The Freshwater Crabs of Ethiopia, Northeastern Africa, with the Description of a New Potamonautes Cave Species

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The freshwater crabs of Ethiopia, northeastern Africa, with the description of a new Potamonautes cave species (Brachyura: Potamonautidae)

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Key words: Potamonautes kundudo sp. nov., Potamonautes antheus, Potamonautes ignestii, freshwater crabs, Mount Kundudo, Potamoidea

Abstract

A recent collection of freshwater Potamonautid crabs from a newly-explored cave in Ethiopia included a new species of Potamonautes Macleay, 1838, which is described. The new species is associated with caves but is not troglobitic because it has no special morphological adaptations for life in caves typical of other species of cave-dwelling freshwater crabs. The taxonomic status and biogeographic affinities of other Ethiopian freshwater crab species are discussed. Potamonautes antheus (Colosi, 1920) and P. ignestii (Parisi, 1923) are recognized as valid species, and a key to the species of the country is included. The addition of P. kundudo sp. nov. and the recognition of two previously suppressed taxa raises to six the number of freshwater crab taxa known to occur in Ethiopia.

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Introduction

This work reports on the discovery of a new species of potamonautid freshwater crab from Ethiopia which is described. The new species of freshwater crab was collected from a resurgent spring flowing inside and outside of a cave on Mount Kundudo (2,499 m asl) in the Ahmar Mountains in the Oromia Region of eastern Ethiopia. The specimens were entrusted for study to the second author by Italian speleologists Prof. Marco Viganò and Dr. Danilo Baratelli who were the first to explore the newly discovered cave. These specimens are described and assigned to the Afro-tropical freshwater crab family Potamonautidae Bott, 1970, based on a novel combination of somatic characters (Figs. 1-4) including the gonopods, carapace, and sternum of the holotype, an adult male. The new discovery raises to six the number of valid species of Ethiopian freshwater crabs (Table 1; Cumberlidge, 2009; Cumberlidge and Meyer, 2010). These species are Potamonautes antheus (Colosi, 1920), P. berardi (Audouin, 1826), P. holthuisi Cumberlidge and Meyer, 2010, P. ignestii (Parisi, 1923), P. niloticus (H. Milne Edwards, 1837), and the new species which is described here.

This treatment of the freshwater crabs of Ethiopia differs radically from that of Bott (1955) who recognized four species from this country which he called Potamonautes (Rotundopotamonautes) berardi berardi, and Potamonautes (Acanthotelpusus) niloticus, P. (R.) aloysisabaudiae (Nobili, 1906), and P. (R.) didieri (Rathbun, 1904) (Table 1). Bott (1955) also included three other taxa Potamon (Geotelphusa) ignestii, Potamon (Potamonautes) lindblomi Colosi, 1924, and Potamon (Geotelphusa) neumanni var. laetabilis De Man, 1914, as either subspecies or junior synonyms of his Ethiopian species. However, recent studies indicate that only two out of four of Bott’s (1955) species (Potamonautes berardi and P. niloticus) are now known to actually occur in Ethiopia. For example, P. aloysisabaudiae is found only in the region of the Ruwenzori Mountains in western Uganda and eastern D. R. Congo, and there are no confirmed records of this species within hundreds of kilometres of Ethiopia (Corace et al., 2001; Cumberlidge, 2009). Similarly, P. didieri is from the Kibali River in the D. R.
Congo, but both Chace (1942) and Bott (1955) incorrectly reported that this locality was in Ethiopia; however, this is doubtful because there are still no reliable records of the presence of *P. didieri* outside of the Congo basin (Cumberlidge, 2009).

In the present study the Ethiopian *Potamonautes* MacLeay, 1838, are reconsidered. Two previously suppressed species, *P. antheus* and *P. ignestii*, are resurrected and recognized as valid. Previously *P. antheus* was treated by Bott (1955) as a junior synonym of *P. aloyisiabaudiae*, and *P. ignestii* as a subspecies of *P. berardi*. Their revised status is based on the examination of a series of unpublished specimens collected in Ethiopia between 1960 and 1980 (Table 1). As a consequence, adult males of *P. antheus* and *P. ignestii* are rediagnosed, redescribed, and illustrated here because of the longstanding taxonomic confusion surrounding these two taxa. Furthermore, two other freshwater crabs, *P. aloyisiabaudiae* and *P. didieri*, previously included in a list of species for Ethiopia compiled by Bott (1955) are not recognized here as members of the fauna of that country (Table 1). All of the freshwater

<table>
<thead>
<tr>
<th>Taxon</th>
<th>Identification in Bott (1955)</th>
<th>Country in present work</th>
<th>Identification in present work</th>
<th>IUCN conservation status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Potamon (Potamonautae) aloyisiabaudiae Nobili, 1906</td>
<td><em>Potamonautes</em> (Rotundopotamonautae) aloyisiabaudiae</td>
<td>D. R. Congo (not Ethiopia)</td>
<td><em>Potamonautes</em> aloyisiabaudiae</td>
<td>LC</td>
</tr>
<tr>
<td>Potamon (Geothelphusa) antheus Colosi, 1920</td>
<td>junior synonym of <em>Potamonautes</em> (Rotundopotamonautae) aloyisiabaudiae</td>
<td>Ethiopia</td>
<td><em>Potamonautes antheus</em></td>
<td>LC</td>
</tr>
<tr>
<td>Thelphusa berardi Audouin, 1826</td>
<td><em>Potamonautes</em> (Rotundopotamonautae) berardi berardi</td>
<td>Ethiopia, Egypt, Sudan, Southern Sudan, Uganda, Tanzania, Rwanda</td>
<td><em>Potamonautes berardi</em></td>
<td>LC</td>
</tr>
<tr>
<td>Potamon (Potamonautae) didieri Rathbun, 1904</td>
<td><em>Potamonautes</em> (Rotundopotamonautae) didieri</td>
<td>D. R. Congo (not Ethiopia)</td>
<td><em>Potamonautes didieri</em></td>
<td>DD</td>
</tr>
<tr>
<td>Potamon (Geothelphusa) ignestii Parisi, 1923</td>
<td><em>Potamonautes</em> (Rotundopotamonautae) berardi ignestii</td>
<td>Ethiopia</td>
<td><em>Potamonautes ignestii</em></td>
<td>VU, B1ab(i); D2</td>
</tr>
<tr>
<td>Potamonautes kundudo sp. nov.</td>
<td>n/a</td>
<td>Ethiopia</td>
<td><em>Potamonautes kundudo</em></td>
<td>NA</td>
</tr>
<tr>
<td>Potamonautes holthuisi Cumberlidge &amp; Meyer, 2010</td>
<td>n/a</td>
<td>Ethiopia</td>
<td><em>Potamonautes holthuisi</em></td>
<td>NA</td>
</tr>
<tr>
<td>Potamon (Geothelphusa) neumanni var. laetabilis De Man, 1914</td>
<td>junior synonym of <em>Potamonautes</em> (Rotundopotamonautae) didieri</td>
<td>Ethiopia</td>
<td>Uncertain taxon, not a junior synonym of <em>P. didieri</em></td>
<td>NA</td>
</tr>
<tr>
<td>Potamon (Potamonautae) lindblomi Colosi, 1924</td>
<td>junior synonym of <em>Potamonautes</em> (Rotundopotamonautae) berardi ignestii</td>
<td>Kenya (not Ethiopia)</td>
<td><em>Potamonautes lindblomi</em></td>
<td>NA</td>
</tr>
<tr>
<td>Telpheusa nilotica H. Milne Edwards, 1837</td>
<td><em>Potamonautes</em> (Acanthopotamonautae) niloticus</td>
<td>Ethiopia, Egypt, Sudan, Southern Sudan, Uganda, Kenya, Rwanda</td>
<td><em>Potamonautes niloticus</em></td>
<td>LC</td>
</tr>
</tbody>
</table>
crab taxa that have been reported to occur in Ethiopia are evaluated (Table 1), including the most recent addition, *P. holthuisi* from the Omo-Turkana basin in the southwest of the country (Cumberlidge and Meyer, 2010). An identification key to the species (Appendix) and distribution maps of the freshwater crabs of Ethiopia are provided.

**Material and methods**

Specimens are deposited in the Natural History Museum, London, UK (NHM); the Department of Biology, Northern Michigan University, Marquette, MI, USA (NMU); the Museo di Storia Naturale di Milano, Italy (MSNM); the United States National Museum of Natural History, Smithsonian Institution, Washington DC, USA (USNM); and the Zoologische Staatsammlung, Munich, Germany (ZSM). All measurements were made with digital calipers and are in millimetres. Abbreviations used: a1-a6, abdominal somites 1-6; a7, telson of the abdomen; asl, above sea level; cw, distance across the carapace at the widest point; ch, carapace height, the maximum height of the cephalothorax; cl, carapace length measured from the frontal margin to the posterior margin; coll., collected by; fw, front width measured along the anterior margin; e, thoracic episternite; G1, first gonopod (= first pleopod of male); G2, second gonopod (= second pleopod of male); juv., juveniles; ovig., ovigerous; p1-p5, pereiopods 1-5; s, thoracic sternite; s1/s2, s2/s3, s3/s4, s4/s5, s5/s6, s6/s7, episternal sutures between adjacent thoracic sternites and episternites. The terminology is adapted from Cumberlidge (1999) and the higher classification used follows that of Ng et al. (2008). Line drawings were prepared using a Leica MZ 16 binocular microscope and the habitus photographs were taken with a digital camera. Post processing was done using Adobe Photoshop 7.0.

**Systematics**

*Potamonautes kundudo* sp. nov.

Figs. 1-4, 7E, Tables 1-2

*Type material and type locality*

Ethiopia: Holotype, adult ♂, cw 24.2, cl 17.5, ch 7.8, fw 7.8 mm (NHM 2012.1033), from a karstic spring flowing out of the Gursum Pearl cave (Biyyu Negheya) on Mount Kundudo at 2,500 m asl, near Dire Dawa, Gursum Province (woreda), East Hararge Zone, Oromia Region (09°26'N, 42°20'E), coll. Prof. Marco Viganò, presented by Danilo Baratelli, 4 Apr. 2010. Paratypes, adult ♂, cw 26.1, cl 19.2, ch 8.8, fw 8.6 mm (NHM 2012.1034); adult ♀, cw 22.9, cl 16.2, ch 7.45, fw 6.3 mm (MSNM 2436), adult ♂ cw 22.8, cl 16.5, ch 7.8, fw 7.5 mm (MSNM 2437), adult ♂ cw 22 mm, damaged (MSNM 2438); subadult ♀ cw 18.2 mm, subadult ♂ cw 14.6 mm, subadult ♂ cw 14.5 mm, juv. ♀, cw 12.3 mm, subadult ♀ cw 18.4 mm, subadult ♀ cw 15.0 mm, (NHM 2012.1035-1040); all paratypes same locality data as holotype. The first specimen (♀) was collected from a locality inside the cave by Prof. Marco Viganò and Giampaolo Rivolta, 13 Feb. 2009, but was not preserved.

*Diagnosis*

Carapace highly arched (ch/fw 1.2). Exorbital, epibranchial teeth reduced to granules, postfrontal crest incomplete, faint in middle, lateral ends well defined, meeting epibranchial teeth; anterolateral margin posterior to epibranchial tooth granular; carapace sidewall vertical suture faint, incomplete, not meeting anterolateral margin. Ischium of third maxilliped lacking vertical groove. Sternal suture s3/s4 complete, U-shaped, deep at edges, faint in middle, almost meeting thick, raised anterior margin of sternoabdominal cavity. Inferior margins of merus of cheliped granular, distal meral tooth pointed; first carpal tooth medium sized, pointed, second carpal tooth reduced to large granule. G1 terminal article straight basally, midsection and tip curving outward, midsection not widened, tip evenly tapering, not upturned.

*Description*

Based on adult male holotype (cw 35 mm). Carapace oval, wide (cw/fw 3.6), high (ch/fw 1.2); surface smooth; cardiac, urogastric grooves faint; cervical grooves short, faint; transverse branchial grooves faint (Fig. 1c). Eyestalks normal length (not shortened), corneas normal size (not reduced). Front wide (fw/cw 0.28), deflexed (Fig. 1c). Postfrontal crest incomplete, faint in middle, lateral ends well defined, meeting epibranchial teeth; postorbital, epigastric crests faint (Fig. 1c). Exorbital, epibranchial teeth both reduced to single granules, continuous with granulated anterolateral margin, latter continuous with posterolateral margin; carapace sidewalls smooth, divided into three parts by two sutures, vertical suture faint and incomplete, not meeting anterolateral margin; suborbital, subhepatic, pterygos-
tomial regions of carapace sidewalls completely smooth (Fig. 1e). Mandibular palp two-segmented, terminal article simple, setose; epistomial tooth triangular, deflexed, edges smooth. Third maxillipeds filling entire oral field, except for transversely oval respiratory openings at superior lateral corners; ischium of third maxilliped lacking vertical groove; exopod of third maxilliped reaching to lower half of merus, terminal segment flagellum-like (Fig. 1e).

Sternal suture s1/s2 absent; s2/s3 deep, complete, running horizontally across sternum; s3/s4 U-shaped, deep at edges, faint in middle, almost meeting thick,
raised anterior margin of sternoabdominal cavity; episternal sutures s4/e4, s5/e5, s6/e6, s7/e7, all faint, incomplete (Fig. 1d). Abdomen slim, outline triangular, tapered, widest at base, telson outline forming straight-sided triangle with broad base, rounded apex; s6/s7 meeting abdomen at a5/a6; s5/s6 meeting a6 one half of segment length from a6/a5 (Fig. 1d). G1 terminal article straight basally, midsection, tip curving outward, midsection not widened, tip evenly tapering, not upturned (Fig. 3). G2 terminal article flagellum-like, less than half as long as subterminal segment. Subterminal segments of G1, G2 equal in length (Fig. 4). Dactylus of major cheliped slender; slightly arched, closed fingers enclosing long narrow interspace; upper margin of dactylus of cheliped smooth; fixed finger of propodus of major (right) cheliped slender with two distinct, large teeth in proximal region followed by series of smaller teeth; lower margin of propodus slightly indented (Fig. 1a-b); first carpal tooth distinct, pointed; second carpal tooth less than half size of first carpal tooth, pointed, followed by several small granules; distal meral tooth small, pointed; ventral margins of merus of cheliped lined by series of large granules; superior surface of merus smooth (Fig. 1c-d). Walking legs (p2-p5) normal length (neither elongated nor shortened); p3 longest limb, p5 shortest limb; dactyli of p2-p5 tapering to point, each bearing four rows of downward-pointing short, sharp spines (Fig. 1c). Colour of dorsal carapace and legs uniformly dark brown-purple.

**Etymology**
This species is named for Mount Kundudo in Ethiopia. The name is used as a noun in apposition.

**Size**
A medium-sized species, the largest known specimen is the adult female paratype, cw 26.1 mm.

**Remarks**
*Potamonautes kundudo* sp. nov. is distinguished from the other species found in Ethiopia (*P. niloticus, P. berardi, P. antheus, P. ignestii, and P. holthuisi*) by its slim G1 terminal article that is straight basally with an outward-curving midsection and tip, a midsection that is not widened, and a tip that tapers evenly and is not upturned (Table 2, and the identification key to the species below).

*Potamonautes kundudo* sp. nov. can be distinguished from *P. holthuisi* by the absence of several teeth. Walking legs (p2-p5) normal length (neither elongated nor shortened); p3 longest limb, p5 shortest limb; dactyli of p2-p5 tapering to point, each bearing four rows of downward-pointing short, sharp spines (Fig. 1c). Colour of dorsal carapace and legs uniformly dark brown-purple.

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*Potamonautes kundudo* sp. nov. can be distinguished from *P. holthuisi* because these two medium-sized species share the following characters: a weak postfrontal crest, a small and pointed first carpal tooth on the P1 carpus, a small pointed distal meral tooth on the P1 merus, and a slim G1 terminal article that is not widened in the midsection. *Potamonautes kundudo* sp. nov. can be distinguished from *P. holthuisi* by the an-
terolateral margin (which is granular in *P. kundudo* sp. nov. and smooth in *P. holthuisi*) and by the vertical suture on the carapace sidewall (which does not meet the anterolateral margin in *P. kundudo* sp. nov. but does meet this margin in *P. holthuisi*) (Fig. 1c; Cumberlidge and Meyer, 2010).

**Potamonautes kundudo** sp. nov. is distinguished from the remaining four Ethiopian species as follows. The new species is distinguished from *P. niloticus* by the postfrontal crest (which is weak and incomplete in *P. kundudo* sp. nov., but strongly defined and complete in *P. niloticus*, by the anterolateral margin (which is granular in *P. kundudo* sp. nov., but distinctly toothed in *P. niloticus*), and by the exorbital and epibranchial teeth (which are both reduced to small granules in *P. kundudo* sp. nov., but both are large and pointed in *P. niloticus*) (see Capart, 1954; Cumberlidge and Clark, 2010a). **Potamonautes kundudo** sp. nov. is distinguished from *P. ignestii* by the postfrontal crest (which is weak and incomplete in *P. kundudo* sp. nov., but strongly defined and complete in *P. ignestii*), and by the carapace sidewall vertical suture (which does not meet the anterolateral margin in *P. kundudo* sp. nov., but does meet this margin in *P. ignestii*) (Figs. 1d-e; 6; Cumberlidge, 1997; Bott, 1955). **Potamonautes kundudo** sp. nov. is distinguished from *P. antheus* by the adult body size range (which is above cw 35 mm in *P. kundudo* sp. nov., but above cw 55 mm in *P. antheus*), by the anterolateral margin (which is granular in *P. kundudo* sp. nov., but smooth in *P. antheus*) and by the carapace sidewall vertical suture (which does not meet the anterolateral margin in *P. kundudo* sp. nov., but does meet this margin in *P. antheus*), and by the midsection of the G1 terminal article (which is slim and not widened in *P. kundudo* sp. nov., but extremely wide in *P. antheus*). Finally, the new species is distinguished from *P. berardi* by the adult body size range (which is above cw 26 mm in adult *P. kundudo* sp. nov., but cw 24-31 mm in adult *P. berardi*),
by the anterolateral margin (which is granular in *P. kundudo* sp. nov., but smooth in *P. berardi*), and by the carapace sidewall vertical suture (which does not meet the anterolateral margin in *P. kundudo* sp. nov., but does meet this margin in *P. berardi*).

**Ecology**

The new species was found during an expedition to newly explored caves on Mount Kundudo, Ethiopia in February 2009 by Italian speleologists from CAI Gallate, Varese, Italy. The first specimen (a female) was encountered from the stream inside the cave by Prof. Marco Viganò and Giampaolo Rivolta, on 13 February 2009, but was only photographed and was not preserved. The second series of specimens (reported on here) were captured a year later from the cave outlet stream close to the cave entrance. This stream then flows southward through a highly disturbed forested area that is drained by perennial rivers such as the Harirro, Goro Obole, Bombas, Ejerti, and Agemsa that are tributaries of the Shebele River that flow southeast through the Somali region of Ethiopia, eventually passing through Somalia before emptying into the Indian Ocean. Crabs were observed to move between the cave and the outlet spring outside, and it is likely that there is more food (plant material and detritus) available outside the cave.

Specialised troglobitic cave-dwelling freshwater crabs are unknown in continental Africa, and although the new species lives in a cave, it has no special morphological adaptations typical of other species of troglobitic freshwater crabs found elsewhere in the world. For example, the cave crab *Stygothelphusa bidentis* (Lanchester, 1900) (Gecarcinucidae) from Sarawak, Malaysia, has extremely elongated pereiopods, an overall pale coloration, and eyestalks and cornae that are distinctly reduced (Ng, 1989). *Potamonautes kundudo* sp. nov. is therefore best described as a species that is associated with caves rather than troglobitic because it is found both inside and outside of caves, and because its pereiopods are not elongated, it is a uniformly dark brown purple colour, and its eyestalks and cornae are both of normal size.

**Distribution**

*Potamonautes kundudo* sp. nov. is endemic to Ethiopia and is known from a single locality, a spring inside and outside the Biyyu Negeya spring cave in Mount Kundudo, a flat top mountain located in the highlands of eastern Ethiopia. The technical reference name given to this cave is the Biyyu Negeya spring cave, and it is also known as the Gursum Pearl cave because it is located close to the town of Gursum in the Oromia Region of Ethiopia in the Misraq (East) Hararghe Zone (09°26’N, 42°20’E).

**Potamonautes antheus** (Colosi, 1920)

Figs. 5, 7A, Tables 1-2

**Potamon (Geothelphusa) antheus** Colosi, 1920: 35.

**Potamon (Geothelphusa) antheus** - Colosi, 1924: 16-17, pl. 1, fig. 6; fig. 12a, b.

**Geothelphusa antheus** - Balss, 1929: 351-352, fig. 1.

**Potamon antheus** - Chace, 1942: 206.

**Potamonautes antheus** - Ng et al., 2008: 170; Cumberlidge et al., 2009: appendix 1, 19; Cumberlidge and Meyer, 2010: 180, 184, 187, table 1.

**Material examined**

Redescription

Based on adult male (non-type) specimen, cw 64.5 mm (NMU TRW 1968.12). Postfrontal crest complete, distinct; epigastric, postorbital crests low, fused; postorbital crests extending laterally to meet anterolateral margins; exorbital, epibranchial teeth both reduced to granules; anterolateral margin behind epibranchial tooth smooth; carapace sidewall vertical suture faint, not meeting anterolateral margin; dactylus of major cheliped strongly arched enclosing broad oval interspace when closed; first carpal tooth on carpus of cheliped large, pointed, second carpal tooth weak, low, blunt; ventral margins of merus of pereiopod 1 both smooth; distal meral tooth reduced to low granule; terminal article of G1 straight basally, distinctly widened in midsection by raised dorsal lobe (higher than ventral lobe), dorsal lobe distinctly visible on dorsal face; dorsal membrane broad. Large-sized species, adult size range from cw 55 to cw 66 mm.

Remarks

The type specimen is an adult male (cw 56, cl 39, fw 15 mm), collected from ‘southwest Ethiopia’ sometime before 1920 (Colosi, 1920). The male type was not illustrated in the original description by Colosi (1920), but sketches of the anterior sternum, telson, and G1 terminal article, and a photograph of the dorsal view of the whole animal were provided later by Colosi (1924: 16-17, pl. 1, fig. 6; fig. 12a, b). Balss (1929) illustrated the dorsal carapace of a male specimen (cw 60 mm) from Doko, Ethiopia, collected by O. Neumann. Despite our best efforts we were unable to locate the type specimens of *Potamon (Geothelphusa) antheus* Colosi, 1920, but we cannot rule out the possibility that this series may still exist; because of this doubt we have deferred the designation of a neotype in this work. The diagnosis given here is based on a non-type adult male (cw 64.5 mm) from Oromia Region (formerly Kefa Province) Bidaru River in the Jimma Area (09°30’N, 38°02’E) of western Ethiopia collected on 2 September 1968 (NMU TRW 1968.12) (see Fig. 5). This specimen conforms to the published description of the type from southwestern Ethiopia by Colosi (1924) in a number of important characters (e.g., large body size, smooth anterolateral margins, granular exorbital and epibranchial teeth, incomplete postfrontal crest, and a widened midsection of the terminal article of G1). The only major difference between the specimens from southwest Ethiopia described here and the type from southwest Ethiopia illustrated by Colosi (1924), is the form of thoracic sternal suture s3/s4, which is incomplete and represented only by two short notches at the sides of the sternum in the specimens described here, and deep and completely crossing the sternum in the type.

This large species shows some important age-related variations in several morphological characters. For example, the anterolateral margin of large yet still subadult specimens of both genders (with cws of up to 52 mm) is distinctly granulated, as are the lateral ends of the postfrontal crest and suborbital margins, whereas all of these margins are smooth in adults (cws 55-65 mm). In addition, the anterolateral corners of the carapace surface of juvenile and subadult specimens of both genders have distinct fields of carinae (whereas these areas of the carapace surface are smooth in adults). Further, although the dactylus of the major cheliped of subadult males is arched, it is only half as high as that of adult males, and it encloses only a long
thin interspace in subadults rather than the wide oval interspace seen in adults. Finally, the major cheliped of subadult males has several large teeth on both of the fingers, whereas the major cheliped of adult males lacks teeth on either of its fingers.

The taxonomy of _P. antheus_ has been unstable for over 60 years because Bott (1955) was not able to examine the type specimens of either _P. antheus_ or _P. aloyisiisabaudiae_ in his monograph. Nevertheless, that author treated _Potamon (Geothelphusa) antheus_ Colosi, 1920, as a junior synonym of _P. aloyisiisabaudiae_ Nobili, 1906 (which he called _P. (Lobopotamonautes) aloyisiisabaudiae_). Bott (1955) described this species from Panga (01°52’N, 26°18’E), Mongbwalu (01°57’N, 30°1’E), and Bondo Mabe specimens because the type of _P. aloyisiisabaudiae_ Nobili, 1906 is unknown. All these localities are from the north of Kisangani in the Orientale Province and lie in the Congo River basin, D. R. Congo. However, it is doubtful that any of these specimens belong to _P. aloyisiisabaudiae_ (or _P. antheus_). For example, Bott’s photographs of ‘P. aloyisiisabaudiae’ (Bott, 1955: pl. 18, fig. 2a-d) show a potentially misidentified specimen from Panga, his sketches of the carapace of ‘P. aloyisiisabaudiae’ (Bott, 1955: figs. 87-89) are based on specimens from Panga, Mongbwalu, and Bondo Mabe, and his sketches of the G1 of ‘P. aloyisiisabaudiae’ are also based on the specimens from Panga and Mongbwalu (Bott, 1955: figs. 87-89). The presence of _P. aloyisiisabaudiae_ in Ethiopia is doubtful because the only confirmed records of this species are from the Ruwenzori Mountain region of western Uganda and adjacent D. R. Congo. However, it is not clear that _P. antheus_ is from Ethiopia, it should be noted that Bott’s (1955) view of _P. antheus_ as a junior synonym of _P. aloyisiisabaudiae_ is not in agreement with a number of other authors who considered both _P. aloyisiisabaudiae_ and _P. antheus_ to be valid species (Colosi, 1924; Balss, 1929; Chace, 1942; Ng et al., 2008; Cumberlidge, 2009; Cumberlidge et al., 2009; Cumberlidge and Meyer, 2010). This taxonomic confusion means that the description of the overall morphology of _P. antheus_ has not been updated since the descriptions made in the 1920s (Colosi 1920, 1924; Balss, 1929).

Ecology
No information available.

Distribution
_Potamonastes antheus_ is endemic to southwest and western Ethiopia (Cumberlidge, 1997, 1998, 2009). The localities from which this species is known to occur (the Bidaru, Atule, Yabo, Marauwa, and Karsa Rivers) are all in the Oromia Region of Ethiopia and all flow westward into the Nile basin.

Conservation status
_Potamonastes antheus_ is listed (IUCN, 2009) as least concern (LC) in view of its relatively wide distribution and lack of known widespread long-term threats (Cumberlidge et al., 2009; Table 1).

_Potamonastes berardi_ (Audouin, 1826)

Fig. 7B, Tables 1-2

_Thelphusa Berardi_ Audouin, 1826: 82, pl. 2, fig. 6, _Potamon berardi_ - Capart, 1954: 827, figs. 4, 31.

_Potamonastes (Rotundopotamonautes) berardi berardi_ - Bott, 1955: 288-289, pl. 23, fig. 5, pl. 23, fig. 1a-d; Monod, 1980: 382-383, pl. V, fig. 28.


Material examined

Type material
The type specimen of _Thelphusa berardi_ Audouin, 1826, is lost (Capart, 1954). Consequently, different authors have used different specimens to illustrate this species. For example, Rathbun (1904) illustrated a non-type adult male of _Thelphusa berardi_ (cw 31, cl 20, fw
8.6 mm) from the Nile River, and Capart (1954) illustrated the carapace and the G1 of a different non-type male collected in the Nile River by Jousseaume in 1887 (identified as *P. berardi* by Nobili (1906) and Bouvier (1917)). Bott (1955: pl. 23, fig. 1 a-d; fig. 53a-b) illustrated this species using a specimen from the Nile River from the SMF collection (SMF 1796, cw 30, cl 21, ch 13, fw 8.5 mm). In addition, Monod (1980) illustrated this species from a specimen from the Nile River from the MNHN collection, and Cumberlidge and Clark (2010a) described it from a specimen from the NHM collection. Although the absence of a type specimen has meant that this species has been described by numerous authors from specimens from different parts of its range, this has fortunately not been taxonomically problematic. This is because there has been little debate about the identification of *P. berardi* since its description in 1826, and it has not generally been confused with other taxa. However, one exception to this were specimens from Mount Elgon, Uganda, now identified as *P. williamsi* Cumberlidge and Clark, 2010b, that were originally provisionally identified by Williams *et al.* (1964) as ‘*P. berardi*’ on the basis of their small body size and smooth carapace margins.

**Diagnosis**

Postfrontal crest incomplete, faint in the middle; exorbital, epibranchial teeth both small granules; anterolateral margin immediately behind epibranchial tooth smooth; ischium of third maxilliped smooth, lacking vertical suture; thoracic sternal suture s3/s4 complete; dactylus of major cheliped strongly arched enclosing broad oval interspace when closed, two large teeth on fixed finger and two large teeth on moveable finger; first carpal tooth on carpus of cheliped large pointed, second carpal tooth weak, low, blunt; ventral margins of merus of pereiopod 1 both granulated; distal meral tooth large, pointed; terminal article of G1 slim, straight basally, curving outward in midsection, not widened in middle, tip curving upward. Small-sized species, adult size range from cw 23 mm. For detailed descriptions, photographs, and illustrations of *P. berardi* see Capart (1954), Bott (1955), Monod (1980), Cumberlidge (2009), and Cumberlidge and Clark (2010a).

**Remarks**

The complete synonymy prior to 1954 is provided by Bott (1955). This was the first species to be reported from Ethiopia and was treated by Bott (1955) as a valid species in the subgenus *P. (Rotundopotamonautes)*. While *P. berardi* is accepted as a valid species, the subgenus *P. (Rotundopotamonautes)* is likely paraphyletic and is not recognized here, an opinion that agrees with a number of other workers (Cumberlidge, 1997, 1998, 2009; Ng *et al.*, 2008; Cumberlidge *et al.*, 2009; Cumberlidge and Meyer, 2010).

**Ecology**

*Potamonautes berardi* is a common aquatic species found throughout the Nile river basin and its tributaries.

**Distribution**


**Conservation status**

This species is assessed as least concern (LC) based on its relatively wide distribution (extent of occurrence (EOO) >3 million km²) and the relatively high
number of localities and records of occurrence (21) from five countries (Cumberlidge et al., 2009; Table 1).

**Potamonautes holthuisi** Cumberlidge and Meyer, 2010
Fig. 7C, Tables 1-2

**Potamonautes holthuisi** Cumberlidge and Meyer, 2010: 179-188, figs. 1-4, table 1.

**Type material**
Holotype adult ♂, cw 34.3, cl 25.4, ch 11.9, fw 8.2 mm. Southwestern Ethiopia, Nechisar National Park, Southern Nations, Nationalities, and Peoples Region (formerly Gamo Gofa Province), Bodessa River, tributary of the Sagan (= Segan) River, 05°49’N, 37°45’E, 1,829 m asl, coll. E.A. Means, 19 May-3 Jun. 1912 (USNM 82304 A).

**Diagnosis**
Carapace highly arched (ch/fw 1.2). Exorbital, epibranchial teeth reduced to granules, postfrontal crest faint in middle, well defined at lateral ends meeting epibranchial teeth; anterolateral margin granular. Ischium of third maxilliped lacking vertical groove. Sternal suture s3/s4 U-shaped, deep at edges, faint in middle, almost meeting sternoabdominal cavity. Inferior margins of merus of cheliped granular, distal meral tooth small, low; first carpal tooth medium-sized, pointed, second carpal tooth reduced to large granule. G1 terminal article slim, straight basally, mid-section curving gently outward at 60° angle to longitudinal axis of gonopod, tip distinctly upturned.

**Remarks**
This species was described and illustrated in detail by Cumberlidge and Meyer (2010). *Potamonautes holthuisi* is a medium sized species that is adult at around cw 35 mm, and this, together with the form of the G1 terminal article help to distinguish it from similar medium-sized species (such as *P. ignestii* and *P. kundudo*), or smaller species (such as *P. berardi*) that lack teeth on the anterolateral margin (Table 2).

**Ecology**
Both of the two known localities for *P. holthuisi* lie in the Omo-Lake Turkana freshwater ecoregion that comprises Lakes Turkana (mostly in Kenya), Lakes Abaya and Chamo (in the northeastern portion of the Turkana ecoregion in Ethiopia), and the headwaters of the Omo River in southwestern Ethiopia (Thieme et al., 2005; Abell et al., 2008).

**Distribution**
*Potamonautes holthuisi* is known from two localities in the highlands of southwestern Ethiopia, in the Bodessa and Werka Rivers. The Bodessa River is a tributary of the Sagan (= Segan) River that flows into Lake Chamo, while the Werka River drains into Lake Abaya, just north of Lake Chamo (Cumberlidge and Meyer, 2010).

**Potamonautes ignestii** (Parisi, 1923)
Figs. 6, 7D, Tables 1-2

**Potamon (Geothelphusa) ignestii** Parisi, 1923: 332-334, pl. 8, fig. 1.

**Potamon ignestii** - Chace, 1942: 213.

**Potamonautes (Rotundopotamonautes) berardi ignestii** - Bott, 1955: 289-290, pl. 23, figs. 2a-d.

**Potamonautes ignestii** - Cumberlidge, 1998: 200; Ng et al., 2008: 171; Cumberlidge et al., 2009: Appendix 1, 20; Cumberlidge, 2009: 548, 554, 557, table 1; Cumberlidge and Meyer, 2010: 180, 184, 187, table 1.

**Type material**
Ethiopia: Adult ♂ holotype, cw 40.0, cl 28.5 mm, Gondar near Lake Tana, MSNM nr. 2003. Three female paratypes (cws between 32 and 40 mm) Gondar, Lake Tana, coll. U. Ignesti, 1921, MSNM.

**Material examined**
Ethiopia: Subadult ♂, cw 29.5, cl .5, ch 12, fw 9.5 mm, subadult ♂, cw 26.5 mm, subadult ♀, cw 32.9, Amhara Region, Caba River, Gondar, north of Lake Tana, 12°35’N, 37°28’E, ZSM 1182/1. Amhara Region, Caba River, Gondar, April, 1923, USNM 59366; adult ♂, cw 33.5, cl 23.4, ch 14.1. fw 11.3 mm, adult ♀, cw 32.5 mm, Amhara Region, Agew Awi Zone, Dangila, southwest of Lake Tana, 11°16’N, 36°50’E, coll. Major Cheeseman, NMH 1927.4.6.1-2/NMH ZOO 2011-381.

**Diagnosis**
Carapace highly arched (ch/fw 1.3). Postfrontal crest complete, well defined, meeting anterolateral margin at epibranchial teeth; exorbital, epibranchial teeth both reduced to granules; anterolateral margin immediately behind epibranchial tooth smooth; ischium of third maxilliped smooth, lacking vertical suture; thoracic
Cumberlidge & Clark – new species of Ethiopian cave crab

sternal suture s3/s4 deep and complete; dactylus of major cheliped slightly arched enclosing long narrow interspace when closed; first carpal tooth on carpus of cheliped large, pointed, second carpal tooth weak, low, pointed; ventral margins of merus of pereiopod 1 both granulated; distal meral tooth large, pointed; terminal article of G1 straight basally mid-section curving sharply outward and distinctly widened, tip turned upward. Medium-sized species, adult at or above cw 35 mm.

Remarks

The type material of *Potamon (Geothelphusa) ignestii* (museum nr. 2003) comprises one adult male (cw 40, cl 28.5 mm) and three females (cws between 32 and 40 mm) that were collected by U. Ignesti in 1921 from Gondar in the region of Lake Tana and deposited in the Museo civico di Storia naturale di Milano, Italy (MSNM). The redescription given here is based on a non-type adult male (cw 33.5 mm), from Amhara Region, Agew Awì Zone, Dangila, southwest of Lake Tana (NMH 1927.4.6.1-2/NMH ZOO 2011-381) (Fig. 6) that conforms closely to the published description of the type described by Parisi (1923) from Gondar near Lake Tana.

The Ethiopian taxon *Potamon (Geothelphusa) neu-manni* (Hilgendorf) var. *laetabilis*, de Man, 1914, from Let Marefia (9°38’0”N, 39°45’0”E) ‘Shoa’ (= Sheba Province, now Oromia Region) resembles *P. ignestii* in some respects, but we are not confident that it is similar enough to *P. ignestii* to warrant it’s inclusion in this species. Bott (1955) treated *Potamon (G.) neu-manni* var. *laetabilis* as a junior synonym of *Potamonautes didieri* (Rathbun, 1904) from the D. R. Congo, but we consider that these two geographically separated taxa probably belong to two distinct species. This opinion has been provisionally accepted by several authors (Yeo et al., 2008; Ng et al., 2008, Cumberlidge et al., 2009).

*Potamonautes ignestii* is a medium sized species (adult at cw 35 mm), with a strikingly-arched carapace, a G1 with a terminal article that curves sharply outward, with a distinctly widened mid-section and an upturned tip. These characters help to distinguish it from similar medium-sized species (such as *P. holthuisi* and *P. kundudo*), or smaller species (such as *P. berardi*) that lack a highly arched carapace and whose G1 terminal article has a slim (not widened) mid-section (Table 2).

Bott (1955) treated *P. ignestii* from Gondar near Lake Tana as the subspecies *P. (R.) berardi ignestii*, but this view is not in agreement with a number of other authors who all considered both *P. berardi* and *P. ignestii* to be valid species (Colosi, 1924; Balss, 1929, Chace, 1942; Ng et al., 2008; Cumberlidge et al., 2009; Cumberlidge, 2009; Cumberlidge and Meyer, 2010).

Bott (1955) also treated *Potamon* (*Potamonautes*) *lindblomi* Colosi, 1924, from Machako, Kenya as a junior synonym of *P. ignestii* (as *Potamonautes (Rotundo-potamonautes) berardi ignestii*). Unfortunately, Bott (1955) added to the taxonomic confusion regarding the identity of *P. ignestii* when he illustrated *P. ignestii* (Bott, 1955, pl. XXIII, fig. 2a-d) with photographs of the lectotype of *Potamon lindblomi* Colosi, 1924 (SNHM 7691, cw 18.5, cl 13.5, ch 8.0, fw 6.0 mm) from Machako, southwest of Nairobi, Kenya. Bott’s 1955 view that *P. (R.) berardi ignestii* was a senior synonym of *P. lindblomi* is not in agreement the opinions of a number of other authors who all considered both *P. berardi* and *P. ignestii* to be valid species (Colosi, 1924; Balss, 1929, Chace, 1942; Ng et al., 2008; Cumberlidge et al., 2009; Cumberlidge, 2009; Cumberlidge and Meyer, 2010).
other authors who all treated *P. ignestii* and *P. berardi* as valid species (Colosi, 1924; Chace, 1942; Ng et al., 2008; Cumberlidge et al., 2009; Cumberlidge and Meyer, 2010). The type specimen of *P. lindblomi* was examined during the course of these studies by the first author who concluded that it should properly be treated as a valid species (*P. lindblomi* Colosi, 1924). *Potamonauites lindblomi* is distinguished from *P. ignestii* by the carapace height (which is flat in *P. lindblomi* but highly arched in *P. ignestii*), and by the ischium of the third maxillipeds (which has a deep vertical suture in *P. lindblomi* but lacks a vertical suture in *P. ignestii*). In order to clarify the long-standing confusion regarding the identity of *P. ignestii* the characters of the gonopods are described and illustrated here for the first time based on an adult non-type specimen from near Gondar near Lake Tana that corresponds closely with the type described by Parisi (1923) from Gondar near Lake Tana.

Bott (1955) also included *Potamonauites (Geothelephusa) didieri* Rathbun, 1904 (as *P. (Rotundopotamonauites) didieri*) as part of the Ethiopian fauna because he accepted the opinion of Chace (1942) that *P. didieri* was from that country. However, it is doubtful that *P. didieri* is actually from Ethiopia. For example, the type locality of *P. didieri* is ‘Le Kibali (embochure) 1,015m asl, Mission du Bourg de Bozas, collected by L. Didier, 1903’. There is no evidence that this locality is in Ethiopia, and it is most likely the Kibali River in eastern D. R. Congo. In summary, *P. didieri* is here regarded as a valid species found in the D. R. Congo, and one that is not part of the Ethiopian freshwater crab fauna.

Ecology
No data available.

Distribution
*Potamonauites ignestii* is endemic to Ethiopia (Cumberlidge, 1997, 1998, 2009) and is known from two localities near Lake Tana, the source of the Nile in Ethiopia. These localities are both in the Amhara Region: the Caba (= Caha) River, Gondar, north of the lake, and Dangila, in the Agew Awi Zone southwest of the lake. This study adds new localities from previously unpublished specimens that were collected between 1923 and 1927, which was the last time that this species was seen in the field.

Conservation status
*Potamonauites ignestii* is listed (IUCN, 2009) as vulnerable (VU, B1ab(i); D2) in view of its narrow distribution (its extent of occurrence is less than 20,000 km²) and the fact that it is known from less than five localities and has not been collected since 1927. It is also vulnerable to threats because it is not found in a protected area (Cumberlidge et al., 2009; Table 1).

*Potamonauites niloticus* (H. Milne Edwards, 1837)
Fig. 7F, Tables 1-2

**Thelphoeusa niloticus** H. Milne Edwards, 1837: 12.

*Potamon niloticus* - Capart, 1954: 841, figs. 35, 16.

*Potamonauites (Acanthothelphusa) niloticus* - Bott, 1955: 260, pl. XIII, fig. 1a-c, fig. 30a-b; Monod, 1980: 382-383, pl. IV, fig. 22.

*Potamonauites niloticus* - Cumberlidge, 1997: 579; 1998: 202; 2009: 548–549, 551–557, fig. 1; Ng et al., 2008: 171; Cumberlidge et al., 2009: appendix 1, 20; Cumberlidge, 2009: 548, 551-557, table 1, fig. 1; Cumberlidge and Clark, 2010a: 1808-1812, fig. 1; Cumberlidge and Meyer, 2010: 184, 186, table 1.

Type material
The type specimen deposited in the Muséum national d’Histoire naturelle, Paris is a dried male, collected from Egypt by Rüppell in 1830 and is in poor condition (Capart, 1954). The diagnosis given by Cumberlidge and Clark (2010a) was based on a non-type adult male specimen collected from the Yala River, Kaimoisi, Kenya that conforms to the published description of the type.

Material examined.

**Diagnosis**
Postfrontal crest complete, distinct; epigastric, postorbital crests fused; postorbital crests extending laterally to meet anterolateral margins; exorhial, epibranchial teeth both strong, sharp; anterolateral margin immediately behind epibranchial tooth with row of distinct spines; thoracic sternal suture s3/s4 complete; dactylus of major cheliped strongly arched enclosing broad oval interspace when closed; first carpal tooth on carpus of cheliped large, pointed, second carpal tooth weak, low, blunt; ventral margins of merus of pereiopod 1 both granulated; distal meral tooth strong, pointed; terminal article of G1 straight basally, curved outward in mid-section, mid-section widened by thickened ven-
central lobe higher than dorsal lobe, upturned at tip. Large species, adult size range from cw 54 to cw 63 mm.

Remarks
The complete synonymy prior to 1954 is provided by Bott (1955). That author assigned this species to the subgenus *P. (Acanthothelphusa)*, but although the present study recognizes this as a valid species, the validity of the subgenus is not accepted, an opinion that is in accordance with other workers (Cumberlidge, 1997, 1998, 2009; Ng et al., 2008; Cumberlidge et al., 2009; Cumberlidge and Meyer, 2010).

Distribution
*Potamonautes niloticus* is a large and common species with a very wide distribution which is known from more than 60 localities in six countries associated with the Nile River and its tributaries in Ethiopia, Egypt, Sudan, Southern Sudan, Uganda, Kenya, and Rwanda (Cumberlidge, 1997, 1998, 2009). Cumberlidge and Clark (2010a) reported that *P. niloticus* also occurs just outside the Afro tropical zoogeographical region in the Mediterranean subregion of the Palaearctic region in Egypt. The material included here from near Pingoperi in southwestern Ethiopia is from the Baro River which rises in the Ethiopian Highlands and flows west for 300 kilometres to join the Pibor and Sobat Rivers, which then drain into the White Nile.

Ecology
*Potamonautes niloticus* lives in a range of aquatic habitats including the major channels of the Nile itself and its lowland tributaries, small and large lakes associated with the river basin, as well as small clear fast-flowing mountain streams with rocky beds, and sluggish warm lowland streams with muddy bottoms (Bott, 1955; Williams *et al.*, 1964; Cumberlidge, 1997, 1998, 2009; Cumberlidge and Clark, 2010a, b). This species is completely dependent on aquatic habitats and it never leaves the water whether it is found in streams, rivers, or lakes. The populations of *P. niloticus* are abundant enough in Lake Victoria to support small-scale local fisheries. In the southern parts of its range in Kenya and Uganda, *P. niloticus* serves as a host for the aquatic larvae of the biting blackfly, *Simulium* sp., which are the vectors of *Onchocerca volvulus*, the parasite that causes river blindness in humans (Crosskey, 1990). There is no evidence that *P. niloticus* is associated with this disease in Ethiopia.

Conservation status
*Potamonautes niloticus* is listed (IUCN, 2009) as least concern (LC) in view of its wide distribution, estimated stable population size and abundance (it supports small-scale local fisheries in Lake Victoria in Uganda and Kenya), and the lack of known widespread long-term threats (Cumberlidge *et al.*, 2009; Table 1).

Biogeography
Ethiopia occupies more than 1.1 million km\(^2\) of northeastern Africa and is bordered to the north by Eritrea, to the east by Djibouti and Somalia, to the west by Southern Sudan, and to the south by Kenya. Ethiopia is divided administratively into nine regions and two chartered cities (Addis Ababa and Dire Dawa). Ethiopia is an ecologically diverse country with deserts along the eastern border, tropical forests in the south, and extensive Afromontane ecosystems in the north and southwest. The landscape of Ethiopia is dominated by a raised central plateau (1,290 to 3,000 m asl) and high mountains (up to 4,500 m asl), and is divided into two highland blocks by the Great Rift Valley that runs southwest to northeast. The northern highland block of the central plateau slopes northward down to the lowlands of Southern Sudan and is drained by a number of rivers (Baro, Tekezé, Abay, Sobat, and Blue Nile) that carry the vast majority (85%) of Ethiopia's fresh water. The southern highland block of the plateau slopes south to the plains of Somalia and is drained by the Wabi Shebele, Genale, and Jubba rivers that flow through lowlands, steppes, and semi-desert. Other notable Ethiopian rivers are the Awash, which flow to the saline lacustrine district along the border with Djibouti, and the Omo River, which drains southwest into the closed basin of Lake Turkana.

Two Ethiopian species (*P. niloticus* and *P. berardi*) are common in the Nile River basin and each has a wide distribution well beyond the borders of the country. For example, *P. niloticus* inhabits the lower reaches of the Blue Nile in the Gambela Region of western Ethiopia, while *P. berardi* is found throughout the Nile basin and is widely distributed in the highland areas in the Amhara, Southern Nations, Nationalities, and Peoples, and Oromia Regions. Two of the four endemic species of Ethiopian freshwater crabs, *P. antheus* and *P. ignestii*, live in the rivers draining the highlands of western Ethiopia. *Potamonautes antheus* is found in the Oromia Region, and *P.
ignestii is found in the Amhara Region in the Lake Tana catchment area that includes the source of the Blue Nile. The other two endemic species, *P. kundudo* and *P. holthuisi*, each has a narrow distribution, the former from a cave in eastern Ethiopia, and the latter from two localities in the Omo River and its tributaries draining the southwestern Ethiopian highlands (in the Oromia and Southern Nations, Nationalities, and Peoples Regions) that flow southwest into Lake Chew Bahir (Cumberlidge and Meyer, 2010). It is likely that other species will be discovered in Ethiopia when exploration improves.

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Appendix

Key to the Ethiopian species of Potamonautes

All Ethiopian species of freshwater crabs lack a vertical groove on the ischium of the third maxilliped. And in all Ethiopian species of freshwater crabs (except for P. niloticus) the exorbital and epibranchial teeth are both either reduced to a granule or not visible at all and the anterolateral margin is either smooth or granular.

1. Anterolateral margin toothed .................................................................................................................................................... P. niloticus
2. Anterolateral margin granular or smooth ................................................................................................................................................. 3
3. Adult body size large (cw 65 mm) ............................................................................................................................................ P. antheus
4. Adult body size medium or small (cw 22-35 mm) ............................................................................................................................... 5
5. Postfrontal crest distinct, complete ............................................................................................................................................. P. ignestii
6. Postfrontal crest faint, incomplete ................................................................................................................................................................ 7
7. Anterolateral margin granular, carapace sidewall vertical suture not meeting anterolateral margin . P. kundudo
8. Anterolateral margin smooth, carapace sidewall vertical suture meeting anterolateral margin .............................................. 9
9. G1 terminal article tip upturned, adult body size medium (cw 35 mm) ............................................................ P. holthuisi
10. G1 terminal article tip straight, adult body size small (cw 24-31 mm) ................................................................. P. berardi