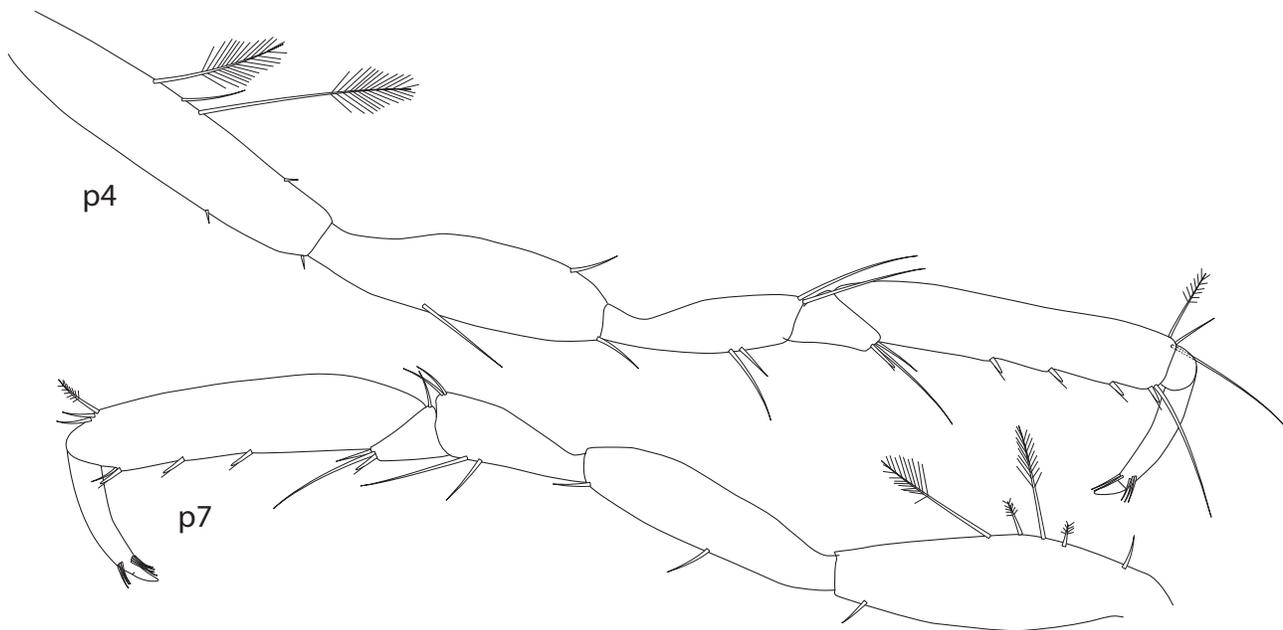


FIGURE 3 *Bundanthura bundera* gen. and sp. nov., holotype: Pereopods 4, 7 (to same scale as figure 2).

over proximal two-thirds, tapering with gently convex margin to acute apex over distal third, 3 pairs of long sublateral setae on distal third, apex with pair of simple and pair of plumose setae.

Antennule 1.5 times middorsal length of head; peduncle article 1 3 times as long as wide, article 2 0.4 length of article 1; article 3 as long as article 2; flagellum 0.7 length of peduncle article 3, of short first article plus 4 articles bearing 3 setae and 4 aesthetascs. Antenna 3.6 times middorsal length of head; peduncle article 3 0.3 length of article 2; article 4 3.5 times as long as wide; article 5 4 times as long as wide, 1.1 times as long as article 4; flagellum 1.6 times as long as peduncle article 5, of 8 diminishing articles. Mandibular palp article 2 with 1 subdistal seta; article 3 half length of article 2, tapering, with 3 short distal simple setae. Maxillule stylet acute, denticulate. Maxillipedal basis with 1 long distolateral seta, endite obsolete; palp article 1 tapering, with 1 mesiolateral seta, 3 distolateral setae; palp articles 2–4 minute, diminishing, with 3 distal setae.

Pereopod 1 merus wider than long, with 1 plumose seta on flexor margin; carpus visible only on flexor margin, with 3 plumose setae distally; propodus body 1.8 times as long as wide, strongly tapering, with narrow proximal thumb with 1 robust seta on distal margin; palm with c. 20 short pectinate setae laterally and 12 simple setae mesially; dactylus tapering, closing on thumb, unguis about 0.2 length.

Pereopod 2 carpus set obliquely along flexor margin, with 1 slender flagellate seta and 2 simple setae on distal angle; propodus 2.5 times as long as basal width, tapering, with broadly-based proximal thumb bearing 1 flagellate robust seta and 1 strong pectinate seta; palm with 13 compact pectinate robust setae and 3 simple

setae laterally, and 4 simple setae mesially; dactylus tapering, overlapping thumb.

Pereopod 3 merus triangular, 1.6 times as long as distal width; carpus set under proximal propodus, with 1 slender flagellate seta and 2 simple setae on distal angle; propodus 3 times as long as wide, dilating to oblique palm, with obtuse angle bearing 1 slender flagellate seta and 2 pectinate robust setae (no thumb); palm with 7 smaller pectinate robust setae; dactylus overlapping palm by more than length of unguis.

Pereopod 4 merus 3.5 times as long as greatest width; carpus triangular, with 1 slender flagellate seta and 2 simple setae on distal angle; propodus 5.5 times as long as wide, with 4 flagellate setae over distal 40% of palm; dactylus 0.4 propodus length.

Pereopod 7 merus 2.5 times as long as greatest width; carpus triangular, with 1 slender flagellate seta and 2 simple setae on distal angle; propodus 5.0 times as long as wide, with 3 flagellate setae over distal half of palm; dactylus 0.5 propodus length.

Uropod 1.25 times as long as telson; endopod 0.7 peduncle length, tapering, 3 times as long as wide, with 8 long distal simple setae and 3+2 plumose setae; exopod 0.6 peduncle length, narrowly leaf like, 3 times as long as greatest width, with 6 marginal plumose setae, with 2 plumose and 2 long simple apical setae.

ETYMOLOGY

Bundera, from the type locality, noun in apposition.

DISTRIBUTION

Western Australia, Exmouth region, stygobiont, known only from type locality.

DISCUSSION

Anchialine systems are noteworthy for their highly stratified water columns containing a diverse crustacean assemblage comprising numerous phylogenetic and biogeographic relicts (Ilfiffe 1992), attributes shared with Bundera sinkhole. The structure of part of the assemblage is highly predictable, even at the generic level, however far apart in the world they occur (Jaume et al. 2001; Wagner 1994), typically comprising atyid shrimps, thermosbaenaceans, hadziid amphipods, cirolanid isopods, remipedes, thaumatocypridid ostracods, and a vast array of copepods such as epacteriscid, pseudocyclopiid, and ridgewayiid calanoids, halicyclopine cyclopoids, speleophriid misophrioids, and superornatiremid harpacticoids. Furthermore, most of these higher taxa are restricted to the fully marine sections of anchialine systems or other subterranean habitats, having no known living marine members.

As noted by Wägele (1985a), the stygobiont members of the Leptanthuridae follow this tethyan distribution closely and the discovery of *Bunderanthura bundera* completes the 'full Tethyan track'. In addition, they all live in anchialine, or meso- to polyhaline habitats. There are, however, significant differences between the five stygobiont leptanthurids (Table 1) and the other taxa with full Tethyan distributions. Firstly, *B. bundera* inhabits the non fully-marine section of the sinkhole whereas the core anchialine taxa occur only in fully marine waters below the zone of hydrogen sulphide in Bundera sinkhole (Humphreys 1999). Secondly, non-stygobiont leptanthurids are widespread in the oceans today where they are represented by 96 species (Poore and Bruce 2012), whereas the core Tethyan taxa are restricted to anchialine habitats. Finally, the stygobiont leptanthurids are absent from the North America plate, where the core anchialine taxa (Boxshall and Iglukowska 2012) are concentrated globally.

ACKNOWLEDGEMENTS

WH thanks Rae Young for her voluntary assistance on field work. The Defence Environment Department facilitated access to the area and funded the field work. Thanks also to Niel Bruce, Wolfgang Wägele and Buz Wilson for comments on the manuscript.

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