



Potamonautes gorongosa, a new species of potamonautid freshwater crab (Decapoda, Brachyura) from Mozambique, southeastern Africa

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ZOOBANK <http://zoobank.org/urn:lsid:zoobank.org:pub:42D60E42-EC4F-412B-A305-BA647217D056>

ABSTRACT

A new species of the freshwater crab genus *Potamonautes* MacLeay, 1838, is described from Gorongosa National Park in Sofala Province, Mozambique, southern Africa. *Potamonautes gorongosa*, new species, is morphologically and phylogenetically distinct from the other species of *Potamonautes* found in Mozambique and nearby countries, and is most closely related to *Potamonautes mutareensis* Phiri and Daniels, 2013, from eastern Zimbabwe. The new species differs from this species and its other congeners by a unique combination of morphological characters of the first gonopod, the anterior sternum, third maxilliped, and the major cheliped. Illustrations of *P. gorongosa* new species are provided, and differences with other species found in Mozambique and southeastern Africa are discussed.

KEY WORDS

Afrotropical region, Gorongosa National Park, Potamonautidae, taxonomy.

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SUBMITTED 25 August 2016
ACCEPTED 16 November 2016
PUBLISHED 12 December 2016

Guest Editor
Célio Magalhães

DOI 10.1590/2358-2936e2016029

INTRODUCTION

The freshwater crab fauna of several countries in southern Africa is poorly known despite a number of recent contributions (Reed and Cumberlidge, 2004; Cumberlidge and Tavares, 2006; Cumberlidge and Daniels, 2007; 2009; Daniels and Bayliss, 2012; Phiri and Daniels, 2013; Daniels *et al.*, 2014; 2015) and some countries, such as Mozambique, have been overlooked until recently when it comes to biological inventories. It is therefore likely that there are still a number of species of freshwater crabs in Mozambique yet to be discovered, given its mountainous terrain and the lack of systematic survey work over the years (Cumberlidge, 1999; Cumberlidge and Daniels, 2009). The specimens reported on here from the Gorongosa National Park have a number of important characters that do not conform to the descriptions of any known African species (Chace, 1953; Bott, 1955; Cumberlidge, 1999; Reed and Cumberlidge 2004, 2006), and proved to belong to a new species of *Potamonautes* MacLeay, 1838 (here named *P. gorongosa* new species) in the exclusively African freshwater crab family Potamonautidae Bott, 1970. The new species is described from a well-developed but still subadult male, and the taxonomically important characters of the gonopods, abdomen, mouthparts, carapace, sternum, and chelipeds are illustrated. *Potamonautes gorongosa*, new species, is compared with the eight other species of freshwater crabs that have been previously reported from Mozambique: *Potamonautes bayonianus* (Brito-Capello, 1873), *Potamonautes bellarussus* Daniels, Phiri and

Bayliss, 2014, *Potamonautes calcaratus* (Gordon, 1929), *Potamonautes choloensis* (Chace, 1953), *Potamonautes namuliensis* Daniels and Bayliss, 2012, *Potamonautes montivagus* (Chace, 1953), *Potamonautes obesus* (A. Milne-Edwards, 1868), and *Potamonautes sidneyi* (Rathbun, 1904). *Potamonautes gorongosa* new species, is referred to as “*Potamonautes* sp. 2” in Daniels *et al.* (2015, table 1, fig. 2). The new species is also compared with superficially similar species found in neighboring countries that belong to the same phylogenetic lineage (such as *Potamonautes mulanjeensis* Daniels and Bayliss, 2012, from Zimbabwe, *Potamonautes mutareensis* Phiri and Daniels, 2013, from Malawi, and *Potamonautes flavusjo* Daniels, Phiri and Bayliss, 2014, from South Africa). The molecular phylogenetic study of Daniels *et al.* (2015, table 1, fig. 2) found that the nine species of freshwater crabs reported from Mozambique (Tab. 1) belong to three separate clades (lineages) within the genus *Potamonautes* that diverged at different times in the past, and these relationships are also discussed here.

MATERIAL AND METHODS

The following abbreviations are used: a, abdominal segment; a5/a6, sulci between adjacent abdominal segments; asl, above sea level, CW, carapace width, the distance across the carapace at the widest point; CL, carapace length measured along the median line, from the anterior to the posterior margin; CH, carapace height, the maximum height of the cephalothorax; e, thoracic episternite; FW, front width measured along the anterior frontal margin between the orbits; G1,

Table 1. Updated list of the nine species of freshwater crabs from Mozambique and the phylogenetic lineage to which they belong. *Potamonautes gorongosa* new species, is referred to as “*Potamonautes* sp. 2” in Daniels *et al.* (2015). Also included are the sister species of *P. gorongosa* new species, from elsewhere in southern Africa. The clade column refers to clade number recovered by Daniels *et al.* (2015).

	Species	Taxonomic authority	Distribution	Clade
1	<i>P. bayonianus</i>	(Brito-Capello, 1873)	Mozambique, Zimbabwe	Clade 3
2	<i>P. bellarussus</i>	Daniels, Phiri and Bayliss, 2014	Mozambique	Clade 4
3	<i>P. calcaratus</i>	(Gordon, 1929)	Mozambique	Clade 1
4	<i>P. choloensis</i>	(Chace, 1953)	Mozambique, Malawi	Clade 1
5	<i>P. flavusjo</i>	Daniels, Phiri and Bayliss, 2014	South Africa	Clade 3
6	<i>P. gorongosa</i>	new species	Mozambique	Clade 3
7	<i>P. montivagus</i>	(Chace, 1953)	Mozambique, Malawi	Clade 4
8	<i>P. mulanjeensis</i>	Daniels and Bayliss, 2012	Malawi	Clade 3
9	<i>P. mutareensis</i>	Phiri and Daniels, 2013	Zimbabwe	Clade 3
10	<i>P. namuliensis</i>	Daniels and Phiri, 2012	Mozambique	Clade 1
11	<i>P. obesus</i>	A. Milne-Edwards, 1868	Mozambique, Malawi	Clade 1
12	<i>P. sidneyi</i>	(Rathbun, 1904)	Mozambique	Clade 3

first gonopod; G2, second gonopod; s4/e4, s5/e5, s6/e6, s7/e7, episternal sulci between adjacent thoracic sternites and episternites; p1–p5, pereopods 1–5; s, thoracic sternite; and s1/s2, s2/s3, s4/s5, s5/s6, s6/s7, s7/s8, sternal sulci between adjacent thoracic sternites. All measurements were made with digital calipers and are given in millimeters (mm). The terminology is adapted from Cumberlidge (1999). The photographs were taken with a digital camera in combination with a Leitz MZ 95 adapter. Post processing was done using Adobe Photoshop 7.0.

TAXONOMY

Family Potamonautidae Bott, 1970

Genus *Potamonautes* MacLeay, 1838

Potamonautes gorongosa new species

(Figs. 1–2)

Potamonautes sp. 2 – Daniels *et al.*, 2015: Pg. 553, Table 1; Pg. 558, Fig. 2.

Material examined. Gorongosa National Park, Sofala Province, 18.47227°S 34.21411°E, 320 m asl. Holotype: male subadult (CW 25.4, CL 18.8, CH 9.0, FW 8.3), coll. P. Naskreski, 2012, Northern Michigan University museum collection (NMU PN3 2012A).

Diagnosis. Vertical sulcus on ischium of third maxilliped absent (Fig. 1B). Fixed finger of propodus of major cheliped slender with 7 distinct molars along its length (Fig. 2A, B); moveable finger of propodus of major cheliped with two large raised teeth in proximal region; first (distal) carpal tooth long, slender, pointed; second (proximal) carpal tooth less than half size of first carpal tooth, pointed, followed by several small granules; distal lower mesial margin of merus with large pointed tooth (Fig. 1A). S3/s4 deep at edges, faint in middle, not meeting tip of sternoabdominal cavity; s4/e4, s5/e5, s6/e6, s7/e7, faint, incomplete (Fig. 1C). G1 terminal article straight basally, curving outward at 60° angle to longitudinal axis of gonopod medially, tip pointed, distinctly upturned (Figs. 2C–E). G2 terminal article flagellum-like, almost as long as subterminal segment (Fig. 2F).

Description of male holotype. Carapace transversely oval, very wide (CW/FW 3.1), medium height (CH/FW 1.1), surface texture smooth; cardiac, urogastric grooves deep, cervical grooves short, faint, transverse branchial grooves absent (Fig. 1A). Front narrow (FW/CW 0.32), deflexed (Fig. 1B). Postfrontal crest faint, complete, strongest at anterolateral margins where it meets epibranchial tooth; postorbital, epigastric crests faint (Fig. 1A). Anterolateral margin finely granulated, continuous with posterolateral margin; epibranchial tooth very small but distinct; exorbital tooth low, blunt; vertical sulcus on carapace sidewall granulated, meeting anterolateral margin at epibranchial tooth; suborbital, pterygostomial region of carapace sidewalls completely smooth; subhepatic region of sidewall with fine granules (Fig. 1B). Mandibular palp two-segmented, terminal article simple, setose; epistomial tooth triangular, deflexed, edges granulated. Third maxillipeds filling entire oral field, except for transversely oval respiratory openings at superior lateral corners; vertical sulcus of ischium of third maxilliped absent; exopod of third maxilliped reaching to lower half of merus, with long flagellum (Fig. 1B).

S1/s2 faint; s2/s3 deep, running horizontally across sternum; s3/s4 deep at edges, faint in middle, almost meeting sternoabdominal cavity; anterior margin of sternoabdominal cavity thin, low; s4/e4, s5/e5, s6/e6, s7/e7, faint, incomplete (Fig. 1C). Abdomen (pleon) slim, outline triangular, tapered, widest at a3, 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. 1C). G1 terminal article straight basally, curving outward at 60° angle to longitudinal axis of gonopod medially, tip pointed, distinctly upturned (Fig. 2C–E). G2 terminal article flagellum-like, almost as long as subterminal segment (Fig. 2F).

Dactylus of major cheliped slender, arched, closed fingers enclosing wide oval interspace; upper margin of dactylus of cheliped smooth; fixed finger of propodus of major cheliped with 5 distinct, large teeth interspersed by smaller teeth; lower margin of propodus slightly indented (Fig. 2A, B); first carpal tooth large, pointed; second carpal tooth less than half size of first carpal tooth, pointed, followed by several small granules; distal meral tooth small, pointed; superior margins of merus of cheliped lined by series of small, pointed

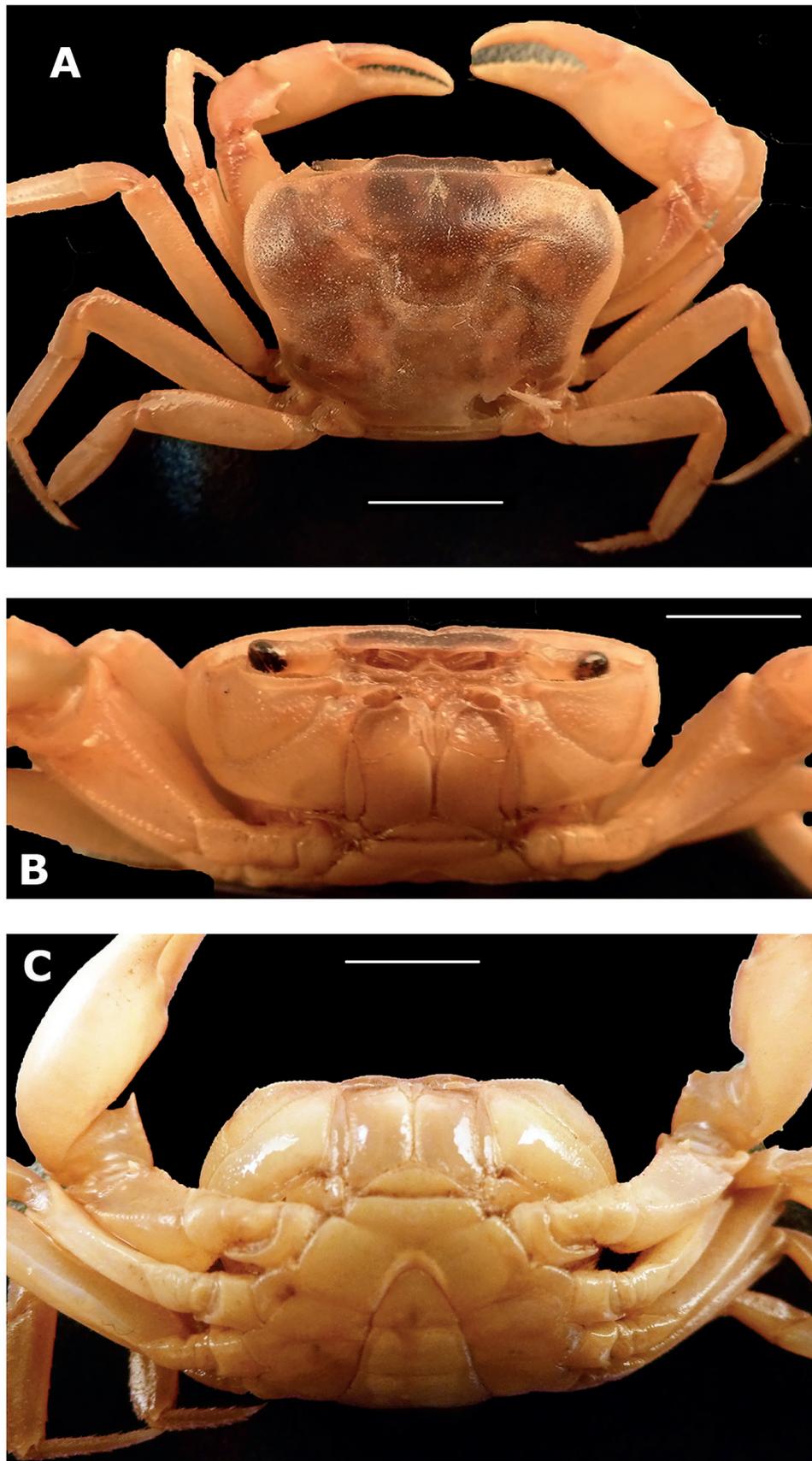


Figure 1. *Potamonautes gorongosa*, new species, male holotype (CW 25.4 mm) from Gorongosa National Park, Sofala Province, Mozambique (NMU PN 2014). A, carapace, dorsal view; B, carapace, frontal view; C, carpus and merus of right pereiopod 1 (cheliped), dorsal view. Scale bar = 8.9 mm, A–C.

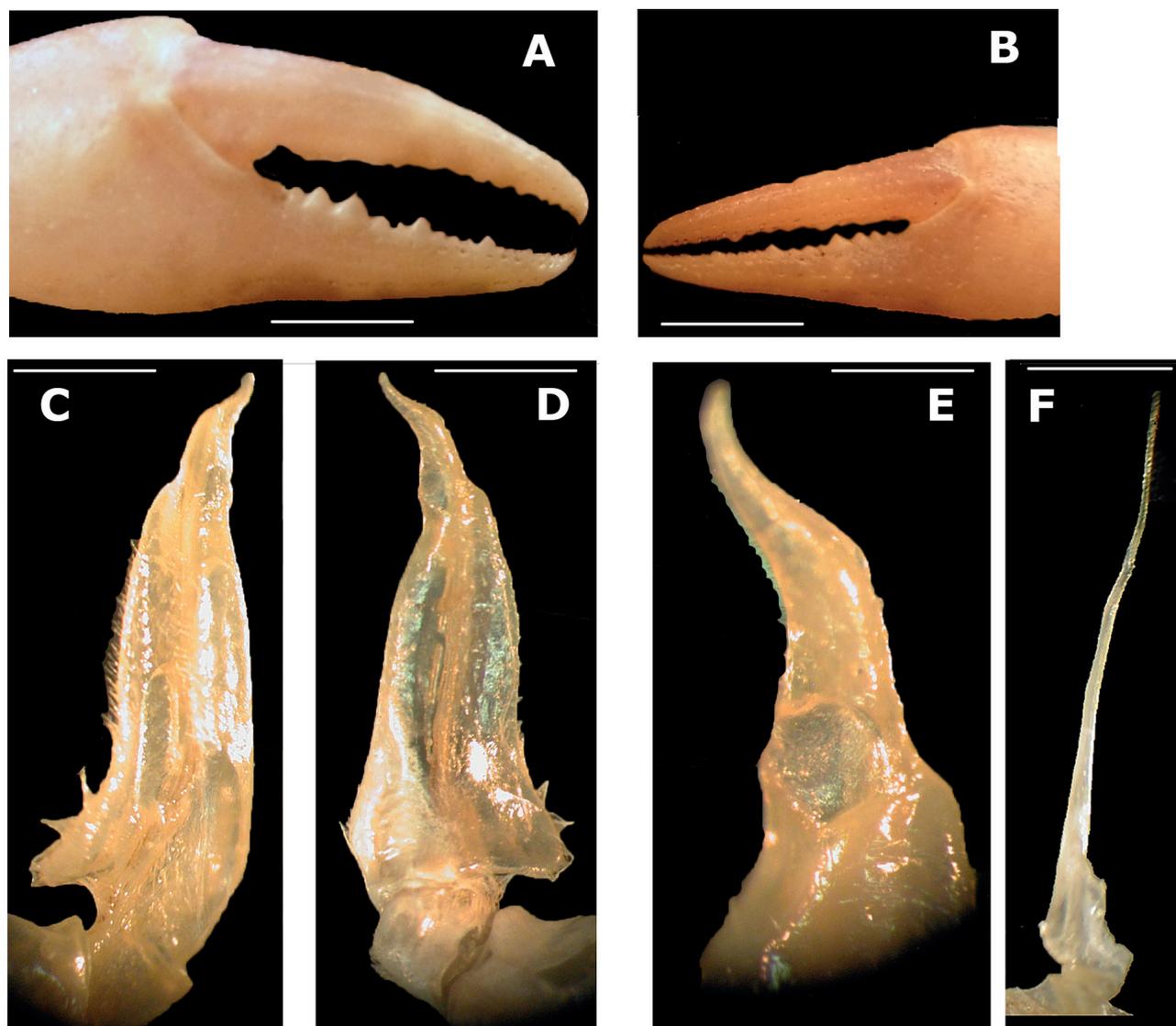


Figure 2. *Potamonautes gorongosa*, new species, male holotype (CW 25.4 mm) from Gorongosa National Park, Sofala Province, Mozambique (NMU PN 2014). A, major cheliped; B, minor cheliped; C, right GO1, ventral view; D, right GO1, dorsal view; E, right GO1, dorsal view showing detail of terminal article; F, right GO1, ventral view. Scale bar = 2.5 mm, A, B; 6.25 mm, C–F.

teeth; superior surface of merus smooth, superior margin with carinae; outer face of merus smooth, lateral margin of inferior face of merus with very small teeth; inferior margin of ischium with small pointed teeth (Fig. 1A). Walking legs (p2–p5) normal length, inner margins of propodi p2–p5 smooth, dactyli of p2–p5 tapering to point, each bearing four rows of downward-pointing short, sharp spines (Fig. 1A).

Size. A medium-sized species, the male holotype has a CW of 25.4 mm.

Type locality. Mozambique: Gorongosa National Park, Sofala Province, 18.47227°S 34.21411°E, 320

m above sea level (asl) (NMU PN3 2012A).

Etymology. The new species is named for Gorongosa National Park in Mozambique, the only place that it is known to occur (so far).

Distribution. *Potamonautes gorongosa*, new species, is known from one locality in Gorongosa National Park in Mozambique. This is a 4,000 km² park at the southern end of the Rift Valley in central Mozambique, and includes Mount Gorongosa (1,863 m asl) where *P. gorongosa* was collected. The Gorongosa National Park dominates the Gorongosa District in Sofala Province of Mozambique.

Habitat. The freshwater crabs reported on in the present study were collected by the second author from Sofala Province in Mozambique, in highland and montane fresh waters where the vegetation type is predominantly savanna with fast-flowing mountain streams and rivers. This narrow 450 km long area lies within the Eastern Zimbabwe Highlands ecoregion in southeastern Africa along the eastern border of Zimbabwe with Mozambique and includes the Nyanga and Chimanimani mountains whose rivers drain eastwards through Mozambique (Thieme *et al.*, 2005; Abell *et al.*, 2008). The known locality for *P. gorongosa* lies in the Zambezi lowveld freshwater ecoregion that comprises most of western and northern Mozambique and extends from south of the Zambezi delta in central Mozambique southwards to the Tugela River system in South Africa (Thieme *et al.*, 2005; Abell *et al.*, 2008). This species was collected with *P. obesus* a semi-terrestrial burrowing freshwater crab found in the coastal belt of eastern Africa from Kenya to Mozambique (Reed and Cumberlidge, 2004). The report of *P. obesus* from western Mozambique is a new record for this species in this part of the country.

Remarks. Afrotropical freshwater crabs undergo morphological changes as they grow and while most of this growth is isometric, some parts of their body (notably the major cheliped and the gonopods of males and pleopods of females) grow allometrically. Freshwater crabs start life as juveniles, then progress to subadults, and finally become reproductive adults after passing through the pubertal moult (Cumberlidge, 1999). The specimen of *P. gorongosa* new species, is judged here to be a subadult following comparisons with congeneric species such as *P. mulanjeensis*, *P. mutareensis*, and *P. flavusjo* (whose adults are between CW 30–34.8 mm) (Daniels and Bayliss, 2012; Phiri and Daniels, 2013; Daniels *et al.*, 2014). This indicates that although the specimen of the new species is a subadult, it is nevertheless of a body size that will soon undergo the pubertal moult. This distinction is important when considering the utility of taxonomic characters of freshwater crabs, although most of the morphological characters commonly used for taxonomy (such as those of the third maxilliped, thoracic sternum, mandible, the merus and carpus of the cheliped, and the number and size of the teeth on the cutting edges of the cheliped

fingers) undergo isometric growth and are not likely to be significantly different in subadults and adults. On the other hand, characters of the gonopods and major cheliped that grow allometrically are more developed in adults than in subadults. The subadult of the new species is well-developed and close to the pubertal moult, and so the gonopods would not be expected to develop a radically different form from those described here even after the next moult. This is supported by the observations that the gonopods of *P. gorongosa* new species (Fig. 2C–F) are similar in most respects to those of the three genetically close species (*P. mulanjeensis*, *P. mutareensis*, and *P. flavusjo* that are adult at CW 30.7 mm, 34.8 mm, and CW 34.8 mm respectively) (Daniels and Bayliss, 2012; Phiri and Daniels, 2013; Daniels *et al.*, 2014). The same cannot be said of the fingers of the chelipeds of *P. gorongosa* new species, because although its major cheliped is enlarged in comparison with the minor cheliped (Fig. 2A, B), the major cheliped still lacks the dramatically curving dactylus and wide oval interspace enclosed by the closed fingers of adult males of *P. mulanjeensis*, *P. mutareensis*, and *P. flavusjo* (see Daniels and Bayliss, 2012; Phiri and Daniels, 2013; Daniels *et al.*, 2014).

Potamonautes gorongosa new species, is referred to as “*Potamonautes* sp. 2” in Daniels *et al.* (2015, table 1, fig. 2). Phylogenetically, *P. gorongosa*, new species, was found to be distinct from all other species in the large Afrotropical genus *Potamonautes* based on mtDNA and nDNA evidence, and it is most closely related to several species that share the same lineage (“Clade 3” in Daniels *et al.*, 2015, fig. 2) such as *P. mutareensis* (from Zimbabwe, misspelt as “*P. mutariensis*” in Daniels *et al.*, 2015: table 1 and fig. 2), *P. mulanjeensis* (from Malawi), and *P. flavusjo* (from South Africa). The G1 terminal article of *P. gorongosa* new species closely resembles that of all three of these species (straight basally, medially curving outward at a 60° angle to the longitudinal axis of gonopod, and ending in a pointed and distinctly upturned tip) and it would be difficult to distinguish these taxa on this character alone. Fortunately, *P. gorongosa* new species, can be distinguished from *P. mutareensis* as follows (Phiri and Daniels, 2013): the vertical sulcus of the ischium of the third maxilliped is absent (vs. deep in *P. mutareensis*), the anterolateral margin of the carapace is smooth (vs. granulated in *P. mutareensis*), and s3/s4 is deep

at edges, faint in the middle, and does not meet the tip of the sternoabdominal cavity (vs. complete, deep and meeting the tip of the sternoabdominal cavity in *P. mutarensis*). *Potamonautes gorongosa*, new species, can be distinguished from *P. mulanjeensis* as follows (Daniels and Bayliss, 2012): the vertical sulcus of the ischium of the third maxilliped is absent (vs. distinct in *P. mulanjeensis*), and s3/s4 is incomplete and deep only at the margins (vs. complete and deep throughout in *P. mulanjeensis*). *Potamonautes gorongosa*, new species, can be distinguished from *P. flavusjo* as follows (Daniels *et al.*, 2014): the vertical sulcus of the ischium of the third maxilliped is absent (vs. distinct in *P. flavusjo*) and s3/s4 is incomplete and deep only at the margins (vs. complete and deep throughout in *P. flavusjo*).

Potamonautes gorongosa, new species, is easily distinguished from other species of freshwater crabs found in Mozambique (*P. namuliensis*, *P. bellarussus*, *P. calcaratus*, and *P. obesus*) both phylogenetically (Daniels *et al.*, 2015, fig. 2) because all are in different lineages from *P. gorongosa*, and morphologically (Reed and Cumberlidge, 2004; 2006; Daniels and Bayliss, 2012; Daniels *et al.*, 2014). For example, *P. gorongosa*, new species, can be distinguished from *P. calcaratus* and *P. obesus* from Mozambique as follows (Reed and Cumberlidge, 2004): the carapace is of medium height in the stream-living *P. gorongosa* (CH/FW = 1.1) (vs. highly vaulted in the semi-terrestrial burrowing crabs *P. calcaratus* and *P. obesus*, CH/FW = 1.2 and 1.3 respectively), and the dactylus of the major cheliped is slim and arched (vs. broadly flattened and high, an adaptation for burrowing in *P. calcaratus* and *P. obesus*), and the anterolateral margin of the carapace is smooth (vs. armed with a small sharp single spine in *P. calcaratus* and *P. obesus*). *Potamonautes gorongosa*, new species, can be distinguished from *P. bellarussus* as follows (Daniels *et al.*, 2014): the anterolateral margin of the carapace is smooth (vs. granulated in *P. bellarussus*), the exorbital tooth is small (vs. large and prominent in *P. bellarussus*), and the carapace is of medium height (CH/FW = 1.1) (vs. flattened in *P. bellarussus* CH/FW = 0.97). Finally, *P. gorongosa*, new species, can be distinguished from *P. namuliensis* as follows (Daniels and Bayliss, 2012): thoracic sternal sulcus s3/s4 is incomplete and deep only at the margins (vs. complete and deep throughout in *P. namuliensis*), the postfrontal crest is incomplete but distinct (vs. very faint throughout in *P. namuliensis*), the dactylus and propodus of the cheliped

are slightly arched with several large and medium sized teeth (vs. highly arched and lacking any conspicuous teeth in *P. namuliensis*), and the tip of the G1 terminal article is curved upward (vs. a straight uncurved tip in *P. namuliensis*).

ACKNOWLEDGEMENTS

This species is dedicated to the memory of Dr. Michael Türkay for his numerous contributions to the taxonomy of decapod crustaceans that includes many important publications on freshwater crabs. Michael Türkay was also a valued friend and colleague who will be missed by the whole scientific community. Liz Hoensen of the Iziko South African Museum in Cape Town South Africa is thanked warmly for her hospitality during visits by the first author to examine type material of the many South African species of *Potamonautes* used in this study. Harrison Moynihan is thanked for his many useful contributions during the development of this work.

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