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Pagurus ikedai (Crustacea: Anomura: Paguridae), a new hermit crab species of the *bernhardus* group from Japanese waters

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Abstract

A new species of Paguridae, *Pagurus ikedai*, from the Tokyo Submarine Canyon and vicinity, Japan, is described and fully illustrated, including information on live coloration. This new species is distinguished primarily by size and shape of the chelipeds, in particular the massiveness of the left, and the presence in some males of a papilla or very short sexual tube on the right coxa of the fifth pereopod and a papilla on the coxa of the left. It is assigned to the *bernhardus* group which now includes eight species.

Key words: Hermit crab, Paguridae, *Pagurus*, new species, *bernhardus* group, Tokyo Submarine Canyon, Japan

Introduction

As part of long-term benthic faunal and ecological studies begun in the early 1960's (*e.g.*, Ikeda 1998, Watabe 1999), numerous specimens of a distinct hermit crab species of the family Paguridae were collected in the Tokyo Submarine Canyon and vicinity. During the earlier years of these studies, some specimens were sent to the late Sadayoshi Miyake (1908–1998, see Baba 1998) who communicated to Hitoshi Ikeda (Hayama Shiosai Museum) that they represented an undescribed genus and species. However, S. Miyake never published a description. Although the specimens sent to S. Miyake have not been located, a good number of additional specimens conspecific with those sent to him, and obtained during more recent samplings, were kept. These are used herein to document this new taxon.

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The massiveness of the chelipeds in these specimens, and in particular the relatively larger size of the left cheliped when compared to that of most other species of the Paguridae, combined with the presence in some males of a papilla or very short sexual tube on the right coxa of the fifth pereopod and a papilla on the coxa of the left, may have suggested to S. Miyake that a new genus was warranted for this new species. Several recent studies, however, concluded that the presence of very short male sexual tubes or papillae alone, is not sufficient justification to erect new genera or even reassign species (McLaughlin & Lemaitre 2001, Lemaitre & McLaughlin 2003a, b, McLaughlin & Asakura 2004). The shape of the chelipeds in hermit crabs can vary widely in species of the same genus, and thus differences in these appendages alone are usually not useful in establishing meaningful generic boundaries. After careful evaluation, we concluded that the hermit crab specimens from the Tokyo Submarine Canyon actually represented a new species of *Pagurus* Fabricius, 1775, assignable to McLaughlin's (1974) *bernhardus* group. This new species is herein fully described and illustrated, including information on live coloration. In addition to *P. bernhardus* (Linnaeus, 1758), McLaughlin (1974) placed in this group *P. armatus* (Dana, 1851), *P. ochotensis* Brandt, 1851, *P. aleuticus* (Benedict, 1892), and *P. acadianus* (Benedict, 1901). More recently, Komai (1998) suggested, and McLaughlin & Asakura (2004) agreed, that *P. gracilipes* (Stimpson, 1858), and *P. nipponensis* (Yokoya, 1933), should be added to this group as well.

Materials and methods

All specimens were collected by one of us (HW) from lobster pots over fine sand with rocks (see Watabe, 1999). The holotype is deposited in the National Science Museum, Tokyo, Japan (NSMT-Cr). Paratypes have been deposited in the Hayama Shiosai Museum, Kanagawa (HSM); Muséum national d'Histoire naturelle, Paris, France (MNHN); Natural History Museum and Institute, Chiba (CBM-ZC); Senckenberg Museum, Frankfurt a. M., Germany (SMF); National Museum of Natural History, Smithsonian Institution, Washington D.C., USA (USNM); and in the personal collections of the second author (HW). McLaughlin (1974, 2003) is followed for general terminology; McLaughlin & de Saint Laurent (1998) for type of gill lamellae; and McLaughlin (1997) for the term "semichelate". The measurements indicated under material examined are shield lengths, measured in millimeters (mm) from the tip of the rostrum to the midpoint of the posterior margin of shield. The length of the ocular peduncle was obtained by measuring the total length of the ultimate peduncular segment, including the cornea (cf. Powar 1969), on the lateral face of the peduncle. Sexual tube length is used in accordance to the definition provided by McLaughlin (2003: 112). The abbreviation "sta" indicates station.

Taxonomy

Family Paguridae Latreille, 1802
Genus *Pagurus* Fabricius, 1775
Pagurus ikedai n. sp. (Figs 1–5)

Type material. **Japan**. *Holotype* male 8.2 mm, entrance to Tokyo Submarine Canyon, SE of Tsurugi-Zaki, Miura Peninsula, sta MM-30, 35°03.93'N, 139° 44.95'E, 290–330 m, 1 August 1994, NSMT-Cr 16121. *Paratypes*, all from entrance to Tokyo Submarine Canyon: N of Su-no-Saki, Boso Peninsula, sta TT-1, 34°59.65'N, 139°45.50'E, 280–350 m, 12 May 1985: 4 males 6.0–9.4 mm, CBM-ZC 8183. SE of Tsurugi-Zaki, Miura Peninsula, sta MS-6, 35°03.80'N, 139°44.38'E, 270–290 m, 4 June 1992: 2 males 8.9, 9.4 mm, 2 females 7.5, 8.9 mm, HSM-Cra 0134 to 0137. ESE of Tsurugi-Zaki, sta MU-8, 35°07.10'N, 139°46.73'E, 280–350 m, 19 July 1992: 1 male 8.5 mm, CBM-ZC 8180. SE of Tsurugi-Zaki, Miura Peninsula, sta MS-28, 35°04.85'N, 139°44.92'E, 240–290 m, 27 October 1994: 1 female 7.2 mm, CBM-ZC 8181. SE of Tsurugi-Zaki, Miura Peninsula, sta MM-28, 35°03.80'N, 139°44.38'E, 290–310 m, 28 June 1994: 2 males 8.7, 9.4 mm, 2 females 8.5, 9.0 mm, NSMT-Cr 16122; 5 males 8.1–8.9 mm, 2 females 7.2, 8.1 mm, HW. Same station data as holotype: 1 male 7.6 mm, 4 females 7.2–7.6 mm, USNM 1069118; 2 males 9.1, 9.2 mm, MNHN-Pg 7263; 1 male 7.4 mm, 1 female 9.2 mm, SMF 29993. SE of Tsurugi-Zaki, Miura Peninsula, sta MM-36, 35°02.96'N, 139°44.60'E, 270–310 m, 16 October 1995: 1 male 7.2 mm, CBM-ZC 8182.

Description. Eleven pairs of biserial gills (Fig. 1a): 2 arthrobranchs on each of third maxilliped and first to fourth pereopods, and pleurobranch on each side of somite XIII (above fourth pereopods). Shield (Fig. 1b) about as broad as long; dorsal surface glabrous except for longitudinal row of tufts of short setae on each side; anterior margins between rostrum and lateral projections concave; anterolateral margins sloping; posterior margin truncate. Rostrum triangular, terminating in small spine, reaching to about level of lateral projections; with short setae dorsally. Lateral projections broadly triangular, terminating in small spine often directed anterolaterally.

Ocular peduncles short, about 0.5 times as long as shield; with few tufts of short setae dorsally. Corneas moderately dilated, width of each about 0.4–0.5 length of ocular peduncle. Ocular acicles narrow, acutely subtriangular, concave dorsally, each with minute to small subterminal spine (often not visible in dorsal view, occasionally absent); separated basally by less than basal width of 1 acicle.

Antennular peduncles overreaching corneas by 0.5–0.8 length of ultimate segments. Ultimate segment with scattered short setae dorsally. Penultimate segment with scattered setae. Basal segment with laterodistal angle blunt, setose.

Antennal peduncles overreaching corneas by about 0.5 length of fifth segment; with supernumerary segment. Fifth segment with few setae on lateral and mesial margins. Fourth segment with scattered setae. Third segment with strong spine at ventrodistal angle.

Second segment with dorsolateral distal angle prominently produced, reaching nearly to distal margin of fourth segment, and terminating in strong spine (rarely multifid); dorsomesial distal angle with small spine. First segment unarmed or with small spine on lateral surface. Antennal acicles reaching slightly beyond distal margins of corneas, weakly curving outwards (dorsal view), and each terminating in strong spine; mesial margin sparsely setose, lacking spines. Flagellum exceeding outstretched right cheliped; articles naked or with short setae > 0.5 flagellum article in length.

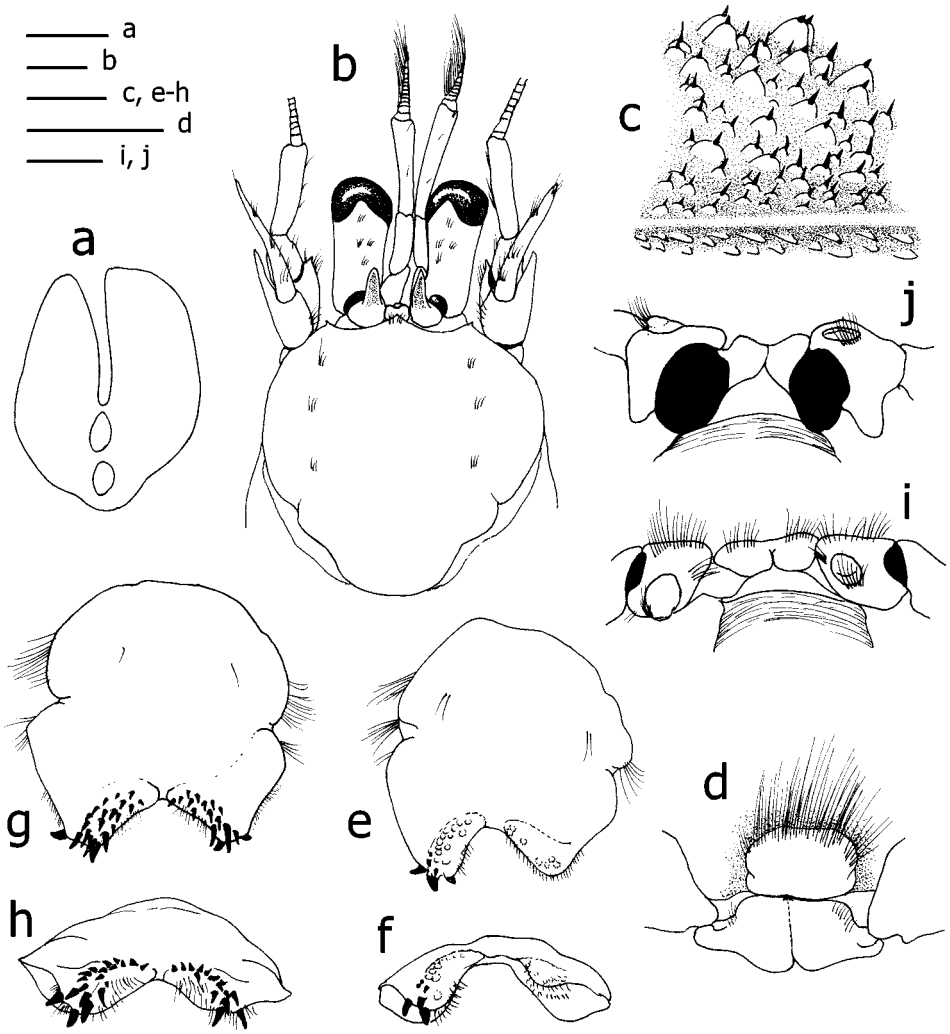

FIGURE 1. *Pagurus ikedai* n. sp., Tokyo Submarine Canyon, Japan, sta MM-30: a, paratype male 7.6 mm (USNM 1069118); b–f, i, j, holotype male 8.2 mm (NSMT-Cr 16121); g, h, paratype male 8.5 mm, sta MM-30 (USNM 1069118). a, gill lamella; b, shield and cephalic appendages, dorsal view; c, portion of dorsal surface of palm of right cheliped near base of fixed finger and lateral margin, dorsolateral view; d, anterior lobe and posterior portion of thoracic sternite XII (third pereopods), ventral view; e–h, telson in dorsal (e, g) and posterior (f, h) views; i, j, coxae of fifth pereopods and thoracic sternite XXIV in ventral (i) and posterior (j) views. Scale bars: a = 0.25 mm; b, d, i, j = 1.0 mm; c, e–h = 0.5 mm.

Mandible (Fig. 2a) with margin of incisor process calcified. Maxillule (Fig. 2b) with external lobe of endopod moderately developed, slightly recurved; internal lobe with long terminal bristle. Maxilla (Fig. 2c) with endopod reaching beyond distal margin of scaphognathite. First maxilliped (Fig. 2d) with endopod reaching distal margin of distal endite. Second maxilliped (Fig. 2e) without distinguishing characters. Third maxilliped (Fig. 2f, g) with crista dentata on ischium consisting of about 18 corneous-tipped teeth and 1 accessory tooth; carpus unarmed on dorsodistal margin.

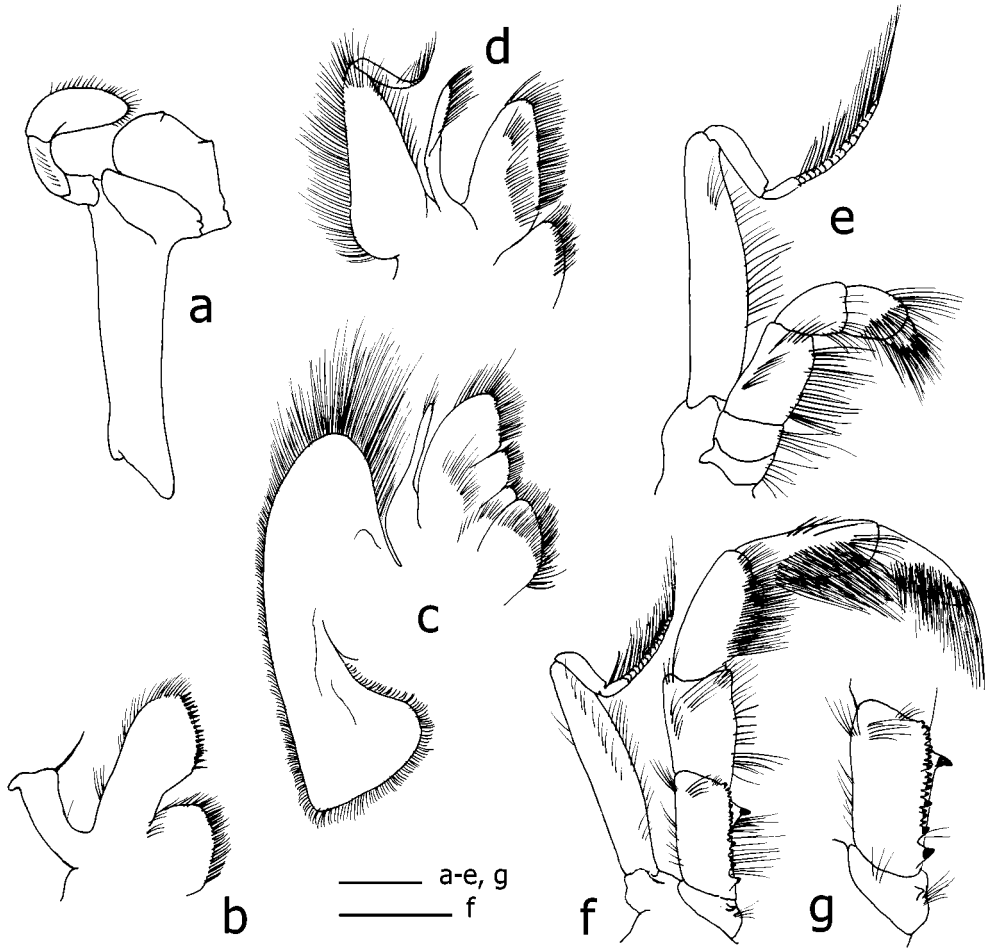

FIGURE 2. *Pagurus ikedai* n. sp., Tokyo Submarine Canyon, Japan, sta MM-30, paratype male 7.6 mm (USNM 1069118). Left mouthparts, internal view: a, mandible; b, maxillule; c, maxilla; d, first maxilliped; e, second maxilliped; f, third maxilliped; g, coxa and ischium of same. Scale bars: a–e, g = 0.5 mm; f = 1.0 mm.

Chelipeds massive and stout, unequal, left reaching to about proximal margin of dactyl of right. Right cheliped (Figs 1c, 3a–c) sparsely setose. Chela operculate, dorsoventrally compressed (more so laterally); dorsolateral and dorsomesial margins of palm and fingers

sharply defined, finely serrate; fingers each terminating in inwardly directed corneous claw crossed when closed; with tufts of setae inwardly directed near base of larger teeth of cutting edges both dorsally and ventrally. Dactyl about as long as mesial margin of palm;

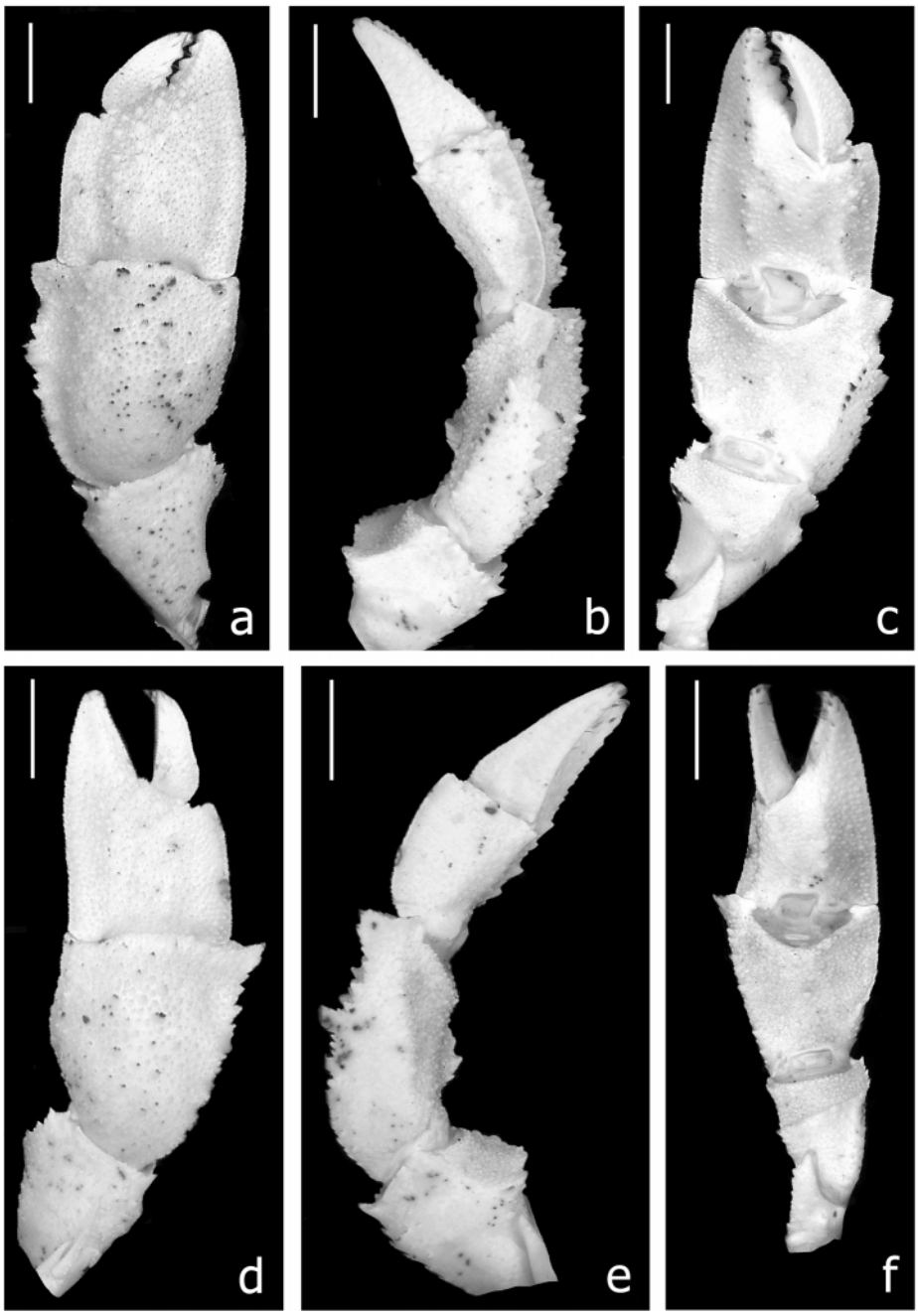

FIGURE 3. *Pagurus ikedai* n. sp., Tokyo Submarine Canyon, Japan, sta MM-30, holotype male 8.2 mm (NSMT-Cr 16121). Right (a–c) and left (d–f) chelipeds: a, d, dorsal view; b, e, mesial view; c, f, ventral view. Scale bars: a–f = 4.0 mm.

cutting edge with row of usually 3 large calcareous teeth, usually with few smaller ones interspersed, and row of small corneous teeth distally; dorsal surface with numerous short, corneous bristles; ventral surface with numerous small tubercles, and elevated longitudinal median ridge with low corneous-tipped spines. Fixed finger dorsal surface with numerous short, corneous bristles; cutting edge with 3 large calcareous teeth proximally, and 3–5 small calcareous teeth distally; dorsal and ventral surfaces each with longitudinal median ridge with low corneous-tipped spines; ventral surface with numerous small tubercles. Palm dorsal surface with numerous calcareous spines or tubercles diminishing in size towards dorsomesial and dorsolateral margins and terminating in short corneous bristles (Fig. 1c), median region with several distinctly larger spines; dorsomesial margin somewhat flared; ventral surface with numerous small tubercles and 2 submedian rows of larger tubercles or spines. Carpus about 0.9 as long as broad, and about 0.8 as long as chela; dorsal surface with numerous spines or tubercles terminating in short corneous bristles, dorsodistal margin spinose; dorsomesial margin well delimited by row of serrate, small or strong, corneous-tipped spines; dorsolateral margin sharply defined, serrate, flaring vetromesially on proximal half; ventral surface with numerous small, low tubercles. Merus usually with 1 or 2 distal spines on dorsal margin, dorsodistal margin spinose; dorsal surface with scattered low tubercles bearing short bristle-like setae; anterior half of ventral surface concave, with numerous small low tubercles, and strongly sloping towards midportion of segment. Ischium with scattered setae; ventromesial margin with minute blunt spines. Coxa with ventromesial row of setae.

Left cheliped (Fig. 3d–f) similar to right in shape and armature, differing primarily in size. Dactyl about as long as mesial margin of palm. Cutting edge of dactyl with row of small, closely set corneous spines; cutting edge of fixed finger with row of small, blunt calcareous teeth interspersed with small corneous spines.

Ambulatory legs (Fig. 4a–d) similar right from left except for longer meri and stronger spination on dorsal margins of carpi and propodi of right; reaching to, or slightly beyond, distal margins of fingers of right cheliped when extended; meri to dactyls with few setae mostly along dorsal and ventral margins. Dactyl about 1.5 times as long as propodus, terminating in sharp corneous claw; lateral and mesial faces each with longitudinal groove, more marked on mesial surface; ventral margin with 14–22 corneous spines, ventromesial margin with 4–18 corneous spines; dorsal margin with 18–26 corneous spines, dorsomesial margin with 9–20 corneous spines. Propodus with row of corneous-tipped calcareous spines on dorsal margin, and scattered small, low tubercles on dorsolateral surface; ventral margin unarmed except for few setae. Carpus with row of strong, corneous-tipped calcareous spines on dorsal margin, and scattered small, low tubercles on dorsolateral surface. Merus with row of spines on ventral margin. Ischium with small, blunt spines on ventromesial margin. Coxa with ventromesial row of setae. Anterior lobe of thoracic sternite XII (third pereopods; Fig. 1d) subrectangular, with long setae distally.

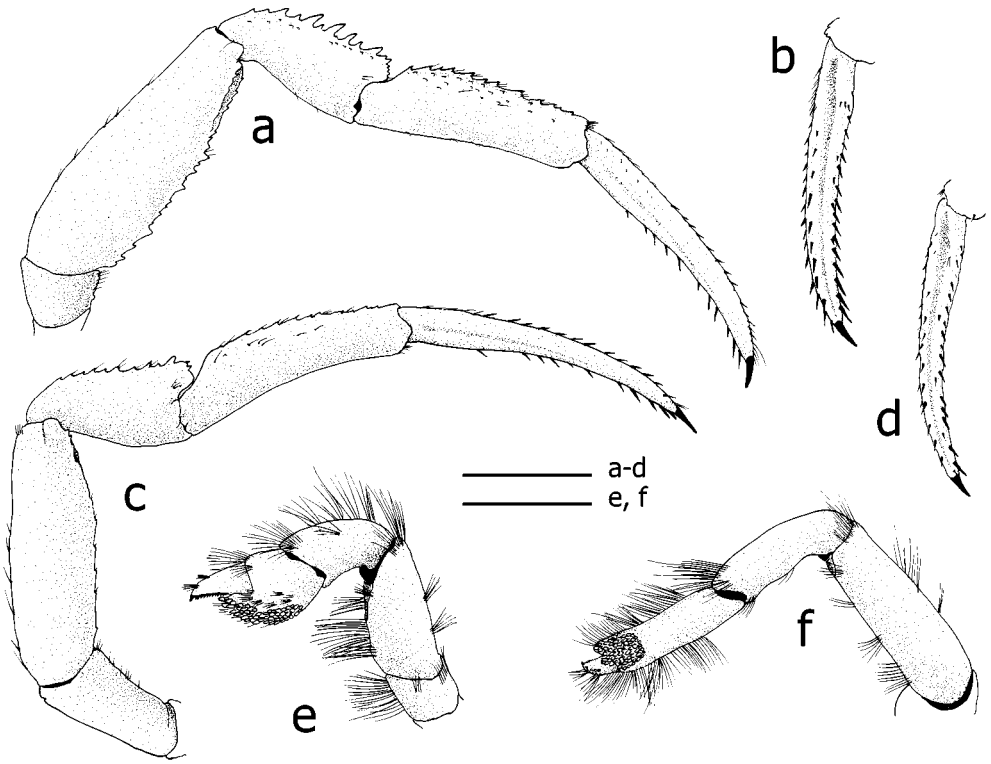

FIGURE 4. *Pagurus ikedai* n. sp., Tokyo Submarine Canyon, Japan, sta MM-30, holotype male 8.2 mm (NSMT-Cr 16121): a, second right pereopod, lateral view; b, dactyl of same, mesial view; c, third right pereopod, lateral view; d, dactyl of same, mesial view; e, fourth pereopod, lateral view; f, fifth pereopod, lateral view. Scale bars: a–d = 2.0 mm; e, f = 1.0 mm.

FIGURE 5. *Pagurus ikedai* n. sp., off Jogashima, Japan, live coloration, male 9.8 mm. (Photo: H. Ikeda).

Fourth pereopod (Fig. 4e) semichelate. Dactyl terminating in corneous claw; with ventrolateral row of small, closely set corneous spines. Propodal rasp with 3 or 4 rows of ovate corneous scales.

Fifth pereopod (Fig. 4f) chelate. Dactyl with ventrolateral row of small ovate scales. Propodal rasp extending proximally for about 0.3 of segment.

Uropods and telson asymmetrical. Telson (Fig. 1e–h) with transverse suture, and scattered setae on dorsal surface; anterior lobes with long setae laterally; posterior lobes separated by U-shaped cleft; terminal margins oblique, setose, armed with irregular rows of corneous marginal and submarginal spines (sometimes worn out as in holotype right side; Fig. 1e, f), stronger spines near outer angles totally or partially hidden in dorsal view.

Female with paired gonopores; with unpaired pleopods 2–5, pleopod 5 not ovigerous. Male gonopores (Fig. 1i, j) with short fringe of setae arising from or near posterior margins of gonopore openings; right coxa with slight papilla or very short (= length of coxa measured on ventral surface) sexual tube protruding from gonopore and directed posteriorly; left coxa at most with slight papilla protruding from gonopore; with unpaired pleopods 3–5.

Live coloration (Fig. 5). Shield orange with some dark orange spots. Ocular peduncles white basally, then orange gradually fading towards corneas. Antennules and antennas light orange; antennal flagella mostly white. Posterior carapace pink, mottled with reddish. Chelipeds whitish, mottled with light orange. Second and third pereopods whitish except for distal and proximal orange bands on dactyl, proximal orange band on each propodus and carpus, and proximal and subdistal orange bands on merus.

Distribution. Presently known only from the Tokyo Submarine Canyon, and off Jogashima, Japan; 240–450 m.

Habitat. Gastropod shells with relatively large aperture: *Bathybembix aeola* (Watson), *Buccinum leucostoma* Lischke, *B. sagamianum* Okutani, *Ginebis crumpii* (Pilsbry), and *G. japonicus* (Dall).

Etymology. The name of this new species is dedicated to Hitoshi Ikeda (Hayama Shiosai Museum), who first collected and photographed specimens. The name also is in recognition of his intensive, long-term research on Japanese deep-sea decapods and mollusks, inspired by the earlier work of German zoologists such as F. Doflein, and H. Balss, as well as the Showa Emperor.

Common name. "Ikeda-hon-yadokari" or "Ikeda's *Pagurus* hermit crab".

Remarks. A good number of additional specimens of *Pagurus ikedai* n. sp. collected by H. Ikeda and one of us (HW) from off Jogashima, Japan, were sent to Dr. S. Miyake many years prior to commencement of the present study. Unfortunately, Miyake's material could not located. This includes the male (9.8 mm) shown in Fig. 5, from off Jogashima, Japan, 280–320 m, collected in 1980. The remaining specimens that could not be located have the following data: 20+ specimens from South of Jogashima, fishing grounds (Heidashi to Iwadogake by way of Shimashita), 280–340 m, sand to rock, coll. H. Ikeda;

and several specimens observed in faunal investigation by HW from top of Misaki Knoll, southwest of Jogashima, 420–450 m, fine sand.

As previously mentioned, *Pagurus ikedai* n. sp. is most closely allied to species of the *bernhardus* group of *Pagurus*, and except for the lack of a spine in the new species on the dorsodistal margin of the merus of the third maxilliped, fits the definition provided by McLaughlin (1974). As in males of *P. ikedai*, males of three of the species in the *bernhardus* group, *P. bernhardus*, *P. gracilipes*, and *P. nipponensis*, can have very short sexual tubes. However, *Pagurus ikedai* can readily be distinguished from those three by the shape, armature and massiveness of both chelipeds. In *P. ikedai*, the dorsal surfaces of carpi and chelae are covered with numerous calcareous spines or tubercles that terminate in short corneous bristles (Fig. 1c). The chelae are dorsoventrally flattened, more so laterally, and the dorsolateral and dorsomesial margins of palms and fingers are sharply defined and finely serrate. The left cheliped is very similar to the right in shape and armature, and although distinctly smaller than the right, is much larger relative to that of other congeners in the *bernhardus* group.

The specimens examined of *Pagurus ikedai* n. sp. are quite constant in morphology, showing only slight but expected variations overall, such as in the number of spines on the dorsal (18–26), ventral (14–22) and ventromesial margins of the dactyls of the second and third pereopods, and the telson (Fig. 1e–h). No significant variations due to sexual dimorphism were detected. Although the overall size range (shield length 7.2 to 9.4 mm) of the specimens examined was relatively narrow, no significant allometric variation was observed either. In some males, the coxa of the right fifth pereopods has a slight papilla protruding from the gonopore, whereas in others there is a very short sexual tube (Fig. 1i, j); the coxa of the left fifth pereopod invariably has a slight papilla protruding from the gonopore. The males of at least three other species of *Pagurus* are also known to have short sexual tubes: *P. constans* (Stimpson, 1858), *P. hartae* (McLaughlin & Jensen, 1996), and *P. imaii* (Yokoya, 1939); however, when other characters are considered, these three species do not appear to be closely related to *P. ikedai* or any of the others in the *bernhardus* group.

Acknowledgements

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