

# On the presence of the alpheid shrimp genus *Bermudacaris* Anker and Iliffe, 2000 (Crustacea: Decapoda: Caridea) in the Pacific Ocean, with description of a new species from Vietnam

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## Abstract

*Bermudacaris britayevi* n. sp. is described on the basis of a single specimen collected from a burrow, presumably of a callianassid ghost-shrimp, on an intertidal sand-mud flat of Dam Bay of Tre Island, Nha Trang Bay, Vietnam, and is the first record of *Bermudacaris* in the Pacific Ocean. The new species differs ecologically from the two previously described species, *B. harti* Anker and Iliffe, 2000 from the anchialine caves of Bermuda in the western Atlantic Ocean, and *B. australiensis* Anker and Komai, 2004 collected in the western Indian Ocean off northwestern Australia. The original diagnosis of *Bermudacaris* Anker and Iliffe, 2000 is emended. A key to the three species of *Bermudacaris* is provided.

**Keywords:** *Alpheidae*, *Bermudacaris*, *commensalism*, *inverted chelipeds*, *new genus diagnosis*, *new species*

## Introduction

The alpheid genus *Bermudacaris* Anker and Iliffe, 2000 was established for a peculiar stygobitic species, *Bermudacaris harti* Anker and Iliffe, 2000, presently known only from the anchialine cave system of Bermuda in the northwestern Atlantic Ocean (Anker and Iliffe 2000; Anker and Komai 2004). Subsequently, a second species, *B. australiensis* Anker and Komai, 2004, was described from subtidal marine waters of the western Indian Ocean, off northwestern Australia (Anker and Komai 2004). The Australian species differs from *B. harti* in having well-pigmented corneas, elongated, strongly curved lateral plate on the coxa of the third maxilliped, and more robust chelipeds and third and fourth pereopods. Anker and Komai (2004) slightly emended the original generic diagnosis of *Bermudacaris* (cf. Anker and Iliffe 2000). A third species of *Bermudacaris* was found by D. Jaume in an

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anchialine sinkhole on Mallorca Island, Spain (Gràcia et al. 2003, p 65, Figure 10), however, this species remains undescribed. Anker and Komai (2004) also noted that Ledoyer's (1970) specimen from Toliara, Madagascar, misidentified as "*Automate dolichognatha* (de Man, 1888)", may actually represent a species of *Bermudacaris*.

During field work in Nha Trang Bay, Vietnam in 2004, one of us (I.M.) collected a single alpheid specimen with features typical of *Bermudacaris*, e.g. the dorsally exposed eyestalks and the robust enlarged chelipeds, equal in size and similar in shape, and carried extended with dactylus in ventral position. Unfortunately, the Vietnamese specimen autotomized both of its chelipeds during its capture, however, one cheliped was recovered. Unlike previously reported *Bermudacaris* specimens, the Vietnamese specimen was found on a sand-mud intertidal area near mangroves. Furthermore, it was collected from a burrow, presumably of a callianassid ghost-shrimp. Examination of the specimen confirmed that it differs from both *B. harti* and *B. australiensis*. Therefore, it is assigned to a new species, which is described herein. Several features present in the new species and in *B. australiensis*, and absent in the type species, make necessary a further emendation of the original generic diagnosis of *Bermudacaris*.

## Material and methods

All drawings were made under a dissection microscope, Wild Type 181300, equipped with a camera lucida. Carapace length (CL, in mm) and total body length (TL, in mm) were measured from the tip of the rostral projection to the posterior margin of the carapace and telson, respectively. The holotype is deposited in the Natural History Museum, London, UK (NHM). The following abbreviations are used in the text: Mxp, maxilliped, P, pereopod.

## Taxonomy

### *Bermudacaris* Anker and Iliffe, 2000

*Bermudacaris* Anker and Iliffe 2000, p 762.

### *Emended diagnosis*

Carapace glabrous, without grooves or sutures; branchiostegial margin without notch or pronounced ventral lip; cardiac notch well developed. Frontal margin with broadly rounded rostral projection; orbital teeth absent. Pterygostomial angle rounded. Eyestalks completely exposed in dorsal and lateral view, subparallel, cornea small, more or less pigmented, sometimes almost depigmented. Antennular peduncle slender, first segment with acute ventromesial tooth; stylocerite not appressed, distally acute; second segment longer than broad; lateral antennular flagellum not bifurcating. Antenna with basicerite not particularly robust, bearing ventrolateral tooth; carpocerite overreaching scaphocerite. Mouthparts not especially modified; mandible with two-segmented palp; first maxilliped with segmented palp and narrow caridean lobe; second maxilliped with ovate epipod. Third maxilliped pediform, lateral plate with more or less elongated posterior process; ultimate segment elongated, armed with spines on dorsal surface and tip; exopod short. First pereopods (chelipeds) enlarged, equal in size, symmetrical in shape, carried extended, with dactylus in ventral position; ischium with dorsal spines; merus unarmed or bearing row of spinules mesially; carpus cup-shaped, with short rows of setae mesially; chela with palm

ovate, smooth, linea impressa and adhesive discs absent; finger cutting edges unarmed or furnished with irregular teeth, snapping mechanism absent. Second pereopod with five-segmented carpus, second segment longer than first. Third pereopod with ischium unarmed or armed with spine on ventral margin, merus and carpus unarmed; propodus with spines on ventral margin, dactylus simple, conical. Fifth pereopod with propodus bearing brush of setae distally. Abdomen with pleura rather feebly produced ventrally; sixth abdominal somite without posterolateral articulated plate. Male second pleopod with appendix interna and appendix masculina (needs confirmation for two Indo-West Pacific species). Uropod with diaeresis more or less developed, sinuous. Telson with two pairs of dorsal spines and two pairs of posterolateral spines; posterior margin short; anal tubercles absent. Gill/exopod formula: five pleurobranchs (P1–5), one arthrobranch (Mxp3), one podobranch (Mxp2), two lobe-like epipods (Mxp1–2), five strap-like epipods=mastigobranchs (Mxp3, P1–4), five sets of setobranchs (P1–5), three exopods (Mxp1–3).

#### *Type species*

*Bermudacaris harti* Anker and Iliffe, 2000 (by original designation).

#### *Other species included*

*Bermudacaris australiensis* Anker and Komai, 2004; *Bermudacaris britayevi* n. sp. (see below).

#### *Distribution*

Atlantic Ocean: Bermuda, Mallorca (Spain); Indian Ocean: northwestern Australia, possibly Madagascar (Anker and Komai 2004; see also below); Pacific Ocean: Vietnam (present study).

#### *Remarks*

*Bermudacaris* can be distinguished from the closely related genera, *Automate* de Man, 1888 and *Coronalpheus* Wicksten, 1999 by the equal, symmetrical, inverted chelipeds (versus unequal, asymmetrical, non-inverted in *Automate* and *Coronalpheus*); the posteriorly more or less elongated lateral plate of the third maxilliped (versus rounded in *Automate* and *Coronalpheus*); the frontal margin with broadly rounded rostral projection (versus with small triangular rostrum or without rostrum in *Automate* and *Coronalpheus*). *Bermudacaris harti* differs specifically from all species of *Automate* by the presence of a small appendix masculina in males (Hart and Manning 1981; Anker and Iliffe 2000). However, the validity of this feature in generic diagnosis must be first confirmed for the two remaining species, *B. australiensis*, known from a single ovigerous female specimen (Anker and Komai 2004), and *B. britayevi* n. sp., described below on the basis of a single non-ovigerous specimen lacking appendix masculina on the second pleopod, and therefore, presumably a female.

#### ***Bermudacaris britayevi* n. sp.**

(Figures 1–4)

#### *Material*

Holotype: female (specimen without appendix masculina), CL 3.3 mm, TL 11.7 mm, NHM 2006.1217, Vietnam, Nha Trang Bay, Tre Island, Dam Bay, intertidal, close to

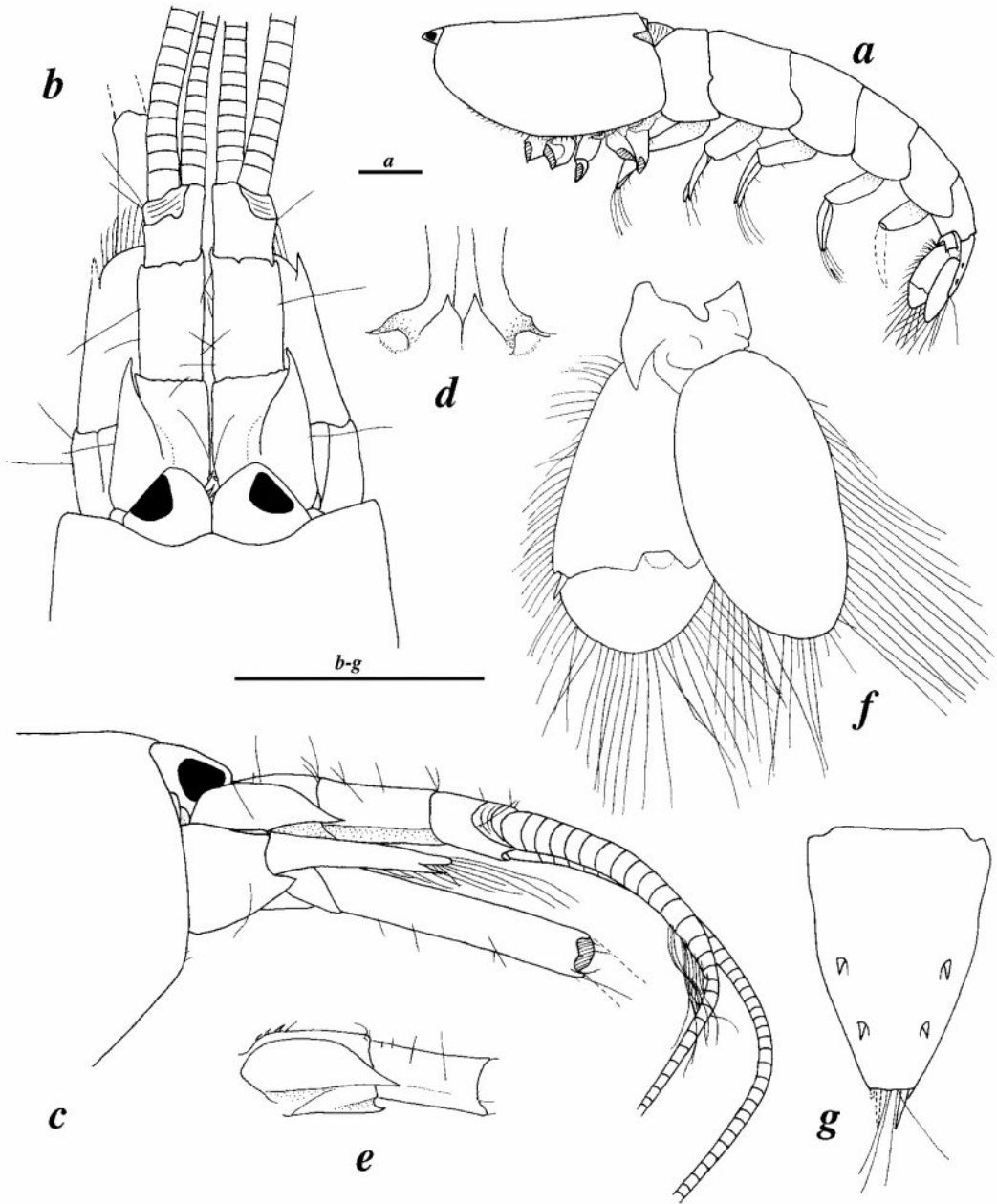


Figure 1. *Bermudacaris britayevi* n. sp., holotype (NHM 2006.1217). (a) General body without cephalic and thoracic appendages, lateral view; (b) frontal region, dorsal view; (c) same, lateral view; (d) epistomial sclerite near ventral base of antennule; (e) antennule, first two segments of peduncle, lateral view; (f) uropod, dorsal view; (g) telson, dorsal view. Scale bars: 1 mm.

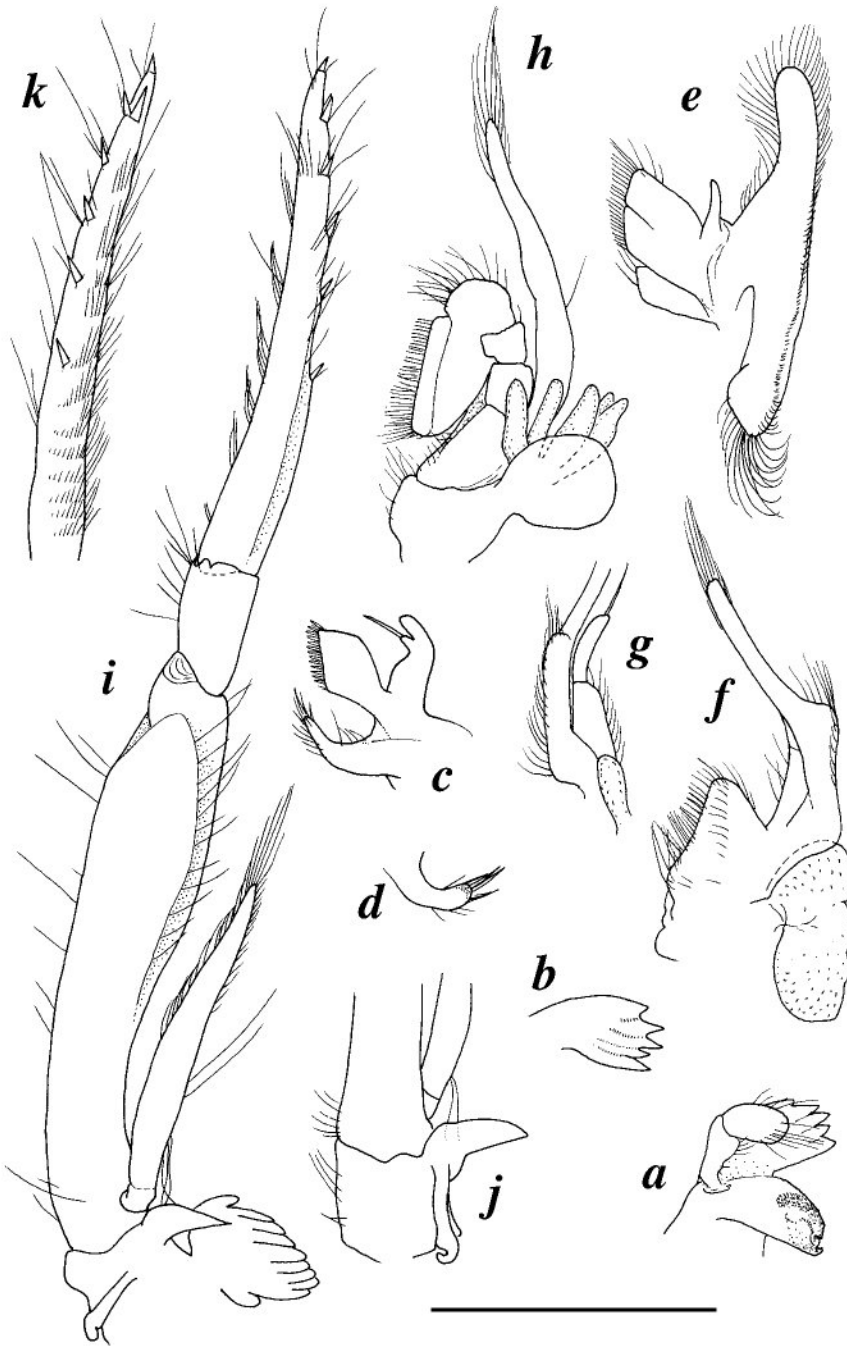


Figure 2. *Bermudacaris britayevi* n. sp., holotype (NHM 2006.1217). (a) Mandible, mesial view; (b) same, incisor process; (c) maxillule, lateral view; (d) same, ventral endite, mesial view; (e) maxilla, lateral view; (f) first maxilliped, lateral view; (g) same, posteromesial view of endopod and proximal portion of exopod; (h) second maxilliped, lateral view; (i) third maxilliped, lateral view; (j) same, detail of coxa; (k) same, ultimate segment, dorsomesial view. Scale bar: 1 mm.

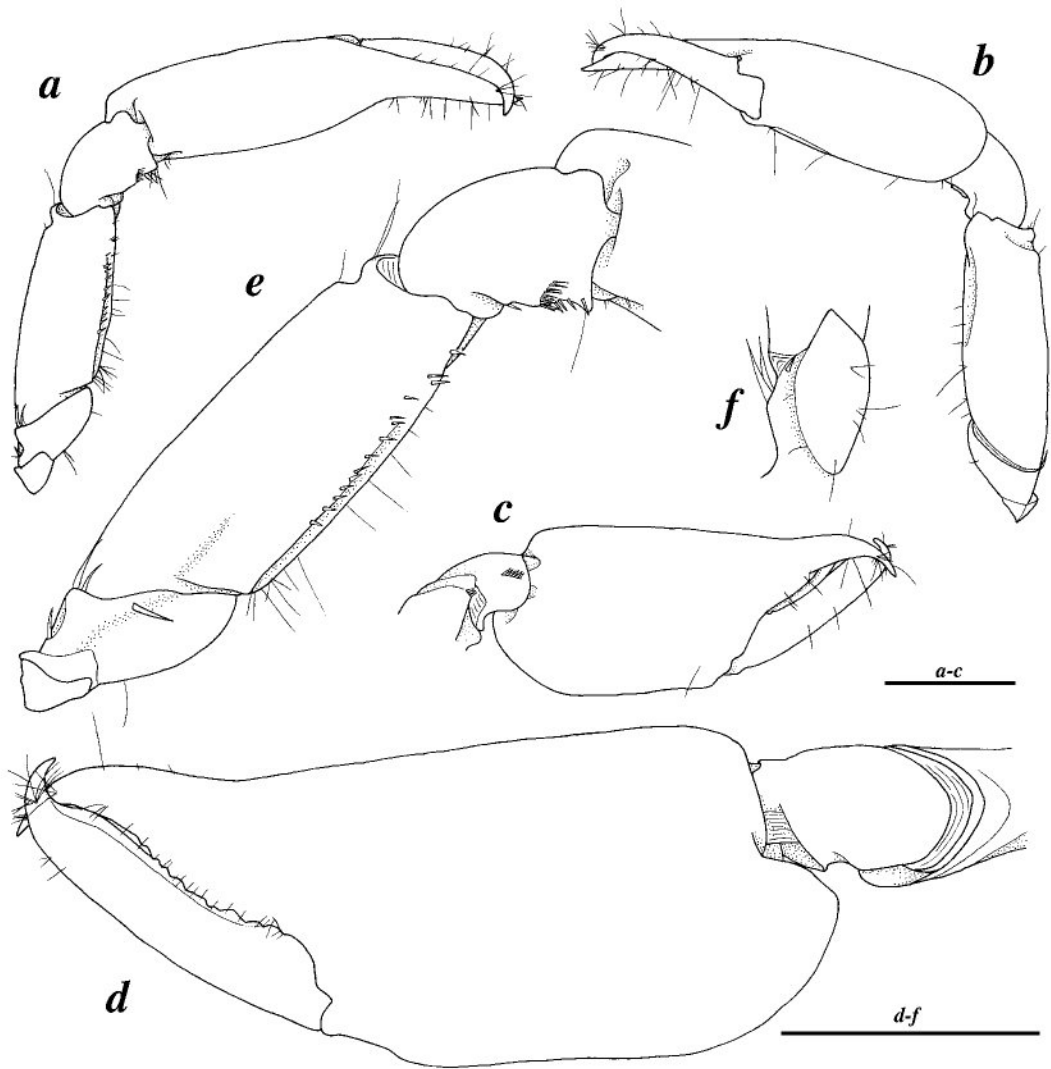


Figure 3. *Bermudacaris britayevi* n. sp., holotype (NHM 2006.1217). (a) Left cheliped, dorsomesial view; (b) same, ventrolateral view; (c) same, chela and carpus, mesial view; (d) same, chela enlarged, lateral view; (e) same, ischium, merus, and carpus, mesial view; (f) same, ischium, ventral view. Scale bars: 1 mm.

mangrove, with suction bait pump (“yabby pump”) from burrow of possibly callianassid host, coll. I. N. Marin, 4 June 2004.

#### *Description*

Body elongate (Figure 1a), not particularly compressed laterally, glabrous. Frontal margin with shallow emargination bearing broadly rounded median rostral projection (Figure 1b); orbital hoods and orbital teeth absent: eyes fully exposed in dorsal and lateral view (Figure 1b, c); pterygostomial angle rounded (Figure 1c); branchiostegial margin furnished with setae (Figure 1a); cardiac notch deep (Figure 1a). Eyestalks juxtaposed, without anteromesial tubercle; cornea modestly pigmented (Figure 1b). Ocellar beak not conspicuous. Epistomial sclerite with projecting subacute tooth (Figure 1d).

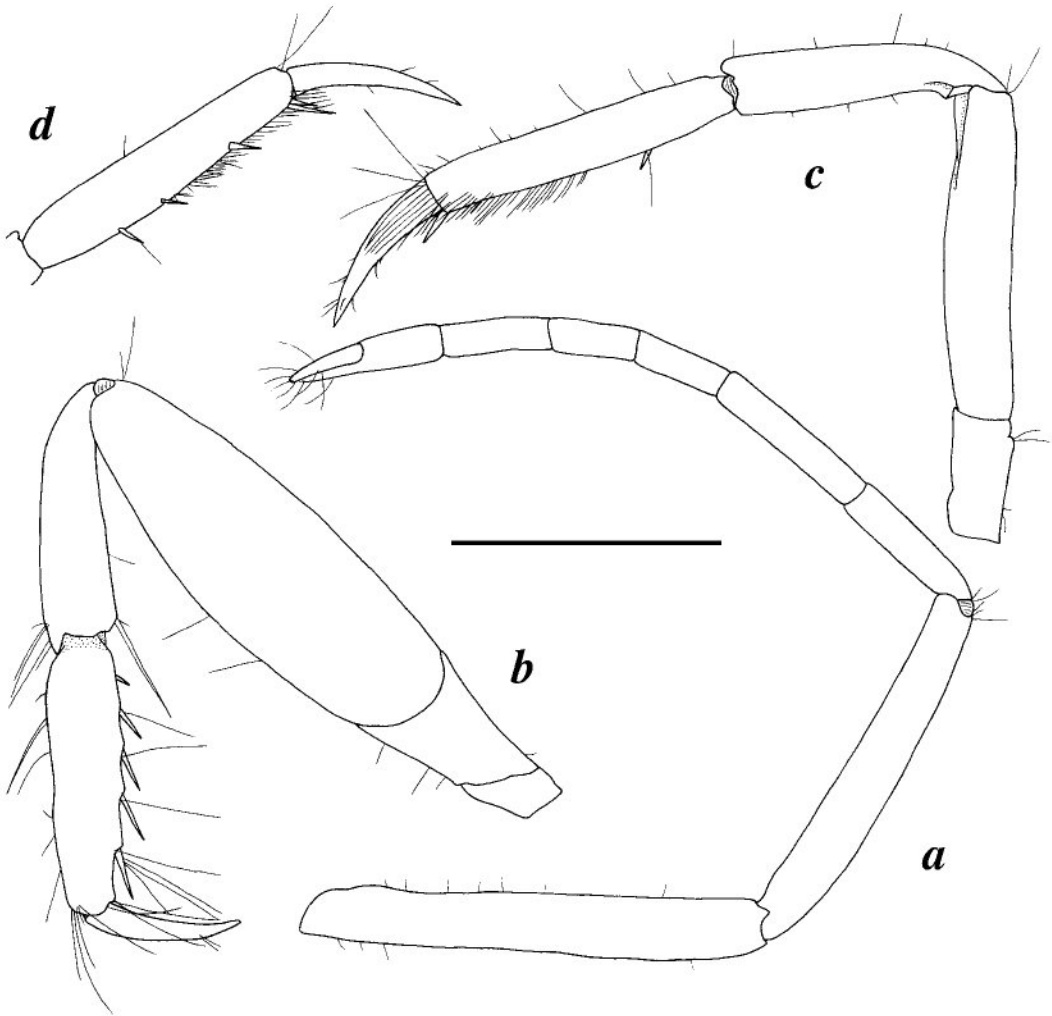


Figure 4. *Bermudacaris britayevi* n. sp., holotype (NHM 2006.1217). (a) Second pereopod, lateral view; (b) third pereopod, dorsal view; (c) fifth pereopod, lateral view; (d) same, propodus and dactylus, mesial view. Scale bar: 1 mm.

Antennular peduncle with second segment about 1.8 times longer than broad, longer than visible portion of first segment; stylocerite overreaching distal margin of first segment, tip acute (Figure 1b, c); ventromesial carina with acute tooth distally (Figure 1e); dorsomesial carina with curved spinules proximally (Figure 1b, e); lateral flagellum not distinctly biramous, with about five aesthetasc-bearing segments (Figure 1c). Antenna with basicerite bearing robust, acute ventrolateral tooth (Figure 1c); scaphocerite subrectangular, anterior margin of blade convex, extending slightly beyond distolateral tooth (Figure 1b); carpocerite reaching far beyond distal margin of scaphocerite (Figure 1b, c).

Mouthparts typical for genus. Mandible (Figure 2a) with two-segmented palp, proximal segment ventrodistally slightly expanded and protruding, furnished with setae, distal segment fringed with elongate setae; incisor process distally with five strong subtriangular teeth (Figure 2b); molar process distally with minute teeth and rows of short setae.

Maxillule (Figure 2c) with bilobed palp, dorsal lobe without setae, ventral lobe with one thick seta (Figure 2c); ventral endite with about five stiff elongated spine-like setae mesiodistally (Figure 2d). Maxilla (Figure 2e) with narrow scaphognathite; endopod small, not segmented, without setae; dorsal endite with deep horizontal cleft (Figure 2e). First maxilliped (Figure 2f) with moderately developed caridean lobe; endopod two-segmented, with one thick seta distally (Figure 2g); exopod distally truncate; epipod irregularly ovate. Second maxilliped of typical form (Figure 2h); epipod rounded, bearing podobranch mesially, latter with five well-developed leaflets (Figure 2h). Third maxilliped (Figure 2i) pediform, slender; lateral plate of coxa with subacute posterior process (Figure 2i, j); antepenultimate segment somewhat flattened on ventral surface; penultimate segment about twice as long as wide, with dense row of moderately elongate setae mesially; ultimate segment slightly shorter than antepenultimate segment, tapering distally, with pairs of spines on dorsal surface starting anterior to mid-length and continuing to segment tip (Figure 2i, k); arthrobranch well developed (Figure 2i).

First pereopods (chelipeds) (Figure 3) subequal in size, symmetrical in shape [only left cheliped present in holotype, right cheliped of size approximately equal to that of left cheliped (I. Marin, personal observation) lost during collection], robust, enlarged compared to other pereopods, carried extended with dactylus in ventrolateral position; coxa and basis unarmed; ischium with curved spines on distal and mesial margins (Figure 3a, e, f); merus stout, about 3.5 times as long as distal width, with row of spinules mesially (Figure 3e); carpus cup-shaped, with row of short stiff setae mesioventrally (Figure 3c, e); chela with palm smooth, subrectangular, compressed laterally (Figure 3b–d); fingers subequal in length, not gaping when closed, finger tips crossing; dactylus in ventrolateral position (Figure 3a, b), cutting edge unarmed; pollex armed with small irregular teeth on proximal two-thirds of cutting edge (Figure 3d); linea impressa, adhesive discs and snapping mechanism absent.

Second pereopod slender, elongate (Figure 4a); ischium slightly longer than merus; carpus with five segments, segment length ratio approximately equal to 1.5:2:1:1:1.3 (Figure 4a); chela simple, as long as first carpal segment, fingers slightly shorter than palm. Third and fourth pereopods similar; third pereopod (Figure 4b) with unarmed ischium; merus more than three times as long as ischium and about twice as long as carpus, unarmed, convex on ventral and dorsal margins (Figure 4b); carpus not inflated, ventrodistally with one stiff elongate seta (Figure 4b); propodus about as long as carpus, ventral margin with five slender spines; dactylus elongate, conical, slightly curved, about half length of propodus (Figure 4b). Fifth pereopod (Figure 4c) more slender than third and fourth pereopods; ischium short, unarmed; merus about three times as long as ischium and 1.5 times as long as carpus, unarmed; carpus unarmed; propodus longer than carpus, ventral margin with three slender spines and distal pair of spines proximal to dactylus (Figure 4d), ventrolateral surface with rows of elongate setae (Figure 4c); dactylus about half as long as propodus, very similar to that of third pereopod.

First to fifth abdominal somites I–V with posterolateral angles of pleura rounded to slightly angular (Figure 1a); sixth somite without articulated plate at posteroventral angle, posterior projection subrectangular; preanal plate posteriorly rounded. Second pleopod with appendix interna only. Uropods distinctly exceeding telson (Figure 1a); lateral lobe of protopod sympodite distally with acute tooth (Figure 1f); endopod and exopod subequal in length; (exopod) with diaeresis distinctly curved at about two-thirds of its length thus forming two subtriangular teeth (Figure 1f); lateral spine rather small, adjacent tooth small, subacute (Figure 1f). Telson (Figure 1g) distinctly tapering distally, almost subtriangular, proximal



width about four times width of posterior margin; dorsal surface with two pairs of spines, one pair at mid-length and another pair at about three-quarters length of telson (Figure 1g); posterior margin straight, with two pairs of slender posterolateral spines, lateral much shorter than mesial (broken on left side, cf. Figure 1g), median portion between spines with four elongate setae; anal tubercles absent. Gill/exopod formula as given for genus.

#### Size

The carapace length of the unique specimen is 3.3 mm; the total length is about 11.7 mm.

#### Colour

Semi-transparent white.

#### Etymology

We are pleased to name this species after Dr Temir Alanovich Britayev, Head of the Laboratory of Ecology and Morphology of Marine Invertebrates, A. N. Severtzov Institute of Ecology and Evolution of the Russian Academy of Science in Moscow; with his continuing support numerous interesting alpheid shrimps, including the present new species, were collected in Nha Trang Bay from 2003 to 2005.

#### Habitat

The single specimen was collected from a burrow presumably of a callianassid host on shallow tidal sand-mud flat with fringing mangroves. The host identity remains unknown. Another question that remains unanswered is whether *B. britayevi* n. sp. is an obligate or (more likely) only occasional burrow commensal. Other commensal animals collected at Dam Bay sand-mud flats were the alpheid shrimp, *Leptalpheus* cf. *pacificus* Banner and Banner, 1974 (Anker et al., in preparation), and the laomediid mud shrimp, *Naushonia* sp. (undescribed species; Dworschak et al., in preparation), both associated with burrows of the callianassid ghost-shrimp, *Glypturus* cf. *armatus* (A. Milne-Edwards, 1870); two further alpheid shrimps, *Salmoneus rostratus* Barnard, 1962 and *S. alpheophilus* Anker and Marin, 2006, both associated with burrows of a larger alpheid, *Alpheus* cf. *rapacida* de Man, 1909 (Anker and Marin, 2006); as well as large, unidentified amphinomid polychaetes.

#### Distribution

Presently known only from the type locality, Nha Trang Bay, Vietnam.

#### Remarks

*Bermudacaris britayevi* n. sp. differs in many features from the type species, *B. harti*, e.g. in the presence of a shallow emargination on the frontal margin of the carapace; the much more robust antennular peduncle, third maxilliped, chelipeds, and third to fifth pereopods; the more adjacent and pigmented eyestalks; the posteriorly elongated lateral plate on the coxa of the third maxilliped; the more conspicuous podobranch on the second maxilliped; and the absence of a ventral spine on the ischium of the third to fifth pereopods (cf. Anker

and Iliffe 2000). On the other hand, *B. britayevi* n. sp. appears to be closely related to *B. australiensis*, from which it may be separated by the shape of the frontal margin of the carapace; the juxtaposed eyestalks (versus somewhat divergent in *B. australiensis*); the more developed podobranch on the second maxilliped; the distinctly longer stylocerite (overreaching distal margin of antennular segment in *B. britayevi* n. sp. versus not reaching this margin in *B. australiensis*); the cutting edges of the cheliped fingers armed with small irregular teeth (versus unarmed in *B. australiensis*); the dorsal lobe of the maxillular palp lacking seta; the incisor process of the mandible bearing stronger teeth; and the better developed diaeresis on the uropodal exopod (cf. Anker and Komai 2004).

As discussed by Anker and Komai (2004), the undescribed species from Toliara, Madagascar, misidentified by Ledoyer (1970) as “*Automate dolichognatha* (de Man, 1888)”, possibly belongs to *Bermudacaris* or at least to a closely related genus. Unfortunately, the whereabouts of Ledoyer’s material remain unknown (Anker and Komai 2004). *Bermudacaris britayevi* n. sp. differs from the Toliara species by the broadly rounded rostral projection (versus small triangular rostrum in Ledoyer’s specimen) and the shape of the cheliped chela, especially the armature of the fingers (with small irregular teeth in *B. britayevi* n. sp. versus with stout molar-shaped tooth on the pollex in Ledoyer’s specimen). Remarkably, the frontal regions of *B. britayevi* n. sp. and of Ledoyer’s unnamed species appear to be closer to the configuration found in some species of *Automate* de Man, 1888, than to *B. harti* and *B. australiensis*.

Table I summarizes the most important features distinguishing the three presently known species of *Bermudacaris*, as well as the undescribed species illustrated by Ledoyer (1970). According to Table I, *B. harti* appears to be more distantly related to *B. britayevi* n. sp. and *B. australiensis*. The latter two species have indeed very similar chelipeds, third pereopod, as well as second and third maxillipeds. Therefore, it is possible that the two Atlantic forms associated with anchialine stygobitic habitats, *B. harti* and *Bermudacaris* sp. from Mallorca (cf. Gràcia et al. 2003), may be also generically different from the Indo-West Pacific forms, *B. britayevi* n. sp., *B. australiensis*, and Ledoyer’s species, all being associated with intertidal and subtidal marine habitats. However, we defer from further speculations on generic assignments, awaiting the description of the stygobitic species from Mallorca (cf. Gràcia et al., 2003; D. Jaume, personal communication) and the recollection and description of the enigmatic species illustrated by Ledoyer (1970).

#### Key to the three described species of *Bermudacaris* Anker and Iliffe, 2000

1. Eyestalks with almost depigmented cornea. All pereopods slender. Third pereopod with ischium bearing ventral spine. Third maxilliped with lateral plate bearing short posterior process. Second maxilliped with rudimentary podobranch [anchialine caves, Bermuda] . . . . . *Bermudacaris harti* Anker and Iliffe, 2000
- Eyestalks with pigmented cornea. All pereopods stout. Third pereopod with ischium unarmed. Third maxilliped with lateral plate bearing elongate posterior process. Second maxilliped with well-developed podobranch. . . . . 2
2. Eyestalks not juxtaposed. Stylocerite not reaching distal margin of first segment of antennular peduncle [subtidal, NW Australia] . . . . .
- . . . . . *Bermudacaris australiensis* Anker and Komai, 2004
- Eyestalks juxtaposed. Stylocerite exceeding distal margin of first segment of antennular peduncle [intertidal, Vietnam] . . . . . *Bermudacaris britayevi* n. sp.

Table I. Major distinguishing features among species of *Bermudacaris* Anker and Iliffe, 2000.

Features	<i>B. harti</i>	<i>B. australiensis</i>	<i>B. britayevi</i> n. sp.	<i>B. (?)</i> sp. Ledoyer (1970)
Rostrum	Broad rostral projection	Broad rostral projection	Broad rostral projection	Small triangular rostrum
Frontal emargination	Quasi-absent	Very shallow	Shallow	Shallow
Eyestalks	Not juxtaposed	Not juxtaposed	Juxtaposed	Juxtaposed
Cornea	Almost depigmented	Pigmented	Pigmented	Pigmented
Stylocerite	Exceeding distal margin of 1st antennular segment	Not exceeding distal margin of 1st antennular segment	Exceeding distal margin of 1st antennular segment	Exceeding distal margin of 1st antennular segment
Uropodal diaeresis	Poorly developed	Poorly developed	Well developed	Well developed
Maxillule, palp	Dorsal lobe with seta	Dorsal lobe with seta	Dorsal lobe without seta	Unknown
Second maxilliped, podobranch	Rudimentary	Large, two leaflets	Large, five leaflets	Unknown
Third maxilliped, ratio ultimate/antepenultimate segment	0.8 (ultimate shorter)	1.1 (ultimate longer)	0.9 (ultimate shorter)	0.9 (ultimate shorter)
Third maxilliped, lateral plate	With short process	With long process	With long process	Unknown
Cheliped, merus	Relatively slender	Robust	Robust	Relatively slender
Cheliped, pollex	Unarmed	Unarmed	Armed with small irregular teeth	Armed with stout tooth
Third pereopod	Slender	Stout	Stout	Unknown
Third pereopod, ischium	With ventral spine	Unarmed	Unarmed	Unknown
Fifth pereopod, ischium	With ventral spine	Unknown	Unarmed	Unknown
Ecology	Anchialine caves	Marine, subtidal (38 m), bottom type unknown	Marine, intertidal, sand-mud, possibly commensal in burrows	Marine, intertidal, sand bank of coral reef flat

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