First record of Syncarida from Queensland, Australia, with description of two new species of Notobathynella Schminke, 1973 (Crustacea, Bathynellacea, Parabathynellidae)

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Two new species of the parabathynellid genus Notobathynella Schminke, 1973 are described from Australia: \textit{N. octocamura} sp. nov. and \textit{N. pentatrichion} sp. nov. \textit{Notobathynella octocamura} sp. nov. has eight claws on the distal endite of the maxillule, a character that is unique in the Parabathynellidae. It is also the first species of the genus with the following characters: five setae on the terminal segment of antenna, 26–28 teeth on labrum, 31 setae on maxilla, a three-segmented exopod on thoracopod I, five-segmented exopods on thoracopods IV and V, three setae and two claws on the fourth endopodal segment of thoracopods I to IV, and six setae on the uropodal exopod. This species also has a unique setal formula for some thoracopods. \textit{Notobathynella pentatrichion} sp. nov. is unique in the genus with five setae on the uropodal exopod and, like \textit{N. octocamura} sp. nov., has a one- or two-segmented exopod on thoracopod I, a four- or five-segmented exopod of thoracopod V, and three setae and two claws in the four segments of the endopod of thoracopods II to IV. The two new species extend the distribution of Bathynellacea in Australia and are the first species to be described from Queensland.

\textbf{Keywords:} Syncarida; Bathynellacea; Parabathynellidae; groundwater fauna; Queensland; Australia

\section*{Introduction}

The genus Notobathynella Schminke, 1973 of the family Parabathynellidae occurs in eastern mainland Australia (New South Wales and Victoria), Tasmania, New Zealand (South Island) and Madagascar. Two new species are described herein, which extends the Australian distribution of the genus Notobathynella into Queensland (Schminke, 1973: p.88). The new species contain several characters new to the genus (i.e. five setae on the terminal segment of the antenna, 26–28 teeth on the labrum, 31 setae on the maxilla, one to three segments in the exopod of thoracopod I, five segments in the exopod of thoracopods IV and V, two or three setae and two claws on the fourth endopodal segment of thoracopods II and III, or six setae on the exopod of the uropod), and some that are previously unknown in the family Parabathynellidae (i.e. presence of the eight claws on distal endite of maxillule in \textit{Notobathynella octocamura} sp. nov.). The setal formula of some thoracopods is also unique.

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Of the seven species of *Notobathynella* previously known, three were described from Australia, and three from New Zealand (Schminke 1973; Morimoto 1978). In 2007, the seventh species of the genus *Notobathynella* was described from Madagascar (Drewes and Schminke 2007). The two new species described here increase the number of Australian species to five and extend the distribution of this genus northwards into central Queensland.

**Materials and methods**

Specimens were collected as part of a groundwater fauna survey of the alluvial aquifers near Bundaberg on the coast of central Queensland. Samples were collected from groundwater monitoring piezometers with an internal diameter of 50 mm. Piezometers were cased in PVC except for a length that was partially slotted to allow entry of water and fauna, and were sampled using a combined net and pump method. Nets (40-mm diameter, 64-µm mesh) were lowered to the bottom of the piezometer and steadily retrieved through the entire water column, then emptied into a 64-µm mesh sieve. After 10 hauls, a volume of water was extracted using an inertial pump (Powerpump II, Waterra, Canada) and passed through a 64-µm mesh sieve. The volume pumped equated to three times the volume of water in the bore casing, plus 50 litres.

The specimens studied were collected from two bores. *Notobathynella octocamura* sp. nov. was found in piezometers 13700234A and 13700234B, in the alluvium of Yellow Waterholes Creek on 19 May 2004, and 13700067 in the alluvium of Elliott River on 20 May 2004. *Notobathynella pentatrichion* sp. nov. was also found in these two aquifers, and in piezometer 13710036 on Gregory River. Data summarizing the location of the bores and some physicochemical properties are included in Table 1 (depth in metres).

A complete dissection of all anatomical parts of all type series was made and kept as permanent preparations (special metal slides, glycerine gelatine stained with methylene blue as the mounting medium) and deposited in the Museo Nacional de Ciencias Naturales, Madrid (MNCN). Anatomical examinations were performed using an oil immersion lens (100 ×) of a Zeiss interference microscope. The descriptions are based on the type series.

The terminology has been adopted from Serban (1972) and Schminke (1973). Abbreviations used: A.I, antennule; A.II, antenna; Lb., labrum; Md, mandible; Mx.I, maxillule; Mx.II, maxilla; Th, thoracopod.

**Systematic account**

*Notobathynella octocamura* sp. nov.

(Figures 1–3)

**Material examined**

*Type locality.* Department of Natural Resources monitoring piezometer number 13700234A, 19 May 2004, in alluvial aquifer beneath Yellow Waters Creek floodplain near Bundaberg, Queensland, Australia; 10 males, 17 females and one juvenile were collected.
Table 1. Data summary of sampled bores.

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<th>Longitude</th>
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<th>Water level</th>
<th>pH</th>
<th>EC µS/cm</th>
<th>Temp. °C</th>
<th>Dissolved oxygen (mg/l)</th>
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Figure 1. *Notobathynella octocamura* sp. nov. (A–C, E–F, H–I) male holotype. (A) Antennule (ventral view); (B) antenna (dorsal view); (C) labrum; (D) labrum female allotype; (E) mandible; (F) pars incisiva of mandible; (G) pars molaris of mandible female allotype; (H) maxillule; (I) maxilla. Scale bar in mm.
Figure 2. *Notobathynella octocamura* sp. nov. All male holotype. (A) Thoracopod I; (B) thoracopod II; (C) thoracopod III; (D) thoracopod IV; (E) thoracopod V; (F) thoracopod VI; (G) thoracopod VII. Scale bar in mm.
Figure 3. Notobathynella octocamura sp. nov. (A–D, G, H) Male holotype. (A) Thoracopod VIII (laterocaudal view); (B) thoracopod VIII (laterofrontal view); (C) thoracopod VIII (latero-external view); (D) thoracopod VIII (latero-internal view); (E) thoracopod VIII female allotype
Other locations. Department of Natural Resources monitoring piezometer number 13700234B, 18 May 2004, in alluvial aquifer beneath Yellow Waters Creek floodplain near Bundaberg (one female) and Piezometer 13700067, 20 May 2006, in alluvial aquifer beneath Elliott River, near Bundaberg, Queensland, Australia (five males and five females were collected).

Details of the descriptions are based on all adult specimens, 15 males and 23 females. The holotype is a male and the allotype is a female. The type series contains 36 additional specimens (14 males and 22 females): holotype MNCN20.04/8229, allotype MNCN20.04/8230 and type series MNCN20.04/8231.

Description

Body. Total length of holotype (male) 1.96 mm and allotype (female) 2.7 mm. Largest male total length 1.97 mm, smallest 1.50 mm. Longest female 2.7 mm, smallest 1.46 mm. Body elongated, segments slightly widening towards posterior end; approximately nine times as long as wide. Head 1.2 times long as wide. Pleotelson with one small barbed ventral seta on either side. All drawings are of the holotype except for female Th VIII.

Antennule (Figure 1A). Eight-segmented; no sexual dimorphism; length of first three segments similar to other four segments; segment seven smaller than others; inner flagellum almost rectangular; fourth and fifth segments similar in size; setation as in Figure 1A; segment three with six setae; segment five with two terminal aesthetascs, and sixth and seventh with three aesthetascs each.

Antenna (Figure 1B). Five-segmented; half the length of the A.I.; first two segments are shortest, third segment twice as long as second, and last two segments almost similar in size, the last a bit longer than the previous one and with five setae, one of which is plumose; fourth segment with inner and outer seta; setal formula: 0/0/1+0/1+1/5(1).

Labrum (Figure 1C). Slightly concave with eight main teeth and 10 lateral teeth at each side. Ventral surface with several rows of fine spinules and two tooth-like protrusions on both sides.

Female labrum of the allotype (Figure 1D). Slightly concave with nine main teeth and nine lateral teeth at each side. Ventral surface with several rows of fine spinules and with five or six tooth-like protusions on both sides.

Mandible (Figure 1E,F). With pars incisiva with five well-developed teeth and triangular small tooth of ventral edge; pars molaris with seven claws, five being strong with subdistal small spines and two small joined proximal claws with a large number of fine hairs; the distal seta of the mandibular palp does not exceed pars incisiva in length.
Female mandible of the allotype (Figure 1G). With pars incisiva similar to the holotype; pars molaris with nine claws, seven being strong with subdistal small spines and two small joined proximal teeth with a large number of fine hairs.

Maxillule (Figure 1H). Proximal endite with four long serrulate claws; distal endite with eight claws: two smooth with one apical and one subapical, and the other six with denticles and fine long setules and three subterminal smooth setae on outer distal margin.

Maxilla (Figure 1I). Four-segmented, segment three elongated and fourth very small; setal formula 4, 4+1, 16, 6.

Thoracopods I–VII (Figure 2A–G). Well developed, length gradually increasing from I to IV, last four similar in size; epipod on I to VII small, measuring less than half length of basipod; basipod with one smooth seta at distal inner corner in Th I, II and VI, VII and with two setae in Th III to V. Exopod shorter than endopod on Th I to III and similar on Th IV to VII and with the following numbers of segments: 3-4-4-5-4-4; each segment with two barbed setae (with one group of ctenidia at base of inner setae) except the last segment, which has a plumose outer seta in Th I to VI, a short, barbed seta in the Th VII; endopod four-segmented with a small first segment longer second and third segments equal in length, and a fourth segment that is small (with two barbed, similar claws and two or three smooth setae). All inner setae on segments are smooth and outer setae of first, second and third segment of Th I to VII are plumose. Thoracopod endopod setal formula: Th I, 4+1/4+1/2+1/4(2); Th II, 2+1/4+2/2+1/5(3); Th III, 2+1/4+2/2+1/5(3); Th IV, V, 1+1/3+2/2+1/4(2); Th VI, 1+1/2+2/1+1/4(2); Th VII, 1+1/2+1/1+1/4(2).

Allotype (female) exopod shorter than endopod on Th I to III and similar on Th IV to VII and with the following numbers of segments: 3-4-4-5-5-4. Setal formula of the endopods of thoracopods: Th I, 3+1/4+1/2+1/4(2); Th II, 2+1/4+2/2+1/5(3); Th III, 2+1/4+2/2+1/5(3); Th IV, V, 1+1/3+2/2+1/4(2); Th VI, 1+1/3+2/2+1/4(2); Th VII, 1+1/3+2/1+1/4(2).

Thoracopod VIII male (Figure 3A to D). Almost square; basal region of the penial complex supports three lobes: inner lobe (I. Lb.), outer lobe (O. Lb.) and dentate lobe (D. Lb.); subtriangular inner lobe completely integrated into the basal region; outer lobe covers at the end of the inner lobe, and does not exceed the end of the external side of the basipod (Bsp); dentate lobe is bigger than inner lobe and has many denticles; endopod (Endp.) very long, almost four times longer than exopod with two smooth terminal setae; exopod (Exp.) small and with one seta; basipod trapezoidal in the external face, in the internal side with a seta above its outer distal corner and with a crest-like protuberance.

Thoracopod female VIII (Figure 3E,F). Small, rounded with one segment with one small bidentate tooth.
First pleopods. Absent.

Uropod (Figure 3H). Sympod four times as long as wide, a bit longer than endopod and shorter than exopod; with nine barbed spines of similar size, and one more distal spine 2.3 times longer than others; endopod much shorter than exopod, with one spinous projection and three groups of ctenidia in the inner margin, one strong spine and a “claw-like” appendage on distal part, two plumose setae near inner margin, one basal and one subterminal, that exceed the distal end of endopod, and two barbed terminal setae of different length; exopod has six barbed setae and six groups of ctenidia in the inner margin.

Uropod female (Figure 3I). Sympod with 10 barbed spines of similar size, and one more distal spine 2.3 times longer than others; endopod shorter than exopod, with four small spinous projections and one strong spine on the distal part, two plumose setae near inner margin, one basal and one subterminal, that exceed the distal end of endopod, and two barbed terminal setae of different length.

Pleotelson (Figure 3G). With one small, plumose ventral seta on either side near the base of the furca. Anal operculum slightly convex, protruded.

Furca (Figure 3G). Rectangular, twice as long as wide, with 12 or 13 barbed spines (the two terminal ones longer and thicker); two unequal dorsal plumose setae, that does not exceed the distal end of terminal spines; with a small lateral furcal organ.

Variability
The number of spines on the furca varies from 10 to 14, the sympod of the uropod 10 to 12 spines, the endopod of the uropod two to five spines. There is also variation in the number of exopodal segments of Th I–VII (3–3, 4–3, 4–4, 5–4, 5–4, 5–4) and setae on different endopodal segments of endopods of some thoracopods of males and females. The setal formula is: Th I, 3,4 + 1/3,4 + 1/2,3 + 1/4,5(2,3); Th II, 2 + 1/3,5 + 2/1,3 + 1/4,5(2,3); Th III, 1,2 + 1/2,4 + 1/2,1,3 + 1/2,4,5(2,3); Th IV, 1,2 + 1/2,4,1,2 + 1/2,1,3 + 1/4,5(2,3); Th V, 1 + 1/2,4 + 1/2,1,2 + 1/2,4,5(2,3); Th VI, 1 + 1/2,3,1,2 + 1/2,0,1,2 + 0,1/4(2); Th VII, 1 + 1/2,4 + 1,2 + 0,1 + 0,1/4(2).

Etymology
The species name means “eight-hooked” and refers to the eight claws on the distal endite of the maxillule; “octocamura” is an adjective.

Remarks
The eight claws on the distal endite of the maxillule distinguish Notobathynella octocamura sp. nov. from other members of the genus (Table 2). Billibathynella humphreysi Cho, 2005 and Montanabathynella salish Camacho et al., 2009 are the only other parabathynellid species known to have more than seven claws on the distal endite of the Mx I (ten and nine, respectively) (Camacho, Stanford and Newell 2009).
Table 2. Characters of the species of the genus *Notobathynella* Schminke, 1973 found in the world.

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<th>N. williamsi</th>
<th>N. chiltoni</th>
<th>N. hineoneae</th>
<th>N. longipes</th>
<th>N. lemurum</th>
<th>N. octocamara sp. nov</th>
<th>N. pentatrichion sp. nov.</th>
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<td>N. spines</td>
<td>10</td>
<td>8</td>
<td>8–11</td>
<td>7</td>
<td>9–10</td>
<td>7</td>
<td>7–8</td>
<td>10–14</td>
</tr>
<tr>
<td></td>
<td>Anal operculum</td>
<td>Pr (M)</td>
<td>NPr</td>
<td>NPr</td>
<td>NPr</td>
<td>NPr</td>
<td>NPr</td>
<td>Pr (S)</td>
<td>Pr (S)</td>
</tr>
<tr>
<td>Max./Min. size</td>
<td>2.37/2.02</td>
<td>1.78/1.1</td>
<td>1.77/–</td>
<td>1.52/–</td>
<td>1.9/1.83</td>
<td>1.5/1.45</td>
<td>2.46/2.05</td>
<td>2.7/1.5</td>
<td>2.3/1.3</td>
</tr>
<tr>
<td>Habitat</td>
<td>R</td>
<td>C</td>
<td>R</td>
<td>R</td>
<td>W</td>
<td>R</td>
<td>W</td>
<td>W</td>
<td></td>
</tr>
</tbody>
</table>


A = absent; C = cave; H = homonomous; I = inhomonomous; Max./Min. = maximum/minimum size in mm; M = medium-sized; Md. = mandible; Mx.I = maxillule; Mx.II = maxilla; N. = number of; NPr = not pronounced; P = present; Pr = pronounced; R = river bank; S = small; sgt = segments; Symp = sympod; Th = thoracopod; Th.I = thoracopod one; W = well.
**Notobathynella octocamura** sp. nov. is the first species of the genus with five setae on the terminal segment of the antenna, 26–28 teeth on the labrum, 31 setae on the maxilla, two setae on the basipod of thoracopods III to V, three segments in the exopod of thoracopod I, five segments in the exopod of thoracopods IV and V, three setae and two claws in the fourth segment of endopod of the thoracopods II and III, and six setae on the exopod of the uropod. The setal formula of some thoracopods is also unique (see Table 3). All of these characters leave no doubt that the specimens described here represent a new species.

**Notobathynella octocamura** sp. nov. is the biggest species of the genus (2.7 mm) and contains many teeth, spines and setae on its extremities, and a high number of segments on the thoracopodal exopods. The genus *Notobathynella* is similar to *Billibathynella* Cho, 2005 in many aspects. In the new species we find two new characters for the genus that bring it nearer to *Billibathynella*: two setae on the basipod of the thoracopod III to V (*Notobathynella* usually have only one) and three setae and two claws in the four segment of the endopod of the thoracopods II and III, *Billibathynella* has five or six setae (*Notobathynella* usually have only one or two setae and two claws) (see Table 3). In addition, all the species known in the genus have a maximum of four segments in the exopod of the thoracopods (see Table 2), whereas the new species has five, compared with *Billibathynella* with up to 10 segments.

**Notobathynella remota** Schminke, 1973 comes from the locality nearest to our new species. *Notobathynella remota* has six segments on A.II and the new species has five, as is common in the genus (see Table 2). The species with the most characters in common with *N. octocamura* sp. nov. are *N. williamsi* Schminke, 1973 (from Victoria), *N. hineoneae* Schminke, 1973 (from New Zealand), *N. remota* Schminke, 1973 (from New South Wales) and *N. pentatrichion* sp. nov., which we describe below.

Unfortunately, previous descriptions of the genus *Notobathynella* have not included detailed drawings of thoracopod VIII of the male of all species (i.e. *N. remota*) because a comparison with these would have allowed a more complete understanding of how the new species is related to previous species.

**Notobathynella pentatrichion** sp. nov. (Figures 4–6)

**Material examined**

*Type locality.* Department of Natural Resources monitoring piezometer number 13700234A, 19 May 2004 from alluvial aquifer of Yellow Waterholes Creek near Bundaberg, Queensland, Australia; nine males and six females were collected.

*Other localities.* Department of Natural Resources monitoring piezometer number 13700067, 20 May 2004, alluvial aquifer of Elliott River near Bundaberg, Queensland, Australia; five males and three females were collected, and piezometer number 13710036, 16 May 2004, from the alluvial aquifer of Gregory River near Bundaberg, Queensland, Australia; one male, two females and one juvenile were collected.

The details of the description are based on all specimens. The holotype is a male and the allotype is a female and the type series contains 20 additional specimens (12 males and eight females): holotype MNCN20.04/8232, allotype MNCN20.04/8233 and type series MNCN20.04/8234.
Table 3. Setal formula of the endopod of the thoracopods of the species of the genus *Notobathynella* Schminke, 1973 found in the world.

<table>
<thead>
<tr>
<th></th>
<th><em>N. remota</em></th>
<th><em>N. tasmaniæ</em></th>
<th><em>N. williamsi</em></th>
<th><em>N. chiltoni</em></th>
<th><em>N. hineoeæ</em></th>
<th><em>N. longipes</em></th>
<th><em>N. lemurum</em></th>
<th><em>N. octocamura</em></th>
<th><em>N. pentatrichion</em></th>
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</thead>
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<tr>
<td>Th.I</td>
<td>3+1/3+1/2</td>
<td>1+1/3+1/1</td>
<td>2+1/3+1/2</td>
<td>2+0/2+1/2</td>
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<td>+1/3(1)</td>
<td>+1/4,5(2,3)</td>
<td>+1/4(2)</td>
</tr>
<tr>
<td>Th.II</td>
<td>1+1/3+1/1</td>
<td>1+0/2+1/1</td>
<td>1+1/2+1/0</td>
<td>1+1/2+2/0</td>
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<td>Th.V</td>
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<td>+1/4,5(2,3)</td>
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<tr>
<td>Th.VII</td>
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<td>1+0/1+1/1</td>
<td>0+1/1+1/0</td>
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<td>1+1/2,4+1,2,0,1</td>
<td>1+1/1,2+1,0,1</td>
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<td>+1/3(1)</td>
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<td>+1/3(1)</td>
<td>+1/4,5(2,3)</td>
<td>+1/4,5(2,3)</td>
</tr>
</tbody>
</table>

Notes: Th.I to Th.VII, thoracopods I to VII;
*N. remota* Schminke, 1973 (NSW, Australia); *N. tasmaniæ* Morimoto, 1978 (Tasmania); *N. williamsi*, Schminke, 1973 (Victoria, Australia); *N. chiltoni*, Schminke, 1973 (New Zealand); *N. hineoeæ*, Schminke, 1973 (New Zealand); *N. longipes*, Schminke, 1978 (New Zealand); *N. lemurum*, Drewes and Schminke, 2007 (Madagascar); *N. octocamura*, sp. nov. (Queensland, Australia); and *N. pentatrichion*, sp. nov. (Queensland, Australia).
Figure 4. *Notobathynella pentatrichion* sp. nov. (A–C, E–G) Male holotype. (A) Antennule (dorsal view); (B) antenna (dorsal view); (C) labrum; (D) labrum female allotype; (E) mandible; (F) maxillule; (G) maxilla. Scale bar in mm.
Figure 5. *Notobathynella pentatrichion* sp. nov. All male holotype. (A) Thoracopod I; (B) thoracopod II; (C) thoracopod III; (D) thoracopod IV; (E) thoracopod V; (F) thoracopod VI; (G) thoracopod VII. Scale bar in mm.
Figure 6. Notobathynella pentatrichion sp. nov. (A–D, G, H) Male holotype. (A) Thoracopod VIII (laterofrontal view); (B) thoracopod VIII (laterocaudal view); (C) thoracopod VIII (latero-external view); (D) thoracopod VIII (latero-internal view); (E) thoracopod VIII female allotype
Description

Body. 1.33 mm long for the holotype (male) and 1.78 mm long for the allotype (female). Largest male total length 2.06 mm, smallest 1.33 mm; largest female total length 2.33 mm, smallest 1.30 mm. Body elongated, segments slightly widening towards posterior end; approximately 8.5 times long as it is wide. Head 1.2 times as long as it is wide. Pleotelson with one small barbed ventral seta on either side.

Antennule (Figure 4A). Seven-segmented; no sexual dimorphism; length of first three segments 1.1 times as long as last four segments; segment seven slightly shorter than segment six; inner flagellum almost trapezoidal; fourth and fifth segments similar in size; setation as in Figure 4A; segment three with four setae; segment five with two setae, and six and seven with three terminal aesthetascs.

Antenna (Figure 4B). Five-segmented; long and curved backwards, half the length of the antennule; two first segments shortest, third segment twice as long as second, and last two segments similar in size, the last a bit longer than the previous one and with four setae, one of which is plumose. Setal formula: 0/0/1+0/1+1/4(1).

Labrum (Figure 4C). Almost flat, with eight main teeth, and seven lateral teeth at either side. Ventral surface with several rows of fine spinules and four tooth-like protusions on both sides.

Labrum female (Figure 4D). Almost flat, with eight main teeth, and eight lateral teeth at either end. Ventral surface with several rows of fine spinules and with five tooth-like protusions on both sides.

Mandible (Figure 4E). Pars incisiva having four well-developed teeth and triangular small proximal tooth; pars molaris with seven claws, five distal with small spines and two small joined proximal claws with a large number of fine hairs; the distal seta of the mandibular palp almost exceeds pars incisiva in length.

Mandible female. Pars incisiva similar to the holotype; pars molaris with eight claws, six being strong, the distal with small spines and two small joined proximal claws with a large number of fine hairs.

Maxillule (Figure 4F). Proximal endite with four long serrulate claws; distal endite with seven claws, two smooth, one apical and other subapical, other five with denticles and fine long setules at the base and three subterminal smooth setae on outer distal margin.

(frontal view); (F) thoracopod VIII female (lateral view); (G) uropod (latero-external view); (H) pleotelson and furcal rami (dorsal view); (I) endopod of uropod female allotype (latero-external view). Scale bar in mm. Abbreviations: D. Lb, dentate lobe; I. Lb, inner lobe; O. Lb, outer lobe; Bsp, basipod; Endp, endopod; Exp, exopod.
Maxilla (Figure 4G). Four-segmented, segment three elongated and fourth small; setal formula 3, 4+1, 14, 6.

Thoracopod I–VII (Figure 5A–G). Well developed, length gradually increasing from I to IV, last four similar in size; epipod on I to VII small, measuring half the length of basipod; basipod with one smooth seta at distal inner corner in all Th. Exopod shorter than endopod on Th I, II and VII and similar on Th III to VI and with the following numbers of segments: 1-3-3-4-4-3-3; each segment with two barbed setae (with one group of ctenidia at the base of inner setae) except last segment that has a plumose outer seta in Th I to VI but is barbed and very short in the Th VII; endopod four-segmented, first segment is small, second and third long and similar in length, and fourth is small (with two smooth similar strong claws and two smooth setae), all inner setae on segments smooth and outer setae of first and second segment of Th I to VII are plumose. Setal formula: Th I, 3+1/3+1/2+1/4(2); Th II, 1+1/3+2/1+1/4(2); Th III, 1+1/2+2/0+1/4(2); Th IV-VI, 1+1/2+1/1+1/4(2); Th VII, 1+1/2+1/0+1/4(2).

Allotype female exopod shorter than endopod on Th I to III and VII and similar on Th IV to VI and with the following numbers of segments: 2-3-4-4-5-4-3. Setal formula of the endopods of thoracopods: Th I, 3+1/3+1/2+1/4(2); Th II, 2+1/3+2/1+1/5(3); Th III, 1+1/3+2/1+1/5(3); Th IV, 1+1/3+2/1+1/5(3); Th V, 1+1/3+2/1+1/4(2); Th VI, 1+1/3+1/1+1/4(2); Th VII, 1+1/2+1/1+1/4(2).

Thoracopod VIII male (Figure 6A–D). Rectangular; basal region of the penial complex supports three lobes: inner lobe (I. Lb.), outer lobe (O. Lb.) and dentate lobe (D. Lb.); subtriangular inner lobe; outer lobe, inner lobe and dentate lobe of similar length, and they do not exceed the end of the external side of basipod (Bsp); dentate lobe has many denticles; endopod (Endp.) long, almost three times longer than exopod with two smooth terminal setae; exopod (Exp.) small and with one tooth; basipod trapezoidal in the external face, well-developed, in the internal side with a seta above its outer distal corner and with a crest-like protuberance.

Thoracopod VIII female (Figure 6E,F). Small, rounded with one segment with one small tooth.

First pleopods. Absent.

Uropod (Figure 6G). Sympod slender, five times as long as wide, bearing eight barbed spines of similar size, and one distal spine three times longer than others; 2.4 times longer than endopod and 1.7 times longer than exopod; endopod shorter than exopod, with two spinous processes on the inner margin and one strong spine on the distal part, two plumose setae near the inner margin, one basal and one subterminal, that exceed the distal end of endopod, and two barbed terminal setae of different length; exopod four times as long as wide and has five barbed setae.

Uropod female. Sympod with eight barbed spines of similar size, and a distal spine three times longer than the others; endopod (Figure 6I) shorter than exopod, with one small spine and one robust spine on the distal part, two plumose setae near the inner margin, one basal and one subterminal, that exceed the distal end of endopod, and two barbed terminal setae of different length.
Pleotelson (Figure 6H). With one small, plumose ventral seta on either side near the base of the furca. Anal operculum convex and distinctly protruded.

Furca (Figure 6G). Rectangular, twice as long as wide, with 10–11 barbed spines (the two terminal ones longer and thicker); two unequal dorsal plumose setae, that do not exceed the distal part of terminal spines; with a smal lateral furcal organ.

Variability
There is variation in the number of spines on the furca (nine to 11), on sympod of uropod (eight to 11), and on endopod of uropod (one to five). There is also variation in the number of exopodal segments of Th I–VII (1,3−3,4−3,4−3,4−3,5−3,4−3,4) and the number of setae on different segments of the endopods of some thoracopods of males and females. Setal formula: Th I, 2,3+1/2,3+1/2+1/4(2); Th II, 1,2+1/2,3+1/1+1/4,5(2,3); Th III, IV, 1+1/2,3+1,2+1/1+1/4,5(2,3); Th V, 1+1/2,3+1,2/0,1+1/4(2); Th VI, 1+1/1,3+1/0,1+1/4(2); Th VII, 1+1/1,2+1/0,1+1/4(2).

Etymology
The species name, “pentatrichion” (substantive in apposition) refers to the five setae on the exopod of the uropod.

Remarks
Notobathynella pentatrichion sp. nov. does not have unique characters within the family, but is the first species of the genus with five setae on the exopod of the uropod. As with N. octocamura sp. nov., N. pentatrichion sp. nov. has three segments in the exopod of the thoracopod I, five segments in the exopod of thoracopod V (see Table 2) and three setae and two claws in the last segment of the endopod of thoracopods II to IV (see Table 3). All of these particular characters, considered together with a unique combination of others (see Table 2 and 3) leave no doubt that the studied specimens belong to a new species.

The nearest (geographically) known species to Bundaberg is N. remota Schminke, 1973, but this has six segments on A.II. In contrast, the new species has five, which is the dominant case in the genus. Notobathynella pentatrichion sp. nov. seems more similar to species from New Zealand (N. hineoneae, N. chiltoni Schminke, 1973) and N. octocamura sp. nov. (described above) than to N. remota (New South Wales).

Discussion
The new species undoubtedly belong to the genus Notobathynella following the series of characters that we analysed in detail here. Thoracopod VIII of the male of the new species has the specific features of the genus, particularly the well-developed basipod, with a crest-like protuberance, which is more or less developed in each of the new
species; the exopod and endopod of both species are more or less triangular in shape and well-developed. The new species have three to five segments in the exopod of the thoracopods extending the possibilities for members of the genus to have from two to five segments (see Table 2). Besides Notobathynella, the only Australian genera with more than three segments in the exopod of some thoracopod are Billibathynella Cho, 2005, Brevisomabathynella Cho et al, 2006 and Octobathynella Camacho and Hancock (2010). Both Billibathynella and Brevisomabathynella almost always have more than five segments.

The combinations of characters seen in N. octocamura sp. nov. and N. pentatrichion sp. nov. are unique among the nine known species of Notobathynella (see Tables 2 and 3). Notobathynella octocamura sp. nov. is the biggest species of the genus and N. pentatrichion sp. nov. is similar in size to N. remota and N. lemurum Drewes and Schminke, 2007.

Notobathynella octocamura sp. nov. is distinguished by having the largest endopod in the male Th. VIII, whereas that of N. pentatrichion sp. nov. is smaller; Notobathynella octocamura sp. nov. has a crest-like basipod larger and sharper than N. pentatrichion sp. nov. and has a sharper inner lobe. In both new species the endopod is longer than the exopod, whereas in N. longipes Schminke, 1978 and N. williamsi Schminke, 1973 the exopod is longer. It is difficult to know which is longer in other species of the genus because of the lack of a detailed description or because the male is unknown.

Both new species have a protruding anal operculum, most pronounced in N. pentatrichion sp. nov., and both have more setae in the exopod of the uropod than the rest of the species of the genus (see Table 2). The new species have a non-homonomous row of spines in the sympod of the uropod, as do five of the congeners.

As with six other species of the genus, N. pentatrichion sp. nov. has seven claws in the distal endite of Mx. I. By contrast, N. octocamura sp. nov. has eight, displaying a new feature in the family Parabathynellidae.

With the discovery of these two new species, the genus Notobathynella has nine species, a high number for a family in which the majority of the genera are monospecific (Camacho 2006). In addition, the new character states increase the variability of the group within the generic characteristics.

Systematic account and distribution of the genus Notobathynella Schminke, 1973 in the world

The current distribution of the nine species of the genus Notobathynella Schminke, 1973 covers Australia (New South Wales, Victoria and Tasmania), New Zealand (South Island) and Madagascar. The new species described herein extend the distribution of this genus in eastern Australia northwards to central Queensland. In Western Australia, six new species of the genus Atopobathynella have recently been found (Cho et al. 2006); several new parabathynellid genera have been described (Kimberleybathynella Cho et al., 2005 with six new species, Brevisomabathynella Cho et al., 2006 with two new species and Billibathynella Cho, 2005, with four new species). A new genus closely related to Notobathynella, Octobathynella, has recently been described from New South Wales (Australia) (Camacho and Hancock 2010). The recent discovery of Notobathynella in Madagascar (Drewes and Schminke 2007)
among material collected in 1974 indicates that a major increase in sampling and subsequent taxonomic study may be necessary to increase the biogeographical knowledge of Parabathynellidae in the world. Nowadays, new species are described from sporadic collections in countries where groundwater fauna have scarcely been sampled. Consequently, the recent increase in the number of groundwater fauna samples collected has led to the discovery of new species elsewhere in the world. In South India the genera *Atopobathynella* Schminke, 1973 (Ranga Reddy et al. 2008), *Chilibathynella* Noodt, 1963 (Ranga Reddy 2006), and three new species of the *Habrobathynella* Schminke, 1973 (Ranga Reddy 2002, 2004; Ranga Reddy and Schminke 2005, 2009) have been found. New species have also been described from South Korea (Cho et al. 2008) and Africa (Cho and Schminke 2006). In China and Vietnam three new genera have been described (Camacho 2005; Camacho et al. 2006). There has also been a new genus recently described from a small area of Montana (USA) (Camacho, Stanford and Newell 2009), which also contained three new species of *Pacificabathynella*, a genus previously known only from California (Camacho, Newell and Reid 2009). Several new species of *Hexabathynella* Schminke, 1973 have also recently been described from California (Cho 2001). It appears that wherever intensive sampling of groundwater fauna occurs, the number of new species increases, suggesting that the Bathynellacea are more abundant and diverse than previously thought.

The world distribution of *Notobathynella* is mapped in Figure 7.
Family PARABATHYNELLIDAE Noodt, 1965


8. **Notobathynella octocamura sp. nov.** Type locality: Alluvial aquifer near Yellow Waterholes Creek, Bundaberg, Queensland, Australia. Other locality: alluvial aquifer near Elliott River, Bundaberg, Queensland, Australia. Habitat: interstitial, alluvial aquifer.

9. **Notobathynella pentatrichion sp. nov.** Type locality: Alluvial aquifer near Yellow Waterholes Creek, Bundaberg, Queensland, Australia. Other localities: alluvial aquifers near Elliott River and Gregory River, Bundaberg, Queensland, Australia. Habitat: interstitial, alluvial aquifer.

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References


