"A revision of the freshwater crabs of Lake Kivu, East Africa."

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The freshwater crabs of Lake Kivu (Crustacea: Decapoda: Brachyura: Potamonautidae)

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Lake Kivu is a volcanic barrier lake in the East African rift valley whose freshwater crab fauna (Potamonautidae) is largely undocumented. The present taxonomic revision revealed four species of freshwater crabs from Lake Kivu: Potamonautes idjwiensis (Chace, 1942), Potamonautes mutandensis (Chace, 1942), Potamonautes lirrangensis (Rathbun, 1904) and Potamonautes bourgaultae, sp. nov. Potamonautes idjwiensis and P. mutandensis are redescribed and distributional maps of all four species are provided. The four species are compared with each other, each species is illustrated, and a key to the species is included. The freshwater crab diversities of the African Great Lakes are also briefly compared.

Keywords: Potamoidea; Potamonautidae; Potamonautes; Lake Kivu; redescription; identification key; Rift Valley Lakes

Introduction

This study focuses on the taxonomy of the largely undescribed freshwater crab fauna of Lake Kivu (2700 km², elevation 1460 m), one of a series of lakes associated with the Albertine Rift Valley in Central Africa (Table 1). Lake Kivu lies surrounded by mountains on the floor of the Western Rift Valley, partly in the Democratic Republic of Congo and partly in Rwanda. The lake is over 89 km long, 48 km wide, and has an average depth of 240 m. The part of Lake Kivu in the Democratic Republic of Congo includes Idjwi island (the world’s 10th largest inland island) and the shoreline settlements of Bukavu, Kabare, Kalehe, Sake and Goma, whereas the shoreline settlements in Rwanda include Gisenyi, Kibuye and Cyangugu. Hydrologically, Lake Kivu is part of the Congo River basin and the lake drains south into Lake Tanganyika via the Ruzizi River. Historically, Lake Kivu was part of the Nile River basin (as the then northward-flowing Rutshuru River that drained into Lake Edward) until the river was blocked by late Pleistocene volcanism and the lake was formed, together with Lake Mutanda and a number of other small volcanic barrier lakes in southwest Uganda (Beadle 1981). The shoreline of Lake Kivu is mostly rocky with submerged rocks encrusted with calcium carbonate from the relatively high salt levels in the lake (Beadle 1981). Kivu is a deep basin lake with a narrow littoral zone (where there are abundant algae, macrophytes, invertebrates and fish) and steep sides that drop off sharply into deeper water (Beadle 1981).

Lake Kivu includes several endemic species of fish, which reflects its ecological diversity, its period of isolation, and its past and present connections with other Rift

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Valley lakes. However, in comparison with Lakes Victoria, Tanganyika and Malawi, the fish fauna of Lake Kivu is quite limited, with only about 35 species of fish, most of which are native to the lake (Coulter 1991). While the fish and zooplankton of Kivu have been relatively well studied (Beadle 1981; Dumont 1986; Snoeks et al. 1997; Kaningini et al. 2003; Isumbisho et al. 2006), little work has been done on the lake’s freshwater crabs, despite their economic, ecological and evolutionary importance (Cumberlidge et al. 2009).

The fish fauna of Lake Kivu has affinities with that of Lake Edward and the Nile River basin (reflecting its ancient connections), and with that of Lakes Victoria and Tanganyika, but the affinities of Kivu’s freshwater crab fauna have been largely undocumented because of a lack of collection efforts coupled with longstanding taxonomic uncertainties (Bott 1955). We can, however, state that *Potamonautes lirrangensis* is found in the Rift Valley lakes south to Lake Malawi, and west into the Congo basin, while *Potamonautes idjwiensis* and *Potamonautes bourgaultae* are found only in Kivu.

The number of species of *Potamonautes* MacLeay, 1838, in the lake varies according to taxonomic authority: either two species (Bott 1955) or four species (Chace 1942; present work). Here we agree with Chace (1942) that *P. lirrangensis* (Rathbun, 1904) and *P. idjwiensis* (Chace, 1942), both from Idjwi Island, are present in Lake Kivu, and we add two other species, *P. mutandensis* and *P. bourgaultae* sp. nov., previously not known to occur in the lake. We differ from Chace (1942) in that we do not recognize *Potamonautes berardi* and *Potamonautes emini* as being present in Lake Kivu. We also disagree with Bott (1955), who treated *P. idjwiensis* from Lake Kivu as a junior synonym of *Potamonautes (Rotundopotamonautes) granviki* Colosi, 1924. Later authors (Cumberlidge 1997, 1998; Ng et al. 2008; Cumberlidge et al. 2009) recognized *P. idjwiensis* as a valid species and considered *P. (G.) granviki* to be a junior synonym of *Potamonautes loveni* Colosi, 1924 (Williams 1991; Cumberlidge and Clark 2010). It is this opinion which is held here.

The third species of freshwater crab from Lake Kivu recognized here is *P. mutandensis* (Chace, 1942), which was treated by Bott (1955) as a junior synonym of the northern Tanzanian species *P. emini* (Hilgendorf, 1892) (Reed and Cumberlidge...
Before the present work \textit{P. mutandensis} was known only from Lake Mutanda, a volcanic crater lake in Kigezi Province in southern Uganda, about 140 km northeast of Lake Kivu. Here we report on a number of new records of \textit{P. mutandensis} that extend the range of this species from a narrowly distributed small lake endemic to a more widespread species with a distribution that now includes Lake Kivu in the Democratic Republic of Congo and Lakes Bunyonyi and Mutanda in Uganda. In addition, we describe here a fourth species from Lake Kivu, \textit{P. bourgaultae}, sp. nov., which is the third species from Idjwi Island.

The growing interest in the biological and other commercially exploitable resources of Lake Kivu has increased the need for a revision of its freshwater crab fauna. It is important to be able to make precise identifications of African freshwater crabs, not only because some of the larger species found in Lake Kivu (e.g. \textit{P. lirrangensis}) support small commercial fisheries, but also because crabs are preyed upon by commercially important species of fish. However, at present it is difficult for the non-specialist to distinguish between the species of \textit{Potamonautes} from Lake Kivu because the identification keys of Chace (1942) and Bott (1955) are out of date and do not include all the described species, and no modern taxonomic treatments are available. The present work therefore aims to revise the taxonomy of the freshwater crabs of Lake Kivu by focusing on important taxonomic characters such as the gonopods, mouthparts, pereiopods and sternum (Cumberlidge 1999). The present work takes into account the modernization of the discipline, updates the identification keys to species, and compares the freshwater crab fauna of Lake Kivu with those of the other African great lakes.

Specimens are deposited in the Museum of Comparative Zoology, Harvard University, Cambridge, MA, USA (MCZ), the United States National Museum, Washington, D.C., USA (USNM), Northern Michigan University, Marquette, MI, USA (NMU), and the Natural History Museum, London, UK (NHM). All measurements were made with digital callipers, and are given in millimetres. Carapace width (CW) is the distance across the carapace at the widest point; carapace length (CL) is measured along the median line, from the anterior to the posterior margin; carapace height (CH) is the maximum height of the cephalothorax from the highest point of the gastric region to the suture between thoracic sternites s2 and s3; front width (FW) is measured along the anterior frontal margin between the base of the orbits. Photographs were taken with a digital camera in combination with a Leiz MZ 95 adapter, post processing was done using ADOBE PHOTOSHOP 7.0. Abbreviations used: s, thoracic sternite; s4/s5, s5/s6, s6/s7, s7/s8, sternal sulci between respectively numbered thoracic sternites; e, thoracic episternite; s4/e4, s5/e5, s6/e6, s7/e7, episternal sulci between respective thoracic sternites and episternites; a1–a6, abdominal somites 1–6; a5/a6, suture between adjacent abdominal somites; a7, telson of abdomen; GO1, first gonopod; GO2, second gonopod; asl, above sea level. The terminology is adapted from Cumberlidge (1999).

**Taxonomy**

Family **POTAMONAUTIDAE** Bott, 1970

**Potamonautes** MacLeay, 1838

**Potamonautes idjwiensis** (Chace, 1942)

(Figures 1, 2, Table 2)
Potamon idjwiensis Chace 1942, p. 197–200, figs. 6,7.


Material examined


Diagnosis

Carapace highly arched (CH/FW 1.42), surface smooth; postfrontal crest faint, almost absent; third maxilliped with faint vertical groove (Figure 1A,B); ventral margins of merus of pereiopod 1 weakly granulated; distal meral tooth low, blunt; first carpal tooth low, blunt, followed by small granules (Figure 1A,C); sternal sulcus s2/s3 deep, completely crossing sternum; s3/s4 deep, meeting top of sternoabdominal cavity; telson of male abdomen with concave sides (Figure 1C); subterminal article of GO1 with strongly setose margins; distal margin of subterminal segment highest on medial side, forming pronounced shoulder, lowest on lateral side; terminal article of GO1 straight, slimmer than subterminal article, curving only slightly outward; GO2 terminal article straight, flagellum-like (Figure 2A–C).

Distribution

Bukavu and Idjwi Island, Lake Kivu, Democratic Republic of Congo.

Conservation status

Potamonautes idjwiensis was assessed as Endangered (EN) using the IUCN Red List criteria (IUCN 2003; Cumberlidge et al. 2009, Appendix 1) (where it is incorrectly spelled as P. idjiwiensis) because it is restricted to two localities from Lake Kivu and therefore has a restricted area of occupancy. No new specimens have been collected since 1942, suggesting that the population may be in decline (Cumberlidge 2008a).

Remarks

This revised diagnosis is intended to update the original description of this species by Chace (1942). Bott (1955) considered P. idjwiensis to be a junior synonym of P. (G.) granviki (Colosi 1924) but that opinion was not accepted by later authors
Table 2. Comparison of morphological characters of the freshwater crabs of Lake Kivu.

<table>
<thead>
<tr>
<th>Character</th>
<th><strong>Potamonautes idjwiensis</strong></th>
<th><strong>Potamonautes mutandensis</strong></th>
<th><strong>Potamonautes lirrangensis</strong></th>
<th><strong>Potamonautes bourgaultae</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Adult size range (CW, mm):</td>
<td>30.8 – 38.5</td>
<td>21 – 25</td>
<td>45 – 65</td>
<td>18 – 20</td>
</tr>
<tr>
<td>Carapace height (CH/FW):</td>
<td>high (1.42)</td>
<td>medium (1.22)</td>
<td>medium (1.25)</td>
<td>high (1.40)</td>
</tr>
<tr>
<td>Postfrontal crest:</td>
<td>incomplete</td>
<td>incomplete</td>
<td>complete, distinct</td>
<td>distinct only at edges</td>
</tr>
<tr>
<td>Cervical grooves:</td>
<td>short</td>
<td>long, faint</td>
<td>long, faint</td>
<td>short</td>
</tr>
<tr>
<td>Carapace post. grooves</td>
<td>present</td>
<td>deep</td>
<td>deep</td>
<td>absent</td>
</tr>
<tr>
<td>Carapace AL margin:</td>
<td>smooth</td>
<td>smooth</td>
<td>toothed</td>
<td>smooth</td>
</tr>
<tr>
<td>Carapace sidewalls:</td>
<td>smooth</td>
<td>smooth</td>
<td>granulated</td>
<td>carinae, granules</td>
</tr>
<tr>
<td>Exorbital tooth:</td>
<td>small, low</td>
<td>small, low</td>
<td>large, pointed</td>
<td>small, low</td>
</tr>
<tr>
<td>Epibranial tooth:</td>
<td>lacking</td>
<td>lacking</td>
<td>small spine</td>
<td>lacking</td>
</tr>
<tr>
<td>Sternal sulcus s3/s4:</td>
<td>complete</td>
<td>incomplete</td>
<td>incomplete</td>
<td>incomplete</td>
</tr>
<tr>
<td>Episternal sulci (s4/e4–s7/e7):</td>
<td>faint</td>
<td>faint</td>
<td>deep</td>
<td>faint</td>
</tr>
<tr>
<td>Distal meral tooth P1:</td>
<td>low, blunt</td>
<td>spine</td>
<td>spine</td>
<td>granule</td>
</tr>
<tr>
<td>First carpal tooth:</td>
<td>low, blunt</td>
<td>low, blunt</td>
<td>large spine</td>
<td>small, pointed</td>
</tr>
<tr>
<td>Second carpal tooth:</td>
<td>granule</td>
<td>granule</td>
<td>small spine</td>
<td>granule</td>
</tr>
<tr>
<td>Terminal article GO1:</td>
<td>straight</td>
<td>curved</td>
<td>curved</td>
<td>straight</td>
</tr>
<tr>
<td>GO1 STS margins:</td>
<td>setose</td>
<td>setose</td>
<td>setose</td>
<td>not setose</td>
</tr>
<tr>
<td>TA/STS GO1 shoulder:</td>
<td>prominent</td>
<td>lacking</td>
<td>lacking</td>
<td>prominent</td>
</tr>
<tr>
<td>GO1 dors. memb. margin:</td>
<td>diagonal</td>
<td>diagonal</td>
<td>diagonal</td>
<td>U-shaped</td>
</tr>
</tbody>
</table>

Notes: AL, anterolateral margin of carapace; TA, terminal article of GO1; STS, subterminal segment of GO1; P1, cheliped; dors. memb., dorsal membrane of GO1 in dorsal view.
See text for other abbreviations.
Figure 1. *Potamonautes idjwiensis* (Chace, 1942). (A) Dorsal view; (B) frontal view; (C) sternal view; (D) right cheliped, frontal view. Adult male (USNM 98923), CW 36.2.
Figure 2. *Potamonautes idjwiensis* (Chace, 1942). (A) GO1, ventral view; (B) GO1, dorsal view; (C) GO2, ventral view. Adult male (USNM 98923), length of the terminal article measured along the mid-line of the dorsal face from tip to dorsal membrane 2.5 mm.

(Ng et al. 2008; Cumberlidge and Clark 2010) who considered *P. idjwiensis* to be a valid species. *Potamonautes idjwiensis* can be distinguished from *P. loveni* as follows. The postfrontal crest is absent in *P. idjwiensis* but faint and incomplete in *P. loveni*; sternal sulcus s3/s4 is deep and complete and meets the top of the sternoabdominal cavity in *P. idjwiensis*, but is deep at the sides and missing in the middle in *P. loveni*; the dactylus of the major cheliped in *P. idjwiensis* is only slightly arched and bears several small teeth, whereas in *P. loveni* the dactylus is highly arched and lacks dentition; finally, the terminal article of GO1 curves slightly upward in *P. idjwiensis* but is straight-sided and tapers evenly to a tip in *P. loveni*.

*Potamonautes mutandensis* (Chace, 1942)
(Figures 3–5, Table 2)

*Potamon mutandensis* Chace 1942: 194–197, fig. 4, 5a–g.


**Material examined**


**Other material.** Democratic Republic of Congo. Adult male (CW 21.6, CL 15.0, CH 7.4, FW 5.7) plus a number of incomplete specimens with detached legs, Lake Kivu, 12 December 1917, coll. Robin Kemp (NHM 1917.12.12 6–25).

**Diagnosis**

Carapace narrow (CW/CL 1.3), medium height (CH/FW 1.22); surface smooth; post-frontal crest faint to absent; epibranchial tooth absent; exorbital tooth low; cervical grooves faint, very long; third maxilliped with faint vertical groove (Figure 3A,B); first carpal tooth low, blunt, followed by two or three granules; distal meral tooth distinct, pointed (Figure 3A,C); sternal sulcus s2/s3 deep, running horizontally across sternum; sulcus s3/s4 incomplete, deep on sides but missing in middle (Figure 3C); terminal article of GO1 turned strongly outward; distal margin of subterminal segment highest on medial side, forming pronounced shoulder, lowest on lateral side; margins of subterminal segment of GO1 with long setae (Figure 4A–C).

**Distribution**

Lake Mutanda and Lake Bunyonyi in Uganda, and Lake Kivu in the Democratic Republic of Congo. The type locality label reads Mushongero (1°10′43″ S, 29°40′58″ E, 1888 m asl), which is on the road close to the northeast shoreline of Lake Mutanda (Figure 5).

**Conservation status**

*Potamonautes mutandensis* was assessed as Endangered (EN) using the IUCN Red List criteria (IUCN 2003; Cumberlidge et al. 2009, appendix) because of its limited range and vulnerability to invasive crayfish. However, the present study shows that this species is more widespread than previously thought, and that this species occurs over a wide range (Figure 5). The conservation status of *P. mutandensis* (Cumberlidge 2008b) therefore needs to be reassessed in the light of the new records presented here.

**Remarks**

This revised diagnosis is intended to update the original description of this species by Chace (1942). Bott (1955) considered *P. mutandensis* to be a junior synonym of *P. emini* (Hilgendorf, 1892) from Tanzania. Reed and Cumberlidge (2006) provided a redescriptions of *P. emini*, plus photographs, illustrations and a distribution map of the species. *Potamonautes mutandensis* can be distinguished from *P. emini* by the following characters: the dactylus of the major cheliped of *P. mutandensis* is highly arched, whereas that of *P. emini* is only slightly arched; the superior margin of the carpus of the cheliped of *P. mutandensis* has only faint carinae, whereas these carinae are strong in *P. emini*; episternal sulci s4/e4, s5/e5, s6/e6, s7/e7 are incomplete but still visible in
Figure 3. *Potamonastes mutandensis* (Chace, 1942). (A) Dorsal view; (B) frontal view; (C) sternal view. Adult male (NHM 1917.12.12 6–25), CW 21.6.
Figure 4. *Potamonautes mutandensis* (Chace, 1942). (A) GO1, ventral view; (B) GO1, dorsal view; (C) GO2, ventral view. Adult male (NHM 1917.12.12 6–25), length of the terminal article measured along the mid-line of the dorsal face from tip to dorsal membrane 1.7 mm.

Figure 5. Distribution of *Potamonautes mutandensis*. Star, type locality; black circles, other localities. Scale bar 70 km.
Potamon (Potamonautes) lirrangensis (Rathbun, 1904)  
(Figures 6–8, Table 2)

Material examined

Type locality
Lirranga, at the junction of the Congo and Ubangi Rivers, Democratic Republic of Congo.

Diagnosis
Carapace medium height (CH/FW 1.25); postfrontal crest distinct, complete; grooves on posterior part of carapace deep; exorbital tooth large, forward pointing spine; epibranchial tooth small spine; anterolateral margin behind epibranchial tooth curving strongly outward, then curving inward over posterolateral margin, lined by either granules or small teeth (Figure 6A); vertical sulcus on ischium of third maxilliped faint to absent; suborbital, subhepatic regions of carapace sidewall with granules; suborbital margin and horizontal sulcus of carapace sidewall both granulated (Figure 6B); first carpal tooth on carpus of cheliped large, sharp spine; second carpal tooth small...
Figure 6. *Potamonautes lirrangensis* (Rathbun, 1904). (A) Dorsal view; (B) frontal view; (C) sternal view. Adult male (NMU TRW 1972.05), CW 46.5 mm.
spine, smaller than first tooth; ventral margins of merus of pereiopod 1 both heavily granulated; distal meral tooth sharp spine (Figure 6A,C).

Distribution
Lake Kivu, Democratic Republic of Congo and Rwanda, Lake Tanganyika in Tanzania, and Lake Malawi in Malawi (Figure 8).

Conservation status
_Potamonates lirrangensis_ was assessed as Least Concern (LC) using the IUCN Red List criteria (IUCN 2003; Cumberledge et al. 2009, appendix) because it has a wide distribution, has been caught recently from a number of different localities, is well represented in museum collections, and has no known threats (Cumberledge 2008c).

Remarks
A number of previous authors (Cunnington 1907; Balss 1929, 1936) have reported on the presence of _P. lirrangensis_ in Lake Kivu (as _Potamon orbitospinus_), and Chace (1942) illustrated the carapace and GO1 of the specimen of _P. lirrangensis_ from the lake (MCZ 11224). However, Bott (1955) was the first to consider _Potamonastes lirrangensis_ to be the valid name for the species also described as _Potamon orbitospinus_ Cunnington, 1907, with _P. lirrangensis_ being the senior synonym. Reed and
Cumberlidge (2006) upheld this opinion and provided a redescription, photographs and illustrations of taxonomically important characters for *P. lirrangensis*, as well as a detailed distribution map for the species, but they did not include any localities from Lake Kivu. Another taxon, *Potamonautes (Lirrangopotamonautes) lirrangensis adeleae* Bott, 1968, from the Democratic Republic of Congo near the Angolan border, was originally described as a subspecies of *Potamonautes (Lirrangopotamonautes) lirrangensis*, but was later recognized as the separate species *P. adeleae* Bott, 1968, by Cumberlidge and Tavares (2006) and Ng et al. (2008). The type locality of *P. lirrangensis* is Lirranga on the Congo River in the Democratic Republic of Congo, and its range includes the Upper Congo River in Central Africa and a number of localities along the Rift Valley in Lakes Kivu, Tanganyika and Malawi (Reed and Cumberlidge 2006).

*Potamonautes bourgaultae*, sp. nov.
(Figures 9–12, Table 2)

*Potamon emini*: Chace 1942: 197, fig. 7 (not *Telphusa emini* Hilgendorf, 1892)
*Potamon berardi*: Chace 1942: 207 (not *Telphusa berardi* Audouin, 1825)

*Type locality*
Idjwi Island, Lake Kivu, Democratic Republic of Congo.
Type material

Diagnosis
Carapace surface smooth; highly arched (CH/FW 1.4); postfrontal crest incomplete, strongest at lateral edges (Figure 9A,B, 11A,B); ischium of third maxilliped with faint vertical groove (Figures 9B, 11I); sternal sulcus s3/s4 incomplete, deep at sides but missing in middle (Figure 11E); distal meral tooth reduced to large granule; first carpal tooth small, pointed; second carpal tooth reduced to granule, followed by several other granules (Figures 9A,C; 11C,D); dactylus of major cheliped lined by alternating large and small teeth; fixed finger of propodus of major cheliped lined by low, rounded teeth, first of two large teeth in line with large tooth on dactylus (Figures 9B, 11G,H); distal margin of GO1 subterminal segment highest on medial side, forming pronounced shoulder; terminal article of GO1 slim, straight, tapering evenly to tip, curving slightly outward (Figures 10A,D, 12A,D); lateral, medial folds of GO1 terminal article low, even; dorsal membrane broad, widest at lateral edge, narrowest at medial edge, proximal margin U-shaped (Figures 10B,D, 12B,E).

Description
Based on holotype, subadult male (CW 17.3). Carapace moderately wide (CW/FW 3.6), high (CH/FW 1.4); surface texture completely smooth; front strongly deflexed, relatively narrow (FW/CW 0.28); postfrontal crest incomplete, strongest at lateral edges, gap between postorbital crests and epigastric crests; mid-groove between epigastric crests faint (Figures 9A, 11A); epibranchial, exorbital teeth low/absent; suborbital margin smooth; anterolateral margin completely smooth, continuous with smooth posterolateral margin; cardiac groove faint to absent, semicircular, urogastric grooves faint, transverse branchial, cervical grooves absent (Figures 9A,B, 11A,B); sidewalls completely smooth with distinct longitudinal suture; vertical suture on carapace sidewall faint, not meeting anterolateral margin (Figures 9B, 11B). Mandibular palp with simple setose terminal segment; epistomial tooth triangular, margins granulated; third maxilliped exopod with long flagellum; third maxilliped ischium with faint vertical groove (Figures 9B, 11I).

Sternal sulcus s1/s2 short, very faint; s2/s3 faint, complete; s3/s4 incomplete, deep at sides but missing in middle; episternal sulci faint (Figures 9C, 11E); abdomen slim, triangular, tapered, widest at base; telson outline triangular with rounded apex and slightly concave sides (Figure 9C, 11F); s6/s7 meeting abdomen at a5/a6.

Distal margin of GO1 subterminal article lowest on lateral side, highest on medial side, forming pronounced shoulder; GO1 terminal article slim, directed straight upward, tapering evenly to tip (Figures 10A,C, 12A,D); lateral and medial folds of
Figure 9. *Potamonautes bourgaultae*, sp. nov. (A) Dorsal view; (B) frontal view; (C) sternal view. Holotype subadult male (MCZ 11231), CW 17.3 mm.
GO1 terminal article low, even; groove on terminal article not visible on dorsal face; dorsal membrane broad, widest at lateral edge, narrowest at medial edge, proximal margin U-shaped; junction between terminal and subterminal segments of GO1 visible on ventral side (Figures 10A,C, 12A,D); GO2 terminal article long, straight, flagellum-like, about as long as subterminal segment (Figures 10E, 12C). Dactylus of major cheliped slightly arched, upper margin smooth, closed fingers enclosing long narrow interspace, lined by alternating large, small teeth; fixed finger of propodus of major cheliped with series of low, rounded teeth, plus two large teeth, first large tooth in line with large tooth on dactylus; lower margin of propodus slightly indented (Figures 9B, 11G,H); first carpal tooth small, pointed; second carpal tooth reduced to small granule, followed by other granules; distal meral tooth reduced to large granule; outer face of merus smooth, superior margin with faint carinae; ventral margins of merus of cheliped with small granules (Figure 11C,D); ischium of cheliped smooth; walking legs p2–p5 slender, length normal, neither elongated or shortened; dactyli of p2–p5 tapering to point, each bearing four rows of downward-pointing short, sharp spines. Small species; holotype male (CW 17.8) almost adult (subadult); pubertal moult estimated to be between CW 18 and 20 mm.

**Distribution**

This species is endemic to Idjwi Island (40 × 12 km, 275 km²), Lake Kivu, Democratic Republic of Congo.

**Etymology**

This species is named in honour of the late Dr Louise M. Bourgault of Northern Michigan University, Marquette, MI, USA, in recognition of her outstanding contributions to the study of HIV-AIDS in Africa.
Figure 11. *Potamonautes bourgaultae*, sp. nov. (A) Carapace, dorsal view; (B) carapace, frontal view; (C) carpus and merus of right pereiopod 1 (major cheliped), dorsal view; (D) carpus and merus of right pereiopod 1 (major cheliped), ventral view; (E) male sternum; (F) male abdomen; (G) major (right) cheliped; (H) minor (left) cheliped; (I) left third maxilliped. Scale bars 10 mm, A–H: 5 mm, I.
**Remarks**

*Potamonautes bourgaultae* is similar to *P. idjwiensis* and *P. mutandensis*, which are also found in Lake Kivu. All of these are small or medium-sized crabs with a smooth untoothed carapace with a faint or absent postfrontal crest. However, *P. bourgaultae* can be easily distinguished from *P. idjwiensis* as follows. *Potamonautes idjwiensis* has a deep complete, sternal sulcus s3/s4, which meets the top of the sternoabdominal cavity, but s3/s4 is deep at the sides but missing in the middle in *P. bourgaultae*; and the dorsal membrane of GO1 of *P. idjwiensis* has equal lateral and medial margins with a diagonal proximal margin, whereas the medial margin is narrower, and the proximal margin is U-shaped in *P. bourgaultae*. *Potamonautes bourgaultae* can be easily distinguished from *P. mutandensis* as follows. The distal meral tooth is distinct and pointed in *P. mutandensis* but reduced to a large granule in *P. bourgaultae*; the grooves on the posterior carapace are deep in *P. mutandensis* but absent in *P. bourgaultae*; the junction between the subterminal and terminal segments of GO1 lacks a shoulder in *P. mutandensis* but has a pronounced medial shoulder in *P. bourgaultae*; and the terminal article of GO1 curves strongly outward in *P. mutandensis* but is straight in *P. bourgaultae*.

Chace (1942) assigned two specimens of *P. bourgaultae* to *P. berardi* and another specimen to *P. emini*, and indeed, *P. bourgaultae* is similar to these species in that all three have a smooth untoothed carapace. However, *P. bourgaultae* can be easily distinguished from *P. berardi* as follows. The ischium of the third maxilliped completely lacks a groove in *P. berardi* but has a faint but distinct groove in *P. bourgaultae*; the ventral margins of the merus of the cheliped of *P. berardi* are lined with small, pointed teeth whereas these margins are lined by small granules in *P. bourgaultae*; the distal meral tooth is large and pointed in *P. berardi* but reduced to a large granule in *P. bourgaultae*; and the first carpal tooth is small and pointed in *P. berardi* but small and rounded in *P. bourgaultae*. *Potamonautes bourgaultae* can be distinguished from *P. emini* by the postfrontal crest, which is distinct and complete in *P. emini* but...
faint and incomplete in *P. bourgaultae*; by the distal meral tooth, which is large and surrounded by granules in *P. emini* but is isolated as a single granule in *P. bourgaultae*; by the junction between the subterminal and terminal segments of GO1, which lacks a shoulder in *P. emini* but has a pronounced medial shoulder in *P. bourgaultae*; and by the terminal article of GO1, which curves strongly outward in *P. emini* but is straight in *P. bourgaultae*.

**Comparisons**

Of the four species of freshwater crabs found in Lake Kivu *P. idjwiensis* and *P. mutandensis* are the most similar. Both species have a medium body size, a smooth untoothed carapace, and a faint to absent postfrontal crest; both lack an epibranchial tooth; both have a faint groove on the ischium of the third maxilliped; both have a low and blunt first carpal tooth followed by granules; both have a complete sternal sulcus s2/s3, and both have faint episternal sulci. However, the two species can be easily distinguished by the following characters: the cervical groove is short in *P. idjwiensis* but long and faint in *P. mutandensis*; the distal meral tooth is low and blunt in *P. idjwiensis* but distinct and pointed in *P. mutandensis*; sternal sulcus s3/s4 is deep in *P. idjwiensis*, meeting the top of the sternoabdominal cavity, but incomplete, deep at the sides, and missing in the middle in *P. mutandensis*. The terminal article of gonopod 1 is straight with an upturned tip in *P. idjwiensis*, but curved strongly outward in *P. mutandensis*; the junction between the terminal article and the subterminal article of gonopod 1 is visible on the ventral face in *P. mutandensis* but not in *P. idjwiensis*.

Both *P. idjwiensis* and *P. mutandensis* are easily distinguished from *P. lirrangensis*, which is a large species with a large pointed exorbital tooth. The postfrontal crest is absent in both of the former species but distinct, complete and lined with small granules in *P. lirrangensis*; the exorbital and epibranchial teeth are both absent in *P. idjwiensis* and *P. mutandensis*, whereas the exorbital tooth is a large, forward pointing spine and the epibranchial tooth is a small spine in *P. lirrangensis*. The anterolateral margin, which is smooth in *P. idjwiensis* and *P. mutandensis*, is lined by either large granules or small teeth in *P. lirrangensis*; the carapace sidewalls are smooth in *P. idjwiensis* and *P. mutandensis* but are roughened by carinae and granules in *P. lirrangensis*. The first carpal tooth in both *P. idjwiensis* and *P. mutandensis* is low and blunt, but a large pointed spine in *P. lirrangensis*. Finally, both *P. idjwiensis* and *P. mutandensis* are medium-sized species with an adult size range between CW 21–25 and CW 31–39 respectively, whereas *P. lirrangensis* is a large species with an adult size range between CW 45 and 65 (Table 2).

A few characters are unique in each of these three species. For example, the distal meral tooth is low and blunt in *P. idjwiensis*, distinct and pointed in *P. mutandensis* and a sharp spine in *P. lirrangensis*. The terminal article of gonopod 1 is straight with an upturned tip in *P. idjwiensis* and curved strongly outward in *P. mutandensis*; in *P. lirrangensis* the first half is straight, the second half is bent strongly outward, tapering to a broad, upcurved tip. Sternal sulcus s3/s4 is complete and deep, reaching the top of the sternoabdominal cavity in *P. idjwiensis*, but incomplete in both *P. mutandensis* and *P. lirrangensis*. Two characters are shared by all three species: a complete s2/s3 and a faint groove on the ischium of the third maxilliped.
Biogeography

Two genera of freshwater crabs (Potamonautes and Platythelphusa) are found in the African Great Lakes and both belong to the Potamonautidae, a family that is found throughout the African continent and which is endemic to the Afrotropical region (Daniels et al. 2006; Cumberlidge et al. 2008; Yeo et al. 2008; Cumberlidge 2009). Of these genera, Potamonautes is widespread and is found throughout sub-Saharan Africa and the Nile River basin, while Platythelphusa is endemic to Lake Tanganyika (Cumberlidge et al. 1999; Marijnissen et al. 2004). Lakes Kivu (with two endemic species of Potamonautes) and Tanganyika (with nine endemic species of Platythelphusa and one endemic species of Potamonautes) are the only two African lakes that have endemic species of freshwater crabs (Table 1). Lake Kivu has one species (P. mutandensis) that also occurs in the Nile catchment, one species (P. lirrangensis) that occurs in the Congo basin (Rwanda and Democratic Republic of Congo), and two species (P. idjwiensis and P. bourgaultae) that are endemic to the lake (Table 2). Lake Kivu shares no species with Lakes Edward and Albert, and one (P. lirrangensis) with Lake Tanganyika’s tributaries. While freshwater crabs are represented in the other African lakes, species richness overall is low and none are lake endemics. For example, even the two largest lakes – Lake Victoria (two species of Potamonautes) and Lake Malawi (one species of Potamonautes) – lack endemic crabs and are species poor (Table 1). The generally low faunal richness and endemism rates of freshwater crabs in the African lakes contrast sharply with the impressive species richness and endemism seen in the cichlid fish in these lakes (Beadle 1981).

Key to the species of Potamonautes from Lake Kivu

1. Postfrontal crest distinct, complete; anterolateral margin with either small teeth or large granules; exorbital tooth large, forward pointing spine; epibranchial tooth small spine; first carpal tooth large, sharp spine ............

   Postfrontal crest faint to absent, incomplete; anterolateral margin smooth; exorbital, epibranchial teeth low or absent; first carpal tooth low ............ 2

2. Sternal sulcus s3/s4 complete, meeting top of sternoabdominal cavity; telson sides strongly concave ......................... P. idjwiensis

   Sternal sulcus s3/s4 missing in middle, not meeting top of sternoabdominal cavity; telson sides slightly concave or straight .................... 3

3. Distal meral tooth distinct, pointed; distal margin of GO1 low, lacking shoulder; dorsal membrane of GO1 broad, lateral and medial margins equal, proximal margin straight; GO1 terminal article evenly curved strongly outward .................. P. mutandensis

   Distal meral tooth granular; distal margin of GO1 highest medially, forming pronounced shoulder; medial margin of dorsal membrane of GO1 narrower than lateral margin, proximal margin U-shaped; GO1 terminal article straight, tapering evenly to tip .................. P. bourgaultae
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References


