A new species of *Pagurixus* Melin, 1939 (Crustacea, Decapoda, Anomura, Paguridae) from the Ryukyu Islands, Japan

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ABSTRACT
A new species of the hermit crab genus *Pagurixus* Melin, 1939, *P. patiae* n. sp., is described from intertidal reef flat of Iriomote Island, Yaeyama Islands of southern Ryukyu Islands, Japan. Morphological similarity suggests that the new species is allied to *P. laevimanus* (Ortmann, 1892) and *P. anceps* (Forest, 1954). However, the notably dissimilar fourth pereopods immediately distinguishes *P. patiae* n. sp. from *P. laevimanus* and *P. anceps*. Furthermore, characters of the cheliped, ambulatory legs and/or coloration in life also separate *P. patiae* n. sp. from the latter two species.

KEY WORDS
Crustacea,
Decapoda,
Anomura,
Paguridae,
Pagurixus,
Iriomote Island,
Ryukyu Islands,
Japan,
new species.

RÉSUMÉ
Une nouvelle espèce de Pagurixus *Melin, 1939 (Crustacea, Decapoda, Anomura, Paguridae) des îles Ryukyu, Japon.*
Une nouvelle espèce de bernard-l'ermite du genre *Pagurixus* Melin, 1939, *P. patiae* n. sp., est décrite de la zone intertidale de l'île Iriomote, îles Yaeyama, au sud de l'archipel des Ryukyu, Japon. Par sa morphologie, la nouvelle espèce est proche de *P. laevimanus* (Ortmann, 1892) et de *P. anceps* (Forest, 1954). Elle s'en distingue facilement par la dissymétrie de ses quatrièmes péréiopodes. La forme du chélipède et des pattes ambulatoires et/ou la coloration permettent également de séparer *P. patiae* n. sp. de *P. laevimanus* et de *P. anceps*.

MOTS CLÉS
Crustacea,
Decapoda,
Anomura,
Paguridae,
Pagurixus,
île Iriomote,
îles Ryukyu,
Japon,
espèce nouvelle.

INTRODUCTION

Hermit crabs of the genus *Pagurixus* Melin, 1939 are found in coral reefs or shallow rocky reefs in tropical and subtropical Indo-West Pacific waters and temperate waters of New Zealand and southern Australia. Fifteen species are known in the genus (Komai & Myorin 2005), of which more than half (nine species) have been described in the last two decades. Most species are small and cryptic in habitats, and it is possible that many more await discovery in what is known to be region of high marine biodiversity.

A new species of *Pagurixus* was discovered while sampling coral reef decapods from intertidal to subtidal habitats of Iriomote Island, Yaeyama Islands, southern Ryukyus. Morphologically, the new species, *P. patiae* n. sp., most closely resembles *P. laevimanus* (Ortmann, 1892) and *P. anceps* (Forest, 1954) (cf. McLaughlin & Haig 1984).

MATERIAL AND METHODS

The type series of the new species is deposited in the Natural History Museum and Institute, Chiba (CBM), Japan, and the Muséum national d'Histoire naturelle, Paris (MNHN). The shield length, abbreviated SL, is measured from the tip of rostrum to the midpoint of posterior margin of the shield. For detailed observation of the surface structure on the integument, the specimens (including removed appendages) were stained with methylene blue. Mouthparts are not illustrated because there are no differences in many characters within the genus (see for example Morgan 1993; Komai & Asakura 1995). Terminology used in the description, for the most part, follows that of McLaughlin (2003), with the exceptions of numbered thoracic sternites and dactylus (dactyli) for dactyl (dactyls).

For comparison, the following specimens were examined.

Pagurixus anceps (Forest, 1954): **Japan.** Kurio, Yakushima Island, Osumi Islands, intertidal, 6.VI.1996, coll. T. Komai, 1 ♀ SL 1.4 mm (CBM-ZC 8342). — Zanpamisaki, Okinawa Island, Ryukyus, intertidal, VI.1996, coll. E. Nishi, 1 ♂ SL 1.0 mm; 1 ovig. ♀ SL 1.4 mm (CBM-ZC 8347).

Pagurixus laevimanus (Ortmann, 1892): **Japan.** Bise-zaki, Okinawa Island, Ryukyu Islands, intertidal, 23.III.2004, coll. T. Komai, 2 ♂♂ SL 1.6, 1.7 mm (CBM-ZC 8407). — **Guam.** Pago reef front, 4-8 m, under rubble in surge channels and pockets, 14.VIII.2000, 6 ♂♂ SL 0.9-1.7 mm; 2 ♀♀ SL 0.9, 1.0 mm; 3 ovig. ♀♀ SL 1.0-1.1 mm; 1 juv. SL 1.0 mm (Florida Museum of Natural History).

SYSTEMATICS

Family PAGURIDAE Latreille, 1802
Genus *Pagurixus* Melin, 1939

Pagurixus patiae n. sp.
(Figs 1-4)

TYPE MATERIAL. — Holotype: **Japan.** Hoshizuna-hama beach, Iriomote Island, Yaeyama Islands, intertidal reef flat, under coral rock, 11.VII.2003, coll. T. Komai, ♂ SL 1.6 mm (CBM-ZC 8354).
Paratypes: same data as holotype, 3 ♂♂ SL 1.4-1.5 mm; 1 ovig. ♀ SL 1.4 mm (CBM-ZC 8355); 2 ♂♂ SL 1.4, 1.5 mm (MNHN-Pg 7611).

ETYMOLOGY. — It is a great pleasure to dedicate this new species to Patsy A. McLaughlin in recognition of her outstanding contributions to systematics of crustaceans and for helping me to study the taxonomy of Paguroidea in Asian waters that I have previously reported on. The specific name is an abbreviated form of her first name.

HABITAT. — Crevices or small holes under coral rocks on intertidal reef flats. Found using various gastropod shells as housing.

DISTRIBUTION. — So far known only from Iriomote Island, Yaeyama Islands, Ryukyu Islands, Japan; intertidal.

DESCRIPTION

Shield (Fig. 1A) 1.0-1.1 times as long as broad; anterior margin between rostrum and lateral projections weakly concave or nearly straight; anterolateral margins sloping; posterior margin roundly truncate; dorsal surface flat, at most with few tufts of short setae laterally. Rostrum triangular, distinctly overreaching lateral projections, moderately slender, terminating acutely. Lateral projections obtuse, with submarginal spinule.

Ocular peduncles (Fig. 1A) moderately stout, 0.6-0.8 length of shield, 3.0-3.5 times longer than corneal width, each with few short setae on dorsomesial

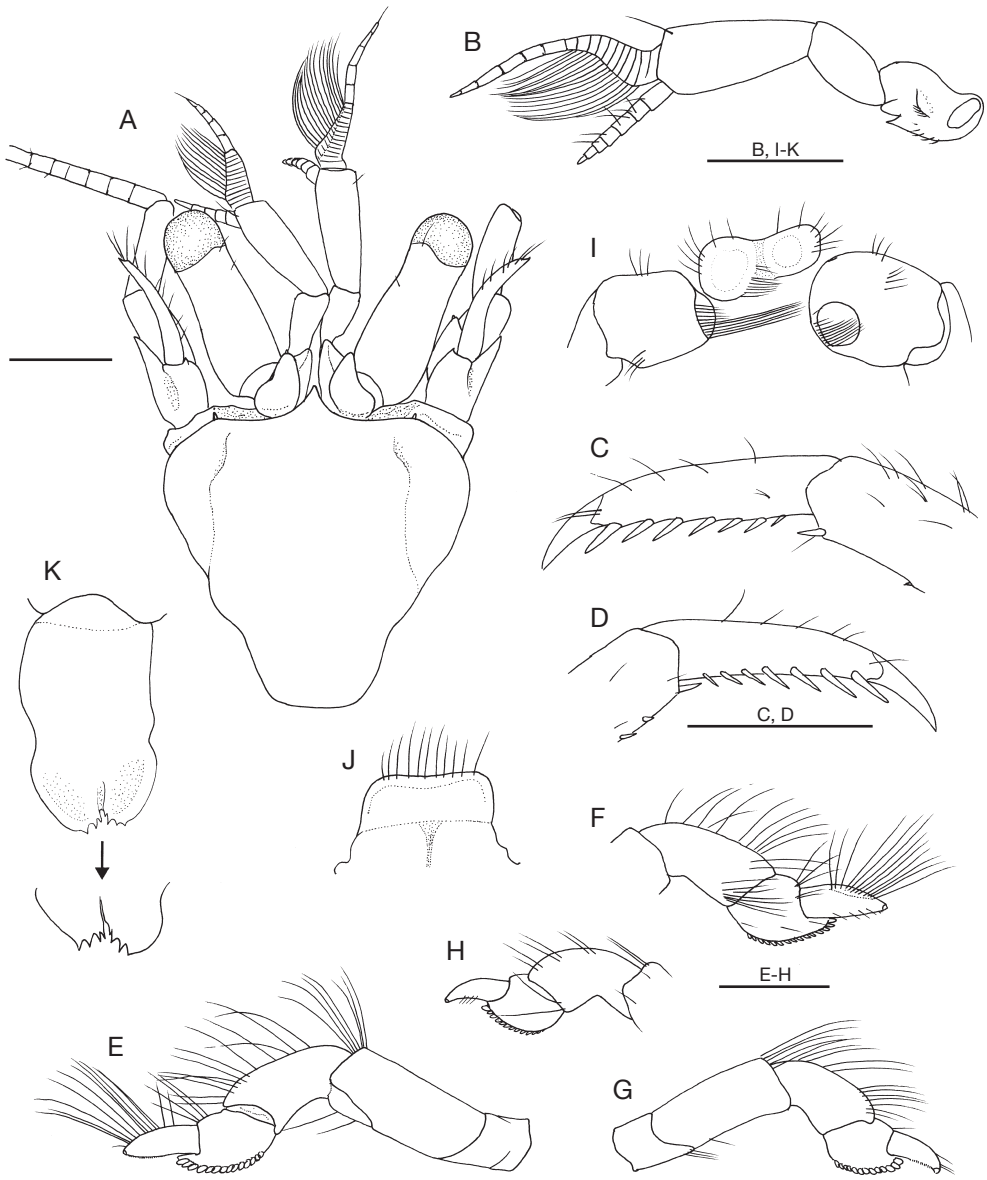

FIG. 1. — *Pagurixus patiae* n. sp., holotype ♂ SL 1.6 mm, Japan (CBM-ZC 8354): **A**, shield and cephalic appendages, dorsal view; **B**, left antennule, lateral view; **C**, dactylus of right second pereopod, mesial view; **D**, dactylus of left third pereopod, mesial view; **E**, left fourth pereopod, lateral view; **F**, same, distal three segments, mesial view; **G**, right fourth pereopod, lateral view; **H**, same, distal three segments, mesial view; **I**, coxae of fifth pereopods and eighth thoracic sternite, ventral view; **J**, sixth thoracic sternite, ventral view; **K**, telson, dorsal view; inset, terminal margins, posterodorsal view. Scale bars: 0.5 mm.

surface; corneas slightly dilated; basal part weakly inflated, slightly wider than cornea. Ocular acicles subtriangular, with small submarginal spinule.

Antennular peduncles (Fig. 1A, B) overreaching distal margins of corneas by 0.2 length of ultimate segment. Ultimate segment with moderately short

individual seta at dorsolateral distal angle; ventral surface without rows or series of short setae. Basal segment with small spine on lateral surface of statocyst lobe.

Antennal peduncles (Fig. 1A) slightly overreaching distal margins of corneas. Fifth segment moderately stout. Fourth segment with few short setae. Third segment with spinule at ventromesial distal angle. Second segment with small spine at dorsomesial distal angle; laterodistal projection moderately long, reaching mid-length of fourth segment, terminating in simple or bifid spine. First segment unarmed or armed with small laterodistal spine; ventromesial distal margin strongly produced, but unarmed. Antennal acicle moderately short, arcuate, overreaching base of cornea, but not reaching distal margin; mesial margin with row of sparse setae. Flagellum moderately long, exceeding 3.0 length of shield; each article with some short setae on distal margin.

Third maxilliped with well developed crista dentata and one accessory tooth on ischium.

Right cheliped of males (Fig. 2) not particularly elongate, massive in full-grown individuals. Chela subovate in dorsal view, 1.8-2.0 times longer than broad, weakly flattened dorsoventrally. Dactylus 0.6-1.0 of palm length, terminating in small corneous claw; dorsomesial margin not delimited; surfaces with small, simple or bifid granules and scattered very short setae; cutting edge with row of very low, obtuse teeth in proximal 0.8, occasionally proximalmost tooth conspicuous, and with row of very small corneous teeth in distal 0.2. Palm 0.8-1.2 of carpus length; convex dorsal surface with scattered small granules and few very short setae; dorsolateral margin slightly or faintly delimited by row of granules extending onto fixed finger; dorsomesial surface rounded, without delineation of dorsomesial margin; dorsomesial distal angle notably produced in triangular projection in holotype, but not produced or weakly produced in paratypes; lateral, mesial and ventral surfaces microscopically granular or nearly smooth. Fixed finger with obtuse calcareous teeth at middle and row of small calcareous teeth in distal 0.4, terminating in small corneous or calcareous claw. Carpus subequal in length to merus, notably widened distally, distal width 0.8-1.2 of length; dorsal surface with longitudinal row of tufts of spiniform setae mesially; dorsolateral and dorsomesial margins not delimited; all surfaces microscopically granular or smooth, lateral surface without longitudinal ridge; ventral surface convex, with few setae. Meral-carpal articulation lacking any pronounced clockwise rotation; dorsal surface of merus smooth, dorsodistal margin unarmed; lateral face smooth, ventrolateral margin with row of small spines in distal half; mesial face also smooth, convex ventromesial margin smooth, unarmed; ventral surface smooth, only with some short setae. Ischium with smooth ventromesial margin; surfaces also smooth.

Right cheliped of female (Fig. 3A-C) moderately stout for genus, subequal in length to left. Chela subovate in dorsal view, 2.3 times longer than broad. Dactylus 1.2 of palm length, terminating in small corneous claw; surfaces almost smooth, with irregular longitudinal rows of short to moderately long setae; cutting edge with row of small corneous teeth. Palm distinctly shorter than carpus; weakly convex dorsal surface with few small granules and scattered short setae; dorsolateral margin delimited by weak crenulate ridge extending onto mid-length of fixed finger, dorsomesial margin not delimited; lateral, mesial and ventral faces nearly smooth, with few setae on ventral surface. Cutting edge of fixed finger with row of small corneous teeth over entire length, terminating in small corneous claw. Carpus slightly shorter than merus and 2.8 times longer than distal width; dorsal surface with three small dorsomesial spines followed by row of tufts of spiniform setae and one dorsolateral distal spine, dorsolateral and dorsomesial margins not delimited; lateral face with scattered minute vertical or oblique ridges, devoid of longitudinal ridge, nearly perpendicular. Merus smooth on dorsal surface; lateral surface with numerous minute vertical ridges; ventrolateral margin with short row of small spines in distal 0.2; ventromesial margin smooth. Ischium unarmed.

Left cheliped (Fig. 3D-F) moderately short and stout, generally similar in both sexes. Chela about 2.5 times longer than wide, 1.2-1.3 of carpus length. Dactylus longer than palm, with sparse setae on surfaces; dorsal surface smooth or with few very

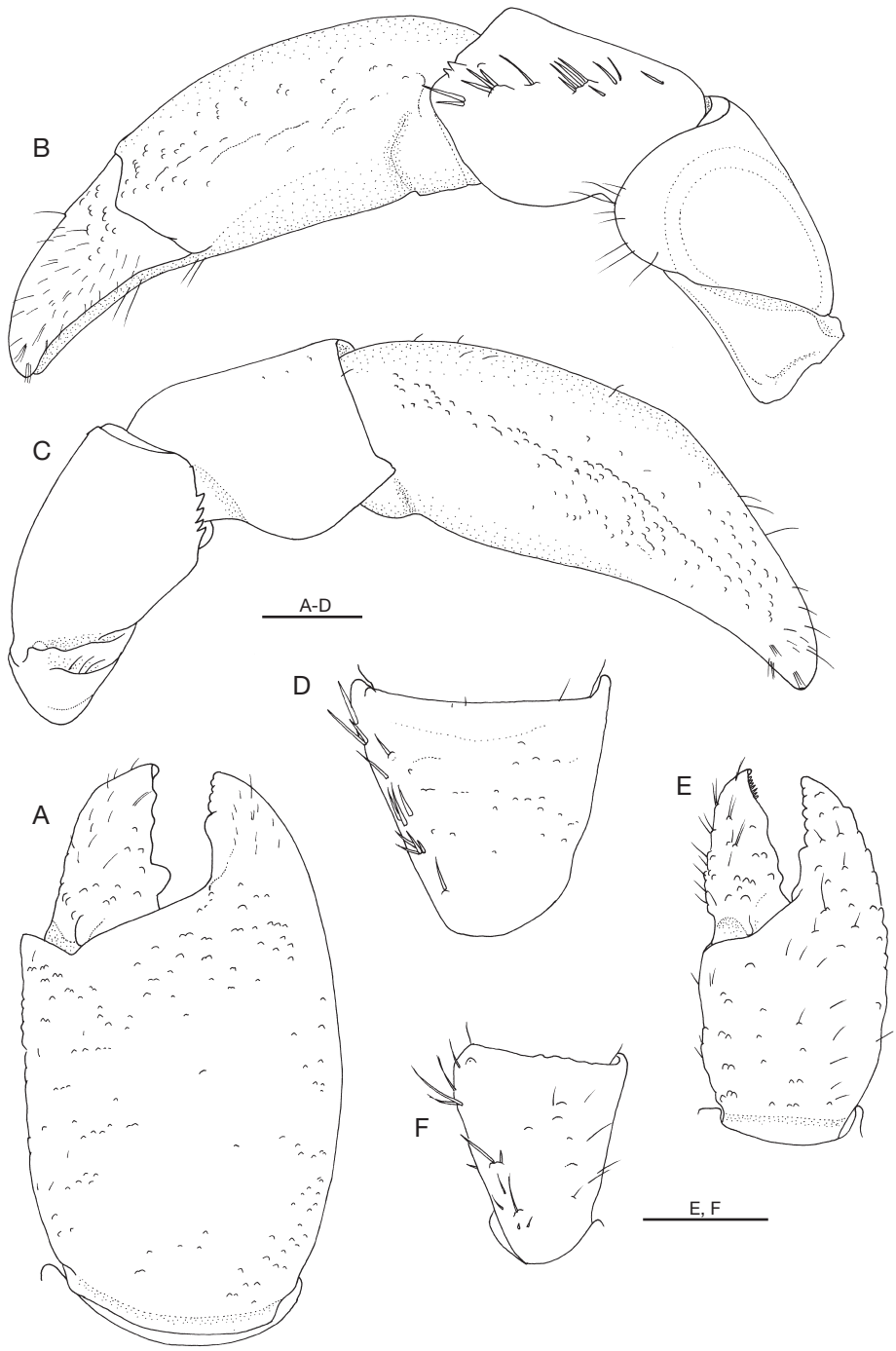

FIG. 2. — *Pagurixus patiae* n. sp., Japan, right cheliped: **A**-**D**, holotype ♂ SL 1.6 mm (CBM-ZC 8354); **E**, **F**, paratype ♂ SL 1.4 mm (CBM-ZC 8355); **A**, **E**, chela, dorsal view; **B**, entire right cheliped, mesial view; **C**, same, lateral view; **D**, **F**, carpus, dorsal view. Scale bars: 0.5 mm.

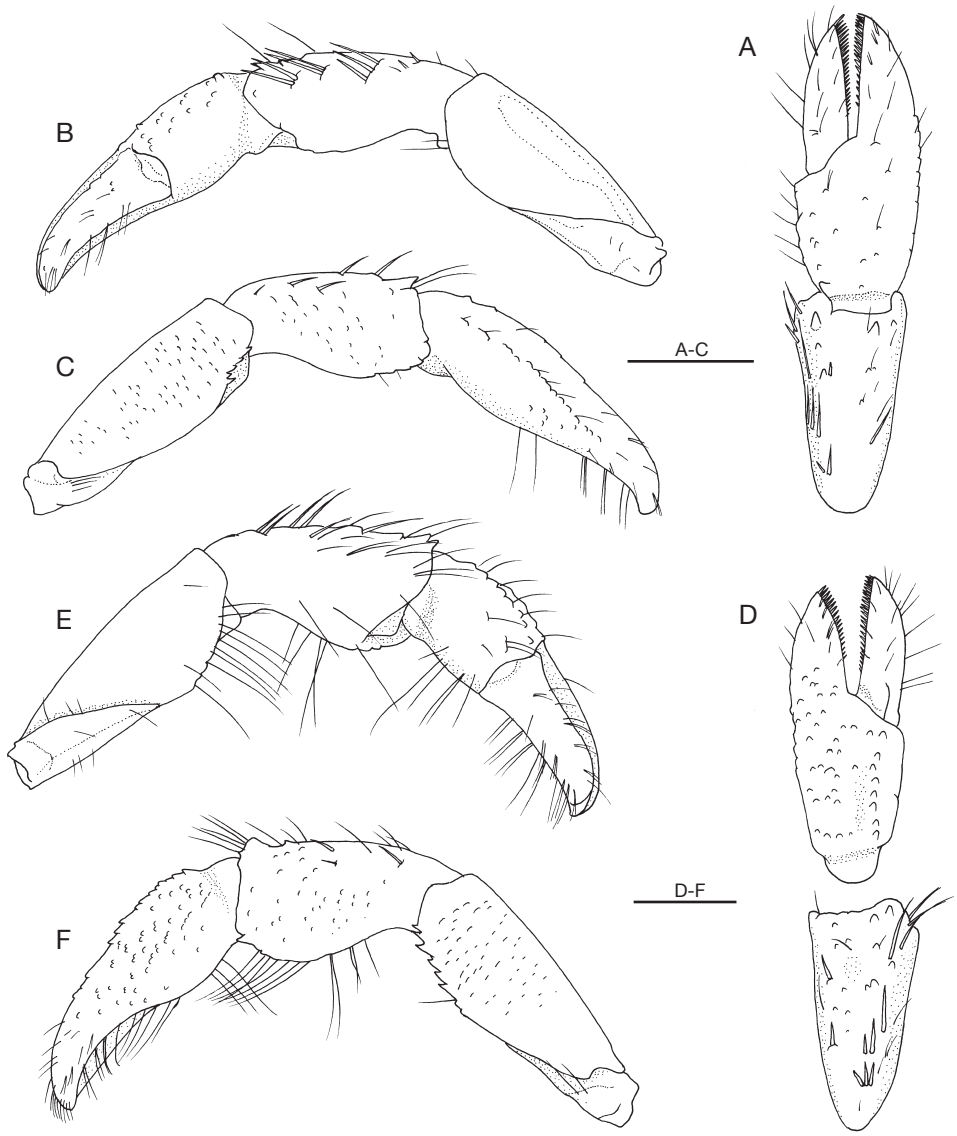

FIG. 3. — *Pagurixus patiae* n. sp., Japan: **A**-**C**, paratype ♀ SL 1.4 mm (CBM-ZC 8355); **D**-**F**, holotype ♂ SL 1.6 mm (CBM-ZC 8354); **A**, chela and carpus of right cheliped, dorsal view; **B**, entire right cheliped, mesial view; **C**, same, lateral view; **D**, chela and carpus of left cheliped, dorsal view; **E**, entire left cheliped, mesial view; **F**, same, lateral view. Scale bars: 0.5 mm.

small tubercles; cutting edge with row of slender corneous teeth, terminating in small corneous claw. Palm about half length of carpus; dorsal surface convex, with scattered small granules lateral to midline and longitudinal row of small granules mesial to midline; dorsolateral and dorsomesial margins not delimited; lateral surface with very small granules; mesial and ventral surfaces nearly smooth, with tufts of short to long setae. Fixed finger terminating in small corneous claw; cutting edge with row of slender corneous teeth. Carpus somewhat compressed laterally, 0.7-0.8 of chela length and shorter than

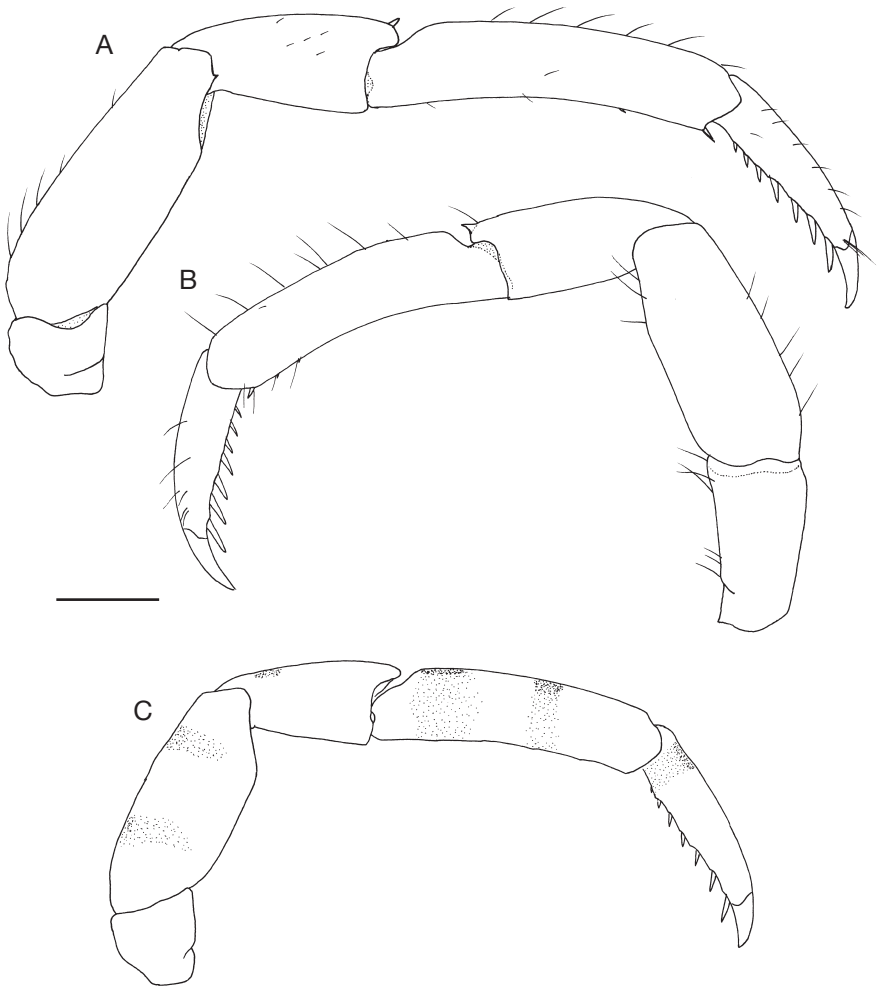

FIG. 4. — *Pagurixus patiae* n. sp., Japan, ambulatory legs; **A**, **B**, holotype ♂ SL 1.6 mm (CBM-ZC 8354); **C**, paratype ♂ SL 1.5 mm (CBM-ZC 8355); **A**, **C**, right second pereopods, lateral view, C showing color pattern (stippling in C indicates tan or reddish brown color pattern); **B**, left third pereopod, lateral view. Scale bar: 0.5 mm.

merus; length about 2.0 of distal width and 1.7-1.8 of greatest height; dorsal surface with few spiniform setae laterally, dorsomesial margin faintly delimited by row of small tubercles and tufts of spiniform setae; dorsodistal margin without distinct spines or tubercles; dorsolateral margin not delimited; lateral face nearly perpendicular, with scattered very low, small granules, but without trace of longitudinal ridge; mesial face smooth, with some long setae dorsally and ventrally; scattered long setae on weakly convex ventral surface. Merus smooth on dorsal surface, dorsodistal margin unarmed; lateral face with numerous, scattered minute vertical ridges, ventrolateral margin with row of small spines in distal half; mesial face smooth, ventromesial margin faintly tuberculate; ventral surface smooth, with few long setae. Ischium unarmed.

Ambulatory legs (Fig. 4) similar from right to left, moderately slender. Dactyli (Fig. 1C, D) 0.7-0.8 of propodi length, 5.2-6.1 times longer than height, terminating in large corneous claws; dorsal surfaces each with sparse short setae; lateral and

mesial faces each with few tufts of short setae, mesial faces unarmed; ventral margins each with five to eight (usually six or seven) corneous spines notably increasing in size distally. Propodi not markedly tapering distally, 4.2-5.5 times longer than distal height; dorsal surfaces smooth, with row of tufts of short setae; lateral faces smooth; ventral margins each with row of two to five corneous spinules, ventrodistal margins each with single or paired corneous spines. Each carpus usually with small dorsodistal spine; dorsal surfaces smooth, with few short setae. Meri with smooth dorsal and ventral margins each bearing row of sparse setae; lateral surfaces nearly smooth; ventrolateral distal margins each with small subdistal spine (second) or unarmed (third).

Fourth pereopods (Fig. 1D-H) semichelate, unequal and dissimilar from right to left, left appreciably larger than right. Left dactylus broad, terminating in small corneous claw, bearing prominent tuft of long setae on dorsal margin; ventral margin faintly sinuous, with row of minute corneous teeth. Right dactylus moderately slender, slightly curved ventrally, with tuft of short setae on dorsal margin. Propodi with setae on dorsal margin (setae longer and more numerous in left than in right); propodal rasp consisting of single row of small corneous scales; mesial face more convex in left than in right. Carpi each with distinct tuft of long setae (left) or few long setae (right) on mesial face ventrodistally.

Anterior lobe of sixth thoracic sternite (Fig. 1J) broadly subrectangular, slightly skewed to left, with row of short setae on anterior margin. Eighth thoracic sternite (Fig. 1I) composed of two slightly unequal, closely set, rounded lobes; right lobe with tuft of short setae posteromesially.

Male with coxae of right fifth pereopods subequal in size (Fig. 1I); right with prominent tuft of setae nearly reaching to left coxa; no development of papilla-like protrusion of vas deferens; left coxa with gonopore partially masked by tuft of short setae. Female with unpaired left gonopore.

Telson (Fig. 1K) with weak lateral indentations; lateral margins of posterior lobes bordered by chitinous edge; terminal margins weakly oblique, each with three to five small spines.

Coloration

In preservative: base colour of appendages cream or white with tan or brown markings. Ocular peduncles with longitudinal row of two or three spots on dorsal surface. Antennular peduncle with one narrow ring subproximally on ultimate segment; penultimate segment white on distal half, brown on proximal half. Antennal peduncle with spots on second segment. Chelipeds with broad, pale band on middle of carpi; meri with narrow ring subdistally. Ambulatory legs with tan or brown bands on white or cream background (Fig. 4C); dactyli each with one proximal band; propodi each with two bands, one medially, and one proximally; carpi each with two bands, one medially, and one proximally, or one spot dorsoproximally; meri each with two bands, one subdistally, and one subproximally.

Size

Males: SL 1.4-1.6 mm; ovigerous female: SL 1.4 mm.

Remarks

The right cheliped of the single ovigerous female is subequal in the length to and only slightly stouter than the left cheliped. In the known species of *Pagurixus*, however, the right cheliped is larger than the left even in females (McLaughlin & Haig 1984; Morgan 1993; Komai & Asakura 1995; Komai & Myorin 2005), and thus it is likely that the right cheliped of this female specimen was in the process of regeneration.

McLaughlin & Haig (1984) divided *Pagurixus* into two groups on the basis of presence or absence of two distinct rows of setae on the ventral surface of the ultimate segment of the antennular peduncle. *Pagurixus patiae* n. sp. has only a few very short setae on the ventral surface of the ultimate peduncular segment and falls into the group lacking two distinct rows. This group includes the following 10 known species: *P. amsa* Morgan, 1993, *P. anceps* (Forest, 1954), *P. fasciatus* Komai & Myorin, 2005, *P. granulimanus* Morgan, 1993, *P. handrecki* Gun & Morgan, 1992, *P. hectori* (Filhol, 1883), *P. jerviensis* McLaughlin & Haig, 1984, *P. kermadescensis* de Saint Laurent & McLaughlin, 2000, *P. laevimanus* (Ortmann, 1892), and *P. stenops*

Morgan, 1993 (McLaughlin & Haig 1984; Gun & Morgan 1992; Morgan 1993). The present new species appears most similar to *P. laevimanus*. In particular, general shape of the right cheliped is similar in both species; the number of the ventral spines on the ambulatory dactyli is relatively fewer (five to eight) in the two species, compared with other species (excepting *P. anceps* and *P. fasciatus*) having eight or more spines. However, *P. patiae* n. sp. differs from *P. laevimanus* in having notably unequal, dissimilar fourth pereopods, of which the left is appreciably larger than the right and is provided with a prominent tuft of setae on the dactylus. Personal examination has shown that *P. anceps* and *P. fasciatus* have similar fourth pereopods, like *P. laevimanus*, although it needs to be verified if the fourth pereopods are actually similar or dissimilar in *P. amsa*, *P. granulimanus*, *P. handrecki*, *P. hectori*, *P. jerviensis*, *P. kermadescensis* and *P. stenops*. Marked asymmetry of the fourth pereopods are also known in some species of the *Pagurus anachoretus* group (Komai & Osawa 2001; Komai & Rahayu 2004), but the function of the asymmetry remains unknown. Furthermore, the carpus of the male right cheliped is devoid of a dorsomesial row of spines in the new species, which is present in *P. laevimanus*; and the dactyli of the ambulatory legs are proportionally shorter in the new species than in *P. laevimanus* (0.7-0.8 times as long as the propodi versus 0.8-1.0 times as long). The coloration in life is also different between the two species (pers. obs.). Although the base colour of the ambulatory legs is white in both species, the present new species has tan rings (see Coloration), whereas there are brown longitudinal stripes, often interrupted medially, on the lateral surfaces in *P. laevimanus*.

Pagurixus patiae n. sp. also resembles *P. anceps*. In these two species, the carpus of the male right cheliped lacks dorsomesial spines. The colour pattern is also similar between the two. Nevertheless, in addition to the similar and subequal fourth pereopods, *P. patiae* n. sp. differs from *P. anceps* in having a non-produced ventrodistal margin of the carpus of the left third pereopod. The ventrodistal margin of the carpus of the left third pereopod is distinctly produced in *P. anceps* (Forest 1954: fig. 19; personal examination). Furthermore, ambulatory legs are less stout, and dactyli are proportionally shorter in *P. patiae* n. sp. than in *P. anceps*. The propodi are 4.2-5.5 times longer than the distal depths in *P. patiae* n. sp., but 3.0-4.0 in *P. anceps*; the dactyli are 0.7-0.8 of the propodi lengths in *P. patiae* n. sp., whereas 0.9-1.1 in *P. anceps*.

Although the number of the ventral spines on the ambulatory dactyli greatly overlap between *P. patiae* n. sp. and *P. fasciatus* (five to eight in the former and five to nine in the latter), *P. fasciatus* can be immediately distinguished from *P. patiae* n. sp. by the sharply keeled dorsomesial margin of the right palm, as well as the subequal, similar fourth pereopods. The coloration in life is quite different between the two. The ambulatory dactyli and propodi of *P. fasciatus* are generally dark brown with white distal band on each propodus (see Komai & Myorin 2005).

NOTE ADDED TO PROOF

Komai & Osawa (in press a) showed that McLaughlin & Haig (1984) misidentified *Pagurixus laevimanus*. After examining the holotype of *P. laevimanus*, they concluded that McLaughlin & Haig's *P. laevimanus* was an undescribed species, which is being described as new by Komai & Osawa (in press b).

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