

A new genus and six new species of the Parabathynellidae (Bathynellacea, Syncarida) from the Kimberley region, Western Australia

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(Accepted 23 September 2004)

Abstract

Six new species of a new genus of the Parabathynellidae are described from the Kimberley Region, Western Australia. The erection of the new genus, *Kimberleybathynella* gen. nov., is based on the two-segmented antenna, the partial fusion of the second and third segments of the maxilla, and the setal condition of the uropodal exopodite, where the outer seta is longer than the inner one. The one-segmented exopodite of thoracopods I–VII and hemispherical form of male thoracopod VIII suggest the close relationship of *Kimberleybathynella* to the genus *Atopobathynella*.

Keywords: *Parabathynellidae*, *Kimberleybathynella* gen. nov., *Western Australia*

Introduction

Bathynellaceans are known from all the continents except Antarctica and inhabit, with a few exceptions, freshwater aquifers. Although their worldwide distribution indicates an origin in the Upper Palaeozoic (Brooks 1962; Schram 1977), it is still controversial whether they entered the ground water via the coastal interstitial (Boutin and Coineau 1987; Coineau 1996) or the hyporheos of the fresh water (Schminke 1981). Recently, the north-western part of Australia has come to receive the attention of biologists because of the diverse stygofaunas being found in limestone, calcrete, sedimentary, and regolith substrata in fresh, saline and anchialine waters (Humphreys 1999). As is typical of stygofaunas these assemblages are dominated taxonomically by crustaceans and many of them are regarded as having tethyan or gondwanan affinities (Poore and Humphreys 1992; Bruce and Humphreys 1993; Humphreys 1993; Yager and Humphreys 1996; Bradbury and Williams 1997).

Here we report on the occurrence of six new parabathynellid species from the Kimberley Region of Western Australia, five species from alluvial and regolith substrata in the Ord

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Published 28 June 2005.

River catchment, East Kimberley and one from a calcrete in a palaeovalley in the Canning Basin (Figure 1). The bulk of the Kimberley craton has not been submerged in the sea since at least the Palaeozoic (Humphreys 1999) but the peripheral lower elevations were submerged in the Cretaceous and probably the Eocene high sea level; the area was subject to continental ice sheets in the Permian. Careful inspection of the material and the discovery of new characters lead us to propose the establishment of a new taxon, *Kimberleybathynella* gen. nov., comprising these six new species. This is the fifth genus

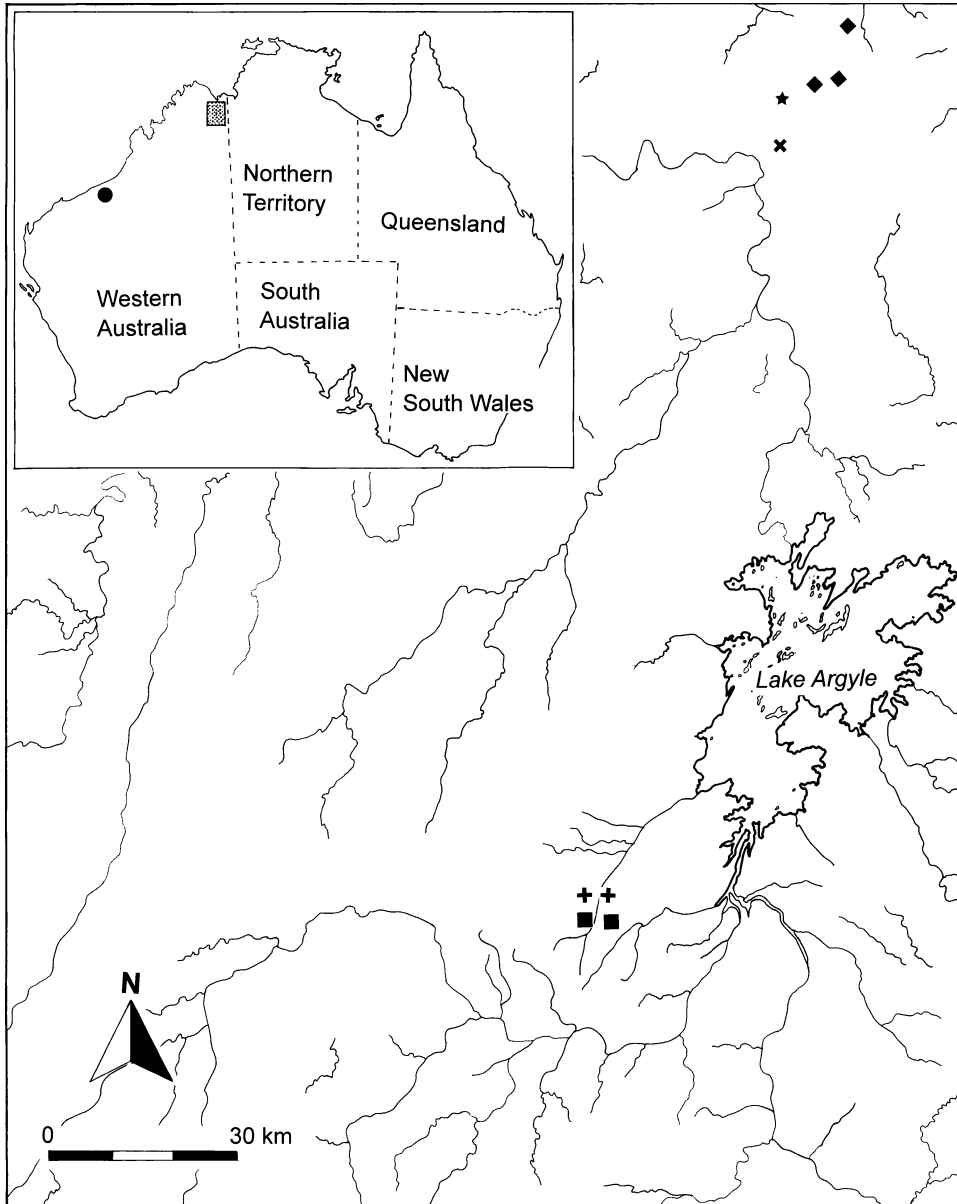


Figure 1. Distribution of the genus *Kimberleybathynella* gen. nov. in Western Australia.

known from the Australian continent following *Hexabathynella* Schminke, 1972, *Atopobathynella* Schminke, 1973, *Chilibathynella* Schminke, 1973, and *Notobathynella* Schminke, 1973.

Material and methods

The samples were prepared and mounted in a mixture of glycerin–formalin. For the drawing and investigation, a Nikon Eclipse E600-Microscope with differential interference contrast equipment was used with oil immersion. Type material is deposited in the collection of the Western Australian Museum, Perth (WAM). OIA refers to the Ord Irrigation Area.

The abbreviations used in the figures and tables are: A. I, antennule; A. II, antenna; Labr., labrum; Md., mandible; Mx. I, maxillule; Mx. II, maxilla; Th. I, II, etc., thoracopod I, II, etc.; Urp, uropod.

Systematics

Family PARABATHYNELLIDAE Noodt, 1964

Genus *Kimberleybathynella* gen. nov.

Diagnosis

Parabathynellidae. Body elongated and cylindrical. Antennule six-segmented. Antenna two-segmented. Labrum flat. Incisor process of mandible consisting of five spines. Maxilla four-segmented, second and third segments of maxilla half fused. Exopodite of thoracopods I–VII one-segmented. Male thoracopod VIII hemispherical, protopodite slightly protruded, basipodite without setae, inner margin of basipodite drawn out into projection. Distal spine of uropodal sympodite longer and thicker than other spines. Uropodal exopodite bearing a ventromedial seta and two terminal setae, of which the outer seta is longer than inner one.

Type species

Kimberleybathynella gigantea n. sp.

Etymology

The generic name alludes to the region, where the majority of its species are found. Gender: feminine.

Kimberleybathynella gigantea n. sp.

(Figures 2–5)

Type material

Holotype: ♂ dissected on six slides, Weber Plains, East Kimberley, Western Australia, Australia, OIA bore WP1 (15°29'19"S, 128°50'09"E), BES 6362, 13 August 1998, S. M. Eberhard leg. coll. Western Australian Museum, Perth (WAM C 34240). Allotype: ♀

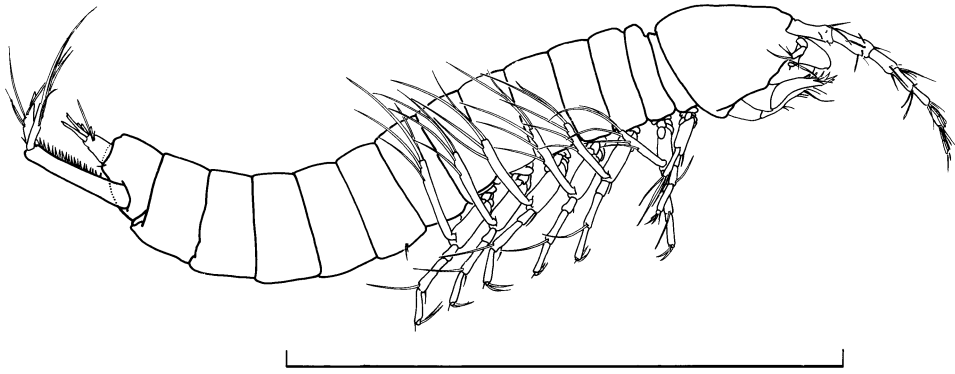


Figure 2. *Kimberleybathynella gigantea* gen. et sp. nov. General habitus ♀, lateral. Scale bar: 2 mm.

dissected on five slides, same data as for holotype (WAM 34241). Paratypes: 1♂ and 4♀♀, same data as for holotype (WAM 34242–34246).

Etymology

The species is named after the large body size.

Description of adults

Size (mm). Body length: ♂ 3.49–3.91, ♀ 3.00–3.22, approximately 10 times as long as wide. Head as long as length of segments 1–4 (Figure 2). The female differs from the male only in thoracopod VIII.

Antennule (Figure 3A). Antennule six-segmented. First segment with one seta on inner distal margin, with two simple dorsal setae, and with one dorsolateral, one lateral and one ventromedial plumose setae. Second segment with one group of four plumose setae, one simple seta on inner distal margin and one ventral seta. Third segment with two setae on outer margin, one simple seta on inner distal margin and one ventral seta. Peduncle of third segment with three simple setae. Fourth segment with one stub seta and a plumose seta on dorsal margin, with two stub setae, and with two plumose setae on lateral apophysis. Fifth segment with two setae on inner margin, with two aesthetascs and one simple seta dorsally, and with one lateral aesthetasc. Sixth segment with four terminal setae and three subterminal aesthetascs.

Antenna (Figure 3B). Antenna two-segmented, as long as the first segment of the antennule, proximal segment without setae, distal segment with two simple setae and one plumose seta terminally and one subterminal seta.

Labrum (Figure 3C). Labrum flat, with four terminally denticulated median teeth flanked by eight to nine main and six to seven additional teeth on both sides.

Mandible (Figure 3D). Mandible with incisor process of four teeth. Tooth of ventral edge small and triangular. Spine row consisting of five spines. Palp of one segment, with one apical seta being seven times as long as palp.

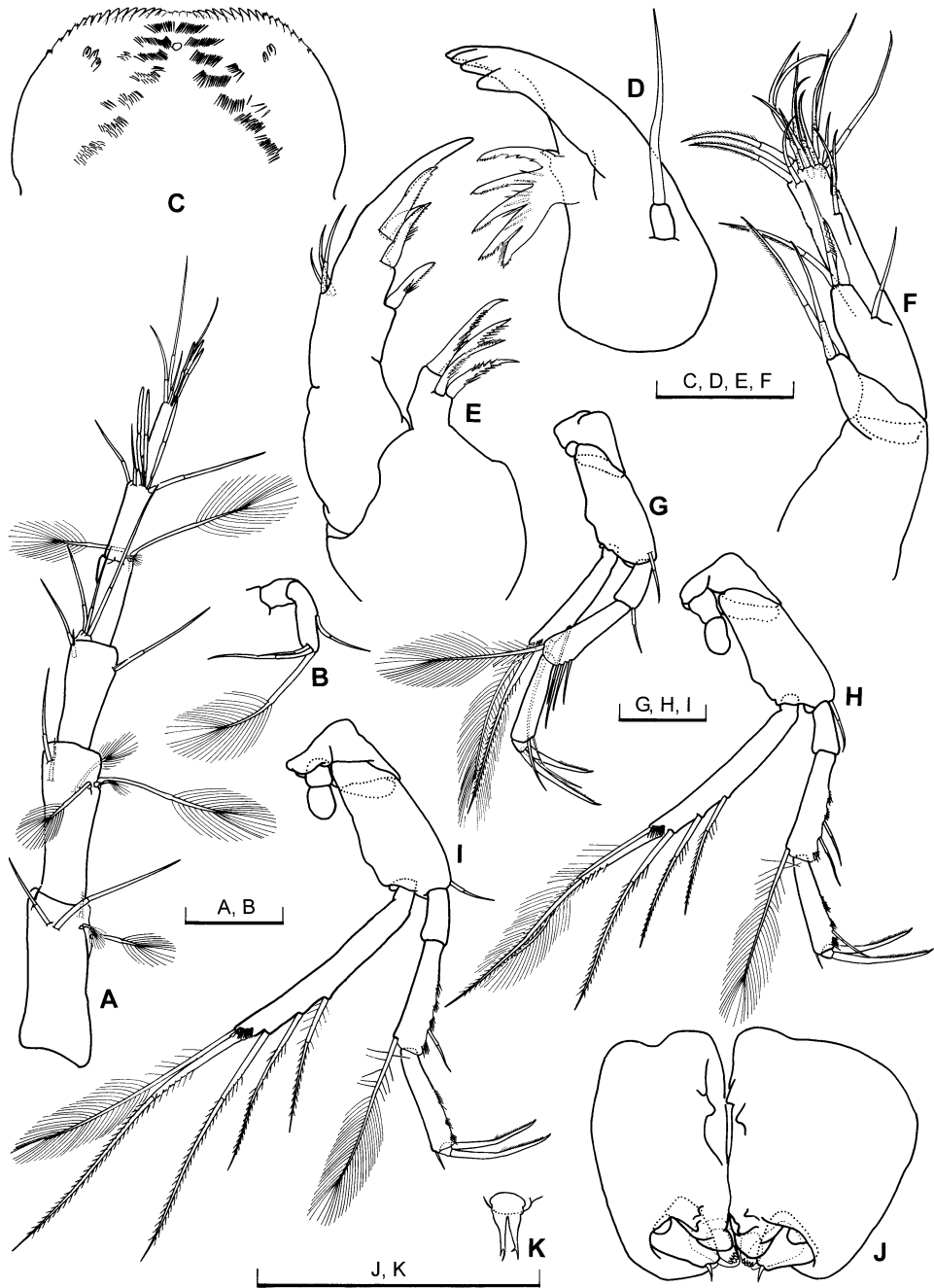


Figure 3. *Kimberleybathynella gigantea* gen. et sp. nov. (A) Right A. I ♂ (dorsal); (B) right A. II ♂ (dorsal); (C) Labr. ♂ (ventral); (D) left Md. ♂ (ventral); (E) right Mx. I ♂ (dorsal); (F) left Mx. II ♂ (dorsal); (G) left Th. I ♂ (frontal); (H) left Th. II ♂ (frontal); (I) left Th. III ♂ (frontal); (J) Th. VIII ♂ (frontal); (K) Th. VIII ♀ (frontal). Scale bars: 0.1 mm.

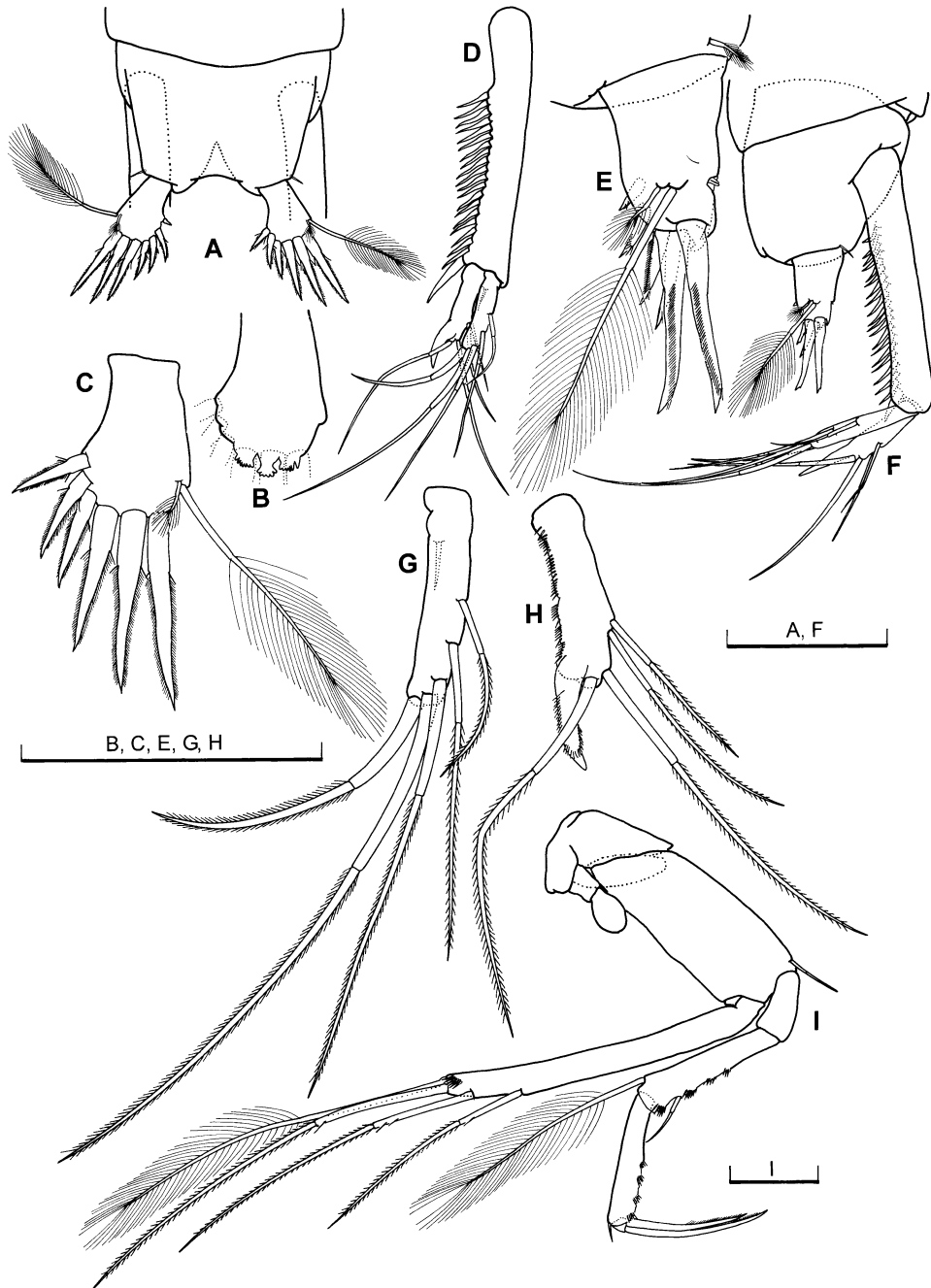


Figure 4. *Kimberleybathynella gigantea* gen. et sp. nov. (A) Pleotelson and furca ♂ (dorsal); (B) right furca ♂ (ventral), without spines; (C) right furca ♂ (dorsal); (D) uropod ♂ (dorsal); (E) right furcal ramus ♂ (lateral); (F) pleotelson, furca and uropod ♂ (lateral); (G) exopodite of right uropod ♂ (dorsal); (H) endopodite of right uropod ♂ (dorsal); (I) left Th. VII ♂. Scale bars: 0.5 mm (A–H); 0.1 mm (I).

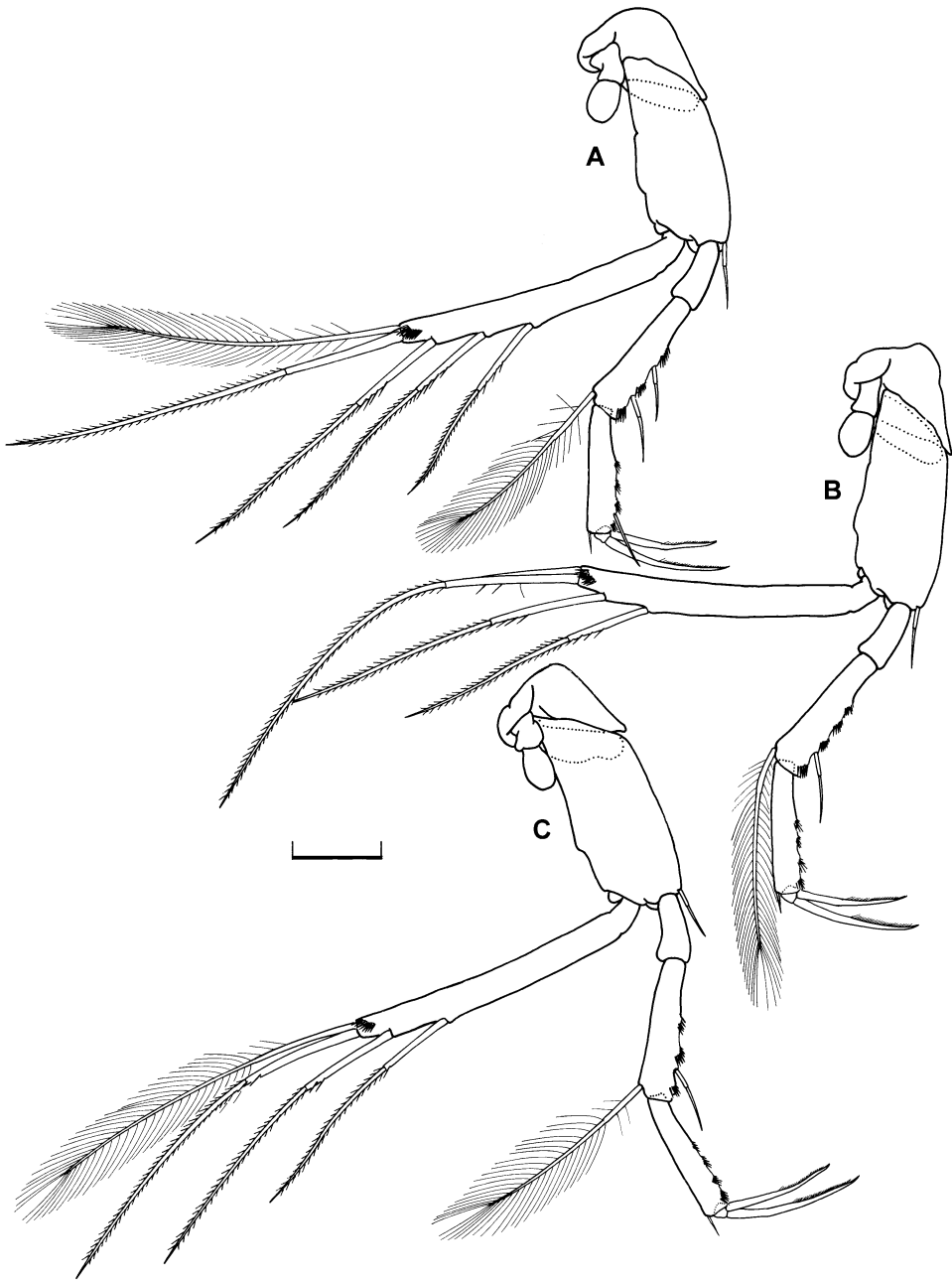


Figure 5. *Kimberleybathynella gigantea* gen. et sp. nov. (A) Left Th. IV ♂ (frontal); (B) left Th. V ♂ (frontal); (C) left Th. VI ♂ (frontal). Scale bar: 0.1 mm.

Maxillule (Figure 3E). Maxillule two-segmented. Proximal segment with four setae on inner distal margin. Distal segment with two terminal claws, with three claws on inner edge, and with three simple setae on outer distal margin. The three simple setae barely reaching beyond the base of the terminal claws.

Maxilla (Figure 3F). Maxilla four-segmented. Second segment half fused with third segment; setal formula 2-4-15-1.

Thoracopods I–VII (Figures 3G–I, 4I, 5A–C). Thoracopods I–VII increasing in length posteriorly. Thoracopods IV–VII equal in length. Protopodite of thoracopods II–VII each bearing one epipodite. Thoracopods I–VII each bearing one basipodal seta. Exopodite of thoracopods I–VII one-segmented. Exopodite of thoracopods I, V, VI, VII with two terminal setae and with two setae on inner margin. Exopodite of thoracopods II–IV with two terminal setae and with three setae on inner margin. Endopodite of thoracopods I–VII four-segmented, setal formulae: thoracopods I: 1+0/2,3+1/2+0/3(1); thoracopods II: 0+0/2+1/1+1/2; thoracopods III: 0+0/1,2+1/0+1/2; thoracopods IV: 0+0/2+1/1+1/2; thoracopods V–VII: 0+0/1+1/0+1/2.

Thoracopod VIII. Thoracopod VIII of male (Figure 3J) hemispherical in lateral view. Protopodite massive, with two hooks on inner margin. Penial region slightly protruded. Epipodite represented by a tiny hemisphere. Basipodite without seta, inner margin of basipodite drawn out into projection. Exopodite triangular, bearing one seta. Endopodite 50% of exopodite, denticulated terminally. Thoracopod VIII of female (Figure 3K) in form of a bifurcated structure resulting from the basal fusion of left and right thoracopods. Distal end of each branch bifurcated.

First pleomere. First pleomere with a pair of two setae.

Uropod (Figure 4D, F–H). Uropod bearing 20 spines on inner distal margin of sympodite. Distal spine twice as long as proximal spines of equal size. Endopodite 30% as long as sympodite, drawn out distally into slightly curved spur, with two setae of equal length at base of spur and further two subterminal setae on outer margin. Exopodite as long as endopodite, with two terminal and three lateral setae and one ventromedian seta. Outer member of both terminal setae 1.5 times as long as the marginally thicker inner seta.

Pleotelson (Figure 4A). Pleotelson with one seta at base of furcal rami on both sides. Anal operculum flat, somewhat concave.

Furcal rami (Figure 4B, C). Furcal rami 1.5 times as long as wide, with six spines and with two dorsal plumose setae.

***Kimberleybathynella kimberleyensis* n. sp.**

(Figures 6, 7)

Type material

Holotype: ♂ dissected on five slides, Weber Plains, East Kimberley, Western Australia, Australia, OIA bore WP 19 (15°23'39"S, 128°57'05"E), BES 6356, 12 August 1998, S. M. Eberhard leg. coll. Western Australian Museum, Perth (WAM C 34247). Allotype: ♀ dissected on four slides, same data as for holotype except OIA bore WP 11 (15°27'31"S, 128°54'08"E), BES 6355 (WAM 34248). Paratypes: 1♂ on a slide, same data as for holotype except OIA bore WP 9 (15°26'21"S, 128°55'10"E), BES 6359 (WAM C 34249).

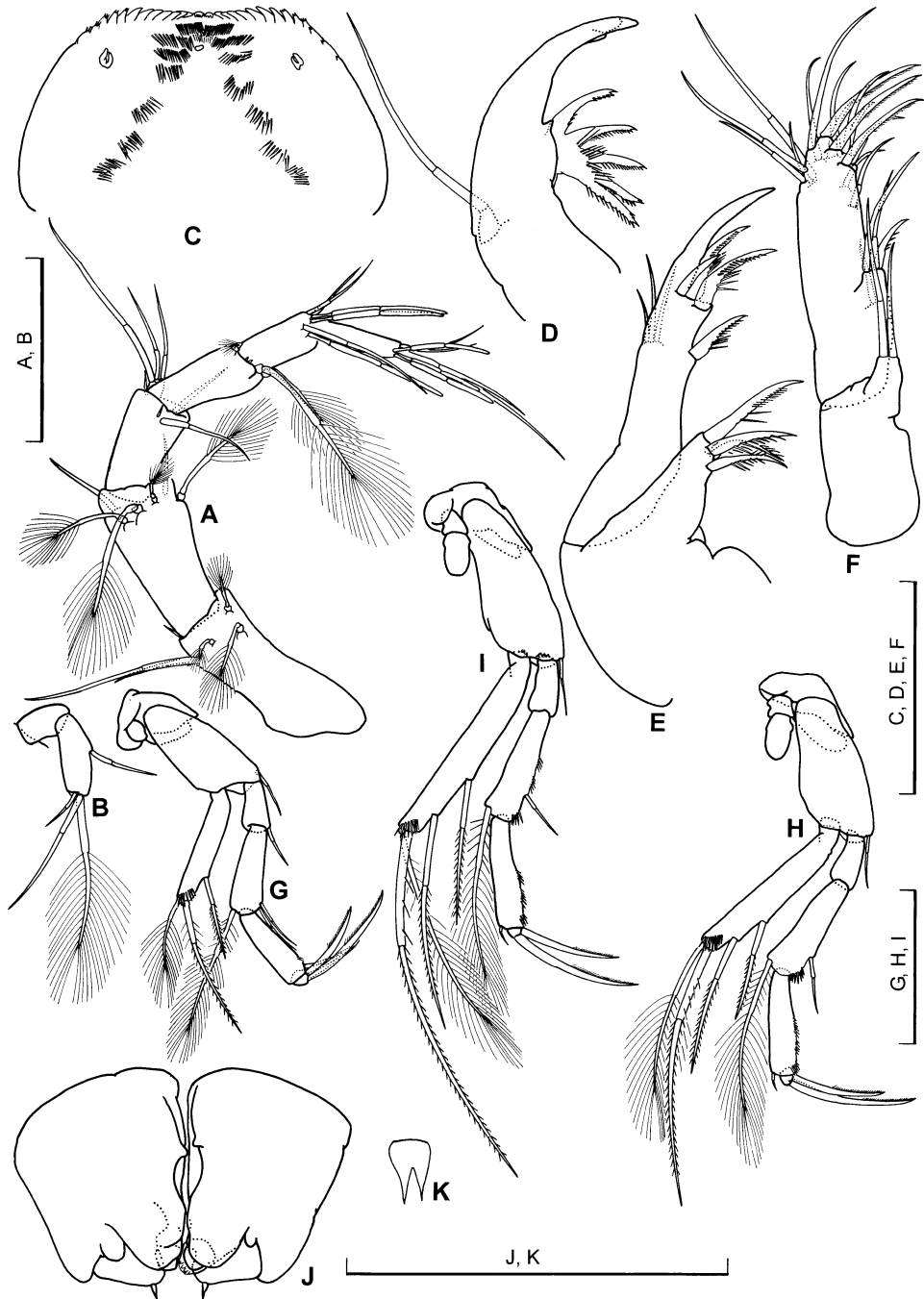


Figure 6. *Kimberleybathynella kimberleyensis* gen. et sp. nov. (A) Right A. I ♂ (lateral); (B) right A. II ♂ (dorsal); (C) Labr. ♂ (ventral); (D) left Md. ♂ (dorsal); (E) left Mx. I ♂ (dorsal); (F) left Mx. II ♂ (dorsal); (G) left Th. I ♂ (frontal); (H) left Th. II ♂ (frontal); (I) left Th. III ♂ (frontal); (J) Th. VIII ♂ (frontal); (K) Th. VIII ♀ (frontal). Scale bars: 0.1 mm.

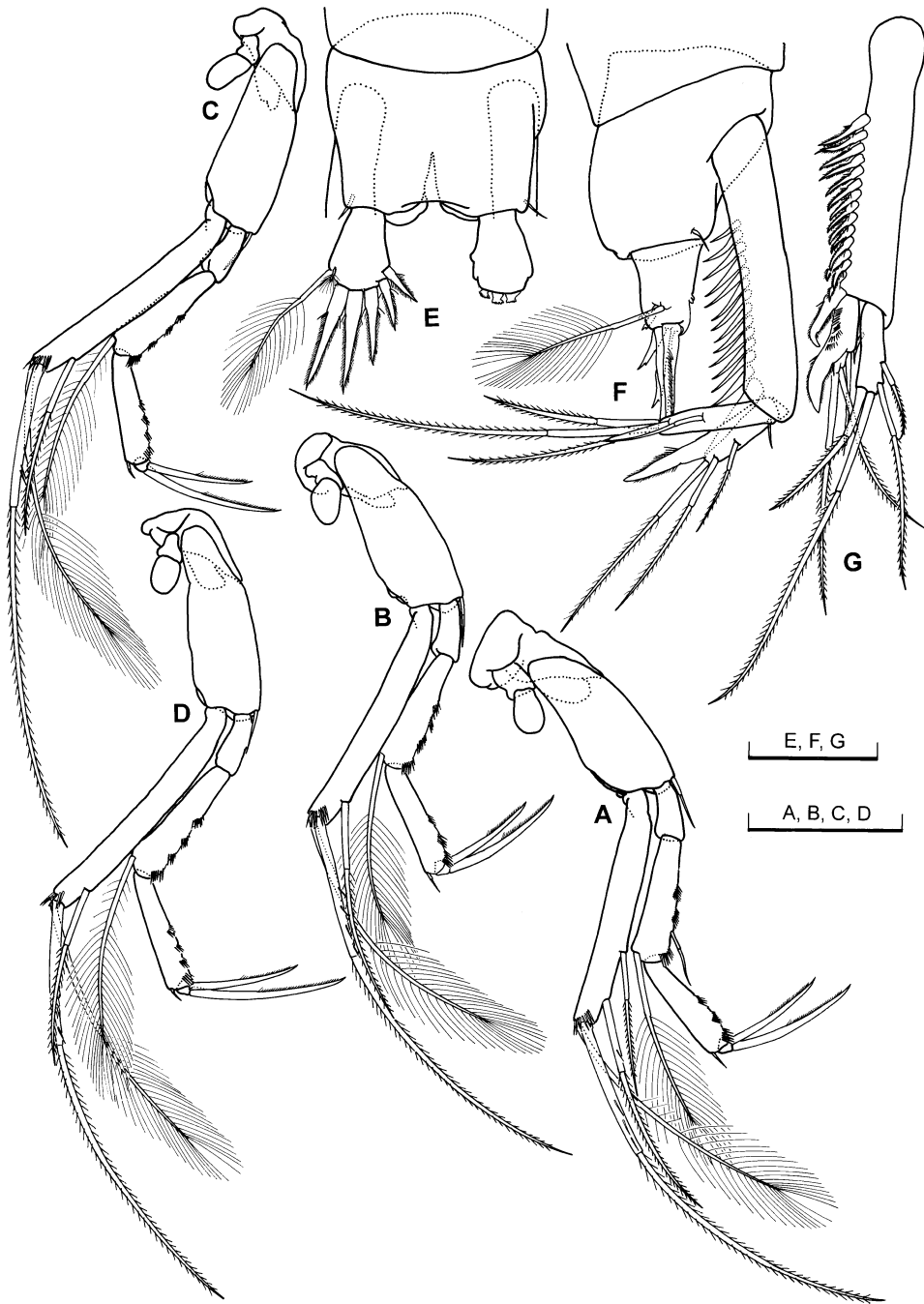


Figure 7. *Kimberleybathynella kimberleyensis* gen. et sp. nov. (A) Th. IV ♂ (frontal); (B) Th. V ♂ (frontal); (C) Th. VI ♂ (frontal); (D) Th. VII ♂ (frontal); (E) pleotelson and furca ♂ (dorsal); (F) pleotelson, furca and uropod (lateral); (G) right uropod (dorsal). Scale bars: 0.1 mm.

Etymology

The species is named after the Kimberley region, where the species was collected.

Description of adults

Size (mm). Body length: ♂ 2.05–2.09, ♀ 2.19, approximately 10 times as long as wide. Head as long as length of segments 1–4. The female differs from the male only in thoracopod VIII.

Antennule (Figure 6A). Antennule six-segmented, setation as in *K. gigantea*.

Antenna (Figure 6B). Antenna two-segmented, setation as in *K. gigantea*.

Labrum (Figure 6C). Labrum flat, with two terminally denticulated median teeth flanked by seven main and six additional teeth on both sides.

Mandible (Figure 6D). Mandible as in *K. gigantea* except the incisor process of three teeth.

Maxillule (Figure 6E). Maxillule two-segmented, ornamentation as in *K. gigantea*.

Maxilla (Figure 6F). Maxilla four-segmented. Second segment half fused with third segment; setal formula 2-4-15-1.

Thoracopods I–VII (Figures 6G–I, 7A–D). Thoracopods I–VII as in *H. gigantea* except following. Exopodite of thoracopods I, V, VI, VII with two terminal setae and with one seta on inner margin. Exopodite of thoracopods II–IV with two terminal setae and with two setae on inner margin. Setal formulae of endopodite of thoracopods I–VII: thoracopods I: 1+0/2+1/1+0/3(1); thoracopods II–IV: 0+0/1+1/0+1/2; thoracopods V–VII: 0+0/0+1/0+1/2.

Thoracopod VIII. Thoracopod VIII of male (Figure 6J) hemispherical in lateral view. Protopodite massive, with two hooks on inner margin. Penial region slightly protruded. Epipodite represented by a tiny hemisphere. Basipodite without seta, inner margin of basipodite drawn out into projection. Exopodite triangular, bearing one seta. Endopodite 50% of exopodite, denticulated terminally. Thoracopod VIII of female (Figure 6K) in form of a bifurcated structure resulting from the basal fusion of left and right thoracopods. Distal end of each branch sharply pointed.

First pleomere. First pleomere with a pair of setae.

Uropod (Figure 7F, G). Uropod bearing 14–15 spines on inner distal margin of sympodite. Distal spine twice as long as proximal spines of equal size. Endopodite 30% as long as sympodite, drawn out distally into slightly curved spur, with two setae at base of spur and one further subterminal seta on outer margin. Exopodite as long as endopodite, with two terminal and two lateral setae and one ventromedian seta. Outer one of both terminal setae twice as long as the somewhat thicker inner seta.

Pleotelson (Figure 7E, F). Pleotelson with one seta at base of furcal rami on both sides. Anal operculum flat, concave.

Furcal rami (Figure 7E, F). Furcal rami 1.5 times as long as wide, with five spines and with two dorsal plumose setae.

***Kimberleybathynella argylensis* n. sp.**
(Figures 8–10)

Type material

Holotype: ♂ dissected on six slides, Argyle Diamond Mine, Kimberley, Western Australia, Australia, bore PB 1 (16°41'58"S, 128°22'39"E), BES 9706, 11 October 2002, W. F. Humphreys and R. Webb leg. coll. Western Australian Museum, Perth (WAM C 34250). **Allotype:** ♀ dissected on five slides, same data as for holotype except bore MB 37S (16°43'24"S, 128°23'48"E), BES 9756, 13 October 2002 (WAM C 34251).

Etymology

The species is named after the Argyle area, where the species was collected.

Description of adults

Size (mm). Body length: ♂ 2.38, ♀ 2.28, approximately 10 times as long as wide. Head as long as length of segments 1–4. The female differs from the male only in thoracopod VIII.

Antennule (Figure 8A). Antennule six-segmented, setation as in *K. gigantea*.

Antenna (Figure 8B). Antenna two-segmented, setation as in *K. gigantea*.

Labrum (Figure 8C). Labrum flat, with two terminally denticulated median teeth flanked by 10 main and one or two additional teeth on both lateral sides.

Mandible (Figure 8D). Mandible as in *K. gigantea* except the incisor process of three teeth.

Maxillule (Figure 8E). Maxillule two-segmented, ornamentation as in *K. gigantea* except that the three simple setae on outer distal margin of the distal segment exceed the base of the terminal claws.

Maxilla (Figure 8F). Maxilla four-segmented. Second segment half fused with third segment; setal formula 2-4-15-1.

Thoracopods I–VII (Figures 8G, H, 9A–C, 10A, B). Thoracopods I–VII as in *H. gigantea* except the following. Exopodite of thoracopods I–VII with two terminal setae and with one seta on inner margin. Setal formulae of endopodite of thoracopods I–VII: thoracopods I: 1+0/2+1/1+0/3(1); thoracopods II–IV: 0+0/1+1/0+1/2; thoracopods V–VII: 0+0/0+1/0+1/2.

Thoracopod VIII. Thoracopod VIII of male (Figure 8I) hemispherical in lateral view. Protopodite massive, with two hooks on inner margin. Penial region protruded. Epipodite absent. Basipodite without seta, inner margin of basipodite drawn out into projection.

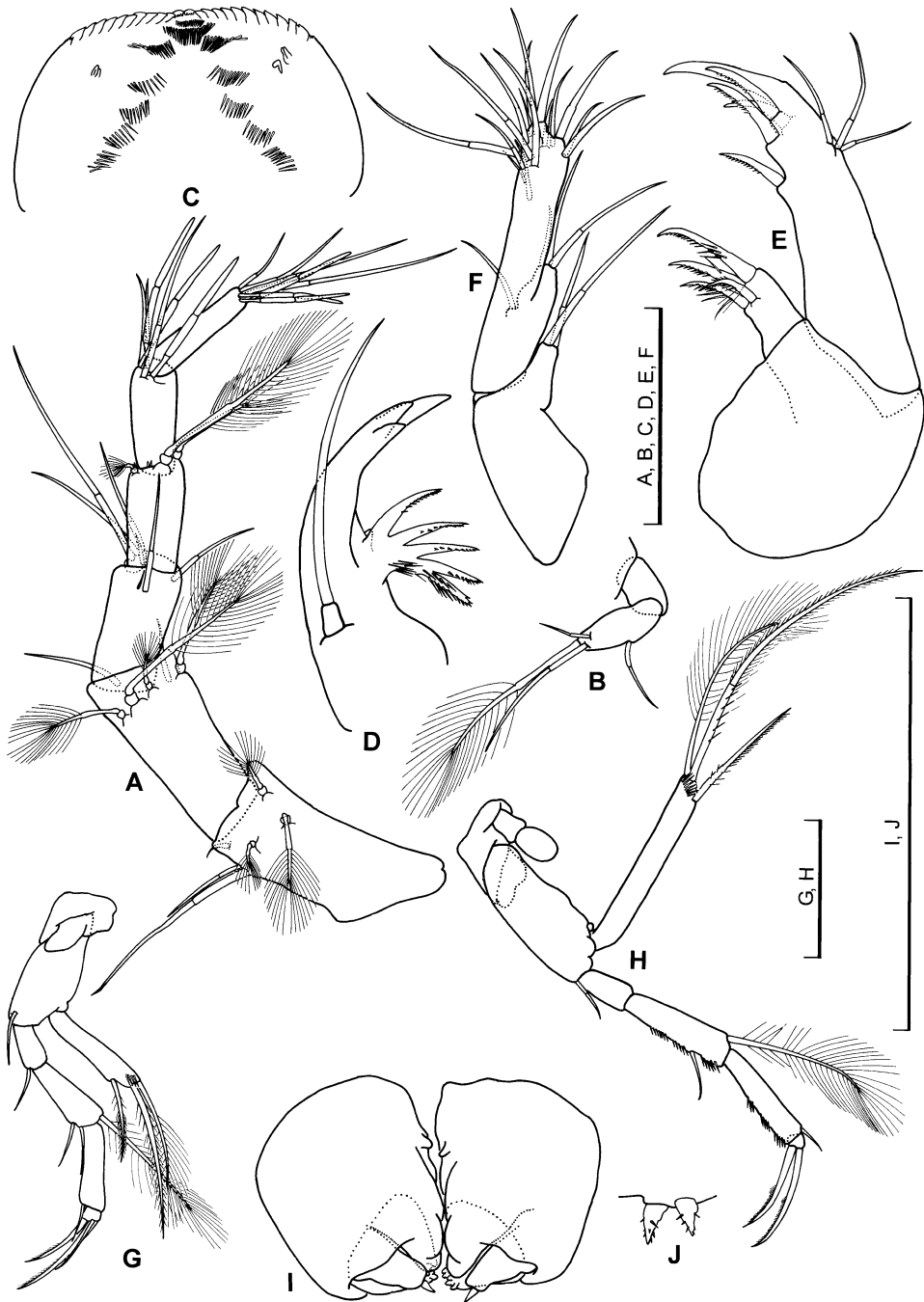


Figure 8. *Kimberleybathynella argylensis* gen. et sp. nov. (A) Right A. I ♂ (lateral); (B) right (A) II ♂ (dorsal); (C) Labr. ♂ (ventral); (D) left Md. ♂ (ventral); (E) left Mx. I ♂ (ventral); (F) left Mx. II ♂ (ventral); (G) right Th. I ♂ (frontal); (H) right Th. II ♂ (frontal); (I) Th. VIII ♂ (frontal); (J) Th. VIII ♀ (frontal). Scale bars: 0.1 mm.

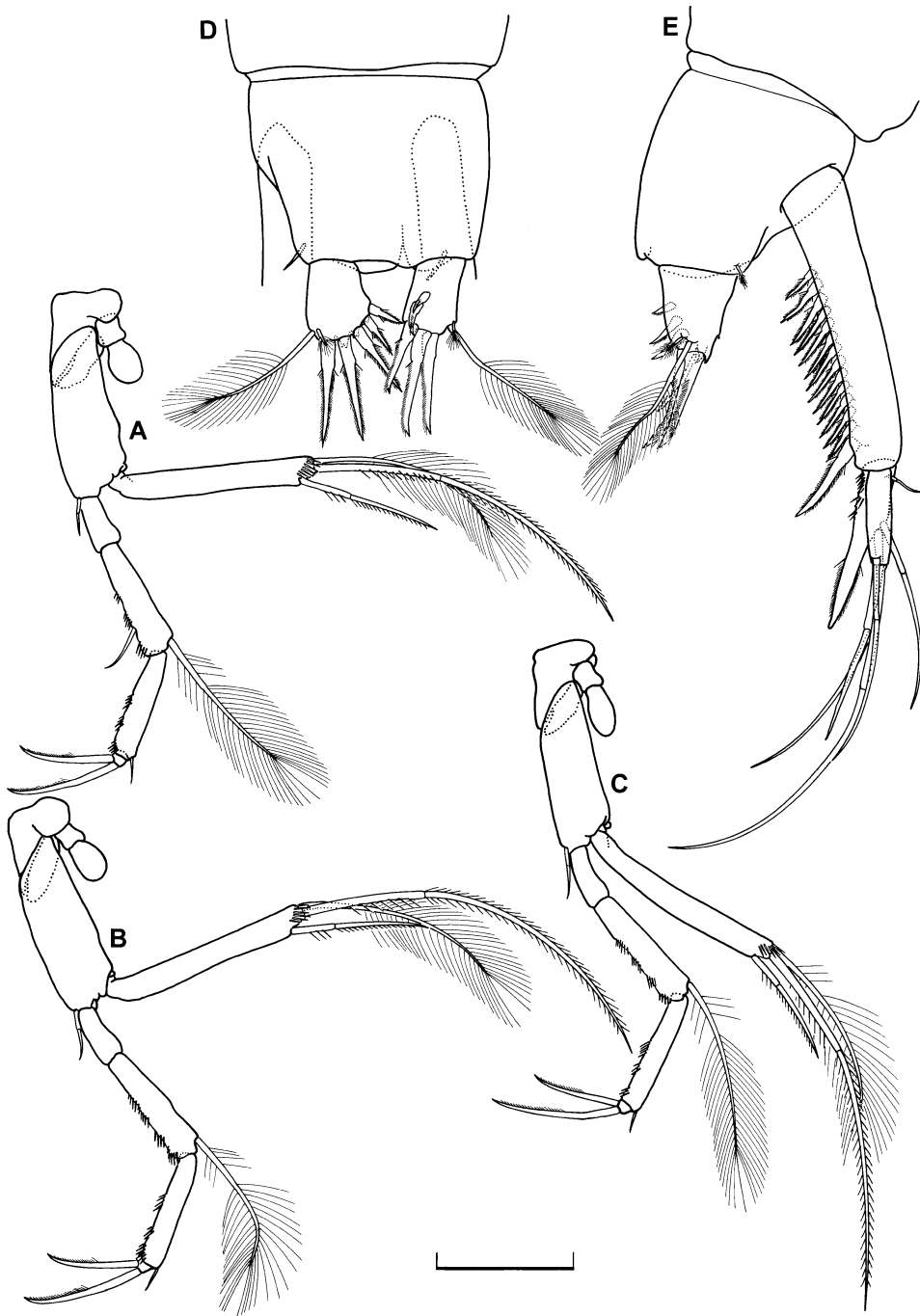


Figure 9. *Kimberleybathynella argylensis* gen. et sp. nov. (A) Right Th. III ♂ (frontal); (B) right Th. VI ♂ (frontal); (C) right Th. VII ♂ (frontal); (D) pleotelson and furca ♂ (dorsal); (E) pleotelson, furca and uropod ♂ (lateral). Scale bar: 0.1 mm.

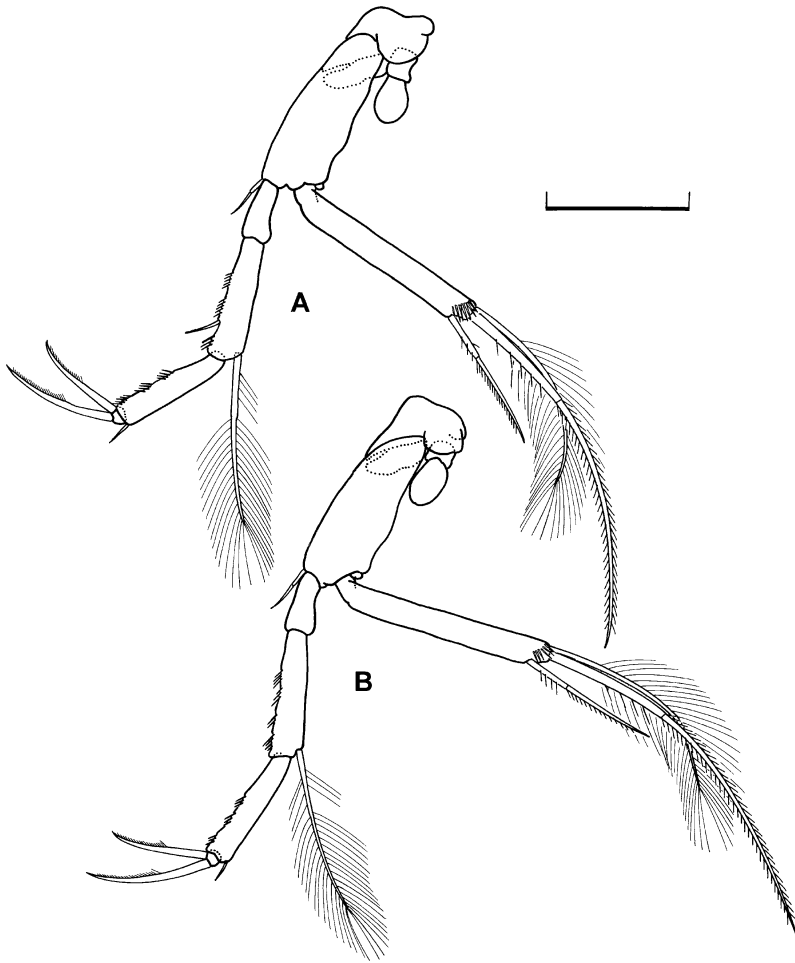


Figure 10. *Kimberleybathynella argylensis* gen. et sp. nov. (A) Right Th. IV ♂ (frontal); (B) right Th. V ♂ (frontal). Scale bar: 0.1 mm.

Exopodite triangular, bearing one seta. Endopodite as large as exopodite, denticulated terminally. Thoracopod VIII of female (Figure 8J) in form of two tiny cones with spikes.

First pleomere. First pleomere with a pair of setae.

Uropod (Figure 9E). Uropod bearing 14 spines on inner distal margin of sympodite. Distal spine twice as long as proximal spines of equal size. Endopodite 30% as long as sympodite, drawn out distally into slightly curved spur, with two setae at base of spur and one further subterminal seta on outer margin. Exopodite as long as endopodite, with two terminal setae, one lateral seta and one ventromedian seta. Outer one of both terminal setae twice as long as somewhat thicker inner seta.

Pleotelson (Figure 9E, E). Pleotelson with one seta at base of furcal rami on both sides. Anal operculum flat, protruded slightly.

Furcal rami (Figure 9D, E). Furcal rami 1.2 times as long as wide, with five spines and with two dorsal plumose setae.

***Kimberleybathynella mandorana* n. sp.**

(Figures 11–13)

Type material

Holotype: ♂ dissected on five slides, Mandora, Western Australia, Australia, Friday Well bore (19°42'27"S, 121°27'42"E), BES 7559, 19 October 1999, A. Storey leg. coll. Western Australian Museum, Perth (WAM C 34252). Allotype: ♀ dissected on five slides, same data as for holotype (WAM 34253). Paratypes: 2♀♀ each on a slide, same data as for holotype (WAM C 34254 and 34255).

Etymology

The species is named after Mandora, where the species was collected.

Description of adults

Size (mm). Body length: ♂ 1.38, ♀ 1.33–1.41, approximately 14 times as long as wide (Figure 11). Head as long as length of segments 1–3. The female differs from the male only in thoracopod VIII.

Antennule (Figure 12A). Antennule six-segmented. First segment with one seta on inner distal margin, with one simple dorsal seta, and with one dorsolateral, one lateral and one ventromedial plumose setae. Second segment with one group of four plumose setae and one simple seta on inner distal margin. Third segment with two setae on outer margin, one simple seta on inner distal margin and one ventral seta. Peduncle of third segment with three simple setae. Fourth segment with one stub seta on dorsal margin, and with three plumose setae. Fifth segment with two setae on inner margin, with two aesthetascs and one simple seta dorsally, and with one lateral aesthetasc. Sixth segment with four terminal setae and three subterminal aesthetascs.

Antenna (Figure 12B). Antenna two-segmented, setation as in *K. gigantea*.

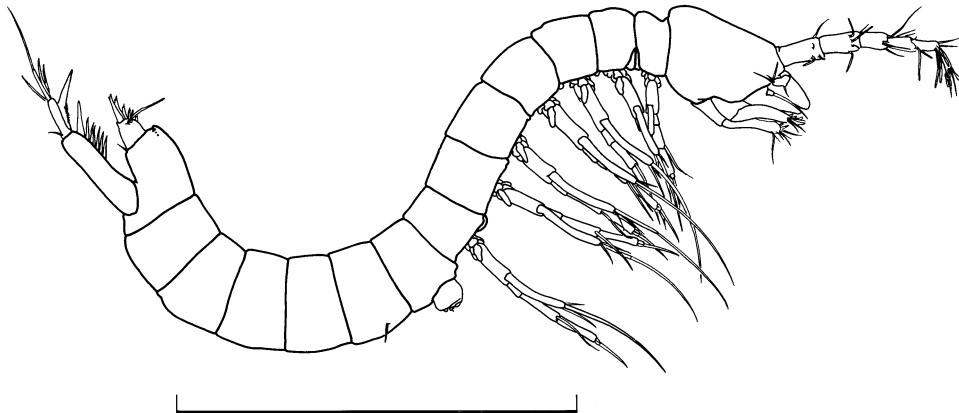


Figure 11. *Kimberleybathynella mandorana* gen. et sp. nov. General habitus ♂, lateral. Scale bar: 0.5 mm.

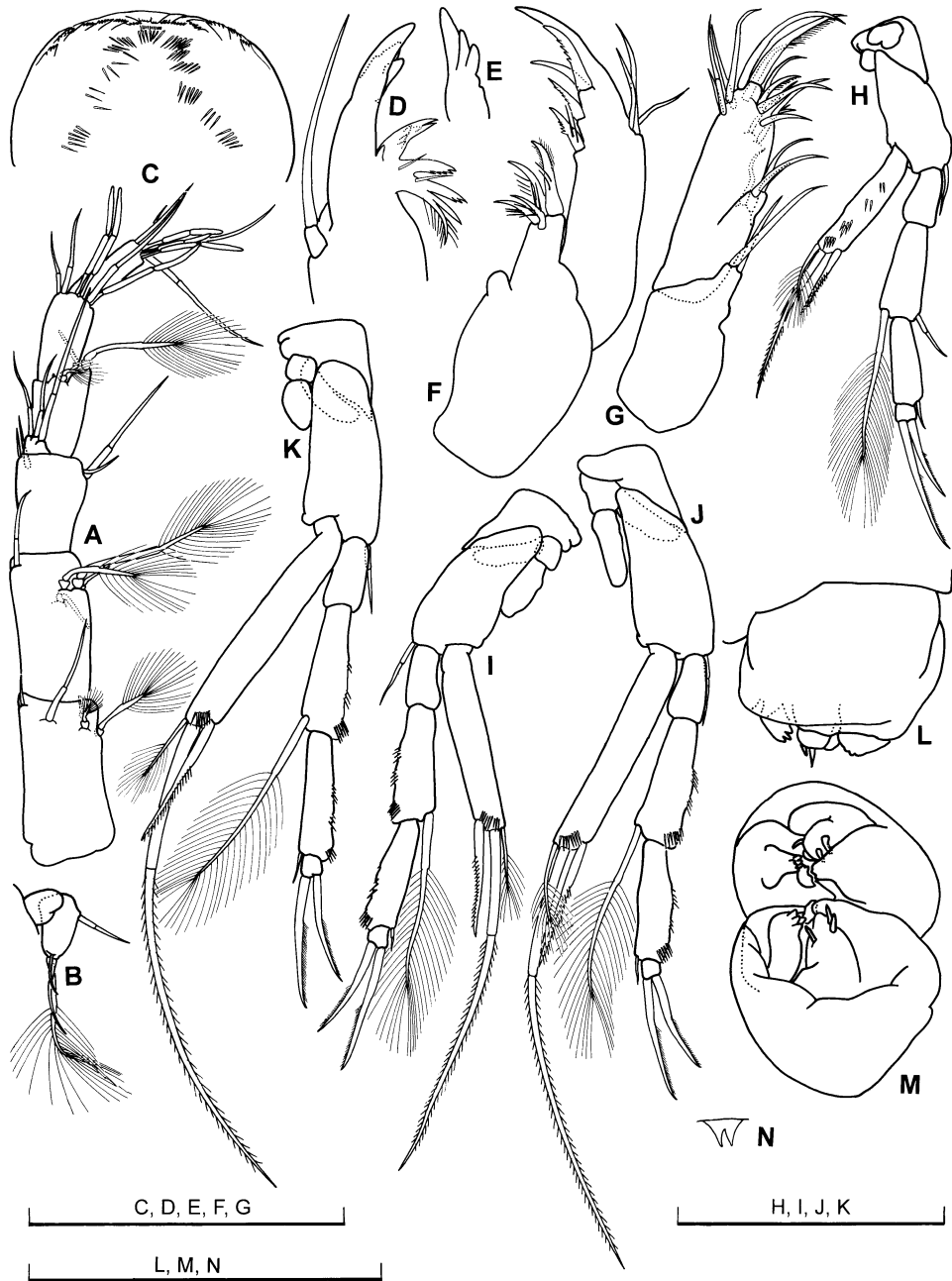


Figure 12. *Kimberleybathynella mandorana* gen. et sp. nov. (A) Right A. I ♂ (dorsal); (B) right A. II ♂ (dorsal); (C) Labr. ♂ (ventral); (D) right Md. ♂ (ventral); (E) incisor process of left mandible; (F) left Mx. I ♂ (dorsal); (G) right Mx. II ♂ (dorsal); (H) left Th. I ♂ (frontal); (I) right Th. II ♂ (frontal); (J) left Th. III ♂ (frontal); (K) left Th. IV ♂ (frontal); (L) right Th. VIII ♂ (lateral); (M) Th. VIII ♂ (ventral); (N) Th. VIII ♀ (ventral). Scale bars: 0.1 mm (A–K); 0.05 mm (L–N).

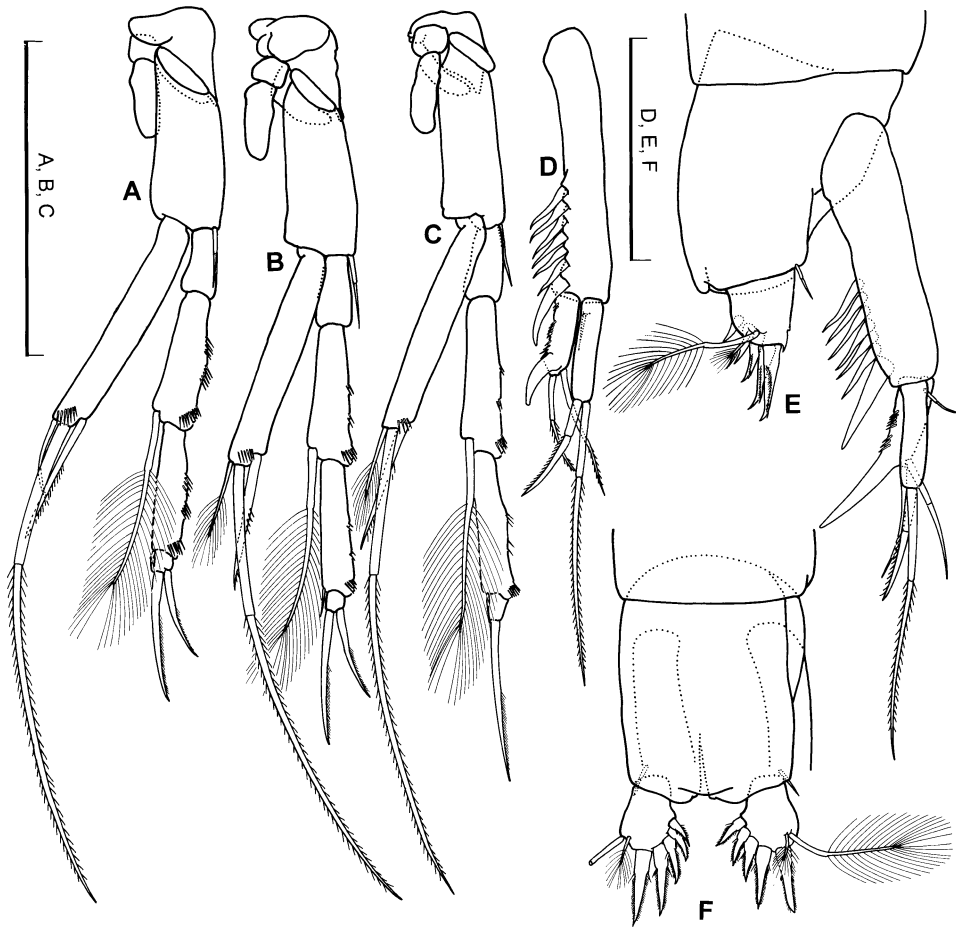


Figure 13. *Kimberleybathynella mandorana* gen. et sp. nov. (A) Left Th. V ♂ (frontal); (B) right Th. VI ♂ (frontal); (C) left Th. VII ♂ (frontal); (D) Right uropod ♂ (dorsal); (E) pleotelson, furca and uropod ♂ (lateral); (F) pleotelson and furca ♂ (dorsal). Scale bars: 0.1 mm.

Labrum (Figure 12C). Labrum flat, with two median teeth flanked by four main and three additional teeth on both lateral sides. All teeth terminally denticulated.

Mandible (Figure 12D, E). Mandible as in *K. gigantea* except the incisor process of three teeth.

Maxillule (Figure 12F). Maxillule two-segmented, ornamentation as in *K. gigantea* except that the three simple setae on outer distal margin of the distal segment exceed the base of the terminal claws.

Maxilla (Figure 12G). Maxilla four-segmented. Second segment half fused with third segment; setal formula 2-4-14-1.

Thoracopods I–VII (Figures 12H–K, 13A–C). Thoracopods I–VII as in *K. gigantea* except the following. Exopodite of thoracopods I–VII with two terminal setae and with one seta on

inner margin. Setal formulae of endopodite of thoracopods I–VII: thoracopods I: 0+0/1+1/1+0/2; thoracopods II–VI: 0+0/0+1/0+1/2; thoracopods VII: 0+0/0+1/0+1/1.

Thoracopod VIII. Thoracopod VIII of male (Figure 12L, M) half-spherical in lateral view. Protopodite massive. Penial region protruded. Epipodite absent. Basipodite without setae, inner margin of basipodite drawn out into projection. Exopodite triangular, bearing three setae. Endopodite as large as exopodite, denticulated terminally. Thoracopod VIII of female (Figure 12N) in form of a bifurcated structure resulting from the basal fusion of left and right thoracopods. Distal end of each branch sharp.

First pleomere. First pleomere with a pair of setae.

Uropod (Figure 13D, E). Uropod bearing seven spines on inner distal margin of sympodite. Distal spine 1.5 times as long as and twice as thick as proximal spines of equal size. Endopodite 30% as long as sympodite, drawn out distally into slightly curved spur, with two setae at base of spur. Exopodite as long as endopodite, with two terminal setae and one ventromedian seta. Outer one of both terminal setae twice as long as somewhat thicker inner seta.

Pleotelson (Figure 13E, F). Pleotelson with one seta at base of furcal rami on both sides. Anal operculum flat, protruded slightly.

Furcal rami (Figure 13E, F). Furcal rami 1.2 times as long as wide, with five spines and with two dorsal plumose setae.

***Kimberleybathynella pleochaeta* n. sp.**
(Figures 14–16)

Type material

Holotype: ♀ dissected on five slides, Argyle Diamond Mine, Kimberley, Western Australia, Australia, bore MB 33S (16°43'58"S, 128°22'39"E), BES 9704, 10 October 2002, W. F. Humphreys and R. Webb leg. coll. Western Australian Museum, Perth (WAM C 34256).



Figure 14. *Kimberleybathynella pleochaeta* gen. et sp. nov. General habitus ♀, lateral. Scale bar: 0.5 mm.



Figure 15. *Kimberleybathymella pleochaeta* gen. et sp. nov. (A) Left A. I ♀ (dorsolateral); (B) right A. II ♀ (dorsal); (C) Labr. ♀ (ventral); (D) right Md. ♀ (dorsal); (E) incisor process of left mandible; (F) right Mx. I ♀ (dorsal); (G) right Mx. II ♀ (inner lateral); (H) right Th. I ♀ (frontal); (I) right Th. II ♀ (frontal); (J) right Th. III ♀ (frontal). Scale bars: 0.1 mm.

Paratypes: 2♀♀ same data as holotype except bore MB 47 (16°43'24"S, 128°23'36"E), BES 9711, 13 October 2002 (WAM C 34257 and 34258).

Etymology

The species is named after the setation on pleomers.

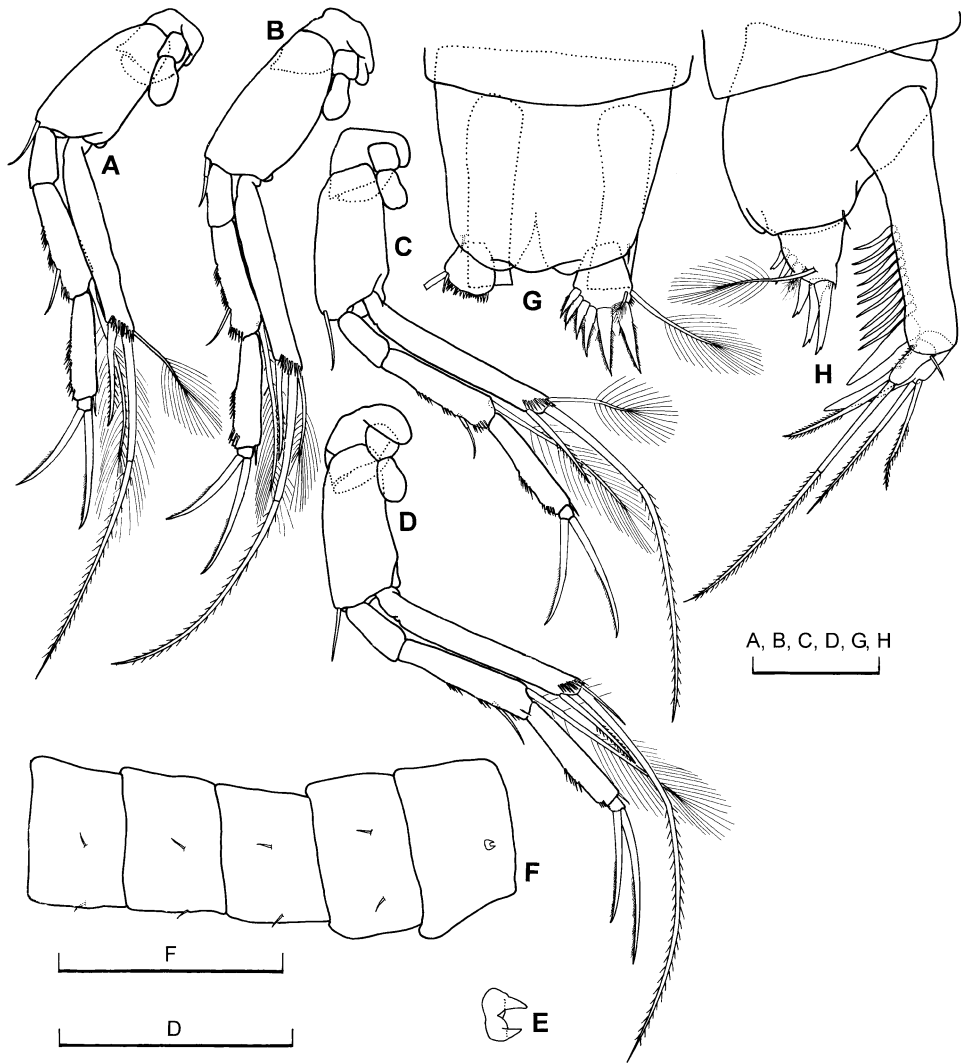


Figure 16. *Kimberleybathynella pleochaeta* gen. et sp. nov. (A) Right Th. IV ♀ (frontal); (B) right Th. V ♀ (frontal); (C) Th. VI ♀ (frontal); (D) Th. VII ♀ (frontal); (E) Th. VIII ♀ (ventral); (F) pleomeres I–IV with setae (ventral); (G) pleotelson and furca ♀ (dorsal); (H) pleotelson, furca and uropod ♀ (lateral). Scale bars: 0.1 mm (A–E, G, H); 0.25 mm (F).

Description of adults

Size (mm). Body length: ♀ 1.56–1.96, approximately 10 times as long as wide (Figure 14). Head as long as length of segments 1–4. Male unknown.

Antennule (Figure 15A). Antennule six-segmented. Setation as in *K. mandorana*.

Antenna (Figure 15B). Antenna two-segmented, setation as in *K. gigantea*.

Labrum (Figure 15C). Labrum flat, with two terminally denticulated median teeth flanked by five main and seven additional teeth on both lateral sides.

Mandible (Figure 15D, E). Mandible as in *K. gigantea* except the incisor process of three teeth.

Maxillule (Figure 15F). Maxillule two-segmented. Proximal segment with four setae on inner distal margin. Distal segment with two terminal claws, with four claws on inner edge, and with three simple setae on outer distal margin. The three simple setae on outer distal margin of the distal segment exceed the base of the terminal claws.

Maxilla (Figure 15G). Maxilla four-segmented. Second segment half fused with third segment; setal formula 2-4-14-1.

Thoracopods I–VII (Figures 15H–J, 16A–D). Thoracopods I–VII as in *H. gigantea* except the following. Protopodite of thoracopods I–VII each bearing one epipodite. Exopodite of thoracopods I–VII with two terminal setae and with one seta on inner margin. Setal formulae of endopodite of thoracopods I–VII: thoracopods I: 1+0/2+1/1+0/3(1); thoracopods II–VII: 0+0/1+1/0+1/2.

Thoracopod VIII. Thoracopod VIII of female (Figure 16E) in form of a bifurcated structure resulting from the basal fusion of left and right thoracopods. Distal end of each branch blunt.

Pleomeres I–V (Figures 14, 16F). Pleomeres I–V each with a pair of setae.

Uropod (Figure 16H). Uropod bearing 11 spines on inner distal margin of sympodite. Distal spine 1.5 times as long and twice as thick as proximal spines of equal size. Endopodite 20% as long as sympodite, drawn out distally into slightly curved spur, with two setae at base of spur. Exopodite as long as endopodite, with two terminal setae and one ventromedian seta. Outer one of both terminal setae twice as long as somewhat thicker inner seta.

Pleotelson (Figure 16G, H). Pleotelson with one seta at base of furcal rami on both sides. Anal operculum flat, protruded slightly.

Furcal rami (Figure 16G, H). Furcal rami 1.2 times as long as wide, with six spines and with two dorsal plumose setae.

***Kimberleybathynella hexapoda* n. sp.**

(Figures 17–20)

Type material

Holotype: ♂ dissected on three slides, Weber Plains, East Kimberley, Western Australia, Australia, OIA bore WP6 (15°27'53"S, 128°50'09"E), BES 6361, 12 August 1998, S. M. Eberhard leg. coll. Western Australian Museum, Perth (WAM C 34259). Allotype: ♀ dissected on five slides, same data as holotype (WAM C 34260). Paratypes: 9♀♀, same data as holotype (WAM 34261–34271).

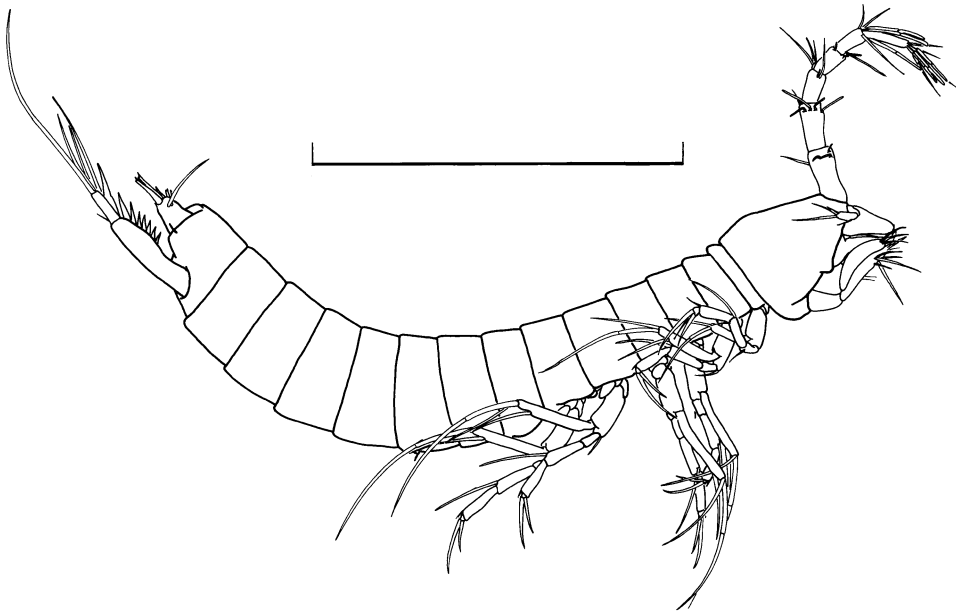


Figure 17. *Kimberleybathynella hexapoda* gen. et sp. nov. General habitus ♀, lateral. Scale bar: 0.5 mm.

Etymology

The species is named after the presence of six pairs of walking legs in adults.

Description of adults

Size (mm). Body length: ♂ 0.90–1.35, ♀ 1.20–1.45, approximately 12 times as long as wide (Figure 17). Head as long as length of segments 1–3. The female differs from the male only in thoracopod VIII.

Antennule (Figure 18A). Antennule six-segmented. Setation as in *K. mandorana*.

Antenna (Figure 18B). Antenna two-segmented, setation as in *K. gigantea*.

Labrum (Figure 18C). Labrum flat, with three median teeth flanked by six main and two additional teeth on both lateral sides. Median teeth terminally denticulated.

Mandible (Figure 18D). Mandible as in *K. gigantea* except the incisor process of three teeth.

Maxillule (Figure 18E). Maxillule two-segmented, ornamentation as in *K. gigantea* except that the three simple setae on outer distal margin of the distal segment exceed the base of the terminal claws.

Maxilla (Figure 18F). Maxilla four-segmented. Second segment half fused with third segment; setal formula 2-4-14-1.

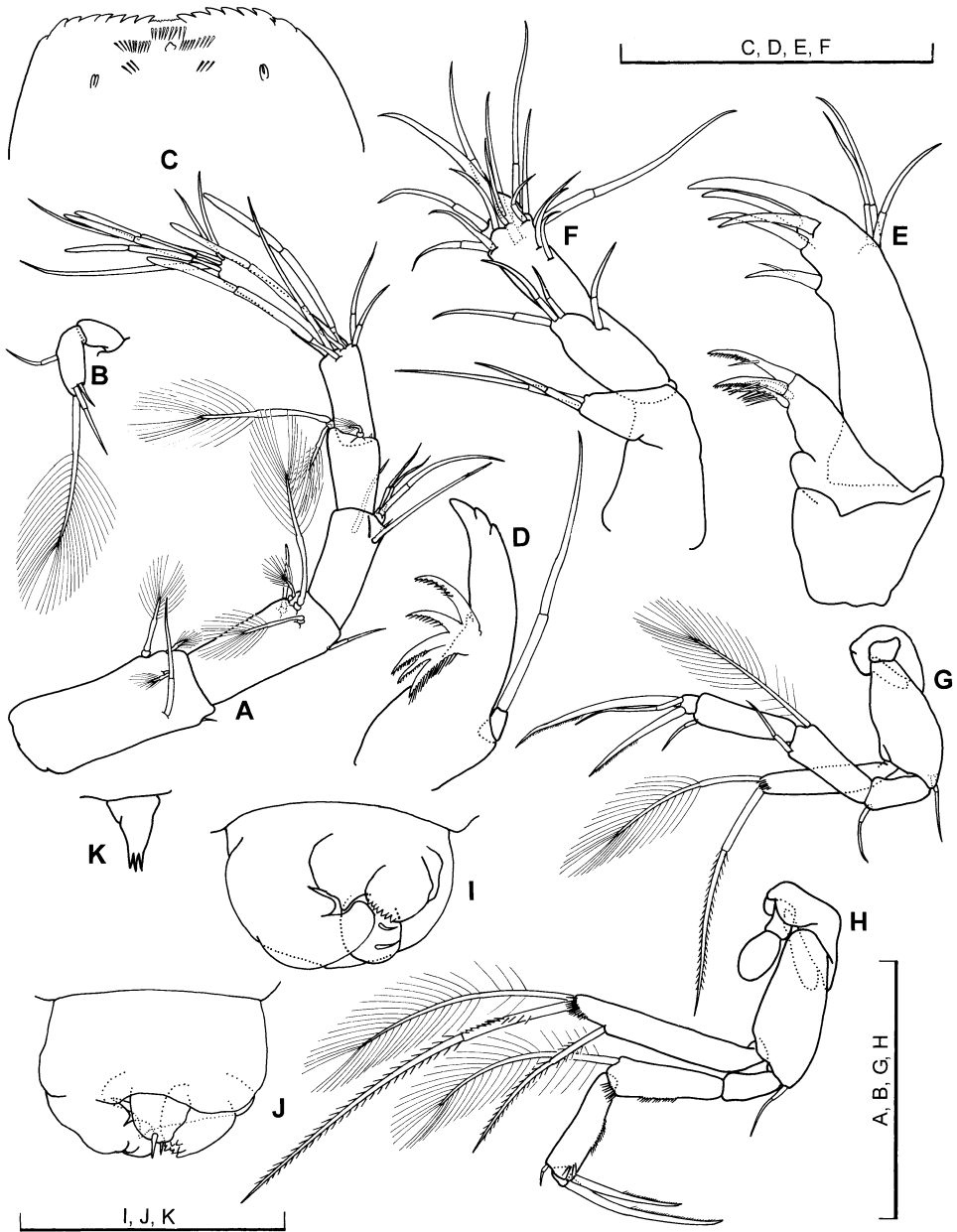


Figure 18. *Kimberleybathynella hexapoda* gen. et sp. nov. (A) Left A. I ♂ (dorsal); (B) left A. II ♂ (dorsal); (C) Labr. ♂ (ventral); (D) right Md. ♂ (dorsal); (E) right Mx. I ♂ (dorsal); (F) right Mx. II ♂? (dorsal); (G) left Th. I ♂ (frontal); (H) right Th. II ♂ (frontal); (I) right Th. VIII ♂ (inner lateral, slightly ventral); (J) Th. VIII ♂ (outer lateral); (K) Th. VIII ♀ (ventral). Scale bars: 0.1 mm (A–H); 0.05 mm (I–K).

Thoracopods I–VI (Figures 18I, J, 19A, B, 20A, B). Thoracopods I–VI increasing in length. Thoracopods IV–VI equal in length. Protopodite of thoracopods II–VI each bearing one epipodite. Thoracopods I–VI each bearing one basipodal seta. Exopodite of thoracopods I–VI one-segmented. Exopodite of thoracopod I with two terminal setae. Exopodite of

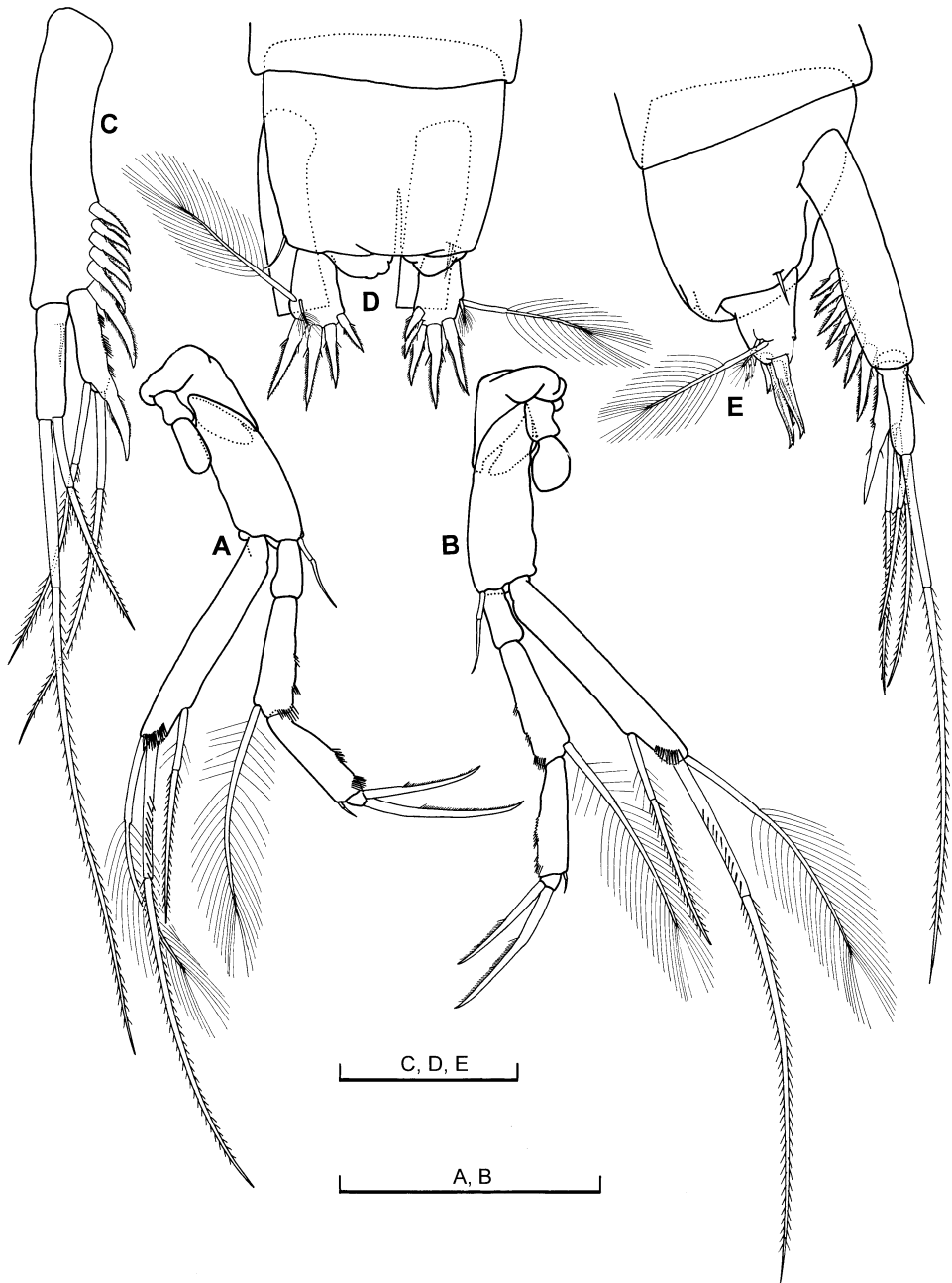


Figure 19. *Kimberleybathynella hexapoda* gen. et sp. nov. (A) Right Th. III ♂ (frontal); (B) left Th. IV ♂ (frontal); (C) left uropod ♂ (dorsal); (D) pleotelson and furca ♂ (dorsal); (E) pleotelson, furca and uropod ♂ (lateral). Scale bars: 0.1 mm.

thoracopods II–VI with two terminal setae and with one seta on inner margin. Endopodite of thoracopods I–VI four-segmented, setal formulae: thoracopods I: 1+0/1+1/1+0/3(1); thoracopods II–VI: 0+0/0+1/0+1/2.

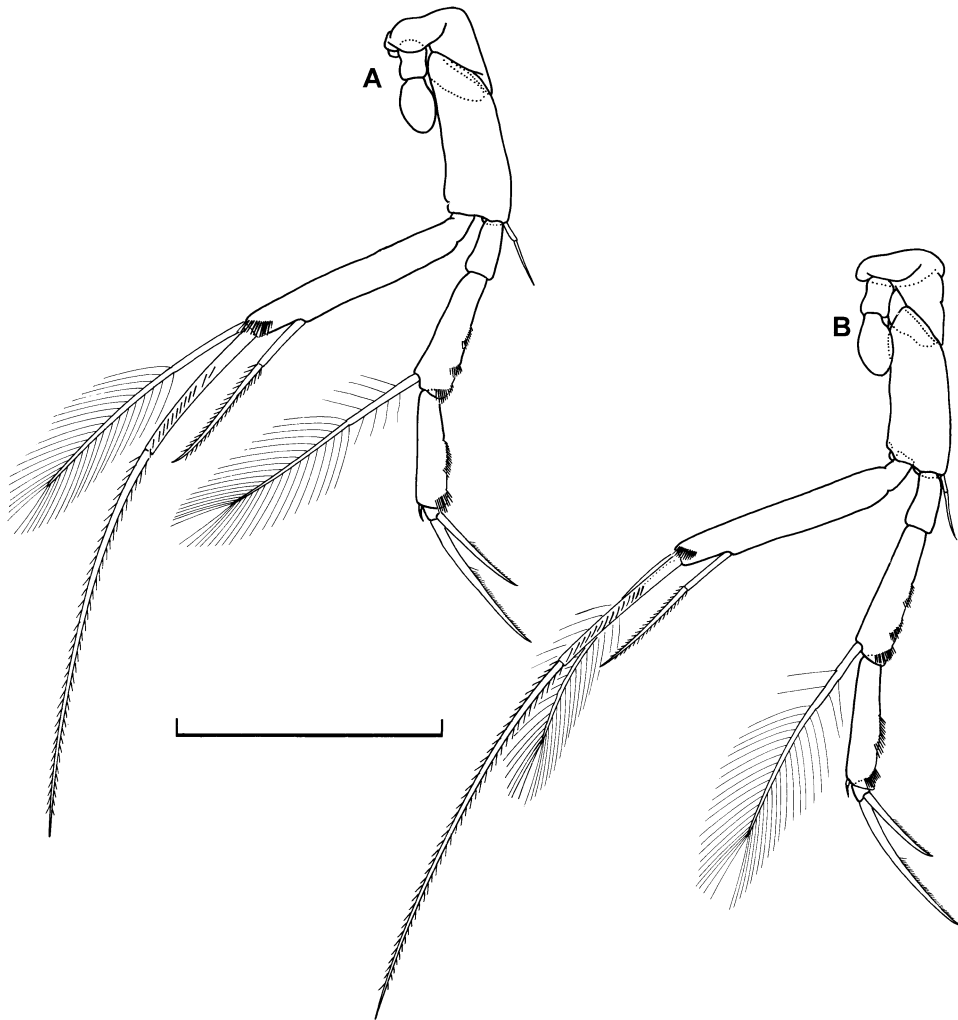


Figure 20. *Kimberleybathymella hexapoda* gen. et sp. nov. (A) Left Th. V ♂ (frontal); (B) left Th. VI ♂ (frontal). Scale bar: 0.1 mm.

Thoracopod VIII. Thoracopod VIII of male (Figure 18I, J) hemispherical in lateral view. Protopodite massive. Penial region protruded. Epipodite absent. Basipodite without setae, inner margin of basipodite drawn out into projection. Exopodite triangular, bearing three setae. Endopodite as large as exopodite, denticulated terminally. Thoracopod VIII of female (Figure 18K) in form of a conical structure resulting from the complete fusion of left and right thoracopods. The conical structure forked to three sharp ends.

First pleomere. First pleomere with a pair of setae.

Uropod (Figure 19D, E). Uropod bearing six (left) or seven (right) spines on inner distal margin of sympodite. Distal spine 1.5 times as long and thick as proximal spines of equal size. Endopodite 30% as long as sympodite, drawn out distally into slightly curved spur, with two setae at base of spur. Exopodite as long as endopodite, with two terminal setae

and one ventromedian seta. Outer one of both terminal setae twice as long as somewhat thicker inner seta.

Pleotelson (Figure 19C, D). Pleotelson with one seta at base of furcal rami on both sides. Anal operculum flat, protruded slightly.

Furcal rami (Figure 19C, D). Furcal rami 1.2 times as long as wide, with four (left) or five (right) spines and with two dorsal plumose setae.

Discussion

The number of antennal segments, the structure of mouth parts and the form of male thoracopod VIII are considered to be decisive characters in grouping the species as well as in subdividing the family Parabathynellidae (Schminke 1973). In this context the six new species cannot be assigned to known genera, although they display unique features in the characters listed in the diagnosis. A two-segmented antenna is found in *Nipponbathynella* Schminke, 1973 and *Habrobathynella* Schminke, 1973; however, in these genera, the second and third segments of the maxilla are either not fused (*Nipponbathynella*) or are fully fused (*Habrobathynella*), and the male thoracopod VIII is either cylindrical (*Nipponbathynella*) or spherical (*Habrobathynella*). The two-segmented exopodites of thoracopod I–VII and the absence of a ventromedian seta on the uropodal exopodite precludes any relationship of the six new species to both genera.

On the other hand, the hemispherical form of male thoracopod VIII in the six new species is very similar to *Atopobathynella* Schminke, 1973. Other similarities are the one-segmented exopodites of thoracopods I–VII and the presence of a ventromedian seta on uropodal exopodite which suggests possible inclusion of the six new species into this genus. However, *Atopobathynella* has a one-segmented antenna, a sexual dimorphism on the second segment of the male antennule, a maxilla with clearly separated second and third segments, equal-sized spines on the uropodal sympodite, and on the uropodal exopodite the inner terminal seta, which is usually longer than the outer one (Schminke 1973).

Hence, we propose that the six new species be assigned to the new genus *Kimberleybathynella* gen. nov., which seems to be closely related to *Atopobathynella*. The half fusion of the second and third segments of the maxilla is otherwise unknown within the Parabathynellidae and thus regarded as a strong autapomorphy of *Kimberleybathynella*. In the context of the relationship to *Atopobathynella*, the characters of equal-sized spines on the uropodal sympodite, and that on the uropodal exopodite, the outer terminal seta is usually longer than the inner one, justify the erection of this genus.

The six new species, *K. gigantea* n. sp., *K. kimberleyensis* n. sp., *K. argylensis* n. sp., *K. mandorana* n. sp., *K. pleochaeta* n. sp., and *K. hexapoda* n. sp., can be recognized by several characters listed in Table I. Whereas many of these characters are meristic, some characters are remarkable. Particularly, the presence of the setae on pleomeres I–V in *K. pleochaeta* and the absence of the thoracopod VII in *H. hexapoda*. In all the species yet described, of both Parabathynellidae and Bathynellidae, only the first pleomere has a pair of setae or two- or one-segmented appendages as rudimentary pleopod. However, *K. pleochaeta* cannot be segregated from *Kimberleybathynella*, as it shares with the other five new species all the characters of the generic diagnosis. The absence of thoracopod VII is rare among known parabathynellids and otherwise present in all species of *Hexabathynella* Schminke, 1972 and of *Hexaiberobathynella* Camacho and Serban, 1998. So, one can establish a new genus

Table I. Morphological differences between species of the genus *Kimberleybathynella* gen. nov.

	<i>K. gigantea</i> n. sp.	<i>K. kimberleyensis</i> n. sp.	<i>K. argylensis</i> n. sp.	<i>K. mandorana</i> n. sp.	<i>K. pleochaeta</i> n. sp.	<i>K. hexapoda</i> n. sp.
No. of dorsal setae on 1st segment of A. I	2	2	2	1	1	1
Ventromedial seta on 2nd segment of A. I	Present	Present	Present	Absent	Absent	Absent
Two stub setae on 4th segment of A. I	Present	Present	Present	Absent	Absent	Absent
No. of teeth on labrum	35	28	25	16	26	19
No. of teeth of incisor process	4	3	3	3	3	3
No. of claws on distal segment of Mx. I	5	6	5	5	5	5
Three setae on distal segment of Mx. I	Barely reaching the basis of terminal claw	Barely reaching the basis of terminal claw	Exceeding the basis of terminal claws	Exceeding the basis of terminal claws	Exceeding the basis of terminal claws	Exceeding the basis of terminal claws
Setal formula of Mx. II	2-4-15-1	2-4-15-1	2-4-15-1	2-4-14-1	2-4-14-1	2-4-14-1
Th. VII	Present	Present	Present	Present	Present	Absent
Epipodite on Th. I	Absent	Absent	Absent	Absent	Present	Absent
No. of setae on inner margin of exopodite of Th. I-VII(VI)	2/3/3/3/2/2/2	1/2/2/2/1/1/1	1/1/1/1/1/1/1	1/1/1/1/1/1/1	1/1/1/1/1/1/1	0/1/1/1/1/1
Setal formula of endopodite of Th. I-VII(VI)	I: 1+0/2,3+1/2+0/3(1) II: 0+0/2+1/1+1/2 III: 0+0/1,2+1/0+1/2 IV: 0+0/2+1/1+1/2 V-VII: 0+0/1+1/0+1/2	I: 1+0/2+1/1+0/3(1) II-IV: 0+0/1+1/0+1/2 V-VII: 0+0/0+1/0+1/2	I: 1+0/2+1/1+0/3(1) II-IV: 0+0/1+1/0+1/2 V-VII: 0+0/0+1/0+1/2	I: 0+0/1+1/1+0/2 II-VI: 0+0/0+1/0+1/2 VII: 0+0/0+1/0+1/1	I: 1+0/2+1/1+0/3(1) II-VII: 0+0/1+1/0+1/2 0+1/2	I: 1+0/1+1/1+0/3(1) II-VI: 0+0/0+1/0+1/2
Female Th.VIII	Fused	Fused	Separated	Fused	Fused	Fused
No. of spines on uropod sympodite	20	14-15	14	7	11	6
No. of spines on furcal rami	6-7	5	5	5	6	6

based on this character. However, *K. hexapoda* does not essentially differ from its congeners in the characters of generic diagnosis and we do not find any need to establish a new genus.

Habitat

Four distinct habitats are represented in the sampling. Weber Plains comprises an alluvial deposit in an abandoned valley of the former course of the Ord River. The area is now included in the Ord Irrigation Area and has partly been subject to intensive irrigation agriculture for several decades, including high pesticide usage on e.g. cotton but the area is now largely under sugar cane. Bores at Argyle Diamond Mine are mostly in the Lamboo Complex comprising extremely fractured fresh granite/diorite, but PB1 is in the basalt of the Antrim Plateau Volcanics. The area has a thin regolith overlying Proterozoic rocks. Most of the bathynellids and other stygofauna are found in colluvium distant from surface drainage lines, but a few samples were taken from alluvium associated with the drainage lines, which in this region are mostly active only following monsoonal rain. Friday Well bore in the Canning Basin is associated with a mound spring and palaeodrainage line in the Great Sandy Desert, probably with calcrete (A. Storey, personal communication).

Water quality

Water temperature in all cases exceeded 30°C (Table II) with pH>7 and specific conductance within the range 1–4 mS cm⁻¹. In contrast, dissolved oxygen was generally low and highly stratified in most bores, being <7% saturation in bore 37S. Unlike many inland sites in Western Australia (Watts and Humphreys 2003; Balke et al. 2004), the salinity of these sites (Table III) lies within the bounds of the world average fresh water

Table II. Mean water quality (±SD) of six bores profiled through *n* depths.

Parameter	33S	37S	47	9D	WP11	Friday Well
Bore depth profile (m)	27	1.7	6	15.5	17.7	–
No. of samples, <i>n</i>	7	3	4	11	10	1
Temperature (°C)						
Mean	32.7	32.8	31	32	30.4	33.6
SD	0.15	0.03	0.52	0.13	0.3	–
pH						
Mean	7.24	7.18	7.472	7.38	7.14	7.05
SD	0.09	0.02	0.07	0.21	0.22	–
Specific conductance (mS cm ⁻¹)						
Mean	1.08	3.7	2.76	1.1	1.18	2.97
SD	0.02	0.07	2.18	0.01	0.59	–
Dissolved oxygen (%)						
Mean	9.5	5.1	25.9	46.5	19.4	70.5
SD	7.2	3.9	2.3	20.9	14.5	–
Range	2–21	4–7	23–29	14–69	3–40	–
<i>Kimberleybathynella</i> species	<i>pleochaeta</i>	<i>argylensis</i>	<i>pleochaeta</i>	<i>kimberleyensis</i>	<i>kimberleyensis</i>	<i>mandorana</i>
Area	ADM	ADM	ADM	OIA	OIA	Canning
Altitude (m)	165	186	–	30	30	–

ADM, Argyle Diamond Mine; OIA, Ord Irrigation Area and proposed extension; Canning, Canning Basin.

Table III. Some water chemistry from selected bores expressed as mg l⁻¹.

Bore	Area	Ca ²⁺	Cl ⁻	Fe ²⁺	K ⁺	Mg ²⁺	N- NH ₃ ⁺	N- NO ₃ ⁻	N- total	Na ⁺	P- total	SO ₄ -S	SiO ₂ -Si
Friday Well ^a	Canning	105	600	<0.05	82	61	0.02	9.7	13	384	0.02	172	66
33 ^b	ADM	19	41	<1.0	12	25	<0.5	7.7	9	190	0.04	6	13
37S ^b	ADM	20	62	0.3	13	32	<0.5	13	15.1	230	0.02	55	55

ADM, Argyle Diamond Mine; Canning, Canning Basin. ^aData from A. Storey (personal communication, 2004); ^bdata from 1995 (Argyle Diamonds, personal communication).

(<3 ppt; Bayley and Williams 1973) and, as commonly found in inland Australia, these waters are Na⁺ dominated (57–72% total milliequivalent anions) versus 7–18% Ca²⁺.

Associated fauna

Bathynellacea are the most commonly sampled fauna in the area and are represented by both Parabathynellidae and Bathynellidae. In the area of Argyle Diamond Mine two species occur, previously unknown to science, of a new subgenus of Candoninae (Ostracoda) (Karanovic I 2004). The only other member of the subgenus is known from ground water in the Murchison Region ~2000 km to the south-west. In addition, a number of copepods occur at the ADM site; *Parastenocaris* n. sp. (Karanovic 2005) (Harpacticoida: Parastenocarididae), *Goniocyclops* n. sp. (Cyclopoida: Cyclopidae: Cyclopinae), *Stygonitocrella* (s.l.) n. sp. (Harpacticoida: Ameiridae) (T. Karanovic, personal communication), and *Metacyclops* n. sp. (Cyclopoida: Cyclopidae: Cyclopinae) (Karanovic T 2004).

Although sparse effort has been expended on stygofauna sampling in the Kimberley Region, some other notable ancient lineages of crustaceans are known from the area. An enigmatic cave-dwelling isopod taxon (Wilson and Ponder 1992; Wilson and Johnson 1999), widespread in the Devonian reef throughout the region and now from groundwater calcretes in the Pilbara (Humphreys 1999; Wilson 2003), has been placed in its own suborder Tainisopidea (Brandt and Poore 2003). In addition, a groundwater-dwelling phreatoicidean isopod from a sandstone aquifer to the west of Argyle is basal to the Australasian clade of Phreatoicidae, suggesting modern phreatoicideans diverged from one another after they entered fresh water but before the fragmentation of eastern Gondwana (Mesozoic Era) (Wilson and Keable 1999).

Acknowledgement

Funding for this work was provided by Argyle Diamonds.

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