

The taxonomic position of *Pagurus gracilipes* (Stimpson, 1858) and *Pagurus nipponensis* (Yokoya, 1933), and description of a new species of *Pagurus* (Decapoda, Anomura, Paguridae) from Japan

Tomoyuki KOMAI

Natural History Museum & Institute, Chiba
Aoba-cho, Chuo-ku, Chiba 260 (Japan)
j90054@simail.ne.jp

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ABSTRACT

Hermit crab specimens, previously assigned to *Pagurus gracilipes* (Stimpson, 1858) from the northwestern Pacific, have been critically reexamined. Examination of specimens from various localities from Japan and Russian Far East, has disclosed that males possess a short sexual tube on the right coxa of the fifth pereopod, and that two species have been synonymized under the name *Pagurus gracilipes*. The two taxa are provisionally transferred to the genus *Parapagurodes* McLaughlin et Haig, 1973. *Parapagurodes gracilipes* is redescribed on the basis of the specimens from northern Japan and Russian Far East, including topotypic material from Hakodate Bay, southern Hokkaido. *Parapagurodes nipponensis* (Yokoya, 1933), which has been considered to be synonymous with *P. gracilipes*, is reinstated for specimens from the Pacific coast of central and southwestern Japanese main islands, from Kashima, Ibaraki to Tosa Bay and Taiwan. The two species are for the most part geographically separated, though their distributions partly overlap. A neotype is designated for *P. gracilipes*, and a lectotype is selected for *P. nipponensis*. In addition, a new species of the genus *Pagurus*, *P. alaini*, is described and illustrated on the basis of material from Tosa Bay and Bungo Strait, Japan. The new species appears closest to *P. kaiensis* McLaughlin, 1997, known only from Kai Islands, Indonesia.

KEY WORDS

Crustacea,
Decapoda,
Anomura,
Paguridae,
Parapagurodes,
Pagurus,
northwestern Pacific,
taxonomy.

RÉSUMÉ

Statut systématique de Pagurus gracilipes (Stimpson, 1858) et Pagurus nipponensis (Yokoya, 1933), et description d'une nouvelle espèce de Pagurus (Decapoda, Anomura, Paguridae) du Japon. Les pagures du nord-ouest du Pacifique auparavant attribués à *Pagurus gracilipes* (Stimpson, 1858) ont été réexaminés de façon critique. L'examen de spécimens de différentes localités du Japon et de l'Extrême-Orient russe montre que les mâles possèdent un court conduit sexuel sur la coxa droite du cinquième péréiopode, et que deux espèces ont été confondues sous le nom *Pagurus gracilipes*. Les deux taxa sont provisoirement transférés dans le genre *Parapagurodes* McLaughlin et Haig, 1973. *Parapagurodes gracilipes* est redécrit d'après les spécimens du nord du Japon et de l'Extrême-Orient russe, dont du matériel topotypique de la baie d'Hakodate au sud d'Hokkaido. *Parapagurodes nipponensis* (Yokoya, 1933), considéré comme synonyme de *P. gracilipes*, est rétabli pour les spécimens de la côte Pacifique des principales îles japonaises du centre et du sud-ouest, de Kashima (Ibaraki) jusqu'à la baie de Tosa et Taiwan. Dans l'ensemble, les deux espèces sont séparées géographiquement, bien que leurs aires de distribution se recoupent partiellement. Un néotype est désigné pour *P. gracilipes*, et un lectotype est choisi pour *P. nipponensis*. Une nouvelle espèce, *P. alaini*, est ajoutée au genre *Pagurus*, et décrite et figurée d'après du matériel de la baie de Tosa et du détroit de Bungo au Japon. La nouvelle espèce semble proche de *P. kaiensis* McLaughlin, 1997 connue seulement des îles Kai en Indonésie.

MOTS CLÉS.

Crustacea,
Decapoda,
Anomura,
Paguridae,
Parapagurodes,
Pagurus,
nord-ouest Pacifique,
taxonomie.

INTRODUCTION

Stimpson (1858) described *Eupagurus gracilipes* from Hakodate Bay, southern Hokkaido, Japan, and later Doflein (1902) and Balss (1913) recorded the species from Sagami Bay. Subsequently, Yokoya (1933) described a number of new species of hermit crabs, among them *Eupagurus nipponensis*. The description of this species was based on specimens collected from various locations in the Japanese main islands during a biological survey of the continental shelf of Japan made by S. S. *Soyo-Maru*. Yokoya was obviously unaware of Stimpson's description as he also described a new species which he named *Eupagurus gracilipes*, which proved to be a homonym of Stimpson's (1858) taxon. Makarov (1938) placed Yokoya's *E. nipponensis* in synonymy with Stimpson's *E. gracilipes*. Yokoya's *E. gracilipes* was renamed *Pagurus yokoyai* by Makarov (1938: 184-185; 1962: 175), and this has been followed by subsequent authors such as Miyake (1965;

1975; 1982), Miyake & Imafuku (1980), Takeda (1982) and Baba (1986).

During a taxonomic study of decapod Crustacea of northern Japan, I collected specimens clearly assignable to Stimpson's *Eupagurus gracilipes*, including topotypic material from Hakodate Bay. I noticed that the northern Japan specimens had apparently different colour patterns from those in the colour photographs of Miyake (1982) and Baba (1986) which depicted specimens from Kii Minabe and Tosa Bay. The northern specimens had two blue iridescent longitudinal lines on the right palm, and lacked brown and cream stripes on the lateral surfaces on the ambulatory propodi. Careful examination of material from various localities in Japan, the Russian Far East and Taiwan disclosed that male specimens bear a short sexual tube on the right coxa of the fifth pereopods, and that two species have been confounded under the name of *Pagurus gracilipes* (Stimpson). According to current definitions of pagurid genera, the two species cannot be assigned to *Pagurus*

Fabricius, 1775, but must instead be assigned to *Parapagurodes* McLaughlin & Haig, 1973.

The two species are geographically separated for the most part, though their distributions partly overlap. The species distributed in Hokkaido, northern Honshu southward to Choshi, Chiba, and Russian Far East is referred to *Parapagurodes gracilipes* (Stimpson), and the species distributed in the Pacific coast of central and southwestern Japanese main islands, from Kashima, Ibaraki to Kyushu and Taiwan is referred to *Parapagurodes nipponensis* (Yokoya). *Parapagurodes nipponensis* has a tendency to inhabit deeper water than *P. gracilipes*. As noted above, Stimpson's taxon originally came from Hakodate, southern Hokkaido. Yokoya's taxon was described on the basis of twenty-nine specimens collected during *Soyo-Maru* cruises around Japanese main islands (see "Remarks" under the account *Parapagurodes nipponensis*). The two species are distinguished morphologically from each other by the armament of the ambulatory dactyls and the shape of the posterior margin of the telson, in addition to the coloration. As was the case with many of Stimpson's species, the type material of *Pagurus gracilipes* apparently was destroyed (cf. Rathbun

1883). However, I was able to find a single lot containing two syntypes of *Eupagurus nipponensis* from south of Omae-zaki (*Soyo-Maru*, stn 278) in the collection of the Kitakyushu Museum of Natural History. My attempts to find other lots were not successful. Yokoya's type material of *E. nipponensis* contained specimens from Tsugaru Strait, very near to Hakodate Bay and from Inubo-zaki, Choshi, where the two species are likely to overlap. In the interest of stability in nomenclature, a neotype is herein designated for *P. gracilipes*, and the larger, more intact syntype specimen is selected as a lectotype of *P. nipponensis*. *Parapagurodes gracilipes* is fully described and illustrated, while brief diagnosis is given for *Parapagurodes nipponensis*, as the species is very similar to *P. gracilipes*.

In addition, I include here a description of a new species of *Pagurus*, *P. alaini*, from Tosa Bay and Bungo Strait, Japan. The new species shows some superficial resemblance to the *bernhardus* group of *Pagurus* (cf. McLaughlin 1974), but it appears closest to *P. kaiensis* McLaughlin, 1997, known only from Kai Islands, Indonesia. At present no species-group assignment can be made for *P. alaini*, nor has one been made for *P. kaiensis*.

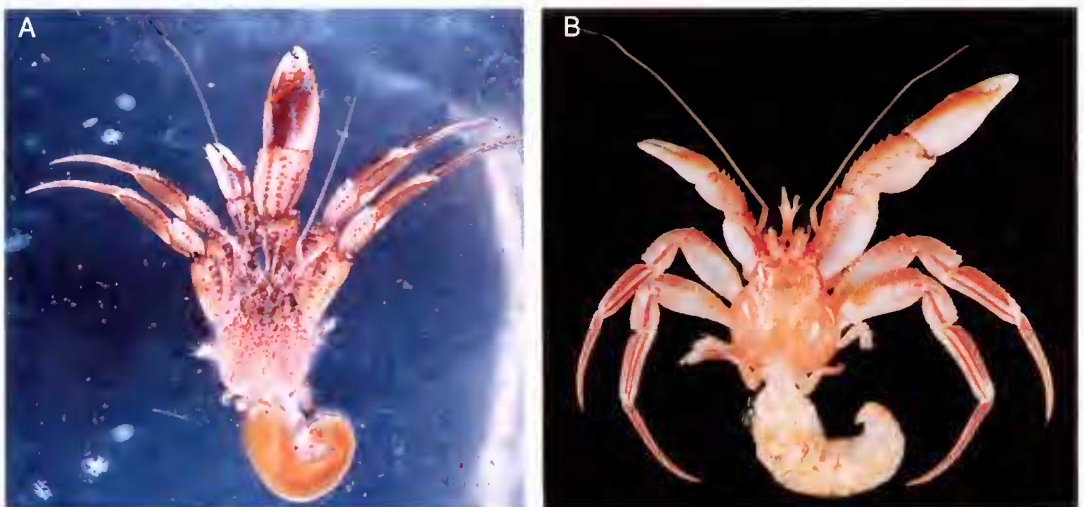


FIG. 1. — A, *Parapagurodes gracilipes* (Stimpson, 1858), entire animal, dorsal, ♂ SL 7.3 mm, Choshi, central Japan, CBM-ZC 3410. B, *Parapagurodes nipponensis* (Yokoya, 1933), ♂ SL 8.7 mm, Su-Aou, NE Taiwan, NTOU (photography by T.-Y. Chan).

The specimens examined in this study are deposited in institutions indicated by the following abbreviations:

CBM	Natural History Museum and Institute, Chiba;
HUMZ	Laboratory of Marine Zoology, Faculty of Fisheries, Hokkaido University Hakodate;
KMNH	Kitakyushu Museum of Natural History;
MNHN	Muséum national d'Histoire naturelle, Paris;
NTOU	National Taiwan Ocean University, Keelung;
SMI-NSMT	Showa Memorial Institute, National Science Museum, Tsukuba;
USNM	National Museum of Natural History, Smithsonian Institution, Washington, D. C.

The general terminology used in the description is that of McLaughlin (1974), but Lemaitre (1995) is referred to for the posterior carapace structure. The term "semichelate" to describe the condition of the fourth pereopods is used following McLaughlin's (1997) definition. The shield length (SL), measured from the tip of the rostrum to the midpoint of the posterior margin of the shield, is used to indicate size of specimens.

SYSTEMATICS

Genus *Parapagurodes* McLaughlin et Haig, 1973

Parapagurodes gracilipes (Stimpson, 1858),
comb. nov.
(Figs 1A, 2-5, 7)

Eupagurus gracilipes Stimpson, 1858: 248; 1907: 217. — Alcock 1905: 177 (in part). — Yokoya 1939: 281. — Urita 1942: 45, fig. 14.

Pagurus gracilipes — Makarov, 1938: 184 (in part), pl. 4, fig. 4; 1962: 175 (in part), pl. 4, fig. 4. — Vinogradov 1950: 227 (in part), fig. 117. — Miyake 1957: 87 (in part); 1965: 647 (in part); 1975: 286 (in part); 1982: 126 (in part). — Igarashi 1970: 4, pl. 3, fig. 9. — Kim 1973: 222, fig. 48, pl. 5, fig. 28. — Takeda 1982: 68 (in part). — Komai et al. 1992: 197.

Not *Eupagurus gracilipes* — Doflein 1902: 647, pl. 6, figs 6-8. — Balss 1913: 56. — Terao 1913: 368. [= *Parapagurodes nipponensis* (Yokoya, 1933)].

Not *Eupagurus gracilipes* Yokoya, 1933: 98, fig. 33 [= *Pagurus yokoyai* Makarov, 1938].

Not *Pagurus gracilipes* — Miyake 1978: 85, fig. 33. — Miyake & Imafuku 1980: 59. — Baba 1986: 201, 303, fig. 149 [= *Parapagurodes nipponensis* (Yokoya, 1933)].

TYPE MATERIAL. — **Japan**. Off Kamiiso, Hakodate Bay, southern Hokkaido, 5-10 m, 8.III.1991, dredge, coll. S. Goshima: neotype ovig, ♀ SL 5.1 mm (CBM-ZC 3414).

MATERIAL EXAMINED. — **Japan**. Obira, Japan Sea coast of Hokkaido, 44°00'N - 141°39'E, 20 m, 21.VII.1991, beam trawl, coll. S. Maruyama: 1 ovig, ♀ SL 5.7 mm (CBM-ZC 501). — Off Choshi, Chiba, ca. 20 m, 18.I.1995, commercial trawl, coll. T. Komai: 1 ♂ SL 7.0 mm, 1 ♀ SL 6.6 mm (CBM-ZC 941). — Off Choshi, Chiba, 10-20 m, 3.IX.1996, commercial trawler, coll. T. Komai: 2 ♂♂ SL 5.4, 9.0 mm, 1 ♀ SL 6.7 mm (CBM-ZC 2977). — Off Obira, Japan Sea coast of Hokkaido, 44°00'N - 141°39'E, 42 m, 19.VIII.1994, sledge net, coll. F. Muro: 4 ♂♂ SL 4.2-7.2 mm (CBM-ZC 3409). — Off Choshi, Chiba, 10-20 m, 10.I.1997, commercial trawler, coll. T. Komai: 1 ♂ SL 7.3 mm (CBM-ZC 3410). — Same data as neotype: 5 ovig, ♀♀ SL 5.5-6.0 mm (CBM-ZC 3415). — Miyako Bay, Iwate, ca. 15 m, IV.1987, gill net, coll. T. Komai: 3 ♂♂ SL 8.4-9.0 mm (HUMZ-C 79).

Russian Far East. Slednaya Bay, Prymorye, subtidal, 27.VIII.1994, beach seine, coll. M. Yabe: 1 ♂ SL 6.4 mm (CBM-ZC 2456).

DISTRIBUTION. — Known with certainty from northern Japan including Hokkaido and northeastern Honshu main island southward to Choshi, Chiba (35°40'N), continental coast of the Russian Far East, Sakhalin, subtidal to 42 m.

SIZE. — Largest ♂: 9.0 mm in SL; largest ♀: 6.7 mm in SL; smallest ovigerous ♀: 5.5 mm in SL.

HABITAT. — Found in gastropod shells; occasionally with one or more anthozoan polyps attached to the shell. Inhabiting sandy or sandy mud bottom, subtidal to a depth of 42 m.

REDESCRIPTION

Shield (Fig. 2A) varying from slightly longer than broad to slightly broader than long; antero-lateral margins sloping; anterior margin between rostrum and lateral projections concave; posterior margin rounded; dorsal surface convex, generally smooth, but with scattered tufts of moderately short setae. Rostrum distinctly exceeding lateral projections, triangular, acute or subacute, usually with small terminal spine. Lateral projections broadly rounded or obtusely triangular, with small terminal spine. Posterior carapace

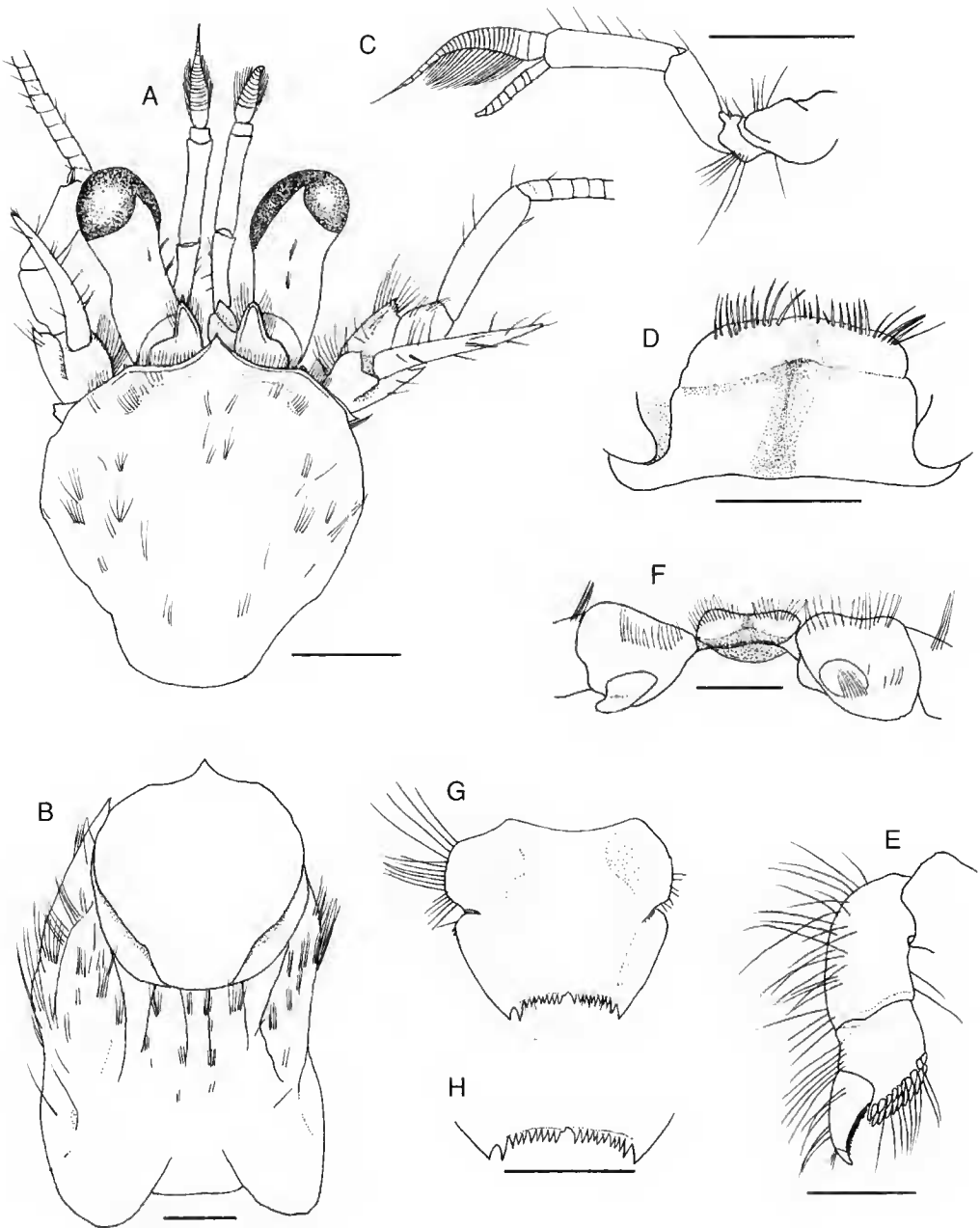


FIG. 2. — *Parapagurodes gracilipes* (Stimpson, 1858). A-E, G, H, neotype, ♀ SL 5.1 mm (CBM-ZC 3414), Hakodate Bay, southern Hokkaido, Japan; F, ♂ SL 9.0 mm (HUMZ-C 79), Miyako Bay, Tohoku district of Honshu, Japan; A, shield and cephalic appendages, dorsal; B, carapace, dorsal (setae on shield omitted); C, left antennule, lateral; D, sternal lobe of sixth thoracic somite, ventral; E, distal three segments of left fourth pereopod, lateral; F, coxae of fifth pereopods and sternal lobe of eighth thoracic somite, ventral; G, telson, dorsal; H, terminal margins of telson, dorsal. Scale bars: A-C, F, 2 mm; D, E, G, H, 1 mm.

(Fig. 2B) with scattered tufts of long setae dorsally; posteromedian plate calcified; cardiac sulci nearly parallel, not extending to posterior margin of carapace; sulci cardiobranchiales slightly divergent posteriorly, not extending beyond cardiac sulci.

Ocular peduncles (Fig. 2A) 0.6-0.7 times as long as shield, stout, weakly inflated basally, corneal region ovate, noticeably dilated; dorsomesial surface with longitudinal row of short setae. Ocular acicles subtriangular or subovate, mesial margins nearly straight or convex, lateral margins nearly straight, sometimes sinuous, dorsal surface concave, terminating roundly, usually with prominent submarginal spine.

Antennular peduncles (Fig. 2A, C) exceeding ocular peduncles by 0.5-0.7 length of ultimate segment; ultimate segment about 1.5 times longer than intermediate segment, with row of setae dorsally; basal segment stout, inflated ventrally and laterally, unarmed laterally.

Antennal peduncles (Fig. 2A) exceeding ocular peduncles by 0.5-0.75 length of fifth segment; with supernumerary segmentation. Fifth segment unarmed, with few setae on mesial surface. Third segment with ventromesial distal angle produced, terminating in prominent spine, partially obscured by tufts of moderately long setae. Second segment with dorsolateral distal angle produced, terminating in simple or bifid spine, mesial margin with few small spines; dorsomesial distal angle with small spine, mesial surface with numerous setae. First segment with or without small spine at laterodistal margin. Antennal acicle arcuate, slightly shorter to somewhat longer than ocular peduncle, nearly reaching or distinctly overreaching distal corneal margin, sharply edged mesially, dorsal surface flattened, mesial margin unarmed, but with tufts of setae. Antennal flagella long, simple.

Mandible (Fig. 3A) typical of genus. Maxillule (Fig. 3B) with proximal endite subquadrate; endopod with one or two bristles on well developed, broadly based internal lobe, external lobe produced, recurved toward interior. Maxilla (Fig. 3C) with endopod inflated basally, extending beyond distal margin of scaphognathite. First maxilliped (Fig. 3D) with endopod extending as far as distal margin of distal endite.

Second maxilliped (Fig. 3E) with basis-ischium fusion incomplete. Third maxilliped (Fig. 3F) with basis-ischium fusion incomplete; basis (Fig. 3G) with strong, corneous tipped spine mesially; crista dentata on ischium (Fig. 3G) composed of relatively stout spines, becoming more slender and closer distally, accessory tooth strong; merus usually with acute spine on dorso-distal margin; carpus with dorsodistal margin unarmed.

Right cheliped (Figs 3H, 4A, B) moderately (small specimens) to considerably (large specimens) elongate. Chela 1.8-2.0 times as long as wide, dorsolateral margin convex. Dactyl approximately equalling length of palm; cutting edge with row of four strong calcareous teeth in proximal 0.75 length and with row of small corneous teeth subdistally, terminating in strong calcareous tooth, overlapped by fixed finger; dorsomesial margin sharply ridged, tuberculate proximally, dorsal surface with sharp ridge mesially, sometimes weakly tuberculate proximally; ventral surface with several tufts of stiff setae. Cutting edge of fixed finger with row of low calcareous teeth and of small corneous teeth subdistally, terminating in calcareous claw. Palm slightly shorter than carpus; dorsal surface convex, with small granules or spinulose tubercles, occasionally arranged in transverse rows, making surface rugose, almost naked; dorsomesial surface weakly elevated, sloping to mesial surface, with larger, flattened tubercles, occasionally multifid distally; dorsolateral margin with row of moderately strong spines or tubercles increasing in size distally; lateral surface with numerous low, occasionally bifid or multifid tubercles and granules; ventral surface with few tubercles. Carpus subequal in length to merus; dorsal surface convex, with numerous scattered spines or spinulose, frequently bifid or multifid tubercles and distinct row of spines mesial to mid-line, distal margin denticulate, dorsomesial margin with row of strong, acute or subacute spines, increasing in size distally; dorsolateral surface sloping to lateral surface; mesial surface with few low tubercles dorsally; lateral surface with scattered short oblique rows of small spines or tubercles and granules; ventral surface with few small acute or subacute spinulose tubercles.

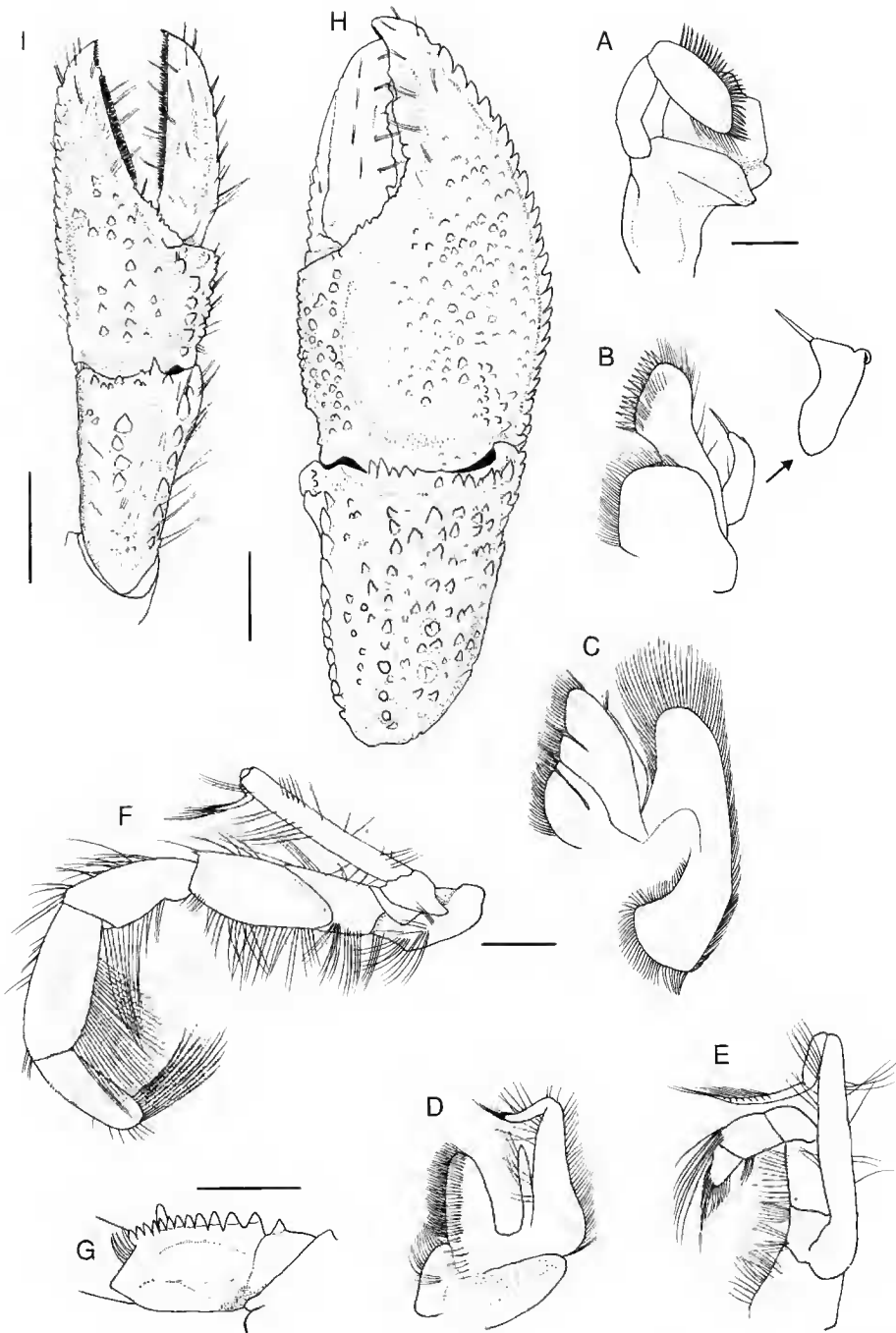


FIG. 3. — *Parapagurodes gracilipes* (Stimpson, 1858), neotype, ♀ SL 5.1 mm (CBM-ZC 3414), Hakodate Bay, southern Hokkaido, Japan; left mouthparts; A, mandible, internal; B, maxillule, external; inset, endopod, lateral; C, maxilla, external; D, first maxilliped, external; E, second maxilliped, external; F, third maxilliped, lateral (external); G, ischium of third maxilliped, dorsal (internal); H, chela and carpus of right cheliped, dorsal; I, chela and carpus of left cheliped, dorsal. Scale bars: A, B, 0.5 mm; C-G, 1 mm; H, I, 2 mm.

Merus with dorsal surface having transverse multidenticulate ridges and row of short setae or bristles, distal margin with several small or moderately strong, acute spines, extending laterally and mesially; lateral and mesial faces almost smooth dorsally, with short vertical granular ridges ventrally; ventral surface spinulose or tuberculate. Ischium with row of small spines or denticles and tufts of setae on ventromesial margin, ventrolateral margin with few small spines or tubercles. Coxa with few small spines at ventrolateral distal angle; ventromesial margin with dense tufts of stiff setae.

Left cheliped (Figs 3I, 4C, D) reaching distal margin of carpus or mid-length of palm of right cheliped. Chela 1.9-2.2 times longer than wide, widest at base of dactyl, dorsolateral margin slightly convex or nearly straight. Dactyl approximately twice length of palm; dorsomesial margin convex, with row of low protuberances or small tubercles and row of tufts of stiff setae, dorsal surface sometimes with row of small tubercles proximally; mesial and ventral surfaces nearly smooth, but with scattered tufts of stiff setae; cutting edge with row of closely set corneous teeth and few obtuse calcareous teeth, terminating in small corneous claw, slightly exceeded in length and overlapped by fixed finger. Cutting edge of fixed finger with row of closely set corneous teeth, terminating in small corneous claw. Palm with dorsolateral and dorsomesial margins weakly elevated, with single row of simple spines or spinulose tubercles, dorsal surface with several rows of moderately strong spines or spinulose tubercles; mesial and lateral surfaces nearly smooth, with few low protuberances and tufts of stiff setae; ventral surface with small, occasionally spinulose tubercles and tufts of short setae. Carpus subequal in length to merus; dorsal surface oblique, dorsomesial margin with single row of strong spines, dorsolateral surface with short submedian row of prominent spines or spinulose tubercles and laterally with obliquely vertical multifid protuberances bearing bristles, distal margin strongly spinous; mesial surface slightly concave, with few low protuberances bearing setae and scattered tufts of moderately long setae, ventromesial margin minutely tuberculate distally; ventral surface nearly smooth.

Merus triangular in cross-section; dorsal surface with transverse, multidenticulate ridges bearing long setae, distal ones extending to mesial surface, distal margin with one prominent spine obscured by setae; mesial face nearly smooth, with few tufts of short setae dorsally, distal margin unarmed; lateral face with few short, vertical ridges distally and scattered setae, distal margin unarmed; ventral surface with multidenticulate tubercles, ventromesial and ventrolateral margins each with row of small, simple or multifid tubercles and short setae. Ischium with row of simple or bifid spines on ventromesial margin, ventrolateral margin with row of small spinulose tubercles. Coxa similar to that of right cheliped. Ambulatory pereopods (Fig. 5A, D) long; right second pereopod often overreaching tip of right chela. Dactyls (Fig. 5B, C) 1.32-1.53 times longer than propodi in second pair, 1.38-1.64 times longer in third pair, relatively broad; in lateral view, weakly or moderately curved ventrally; in dorsal view, strongly twisted; dorsal surfaces each with shallow longitudinal sulcus proximally and row of moderately small spines laterad to sulcus, continuous with acute subdistal ridge bearing bristles; lateral and mesial surfaces each with prominent longitudinal sulcus, accompanied proximally with deep depression; mesial surfaces each with rows of small corneous spines on either side of sulcus and with tufts of stiff setae ventrally; ventral margins weakly sinuous, each with twenty-six to forty-one spinules, becoming more closely-set distally. Propodi distinctly longer than carpi; dorsal surfaces each with irregular rows of simple or multidenticulate spines, distal margins each with few small spines; lateral surfaces each with obliquely vertical, multidenticulate protuberances bearing short setae dorsally and few bidenticulate small tubercles ventrally, distal margins denticulate; mesial surfaces each with scattered bidenticulate tubercles; ventral surfaces each with small tubercles and tufts of short setae. Carpi much shorter than meri; dorsal surfaces each with single or double row of strong, simple or multifid spines, increasing in size distally; lateral surfaces each with prominent denticulate ridge bearing short setae and multidenticulate protuberances or tubercles dorsally, surfaces ventrad to ridge nearly smooth; mesial surfaces near-

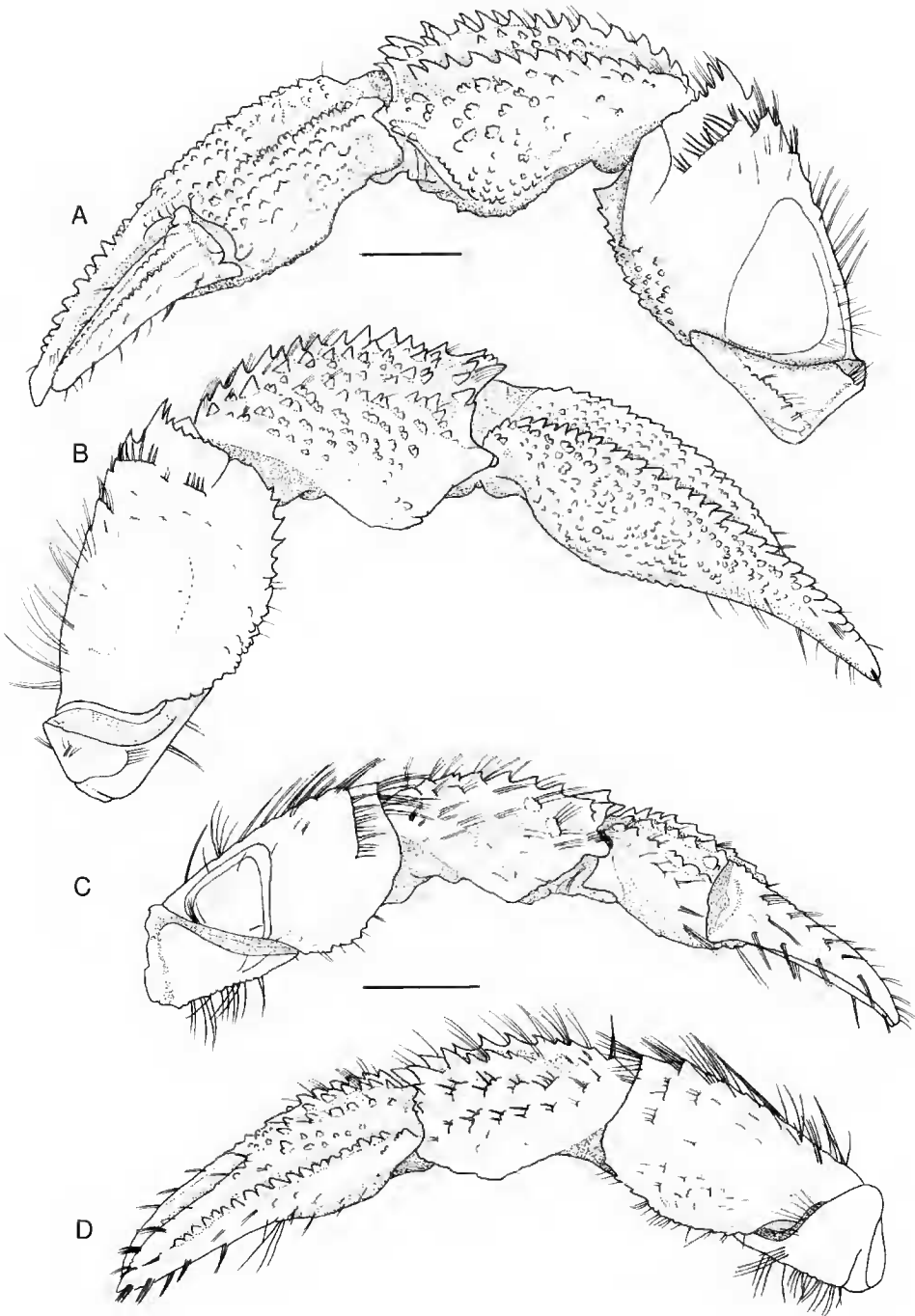


FIG. 4. — *Parapagurodes gracilipes* (Stimpson, 1858), neotype, ♀ SL 5.1 mm (CBM-ZC 3414), Hakodate Bay, southern Hokkaido, Japan; A, right cheliped, mesial; B, same, lateral; C, left cheliped, mesial; D, same, lateral. Scale bars: 2 mm.

ly smooth, each with few simple or bifid small tubercles dorsally; ventral surfaces smooth. Meri with convex dorsal and ventral margins, those of second pereopods relatively broad; dorsal surfaces each with strong, transverse, multidenticulate ridges bearing bristles (ridges less developed in left third pereopod), mesial margins delimited except for left third pereopod, with row of long setae and few small spines; lateral surfaces nearly smooth, with few tufts of minute setae; mesial surfaces nearly smooth, with few simple or bifid tubercles near ventral margins except for left

third pereopod; ventral margins each with irregular rows of simple or multidenticulate spines in second pair and right third, nearly smooth in left third. Ischia of second pair with small tubercles on ventral surfaces, third pair with ventral surfaces unarmed; dorsal and ventral surfaces each with tufts of setae. Coxae unarmed; females with paired gonopores. Anterior sternal lobe on sixth thoracic somite (Fig. 2D) proportionally broad, subquadrate, weakly skewed, sulcate medially, with stiff setae on anterior surface.

Fourth pereopods (Fig. 2E) setose, semichelate.

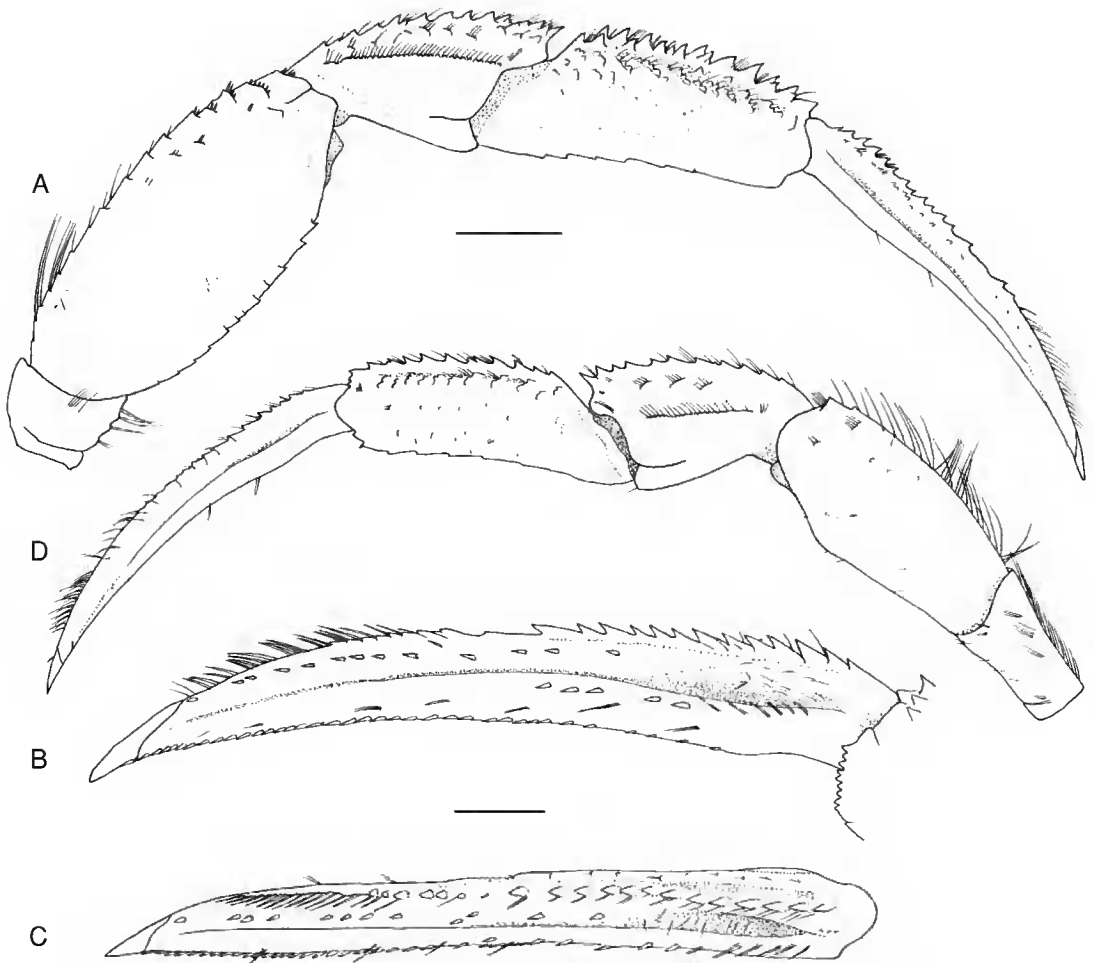


FIG. 5. — *Parapagurodes gracilipes* (Stimpson, 1858), neotype, ♀ SL 5.1 mm (CBM-ZC 3414), Hakodate Bay, southern Hokkaido, Japan; A, right second pereopod, lateral; B, same, dactyl, mesial; C, same, dorsal; D, left third pereopod, lateral. Scale bars: A, D, 2 mm; B, C, 1 mm.

Dactyl curved, without preungual process. Propodal rasp composed of several rows of corneous scales.

Fifth pereopods chelate. Right coxa (Fig. 2F) of males with short sexual tube, sometimes curved posteriorly; left coxa with gonopore encircled posteriorly by row of setae, no sexual tube.

Sternite of eighth thoracic somite (Fig. 2F) developed anteriorly as two subovate lobes separated by shallow median groove, anterior margins each with tuft of dense setae.

Abdomen with three unequally biramous unpaired pleopods on third to fifth somites in males, with exopods moderately well-developed, endopods strongly reduced; with four unpaired pleopods in females, second to fourth pleopods with both rami well-developed, fifth pleopod with exopod well-developed, endopod noticeably reduced.

Uropods strongly asymmetrical. Telson (Fig. 2G) with posterior lobes nearly symmetrical, lateral margins oblique, occasionally with spinules proximally at least on left side; posterior margin (Fig. 2H) with indistinct or very small median cleft, each terminal margin nearly horizontal, eight to ten small spines and two or three stronger spines at posterolateral angle; transverse incision moderately deep.

Eleven pairs of phyllobranchiae.

COLORATION

In life: shield mottled or reticulated with brown and cream, anterior margins between rostrum and lateral projections reddish. Posterior carapace mottled reddish brown. Ocular peduncles with base colour gray-brown, reticulated basally, becoming darker toward corneal base, with row of four dark brown spots on dorsomesial surfaces. Antennular peduncles mottled brown, few dark brown spots on distal segment. Antennal peduncles mottled or reticulated with grey-brown, with tinge of red at articulations of each segment. Merus of third maxilliped with strong iridescence on dorsal surface. Palm of right cheliped generally brown, paler laterally and mesially, with two longitudinal lines of blue iridescence on dorsal surface, confluent distally and extending onto basal part of fixed finger; palm of left cheliped with blue iridescence medially; spines,

tubercles or protuberances on both palm dark brown; carpi of both chelipeds generally pale yellowish brown, with spines or tubercles darker; meri generally pale yellowish brown, becoming darker distally, protuberances dark brown. Dactyls of ambulatory pereopods with three dark grey and two cream stripes on lateral surface, becoming obscure distally; propodi grey-brown generally, with tinge of cream or yellowish brown dorsodistally, ventrolateral to ventral surface pale yellowish brown or cream; carpi grey-brown generally, lateral surface ventral to granular ridge appearing as dark grey line with tinge of reddish brown, tubercles and dorsal row of spines dark brown; meri mottled or reticulated with yellowish brown, becoming darker distally, with spots of dark brown on lateral surfaces, dorsal protuberances dark brown.

In preservative: faded into straw colour entirely.

REMARKS

There is a marked variation in growth of the chelipeds, with those of larger specimens becoming elongate and more slender with increasing body size. The shape of the ocular acicles varies from subtriangular to semiovate.

Parapagurodes nipponensis (Yokoya, 1933), comb. nov. (Figs 1B, 6, 7)

Eupagurus gracilipes – Doflein 1902: 647, pl. 6, figs 6-8. – Balss 1913: 56. – Terao 1913: 368. Not *Eupagurus gracilipes* Stimpson, 1858.

Eupagurus gracilipes – Alcock 1905: 177 (in part).

Eupagurus nipponensis Yokoya, 1933: 87 (? in part), fig. 32.

Pagurus gracilipes – Makarov 1938: 184 (in part); 1962: 175 (in part). – Vinogradov 1950: 227 (in part), fig. 117. – Miyake 1965: 647 (in part), fig. 1093; 1975: 286 (in part), pl. 116, fig. 5; 1982: 126 (in part), pl. 42, fig. 5. – Takeda 1982: 68 (in part).

Pagurus gracilipes – Miyake 1978: 85, fig. 33. – Miyake & Imafuku 1980: 59. – Baba 1986: 201, 303, fig. 149. Not *Pagurus gracilipes* (Stimpson, 1858).

TYPE MATERIAL. — **Japan**. South of Omae-zaki, Shizuoka, *Soyo-Maru*, stn 278, 79 m, 2.VII.1927: lectotype (herein selected) ♂ SL 8.0 mm (KMNH). —

Same lot: paralectotype ovig ♀, fragmented (KMNH).

MATERIAL EXAMINED. — **Japan.** Off Kashima, Ibaraki, 35°55.8'N - 140°54'E, 65 m, 24.IV.1991, commercial trawler: 2 ♂♂ SL 8.0, 9.2 mm (CBM-ZC 50). — Off Choshi, Chiba, 65 m, 8.V.1991, commercial trawler: 1 ♂ SL 8.4 mm (CBM-ZC 51). — Off Choshi, ca. 60 m, 18.VI.1991, commercial trawler: 3 ♂♂ SL 8.0-10.4 mm (CBM-ZC 54). — Off Choshi, 35°45'N - 140°58'E, 60 m, 21.X.1991, commercial trawler: 1 ovig. ♀ SL 7.2 mm (CBM-ZC 60). — Off Kochi, Tosa Bay, Shikoku, 90-190 m, 2.X.1989, beam trawl by RV *Toyohata-Maru*, coll. K. Sasaki: 2 ♂♂ SL 5.4, 8.2 mm; 4 ♀♀ SL 4.3-6.4 mm (CBM-ZC 637). — Off Kii Minabe, Kii Peninsula, 80-100 m, 24.III.1995, gill net, coll. T. Komai: 1 ♂ SL 7.3 mm (CBM-ZC 1162). — Off Kochi, Tosa Bay, 150-154 m, 5.III.1993, beam trawl by RV *Toyohata-Maru*: 3 ♀♀ SL 5.6-7.5 mm (CBM-ZC 3389). — Off Kochi, Tosa Bay, 188-190 m, 10.VIII.1992, beam trawl by RV *Toyohata-Maru*, coll. K. Sasaki: 3 ♂♂ SL 7.0-8.4 mm, 1 ovig. ♀ SL 8.8 mm (CBM-ZC 3462). — Off Kochi, Tosa Bay, 110-130 m, 14.XI.1988, beam trawl by RV *Toyohata-Maru*, coll. T. Komai: 3 ♂♂ SL 7.4-12.3 mm, 2 ♀♀ SL 10.0, 13.2 mm (HUMZ-C 666). — Off Hayama, Miura Peninsula, Sagami Bay, depth unknown, 22.V.1925, beam trawl: 2 ♂♂ SL 7.4, 8.3 mm, 1 ♀ SL 8.1 mm, 1 ovig. ♀ SL 8.4 mm (SMI-NSMT-CrR 120). — Kannonzuka-dashi, Amadaiba, Sagami Bay, 60-80 m, 16.VII.1957: 1 ♂ SL 11.0 mm (SMI-NSMT-CrR 1312). — Off Jogashima, Sagami Bay, 80-85 m, 25.VII.1959: 1 ♂ SL 8.2 mm (SMI-NSMT-CrR 1617). — Off Jogashima, Sagami Bay, 110-175 m, 6.II.1954: 1 ♂ SL 8.0 mm (SMI-NSMT-CrR 2198). — Off Jogashima, Sagami Bay, 83 m, 26.I.1965: 1 ♂ SL 7.0 mm (SMI-NSMT-CrR 2303). — Kannonzuka-dashi, Amadaiba, Sagami Bay, 65-68 m, 14.III.1968: 1 ovig. ♀ SL 5.0 mm (SMI-NSMT-CrR 3568). — Off Kochi, Tosa Bay, 190 m, 6.IX.1989, beam trawl by RV *Toyohata-Maru*, coll. K. Sasaki: 1 ♀ SL 6.7 mm (USNM 284142). — Off Kochi, Tosa Bay, 33°16.14'N - 133°40.13'E, 186-190 m, 17.V.1993, beam trawl by RV *Toyohata-Maru*, coll. K. Sasaki: 1 ♂ SL 7.2 mm (USNM 284143).

Taiwan. Off Ta-Shi, NE Taiwan, I-Lan County, depth unknown, 26.I.1997, commercial trawler, coll. T.-Y. Chan: 1 ♂ SL 8.7 mm (NFOU).

DISTRIBUTION. — Known with certainty from the Pacific coast of Japan from Kashima, Ibaraki, southward to Kagohima, Goto Islands, Kosiki Islands, Taiwan (new record), at depths of 30-300 m. It remains unclear whether *P. nipponensis* occurs in the Japan Sea.

SIZE. — Largest ♂: 12.3 mm in SL, largest ♀: 13.2 mm in SL, smallest ovigerous ♀: 5.0 mm in SL.

HABITAT. — Found in gastropod shells (apparently prefers naticid shells), usually with one or more anthozoan polyps attached to the shell. Inhabiting sandy or sandy mud bottom often mixed with shell fragments, at depths of 30-300 m.

DIAGNOSIS

Shield, cephalic appendages, and chelipeds (Fig. 6A-C) similar to those of *Parapagurodes gracilipes*. Dactyls of second and third pereopods (Fig. 6D, E) slender, occasionally elongate, 1.14-1.63 times longer than propodi in second pair, 1.38-1.65 times longer in third pair, ventral margins each with 37-62 small corneous spinules, carpi with granulate ridge on each lateral surface, meri of second pereopods relatively slender. Right coxa of fifth pereopod in males with short sexual tube, sometimes curved posteriorly; left coxa with gonopore encircled posteriorly by row of setae, no sexual tube. Telson (Fig. 6F, G) with posterior margin deeply concave, each terminal margin strongly oblique, with eight or nine small spines increasing in size laterally and one strongly ventrad curved spine at posterolateral corner. Eleven pairs of phyllobranchiae.

COLORATION

In life: shield generally brown, but mottled or reticulated with brown and cream under higher magnification. Posterior carapace reddish brown. Ocular peduncles with base colour grey-brown, reticulated basally, becoming darker toward corneal base. Antennular peduncles mottled brown, with few dark brown spots on distal segment. Antennal peduncles mottled or reticulated with grey-brown, with tinge of red at articulations of each segment. Merus of third maxilliped with strong iridescence on dorsal surface. Palm of right cheliped generally brown, paler laterally and mesially, without longitudinal lines of blue iridescence on dorsal surface; palm of left cheliped without line of iridescence medially; spines, tubercles or protuberances on both palm dark brown; carpi of both chelipeds generally brown, with spines or tubercles darker; meri generally pale yellowish brown, becoming darker distally, protuberances dark brown; each segment with

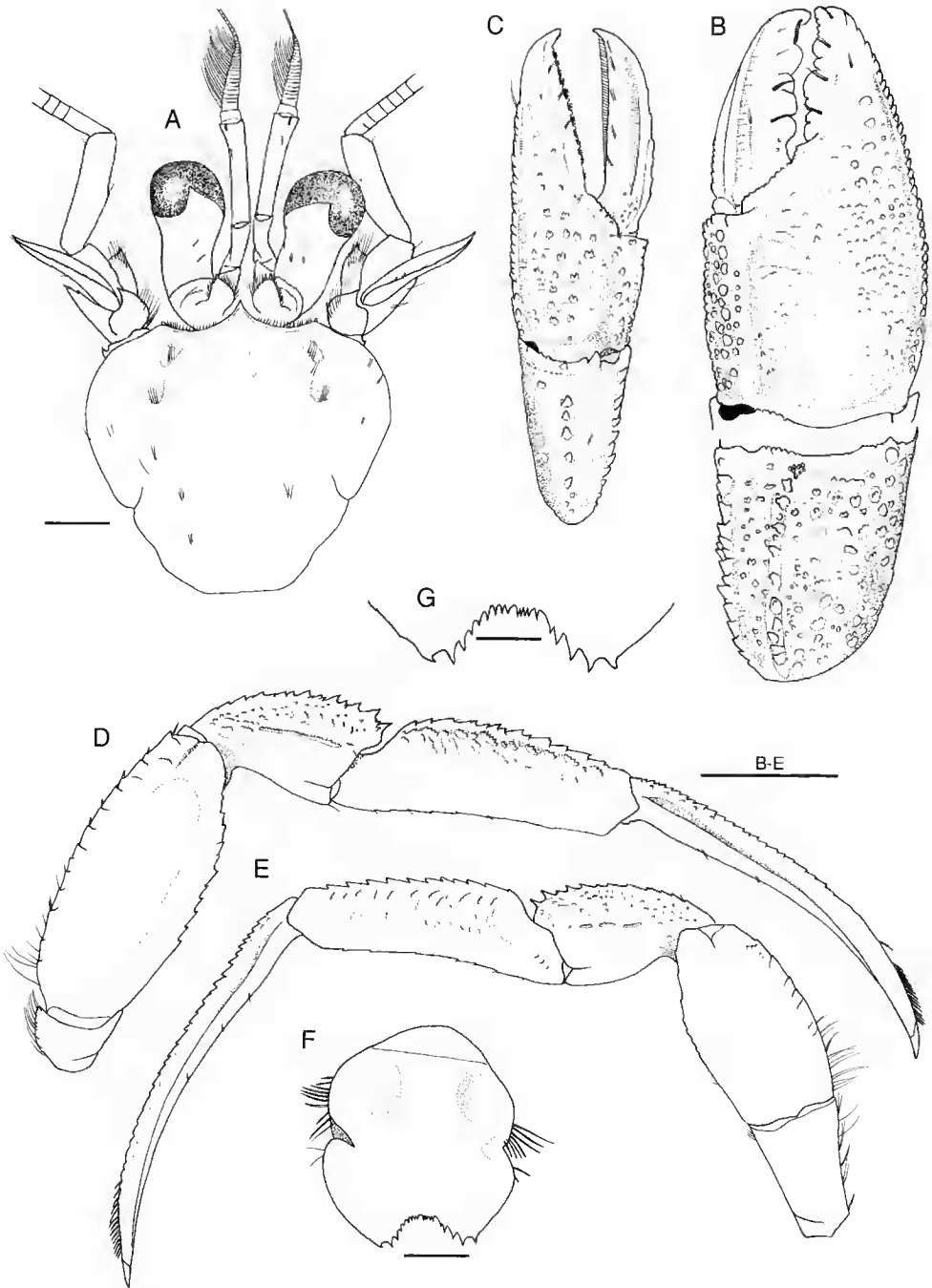


FIG. 6. — *Parapagurodes nipponensis* (Yokoya, 1933), ♂ SL 8.4 mm (CBM-ZC 3462), Tosa Bay, Shikoku, Japan; **A**, shield and cephalic appendages, dorsal; **B**, chela and carpus of right cheliped, dorsal; **C**, chela and carpus of left cheliped, dorsal; **D**, right second pereopod, lateral; **E**, left third pereopod, lateral; **F**, telson, dorsal; **G**, same, posterior margin, dorsal. Scale bars: **A**, 2 mm; **B-E**, 5 mm; **F**, 1 mm; **G**, 0.5 mm.

strong iridescence. Dactyls of ambulatory pereopods with three dark grey and two cream stripes on lateral surface, becoming obscure distally; propodi with lateral surfaces bearing three cream (dorsal, middle and ventral) and two brown stripes; carpi grey-brown generally, lateral surface ventral to granular ridge appearing as dark grey line with tinge of reddish brown, tubercles and dorsal row of spines dark brown; meri mottled or reticulated with yellowish brown, becoming darker distally and dorsally, with spots of dark brown on lateral surfaces, dorsal protuberances dark brown; carpi and meri with strong iridescence.

In preservative: faded into straw colour entirely.

REMARKS

Yokoya (1933) described *Eupagurus nipponensis* on the basis of twenty-nine specimens from twelve *Soyo-Maru* stations: north of Inubo-zaki, Chiba, 33 m (stn 133); south of Misaki, Sagami Bay, 106 m (stn 238), Suruga Bay, 64 m (stn 267); Suruga Bay, 91 m (stn 277); south of Omae-zaki, Shizuoka, 79 m (stn 278); south of Lake Hamana, 77 m (stn 288); east of Sata-misaki, Kagoshima, 117 m (stn 298); south of Owase, Mie, 123 m (stn 360); near Omae-zaki, Shizuoka, 64 m (stn 376); south of Koshiki Islands, 132 m (stn 132); southeast of Goto Islands, 152 m (stn 431); and Tsugaru Strait, 91 m (stn 651). Yokoya's original description and figure of the species was presumably based on the ovigerous female from Kagoshima (stn 298). He did not designate a holotype, and therefore, all specimens are syntypes. Despite my attempts, I was able to find only a single lot containing one male (SL 8.0 mm) and one ovigerous female (fragmented!) from south of Omae-zaki, Shizuoka (stn 278), in the collection of the Kitakyushu Museum of Natural History. I selected herein this male specimen as a lectotype for *Parapagurodes nipponensis*. The lectotype is dried, and its poor condition prevents me from making detailed observations.

DISCUSSION ON *Parapagurodes gracilipes* AND *P. nipponensis*

The present study discloses the presence of a short right sexual tube in males of the two taxa

which have been previously assigned to *Pagurus*. The tube is quite small, usually translucent, and often curved posteriorly, making it easily overlooked in casual examination. It is interesting to note that the two species show close resemblance to the members of the *bernhardus* group of *Pagurus* proposed by McLaughlin (1974), containing *P. bernhardus* (Linnaeus, 1758), *P. armatus* (Dana, 1851), *P. ochotensis* Brandt, 1851, *P. aleuticus* (Benedict, 1892) and *P. acadianus* (Benedict, 1901). The characters showing similarity include a recurved external lobe of the endopod of maxillule; short, stout ocular peduncles with ovately dilated corneae; slightly raised dorsolateral and dorsomesial margins of the palm of chelae; and elongate, strongly twisted dactyls of the second and third pereopods, which bear prominent median sulcus on each lateral and mesial surfaces. The absence of the right sexual tube in males has been confirmed for *Pagurus armatus*, *P. ochotensis* and *P. aleuticus* (cf. McLaughlin, 1974; pers. obs.), but it needs to be verified for *P. bernhardus* and *P. acadianus*. Apart from the presence of a short right sexual tube, *P. gracilipes* and *P. nipponensis* do not show close resemblance to the three previously described species of *Parapagurodes* (*P. makarovi* McLaughlin et Haig, 1973; *P. laurentae* McLaughlin et Haig, 1973, and *P. bartae* McLaughlin et Jensen, 1996) and

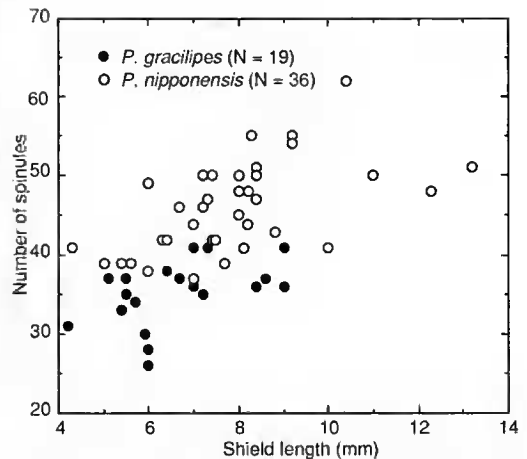


FIG. 7. — Scatter plot of number of ventral spinules on dactyl of left third pereopod and shield length for *Parapagurodes gracilipes* and *P. nipponensis*.

they are immediately distinguished from the latter three species by the characters above mentioned. The strong similarity found between two species herein assigned to *Parapagurodes* and the *bernhardus* group of *Pagurus* may cause a question about the phylogenetic significance of the sexual tube development exhibited by the genus *Parapagurodes*. The present generic assignment should be considered provisional, at least until such time as the phylogenetic significance of the sexual tube development in the Paguridae is thoroughly discussed.

Parapagurodes gracilipes and *P. nipponensis* are quite similar. At present, the geographical ranges of *P. nipponensis* appear restricted to the central and southwestern parts of the Japanese main islands, from Kashima, Ibaraki to southern Kyushu and Taiwan, whereas *P. gracilipes* is distributed from Choshi, Chiba northward to Hokkaido, Sakhalin, and the continental coast of Russia (and probably Korea). Only in the southern part of the Kashima-nada region of the Pacific coast, are these two species likely to overlap. However, the available data strongly suggest that they are bathymetrically separated in the region: *P. gracilipes* occurs at depths shallower than 42 m, and *P. nipponensis* occurs at depths greater than 30 m. The telson provides a good character to separate the two species. In *P. gracilipes*, the posterior margin of the telson is less concave, with the terminal margins nearly horizontal (Fig. 2IU). In contrast, in *P. nipponensis*, the posterior margin of the telson is noticeably concave, with the terminal margins strongly oblique (Fig. 6G); the spines on the terminal margin may be more widely separated in *P. nipponensis* than in *P. gracilipes*. *Parapagurodes nipponensis* usually has more numerous spinules on the ventral margin of the ambulatory dactyls than *P. gracilipes*. For example, the dactyl of the left third pereopod bears thirty-seven to sixty-two spinules (45.9722 on average; N = 36) in *P. nipponensis*, whereas it bears twenty-six to forty-one spinules (35.0555 on average; N = 19) in *P. gracilipes* (see Fig. 7). Live coloration is different in the two species. In *P. gracilipes*, the palm of the right cheliped bears a clear longitudinal line of blue grey iridescence that is absent from the right palm of *P. nipponensis*. In *P. nipponensis*, the pro-

podi of the second and third pereopods bear clear brown and cream stripes on the lateral surfaces, whereas in *P. gracilipes*, the segments are devoid of clear stripes on the lateral surfaces.

The type material of *P. nipponensis* included specimens from a station in Tsugaru Strait, very near Hakodate, the type locality of *P. gracilipes*, and Inubo-zaki, where the two species are likely to overlap. I could not confirm the identity of those specimens as they could not be located. Therefore, Yokoya's reference is listed questionably as "in part" in the synonymy because of the possibility that the type material might include specimens of the two species. Makarov (1938; 1962) placed Yokoya's taxon in synonymy with *P. gracilipes* without comment. The citations by Alcock (1905), Vinogradov (1950), Miyake (1965; 1975; 1982) and Takeda (1982) of *Pagurus gracilipes* are listed as "in part" because their general accounts include the ranges of both species. The reports by Doflein (1902), Balss (1913), Miyake & Imafuku (1980) and Baba (1986) of *Pagurus gracilipes* pertain exclusively to the taxon occurring in Sagami Bay, Kii Peninsula, or Tosa Bay, and therefore are referable to *Parapagurodes nipponensis*. I reexamined the specimens from Sagami Bay referred to as *Pagurus gracilipes* by Miyake (1978), and confirmed that all actually represent *Parapagurodes nipponensis*.

Genus *Pagurus* Fabricius, 1775

Pagurus alaini n.sp. (Figs 8-11)

TYPE MATERIAL. — **Japan.** Off Kochi, Tosa Bay, Shikoku, 33°15'N - 133°39'E, 188-190 m, 10.VIII.1992, beam trawl by RV *Toyohata-Maru* of Kochi University, coll. K. Sasaki: holotype ♂ SL 7.7 mm (CBM-ZC 3416). — Same data, 190 m, 7.VII.1992, beam trawl by RV *Toyohata-Maru*, coll. K. Sasaki: 2 paratypes. ♂♂ SL 4.6, 10.0 mm, CBM-ZC 3417. — Same data: 1 paratype ♂ SL 6.1 mm (MNHN-Pg 5497). — Off Saiki, Bungo Strait, 150-200 m, 7.XI.1994, commercial trawler, coll. T. Komai: 1 paratype ♂ SL 4.0 mm, 1 ovig. ♀ SL 4.3 mm (CBM-ZC 3418).

DISTRIBUTION. — Known only from Tosa Bay, Shikoku, and Bungo Strait, Japan, 188-190 m.

SIZE. — Largest specimen: SL 10 mm; ovigerous ♀: SL 4.3 mm.

HABITAT. — Found inhabiting gastropod shells.

ETYMOLOGY. — This species is dedicated to Dr Alain Crosnier, the eminent scientist of ORSTOM, Paris. I would like to express herein my sincere thanks to him for his generous help in various ways.

DESCRIPTION

Shield (Fig. 8A) as wide as or wider than long; anterolateral margins terraced; anterior margin between rostrum and lateral projections concave; posterior margin rounded; dorsal surface convex, generally smooth, with few tufts of short setae laterally. Rostrum slightly exceeding lateral projections, broadly triangular, with or without small terminal spinule, with few setae dorsally. Lateral projections triangular, well-produced, with long terminal spine. Posterior carapace (Fig. 8B) with scattered tufts of short setae dorsally; posteromedian plate calcified; cardiac sulci nearly parallel, not extending to posterior margin of carapace; sulci cardiobranchiales noticeably divergent posteriorly, extending posteriorly beyond cardiac sulci.

Ocular peduncles (Fig. 8A) 0.52-0.7 times as long as shield, stout, not inflated basally, corneal region ovate, noticeably dilated; dorsomesial surface with longitudinal row of tufts of short setae. Ocular acicles triangular, dorsal surface weakly concave, terminating subacutely, usually with prominent submarginal spine.

Antennular peduncles (Fig. 8A) exceeding ocular peduncles by 0.5-0.7 length of ultimate segment; ultimate segment about 1.5 times longer than penultimate segment, with row of setae dorsally; basal segment stout, inflated ventrally and laterally, bearing acute spine laterally.

Antennal peduncles (Fig. 8A) exceeding ocular peduncles by half to three-fourths length of fifth segment, with supernumerary segmentation. Fifth segment unarmed, with few setae on mesial surface. Third segment with ventromesial distal angle produced, terminating in prominent spine partially obscured by tufts of moderately long setae. Second segment with dorsolateral distal angle produced, terminating in simple spine, mesial margin with seven to nine small spines

increasing in size distally; dorsomesial distal angle with prominent spine, mesial surface with numerous setae. First segment with or without spine laterodistally, ventrodistal margin with prominent spine at distolateral angle. Antennal acicle slightly arcuate, distinctly overreaching distal corneal margin, mesial margin unarmed, but with numerous setae. Antennal flagella long, simple.

Mandible (Fig. 9A) typical of genus. Maxillule (Fig. 9B) with proximal endite subquadrate; endopod with one bristle and one seta on well-developed, broadly based internal lobe, external lobe produced, not recurved. Maxilla (Fig. 9C) with endopod inflated basally, reaching distal margin of scaphognathite. First maxilliped (Fig. 9D) with endopod extending beyond distal margin of distal endite. Second maxilliped (Fig. 9E) with basis-ischium fusion incomplete. Third maxilliped (Fig. 9F) with basis-ischium fusion incomplete; basis (Fig. 9G) with few prominent spines mesially; crista dentata (Fig. 9G) composed of relatively stout spines, becoming smaller distally, accessory tooth strong, stout; merus usually with acute spine on dorsodistal margin; carpus with dorsodistal margin unarmed. Third thoracic sternite with distal margin slightly convex, with assemblage of setae medially.

Right cheliped of male (Figs 9H, I, 10A, B) considerably elongate, not setose. Chela 2.0-2.2 times longer than wide. Dactyl shorter than palm; dorsal surface convex with obtuse ridge mesial to midline, granular, bearing few tufts of stiff setae; dorsomesial margin not distinctly delimited; mesial surface granular, with few tufts of short setae; ventral surface almost smooth, with tufts of moderately short setae; cutting edge with row of moderately strong calcareous teeth and short row of small corneous teeth subdistally, terminating in calcareous claw. Curting edge of fixed finger with row of moderately strong calcareous teeth in proximal 0.75 and small calcareous teeth in distal 0.25, terminating in calcareous claw. Palm slightly longer than carpus; dorsal surface convex, granular (granules subsquamate under high magnification, often forming transverse rows, Fig. 9I), dorsomesial margin nearly straight, not strongly delimited but weakly eleva-

ted, dorsolateral margin convex, with row of small blunt spines or granules, extending posteromesially, and becoming stronger distally; mesial, lateral and ventral surfaces granular; ventral surface moderately inflated, with tufts of moderately short or long setae on fixed finger.

Carpus distinctly broadened distally, with small to moderately strong spines on dorsomesial margin, dorsolateral margin not delimited, dorsal surface with moderately strong spines and multifid or simple tubercles of various size, distal margin with few spines; lateral surface with

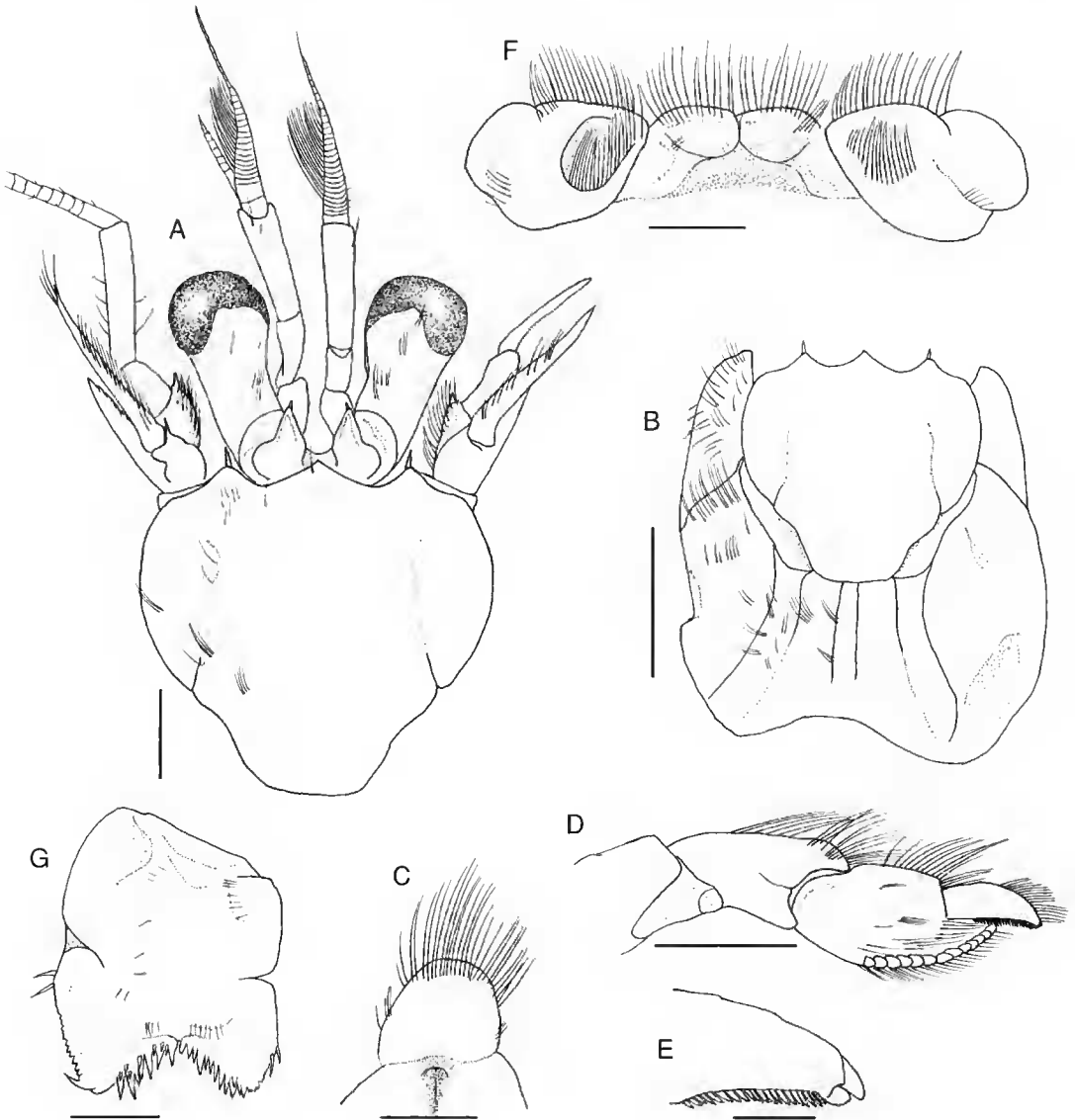


FIG. 8. — *Pagurus alaini* n.sp., holotype ♂ SL 7.7 mm (CBM-ZC 3416), Tosa Bay, Shikoku, Japan; A, shield and cephalic appendages, dorsal (setae on right side partially omitted); B, carapace, dorsal (setae on shield and right side of remaining carapace omitted); C, sternal lobe of sixth thoracic somite, ventral; D, distal three segments of right fourth pereopod, lateral; E, distal part of dactyl of right fourth pereopod, lateral; F, coxae of fifth pereopods and sternal lobe of eighth thoracic somite, ventral; G, telson, dorsal. Scale bars: A, D, 2 mm; B, 5 mm; C, F, G, 1 mm; E, 0.5 mm.

numerous multifid or simple tubercles; mesial surface slightly concave, with fewer small simple tubercles or protuberances, ventromesial margin with row of small tubercles; ventral surface moderately inflated, ventrolateral margin with row of small tubercles or subacute spines distally. Merus with dorsal surface bearing transverse low protuberances accompanied by bristles and tufts of moderately long setae proximally, distal margin with one prominent spine; mesial surface not granulate, lateral surface with small simple or multifid tubercles ventrally; ventral surface with moderately small tubercles (simple or sometimes multifid) or with clusters of granules, ventrolateral margin with row of small or moderately small tubercles or spines, becoming stronger and more acute distally. Ischium with scattered tufts of setae and row of small but acute spines on mesial margin.

Left cheliped (Figs 9J, 10C, D) overreaching base of dactyl of right cheliped or reaching mid-length of palm. Chela with greatest width across base of dactyl 2.4 times longer than wide. Dactyl distinctly longer than palm; dorsal surface slightly convex, mostly smooth, with median row of small simple or bifid tubercles proximally and scattered tufts of stiff setae, dorsomesial margin not distinctly delimited; mesial surface with row of small tubercles or low bifid protuberance; ventral surface almost smooth, with tufts of moderately long setae; cutting edge with row of small, acute or blunt calcareous teeth and interspersing small corneous teeth, terminating in small corneous claw. Cutting edge of fixed finger with row of small corneous teeth, terminating in calcareous claw. Palm distinctly shorter than carpus; dorsal surface with granules and small tubercles, often forming transverse rows, prominently elevated in midline and with two or three rows of small tubercles, extending onto fixed finger and increasing in size distally; dorsomesial margin not strongly delimited, dorsolateral margin nearly straight or slightly sinuous, with row of small tubercles, extending to proximal 0.3 of fixed finger; mesial surface with relatively strong tubercles dorsally, rather smooth, with few tufts of setae ventrally; lateral surface coarsely granular; ventral surface moderately inflated, nearly smooth, with scattered tufts of setae on fixed finger. Carpus

slightly widened distally, with row of small tubercles and one or few moderately strong spines, dorsolateral margin with row of moderately strong spines and small spines or tubercles, dorsal surface nearly smooth, distal margin concave, with strong submedian projection, bearing few moderately strong spines; lateral surface with scattered multifid protuberances and vertical rows of granules, often bearing few setae; mesial surface with fewer moderately small, simple or multifid tubercles or protuberances, ventromesial margin with row of relatively strong simple or multifid tubercles; ventral surface moderately inflated, with low tubercles or protuberances. Merus with dorsal surface bearing transverse low protuberances, sometimes extending to mesial surface, and with bristles and tufts of moderately long setae proximally, distal margin with one prominent spine; mesial surface not granulate, but with low protuberances ventrally, lateral surface also not granulate, but with small tubercles ventrally; ventral surface with moderately small tubercles (simple or sometimes multifid) and few setae, ventrolateral margin with row of small to moderately small tubercles or spines becoming more acute distally. Ischium with scattered tufts of setae and row of small but acute spines on mesial margin.

Ambulatory pereopods (Fig. 11A-C) long, similar to left from right. Dactyls 1.45-1.81 times longer than propodi in second pair, 1.63-1.79 times longer in third pair, relatively slender; in lateral view, weakly to moderately curved ventrally; in dorsal view, weakly twisted; dorsal surfaces obtusely ridged throughout length, with small subacute protuberances and row of long bristles or small corneous spines in distal half; lateral and mesial surfaces each with prominent longitudinal sulcus, accompanied proximally with deep depression; mesial surfaces with row of small corneous spines dorsally; ventral margin weakly sinuous, with eleven to twenty-three small corneous spines, becoming longer and more closely-set distally. Propodi distinctly longer than carpi; dorsal surfaces each with irregular rows of simple or small multidenticulate spines and very few bristles, distal margins usually unarmed; lateral and mesial surfaces each with small simple or multidenticulate spines dorsally and

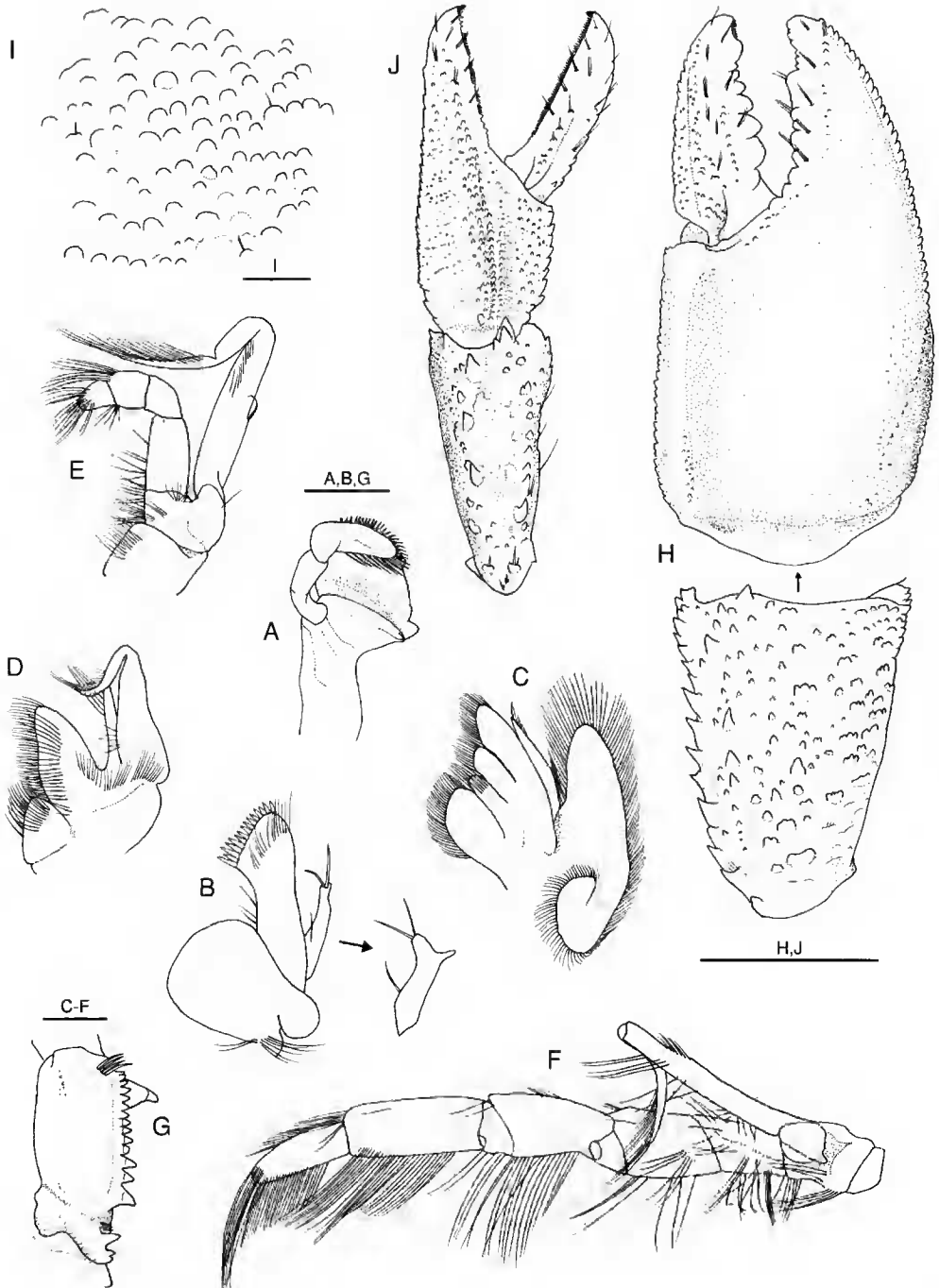


FIG. 9. — *Pagurus alaini* n.sp., holotype ♂ SL 7.7 mm (CBM-ZC 3416), Tosa Bay, Shikoku, Japan; left mouthparts; A, mandible, internal; B, maxillule, external; inset, endopod, lateral; C, maxilla, external; D, first maxilliped, external; E, second maxilliped, external; F, third maxilliped, lateral (external); G, ischium of third maxilliped, dorsal (internal); H, chela and carpus of right cheliped, dorsal (granules on dorsal surface of palm not depicted); I, central portion of dorsal surface of right palm, dorsal; J, chela and carpus of left cheliped, dorsal. Scale bars: A-G, 1 mm; H, J, 5 mm; I, 0.5 mm.

scattered minute setae ventrally, distal margins not denticulate; ventral surfaces each with row of few low protuberances and few corneous spinules, distal margins with one or two corneous spinules. Carpi much shorter than meri; dorsal surfaces each with single row of moderately small spines or spinulose tubercles, increasing in size distally; lateral surfaces each with scattered small tubercles or low protuberances, lacking longitudinal tidge; mesial surfaces nearly smooth, each

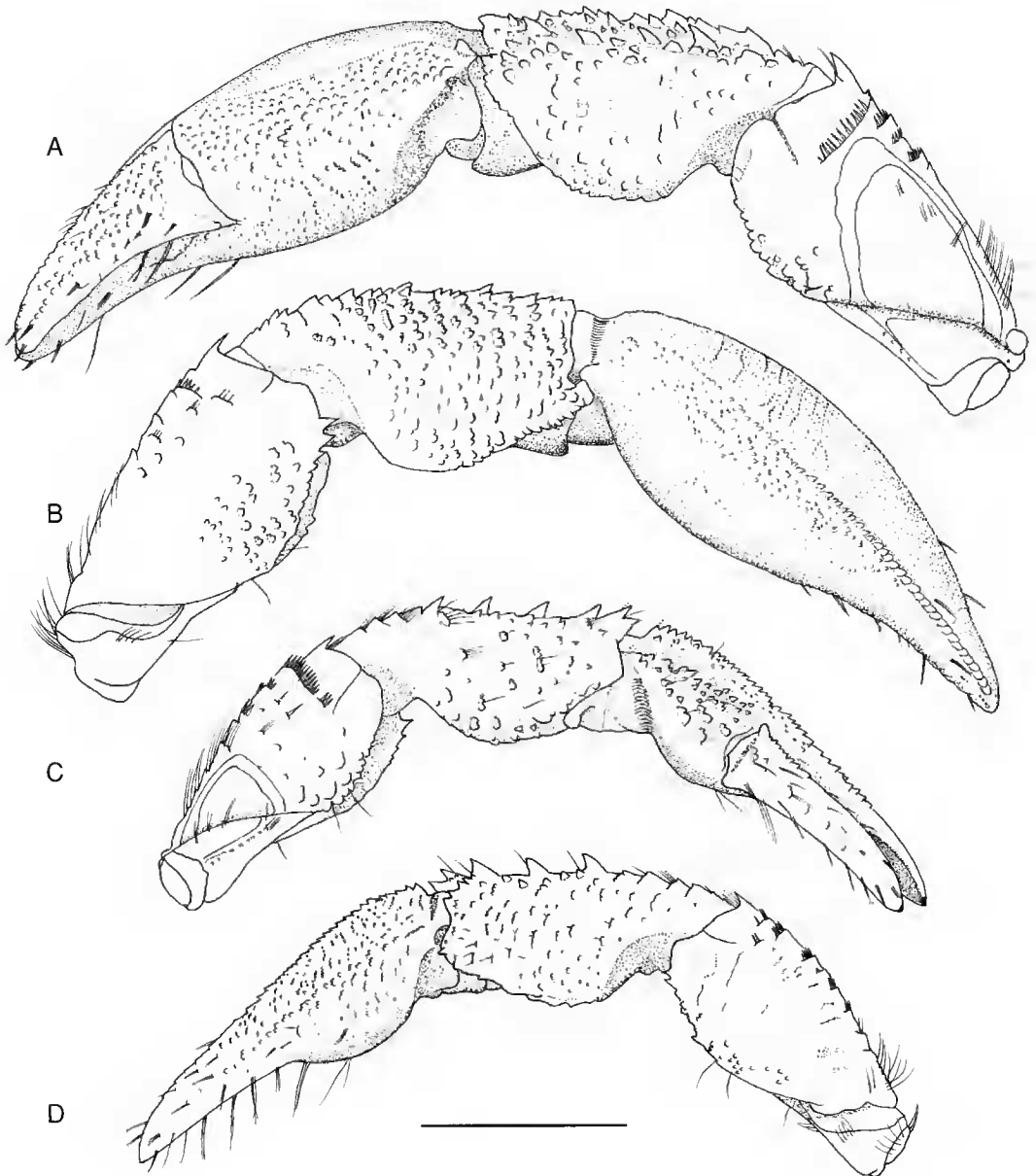


FIG. 10. — *Pagurus alaini* n.sp., holotype ♂ SL 7.7 mm (CBM-ZC 3416), Tosa Bay, Shikoku, Japan. A, right cheliped, mesial; B, same, lateral; C, left cheliped, mesial; D, same, lateral. Scale bar: A-D, 5 mm.

with few simple or bifid small tubercles dorsally; ventral surface smooth. Meri with weakly convex dorsal and ventral margins; dorsal surfaces each with transverse, multidenticulate ridges bearing bristles, mesial margins not particularly delimited; lateral surface nearly smooth, with scattered small, low protuberances dorsally and ventrally; mesial surface nearly smooth; ventral margins each with row of small protuberances. Ischia with ventral margins smooth but with few setae; dorsal surfaces each with dense setae. Coxae unarmed; female with paired gonopores on third pereopods. Anterior sernal lobe on sixth thoracic somite subovate, slightly skewed, anterior surface with long setae.

Fourth pereopods (Fig. 8D, E) setose, semichelate. Dactyl slightly curved, terminating in corneous

claw, ventral margin with row of corneous spinules; preungual process distinctly smaller than terminal claw, basally articulated, showing a strongly compressed, scale-like piece. Propodal rasp composed of single row of relatively large corneous scales.

Fifth pereopods chelate. Male gonopores on coxae (Fig. 8F) each encircled by row of setae, vas deference not protruded on either side.

Sternite of eighth thoracic somite (Fig. 8F) developed anteroventrally as two subovate lobes separated by deep median and posterior grooves, anterior margins each with long setae.

Abdomen with three unequally biramous unpaired pleopods on third to fifth somites in males, exopods moderately well-developed, endopods reduced; with four unpaired pleopods in females,

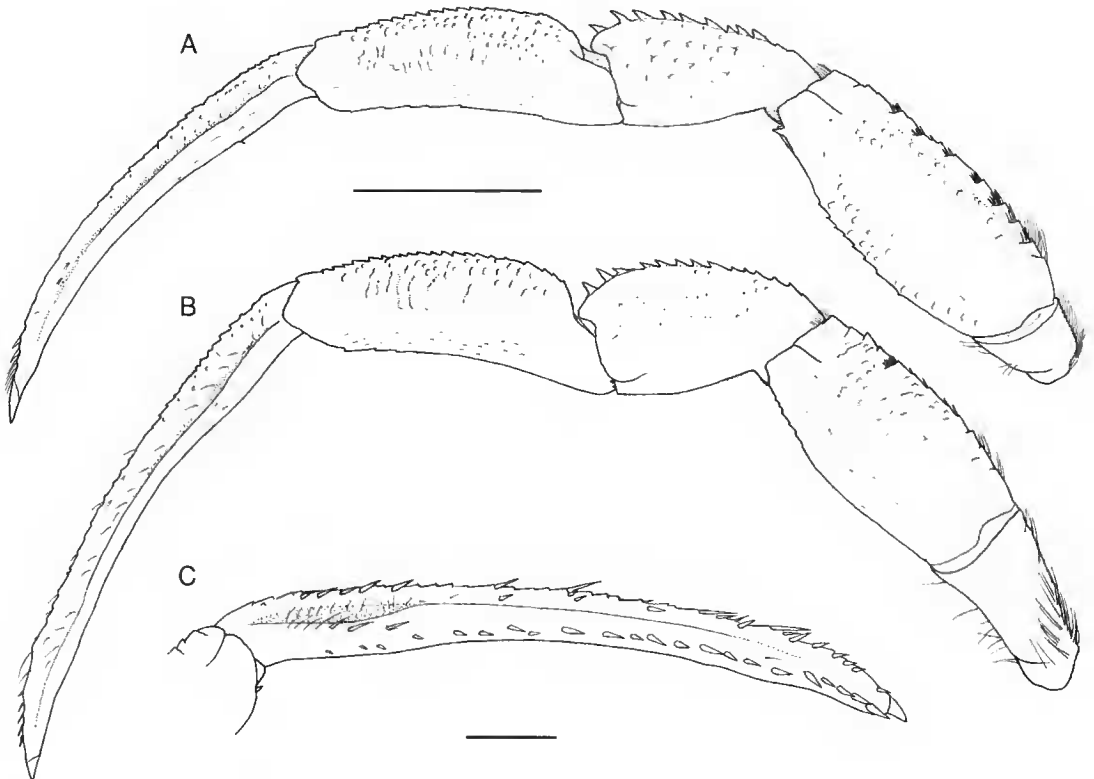


FIG. 11. — *Pagurus alaini* n.sp., holotype ♂ SL 7.7 mm (CBM-ZC 3416), Tosa Bay, Shikoku, Japan; **A**, left second pereopod, lateral; **B**, left third pereopod, lateral; **C**, same, dactyl, mesial. Scale bars: A, B, 5 mm; C, 2 mm.

second to fourth pleopods with both rami well-developed, fifth pleopod with exopod well-developed, endopod noticeably reduced.

Uropods strongly asymmetrical. Telson (Fig. 8G) with posterior lobes strongly asymmetrical, separated by indistinct or small median cleft; terminal margins oblique, with marginal and submarginal spines, strongest at outer angles; lateral margins denticulate, particularly on left side, sometimes with few corneous spinules; transverse incision moderately deep.

Eleven pairs of phyllobranchiae.

COLORATION

In fresh specimens: carapace, chelipeds and ambulatory pereopods generally light brown. Chelipeds with strong iridescence on chela and carpus. Second and third pereopods with tinge of red around each articulation of dactyl, propodus and carpus, no marked stripes or bands.

In preservative: faded into straw colour generally, but iridescence on chelipeds preserved for a long time.

REMARKS

The number of corneous spines on the ventral margins of the ambulatory dactyls tends to increase with growth in this new species. The right antenna and the dactyl of the right second pereopod of the holotype are apparently aberrant. The distal two segments of the antennal peduncle are abnormally short and slender and the flagellum is not fully differentiated. The dactyl of the right second pereopod is abnormally short. These are presumably due to injury.

Pagurus alaini is very similar to *P. kaiensis* McLaughlin, 1997, recently described from the Kai Islands, Indonesia. Nevertheless, it is distinguished from the Indonesian species by the relatively well-produced rostrum reaching beyond the lateral projections and the structure of the preungual process of the dactyl of the fourth pereopod. In the new species, the preungual process appears as a small scale-like piece which is distinctly smaller than the terminal claw. In *P. kaiensis*, it is a stout projection, being distinctly larger than the terminal claw. More numerous ventral spines on the ambulatory dactyls (13-23 vs 11-14) separates *P. alaini* from *P. kaiensis*.

Coloration is apparently different in the two species. In *P. alaini*, the chelipeds and ambulatory pereopods are entirely light brown or tan, sometimes with tinge of red around each articulation of the ambulatory pereopods; the dorsal surfaces of each pereopod bears strong iridescence. In *P. kaiensis*, even in preserved conditions, the chelipeds bear an overall faint orange tint, appreciably faded on the chelae, but darker on the carpi and meri; the meri have splotches of white; each ambulatory pereopod bears longitudinal stripes of orange on the lateral face of the carpus and the lateral, mesial, and ventral surfaces of the dactyl (McLaughlin 1997).

Although previous authors (e.g. Forest & de Saint Laurent 1967; McLaughlin 1974) have tried to divide the genus *Pagurus* into several informal species groups, at present no species-group assignment can be made for *P. alaini*. In the structure of the ambulatory dactyls, which are twisted and bear a prominent median sulcus on each surface, and associate proximal depressions on the lateral and mesial surfaces, as well as the armament of the posterior margin of telson, *P. alaini* (also *P. kaiensis*) appears superficially related to the members of the *bernhardus* group of *Pagurus* of McLaughlin (1974). However, the less-produced rostrum, straight, not recurved outer lobe of the endopod of maxillule, conformation of the left chela, and single row of corneous scales of the propodal rasp, exclude *P. alaini* from that group.

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