A new anchialine cave dwelling species of *Potamalpheops* Powell, 1979 from the Solomon Islands (Crustacea, Decapoda, Alpheidae)

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**Abstract.**— A new species of the alpheid shrimp genus *Potamalpheops* Powell, 1979 is described from an anchialine cave on Nggela Pile Island, Solomon Islands. *Potamalpheops nazgul* sp. nov. belongs to the *P. monodi* (Sollaud, 1932) species group, defined by the presence of two pairs of cuspidate setae on the distal margin of the telson and feebly or non-enlarged chelipeds. The new species is morphologically closer to *P. pininsulae* Bruce & Iliffe, 1992 and it is characterised among others by the presence of a well-developed antero-mesial tubercle on the eyestalk, a short rostrum with a dentate ventral carina, a toothed distal margin of first antennular segment and a non-strongly inflated carapace. The description of this new species raises the number of known species of *Potamalpheops* to fifteen.

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**Key words**: Crustacea, Decapoda, Alpheidae, Pacific, Melanesia, shrimp

**Introduction**

The alpheid shrimp genus *Potamalpheops* currently comprises 14 species (De Grave & Fransen, 2011; Soledade *et al.*, 2014), with representatives in Central and South America, West Africa and the Indo-West Pacific (Anker, 2008). Although largely a marine and brackish water genus, five species are currently known to be restricted to freshwater habitats: *P. haugi* (Coutière, 1906) and *P. monodi* (Sollaud, 1932) in West Africa, *P. amnicus* Yeo & Ng, 1997 in South-East Asia, the cave dwelling *P. stygicola* (Hobbs, 1973) in Mexico and *P. palawanensis* Cai & Anker, 2004 in the Philippines. Although the latter species is considered to be a freshwater dweller, Anker (2008) noted that the hydrography in the Puerto Princesa Subterranean River National Park is complex, ranging from pure freshwater to oligohaline. The Sri Lankan *P. galle* Anker, 2005 and the West African *P. pylorus* Powell, 1979 appear to be transitional freshwater – brackish water forms (Anker, 2005; Powell, 1979), whereas the remaining species of the genus are largely found in mangroves (Bruce, 1993; Yeo & Ng, 1997; Anker, 2003; Soledade *et al.*, 2014).

Until now, only one species of *Potamalpheops* was known from anchialine systems, namely *P. pininsulae* Bruce & Iliffe, 1992 from two disjunct locations in New Caledonia: Île des Pins (Isle of Pines) off the southeastern coast of Grande Terre (Bruce & Iliffe, 1992) and the Pindai Caves on the Népoui Peninsula, along the western coast of Grande Terre (Cai & Anker, 2004; Anker, 2008). Here we describe a further new species of *Potamalpheops* from an anchialine limestone cave on Nggela Pile Island, Solomon Islands.

Type material is deposited in the Zoological Collections of the Oxford University Museum of Natural History (OUMNH.ZC). Carapace length (cl) was measured from the tip of the rostrum to the posterior margin of the carapace.
Taxonomy

Family Alpheidae Rafinesque, 1815
Potamalpheops Powell, 1979
Potamalpheops nazgul sp. nov.

Type material
Holotype: male, cl 4.7 mm, Mbetibula Cave (station 88–083), 1 km north of Vuturua village, Nggela Pile Island, Solomon Islands (09°09′32″S 160°23′12″E), leg. T.M. Iliffe & S. Sarbu, 15.VIII.1988 (OUMNH.ZC.2018–09–01). Paratypes: 1 female, dissected (cl 5.4 mm), same collection data (OUMNH.ZC.2018–09–02); 5 females (cl 4.7–5.8 mm), 1 male (cl 5.7 mm), same collection data (OUMNH.ZC. 2018-09-03).

Comparative material
Potamalpheops pininsulae Bruce & Iliffe, 1992. Pindai caves, Pindai Peninsula, New Caledonia (21°21.010′S 164°57.778′E), leg. L. Lemaire, 01.V.2001; 3 females, 1 male (cl 4.8–5.9 mm) (OUMNH.ZC.2002-16-001).

Description
Body laterally slightly compressed. Carapace smooth, dorsally somewhat inflated, glabrous. Rostrum (Fig. 1) narrowly triangular, acute, slightly directed downwards, reaching midlength of first article of antennular peduncle, ventral carina well developed, dorsally unarmed, ventrally usually a subdistal tooth. Extra-corneal teeth moderately developed (Fig. 1A), acute; infra-corneal angle rounded. Pterygostomial margin rounded to slightly angular, setae absent (Fig. 1A, C).

Major portion of eye exposed in dorsal and lateral views, cornea somewhat reduced, not occupying entire anterior and lateral portion of eyestalk, bearing pointed anteromesial tubercle (Fig. 1). Antennular peduncle elongate; stylocerite slightly exceeding distal margin of first article of antennular peduncle, tip acute, mesio-ventral carina without distal tooth; first article with short, disto-lateral small teeth; second article about 1.4 times as long as first segment; third article slightly shorter than first, outer flagellum biramous (Fig. 1A–B, Fig. 2A). Antennal peduncle less robust than antennule; basicerite with well-developed, curved, acute tooth; distal margin of scaphocerite falling short of antennular peduncle, anterior margin convex, anterolateral tooth well developed (Fig. 1A–B, Fig. 2B).

Mouthparts typical for Potamalpheops. Mandible (Fig. 3A) with biarticulated palp, incisor process with 5 grinding teeth, molar process with circular rows of short setae. Maxillule (Fig. 3B) with bilobed endopod, basal endite spatulate, coxal endite tapering. Maxilla (Fig. 3C) with rather narrow scaphognathite, dorsal endite with deep incision and short endopod. First maxilliped (Fig. 3D) with endopod furnished with long plumose setae, endite bilobed, caridean lobe small, epipod large and subrectangular. Second maxilliped (Fig. 3E) typical for Alpheidae, with well-developed lobiform epipod. Third maxilliped (Fig. 3F) slender, coxa with mastigobranch and triangular lateral plate; ultimate article not overly setose, ending in conicous spiniform seta, subdistally with 2 spiniform setae (Fig. 3G).}

First pereiopods (= chelifeds) (Fig. 4A) not enlarged, symmetrical in shape, equal in size; when fully extended overreaching scaphocerite by distal third of chela; merus slightly longer than carpus; carpus cylindrical, mesial cleaning brush with 7–8 rows of 1–4 serrulate setae each; chelae slender, subequal in length to carpus; fingers subequal in length to palm, cutting edges unarmed, distally minutely bidentate. Second pereiopod (Fig. 4B) slender, when fully extended overreaching scaphocerite by third carpal division; ischium and merus elongate;
Fig. 1. *Potamalpheops nazgul* sp. nov. A, frontal region and cephalic appendages, lateral view; B, same, dorsal view; C, carapace and rostrum, lateral view; D, detail of rostrum, orbital teeth and eyes, dorsal view; E, frontal region, lateral view; F, frontal region, lateral view. A–D, male holotype, cl 4.7 mm (OUMNH.ZC.2018-09-01); E, male paratype, cl 5.7 mm (OUMNH.ZC.2018-09-03); F female paratype, cl 5.4 mm (OUMNH.ZC.2018-09-02). Scale bars equal 1 mm.
Fig. 2. *Potamalpheops nazgul* sp. nov. A, antennule, dorsal view; B, antenna, dorsal view; C, telson, dorsal view; D, distal part of telson, dorsal view; E, fifth and sixth abdominal somites, lateral view. A–D, female paratype, cl 5.4 mm (OUMNH.ZC.2018-09-02); E, male holotype, cl 4.7 mm (OUMNH.ZC.2018-09-01). Scale bars equal 1 mm (A–C, E) or 0.5 mm (D).
Fig. 3. *Potamalpheops nazgul* sp. nov. A, mandible; B, maxillule; C, maxilla; D, first maxilliped; E, second maxilliped; F, third maxilliped; G, same, distal part, ventromesial view. All from female paratype, cl 5.4 mm (OUMNH.ZC.2018-09-02). Scale bars equal 0.5 mm (A–F) or 0.25 mm (G).
Fig. 4. *Potamalpheops nazgul* sp. nov. A, first pereiopod; B, second pereiopod; C, third pereiopod; D, fourth pereiopod; E, fifth pereiopod. All from female paratype cl 5.4 mm (OUMNH.ZC.2018-09-02). Scale bars equal 0.5 mm.
Fig. 5. *Potamalpheops nazgul* sp. nov. A, uropod; B, diaeresis; C, first pleopod; D, same, endopod; E, second pleopod; F, appendix masculina and appendix interna. A–B, female paratype cl 5.4 mm (OUMNH.ZC.2018-09-02); C–F, male holotype, cl 4.7 mm (OUMNH.ZC.2018-09-01). Scale bars equal 1 mm (A), 0.5 mm (C, E) or 0.25 mm (B, D, F).
carpus subdivided into 5 divisions, ratio of carpal divisions (proximal to distal) 4.2 : 1.0 : 1.2 : 1.2 : 2.0; chela slender, simple, about 1.5 as long as most-distal carpal division. Third pereiopod (Fig. 4C) slender, when fully extended overreaching scaphocerite by distal half of propodus; ischium armed with 1 cuspidate seta; merus about 1.7 times as long as ischium, armed with 2 cuspidate setae; carpus about 0.75 times as long as merus, unarmed; propodus about 1.3 times as long as carpus, bearing 8 spinules on inferior margin and pair of spinules disoventrally; dactylus relatively stout, slightly curved, about 0.25 times as long as propodus, simple. Fourth pereiopod (Fig. 4D) similar to third pereiopod, when fully extended overreaching scaphocerite by distal margin of propodus; ischium armed with 1 cuspidate seta, merus armed with 2 cuspidate setae. Fifth pereiopod (Fig. 4E) similar to third pereiopod, when fully extended overreaching scaphocerite by distal margin of propodus; ischium unarmed, merus armed with one cuspidate seta; propodus with well-developed grooming brush, comprising of 5–7 rows of 3–5 serrulate setae each.

Pleon (Fig. 2E) without specific features, pleura of first 3 segments broadly rounded, fourth pleuron bluntly rectangular, fifth pleuron feebly acute, sixth pleonite with articulated plate posteroventrally.

Male first pleopod (Fig. 5C) with endopod about 0.34 times length of exopod; tapering distally along both margins (Fig. 5D), apex rounded. Male second pleopod (Fig. 5E) with endopod about 0.9 length of exopod, appendices inserted at 0.6 of length; appendix masculina (Fig. 5F) long, reaching 0.85 of endopod length, distally with 5 simple setae of varying lengths; appendix interna short (Fig. 5F), about half-length of appendix masculina, with few distal cincinulli.

Uropod (Fig. 5A) exceeding telson by about quarter of endopod length; exopod slightly longer than endopod, lateral margin straight, ending in acute distal tooth, medial spine well developed, overreaching distal tooth by half of its length; diaeresis well developed (Fig. 5B), furnished with 14–19 teeth (18 in holotype).

Telson (Fig. 2C) about twice as long as wide, widest proximally, dorsally with 2 pairs of cuspidate setae, situated at 0.35 and 0.65 of telson length; distal margin (Fig. 2D) with central part convex, furnished with 7 pairs of plumose setae; lateral part with 2 pairs of elongate, cuspidate setae, mesial slightly longer than lateral.

Branchial formula typical for Potamalphe-ops: 5 pleurobranchs (P1–P5); 0 podobranch; 1 arthrobranch (Mxp3); 2 lobiform epipods (Mxp1, Mxp2); 5 mastigobranchs (Mxp3, P1–P4); 5 sets of setobranchs (P1–P5), 3 exopods (Mxp1–Mxp3).

Morphological variation

Males are generally very similar to females, although the latter are larger and have a more pronounced vaulted carapace. The ventral rostral carina usually bears a single tooth, rarely two (Fig. 1F), which in one specimen were minute (Fig. 1E). Other morphological variation is slight and rather insignificant taxonomically.

Etymology

Named after J.R.R. Tolkien’s fictional characters, the Nazgul, who dwell in the realm of shadows, akin to the habitat of this new shrimp species; used as a noun in apposition.

Type locality

Mbetibula Cave, 1 km north of Vuturua village, Nggela Pile Island, Solomon Islands (09°09′32″S, 160°23′12″E).

Distribution

Currently only known from the type locality.

Colour pattern

White translucent to pink (based on brief colour notes of the collector).
**Habitat**

The new species was collected from a small anchialine pool inside a coastal limestone cave (Mbetibula Cave), a description of which can be found in Ng *et al.* (1994); specimens were collected with a dip net in 0–50 cm deep water of the main pool, which had a salinity of 9–10 ppt.

**Remarks**

Cai & Anker (2004) defined the *P. monodi* (Sollaud, 1932) group, to which the present new species clearly belongs, by the posterior margin of the telson bearing two pairs of “spines” (= cuspidate setae), the carapace lacking conspicuous grooves, well-pigmented corneas and the mesial face of the carpus of the feebly enlarged or non-enlarged chelipeds bearing several setal rows (= carpal cleaning brush). Only three currently recognised species in *Potamalpheops* do not belong to this group: *P. haugi*, *P. pylorus* (both with only a single pair of cuspidate setae on telson margin and enlarged chelipeds), both referred to the “pylorus – haugi line” in Powell (1979) or *P. haugi* group in Soledade *et al.* (2014), and *P. stygicola* (with a deep grooved carapace and vestigial corneas). Although the phylogenetic significance of this grouping remains unproven, it remains a useful morphological framework for an initial comparison of species in the genus *Potamalpheops*.

The *P. monodi* group is currently comprised of 11 species: *P. amnicus* Yeo & Ng, 1997, *P. darwiniensis* Bruce, 1993, *P. galle* Anker, 2005, *P. hanleyi* Bruce, 1991, *P. johnsoni* Anker, 2003, *P. miyai* Yeo & Ng, 1997, *P. monodi* (Sollaud, 1932), *P. palawanensis* Cai & Anker, 2005, *P. pininsulae* Bruce & Iliffe, 1992, *P. tigger* Yeo & Ng, 1997 and *P. tyrymeme* Soledade, Santos & Almeida, 2014. The presence of an antero-mesial tubercle on the eyestalk in *P. nazgul* sp. nov. at once separates it from all other species in this group, with the exception of *P. darwiniensis* and *P. pininsulae*, both of which also have a tubercle, albeit less pronounced (cf. Bruce & Iliffe, 1992, fig. 5; Bruce, 1993, fig. 2). The new species can be easily distinguished from *P. darwiniensis* by the shape and size of the rostrum, being very short, not exceeding the anterior margin of the cornea in *P. darwiniensis* (cf. Bruce, 1993, fig. 2) vs. longer in *P. nazgul* (Fig. 1), as well as a well-developed ventral dentate carina in *P. nazgul* (vs. feebly developed and non-dentate in *P. darwiniensis*).

The new species is morphologically very close to *P. pininsulae* from anchialine caves in New Caledonia (Bruce & Iliffe, 1992; Anker, 2008). However, *P. nazgul* sp. nov. can be distinguished from *P. pininsulae*, in addition to the better developed eye tubercle, by (1) the carapace not being strongly inflated vs. strongly inflated in *P. pininsulae* (especially in females); (2) the shorter rostrum (0.12–0.14 vs. 0.17–0.18 of carapace length in the new species and *P. pininsulae*, respectively), reaching only to the mid-length of the first antennular article in the new species vs. reaching to or slightly overreaching the distal margin of the first antennular segment in *P. pininsulae*; (3) the rostrum being straight or only slightly directed downwards in *P. nazgul* sp. nov. vs. strongly directed downwards in *P. pininsulae*; and (4) the uropodal diaeresis harbouring at most 19 (14–19) teeth in *P. nazgul* sp. nov. vs. 20 (20–22) in *P. pininsulae*. Based on the limited material available, a further, minor difference lies in that the first antennular article has shorter and smaller distolateral teeth in the new species.

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