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Pseudopaguristes shidarai, a new species of hermit crab (Crustacea: Decapoda: Diogenidae) from Japan, the fourth species of the genus

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Abstract.—*Pseudopaguristes shidarai,* a new species of the recently established diogenid genus *Pseudopaguristes* McLaughlin, is described and illustrated from Okinawa, Japan. This is the fourth species assigned to this genus.

The diogenid genus *Pseudopaguristes* McLaughlin, 2002, was established for *P. janetkae* McLaughlin, 2002, on the basis of specimens from Guam, the Mariana Islands. The genus is characterized by eight functional gills, male chelipeds with the right larger than the left and dissimilar armature, female chelipeds similar from left to right, fourth pereopods with a clump of long capsulate setae on the carpi, and the paired first and second pleopods modified as gonopods. The second species, *P. bollandi* Asakura & McLaughlin, 2003, and the third species *P. bicolor* Asakura and Kosuge, 200x, were recorded from Okinawa, tropical Japan. Through the courtesy of Mr. Hiroyuki Shidara, the author recently obtained the fourth species of this genus, which was again collected from Okinawa. This new species is separated from all of the described species by coloration and morphology of antenna and telson.

The holotype is deposited in the Natural History Museum and Institute, Chiba (CBM-ZC). The terminology used follows McLaughlin (1974, 2002) with the exception of the fourth pereopods as defined by McLaughlin (1997), gill structure by McLaughlin & de Saint Laurent (1998), and the posterior carapace by McLaughlin (2000). Abbreviation used is; SL, shield length as measured from the tip of the rostrum to the posterior margin of the shield.

Pseudopaguristes shidarai, new species
Figs. 1–12

Material.—Holotype: male, SL = 2.55 mm, 20–25 m, SCUBA diving, Miyako-jima Island, Okinawa, Feb. 2003, CBM-ZC 6814. Paratypes: 2 males, SL = 1.85, 2.05 mm, 1 female, SL = 2.65 mm, data same as holotype, CBM-ZC 6815.

Description of holotype and paratype males.—Eight functional pairs of quadriserial, phyllobranchiate gills (Fig. 1A): no pleurobranchs on fifth and eighth thoracic somites, arthrobranchs of third maxillipeds and chelipeds vestigial (Fig. 1B). Shield (Fig. 1C) 1.25–1.35 times longer than broad; anterior margin between rostrum and lateral projections concave; lateral projections triangular, with small submarginal spine; anterolateral angles each with blunt-tipped corneous spine, not visible dorsally; lateral margins nearly straight, somewhat irregular; posterior margin truncate; dorsal surface slightly convex, with some elevated areas bearing anterior row of spines and setae laterally. Rostrum (Fig. 1C) prominent, triangular, produced, with terminal spine. Posterior carapace lateral elements (Fig. 1C, arrow) small, well calcified, unarmed. Branchiostegites (Fig. 1D) each with row of spines on dorsal margin anteriorly.

Ocular peduncles (including corneas) (Fig. 1C) moderately long, 0.75–0.85 length of shield. Corneas (Fig. 1C) very

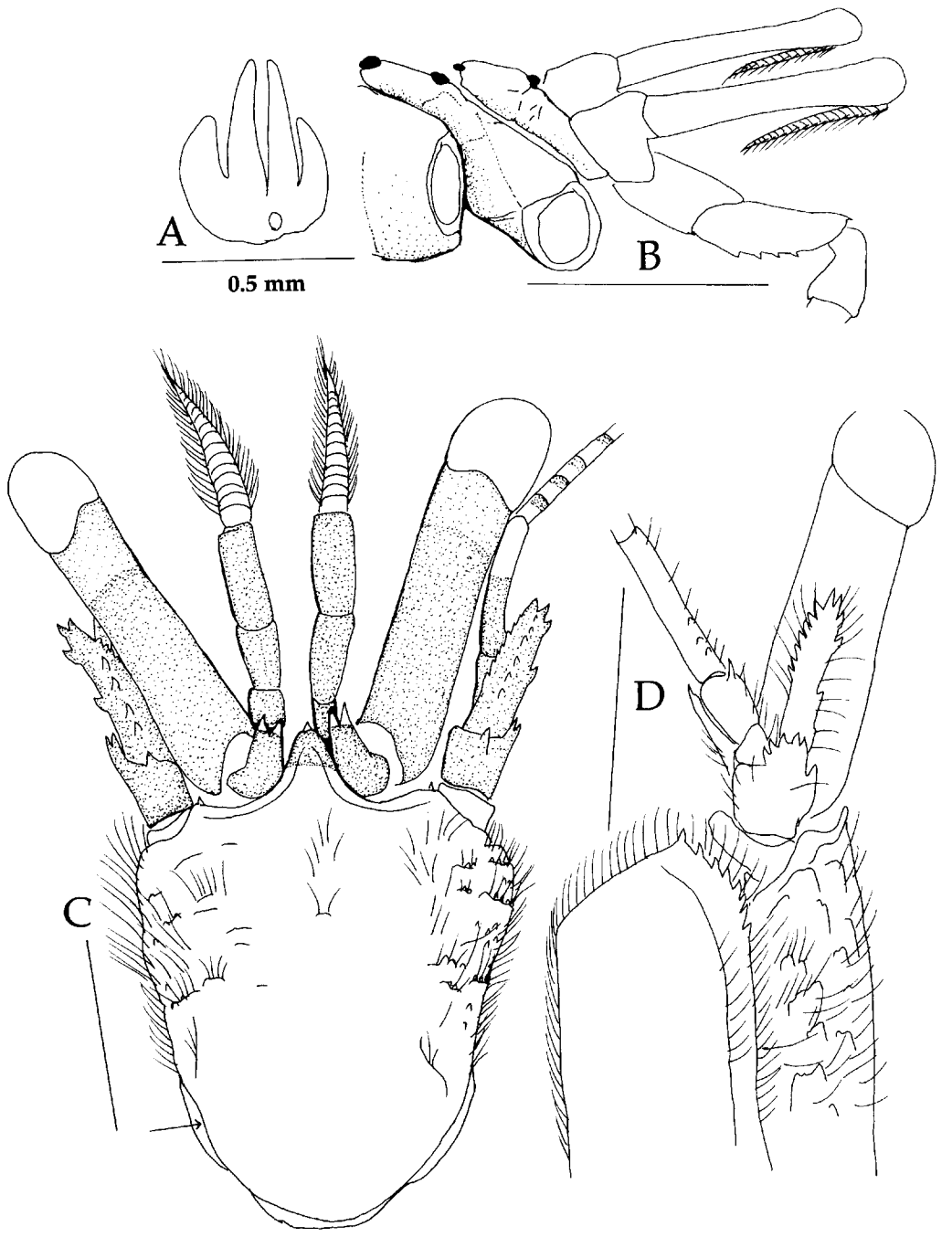

Fig. 1. *Pseudopaguristes shidarai*, new species: holotype male (CBM-ZC 6814), SL = 2.55 mm, off Miyako Is., Okinawa. A, arthrobranch gill lamella on fourth pereopod; B, vestigial gills on third maxilliped and cheliped; C, shield and cephalic appendages; D, left lateral view of distal half of cephalothorax and antenna. Color pattern indicated in C. Scales equal 0.5 mm (A) and 1 mm (B–D).

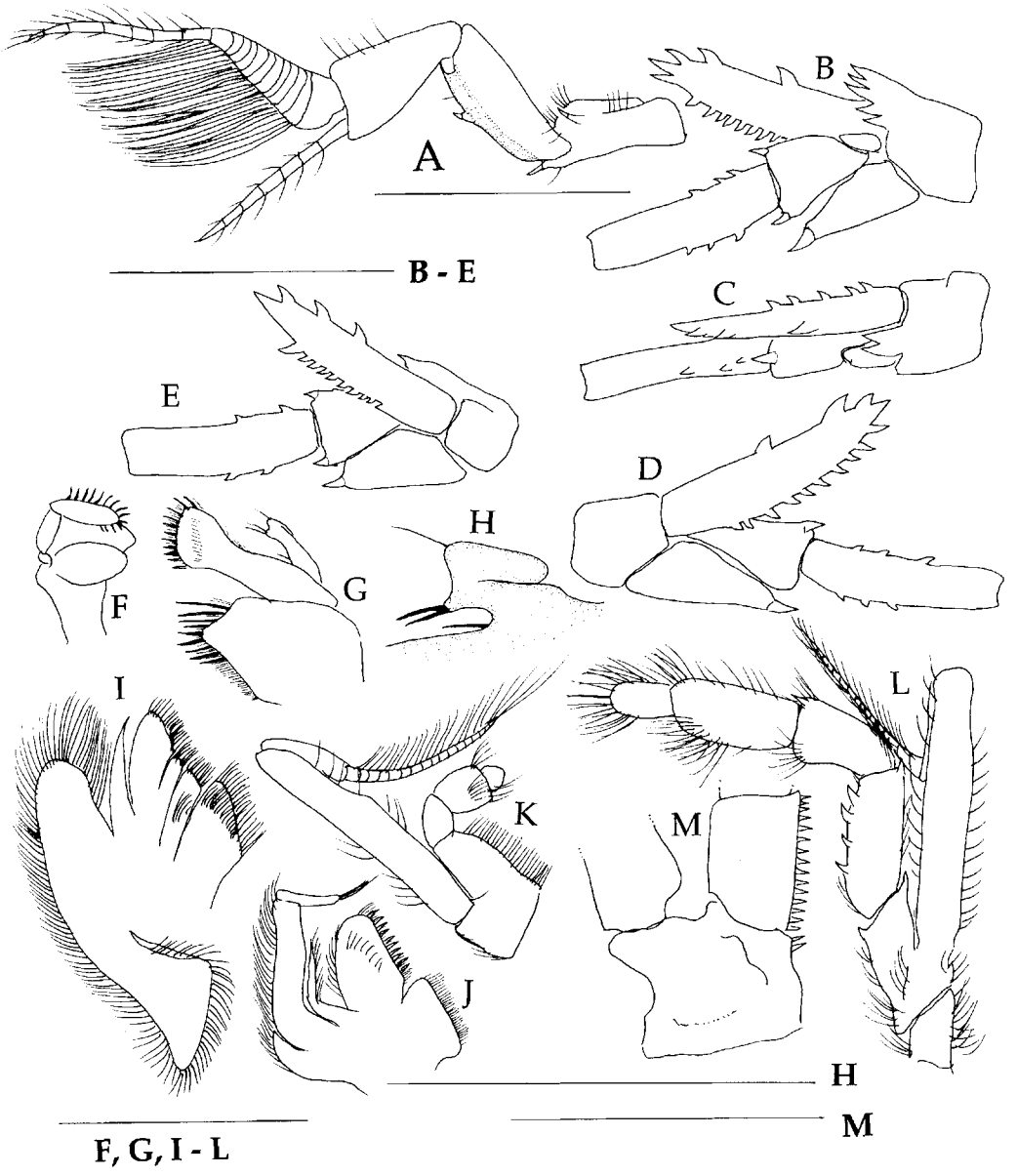

Fig. 2. *Pseudopaguristes shidarai*, new species: A–D, F–M: holotype male (CBM-ZC 6814), SL = 2.55 mm, off Miyako Is., Okinawa. E: paratype male (CBM-ZC 6815), SL = 2.05 mm, same locality. Left antennule: A, lateral. Left antennal peduncle: B, lateral; C, dorsal; D, mesial. Right antennal peduncle: E, mesial. Left mouthparts: F, mandible, internal; G, maxillule, external; H, same, endopod; I, maxilla, internal; J, first maxilliped, internal; K, second maxilliped, internal; L, third maxilliped, external; M, same, proximal portion, internal. Scales equal 1 mm.

slightly dilated. Ocular acicles (Fig. 1C) each with 2 or 3 strong spines on distal margin; separated basally by breadth of rostrum.

Antennular peduncles (Fig. 2A) stout, scarcely setose; when fully extended, distal margins of ultimate segments reaching distal margins of corneas, spines onto segments all with semitransparent tips; ultimate segments unarmed; penultimate seg-

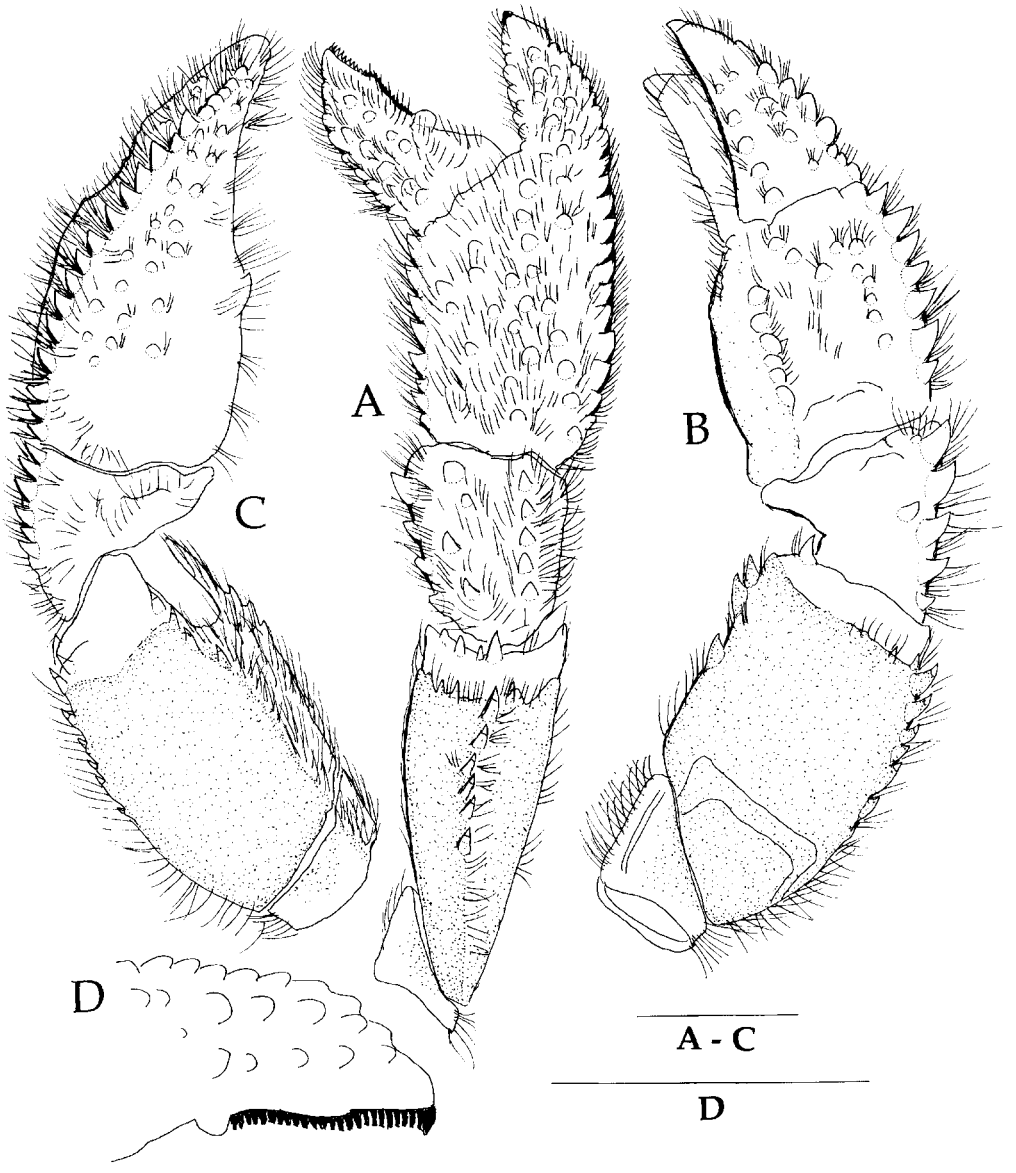

Fig. 3. *Pseudopaguristes shidarai*, new species: holotype male (CBM-ZC 6814), SL = 2.55 mm, Miyako Is., Okinawa. Right cheliped: A, dorsal; B, mesial; C, lateral; D, dactyl, dorsal. Color pattern indicated in A–C. Scales equal 1 mm.

ments with ventromesial margins each bearing acute spine; basal segments with ventromesial and ventrolateral distal angles each bearing acute spine and dorsolateral margins each bearing acute subdistal spine.

Antennal peduncles (Figs. 1C, D, 2B–E) moderately long, when fully extended, reaching basal portions of corneas; fifth segments with dorsal and ventral margins each bearing 2 or 3 small spines; fourth segments with dorsodistal margins each bearing acute spine and ventrodistal margins each also bearing acute spine; third segments each with prominent spine at ventrodistal margin; spines on fourth and third segments often with semitransparent tips;

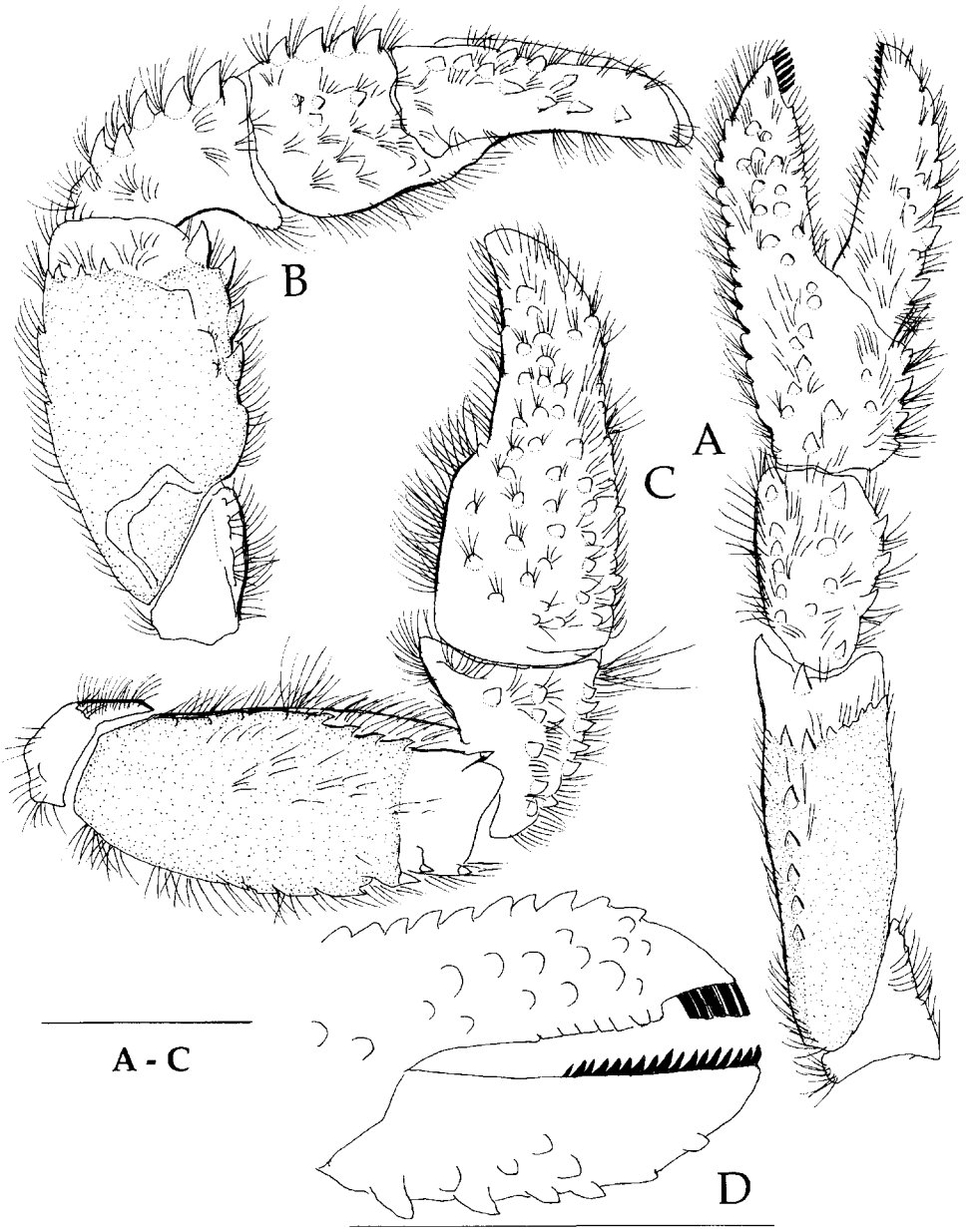

Fig. 4. *Pseudopaguristes shidarai*, new species: holotype male (CBM-ZC 6814), SL = 2.55 mm, Miyako Is., Okinawa. Left cheliped: A, dorsal; B, mesial; C, lateral; D, dactyl and fixed finger, dorsal. Color pattern indicated in A–C. Scales equal 1 mm.

second segments with dorsolateral distal angles produced, bearing strong bifid spine dorsally and 3 or 4 strong spines laterally, dorsomesial distal angles each with blunt-tipped, small spine; first segment unarmed. Antennal acicles moderately long, straight, terminating in strong spine; dorsomesial margins each with 4–6 strong spines; dorsolateral margins each with 2 or 3 strong spines; ventral margins each with row of 9–11 acute spines. Antennal flagella scarcely setose.

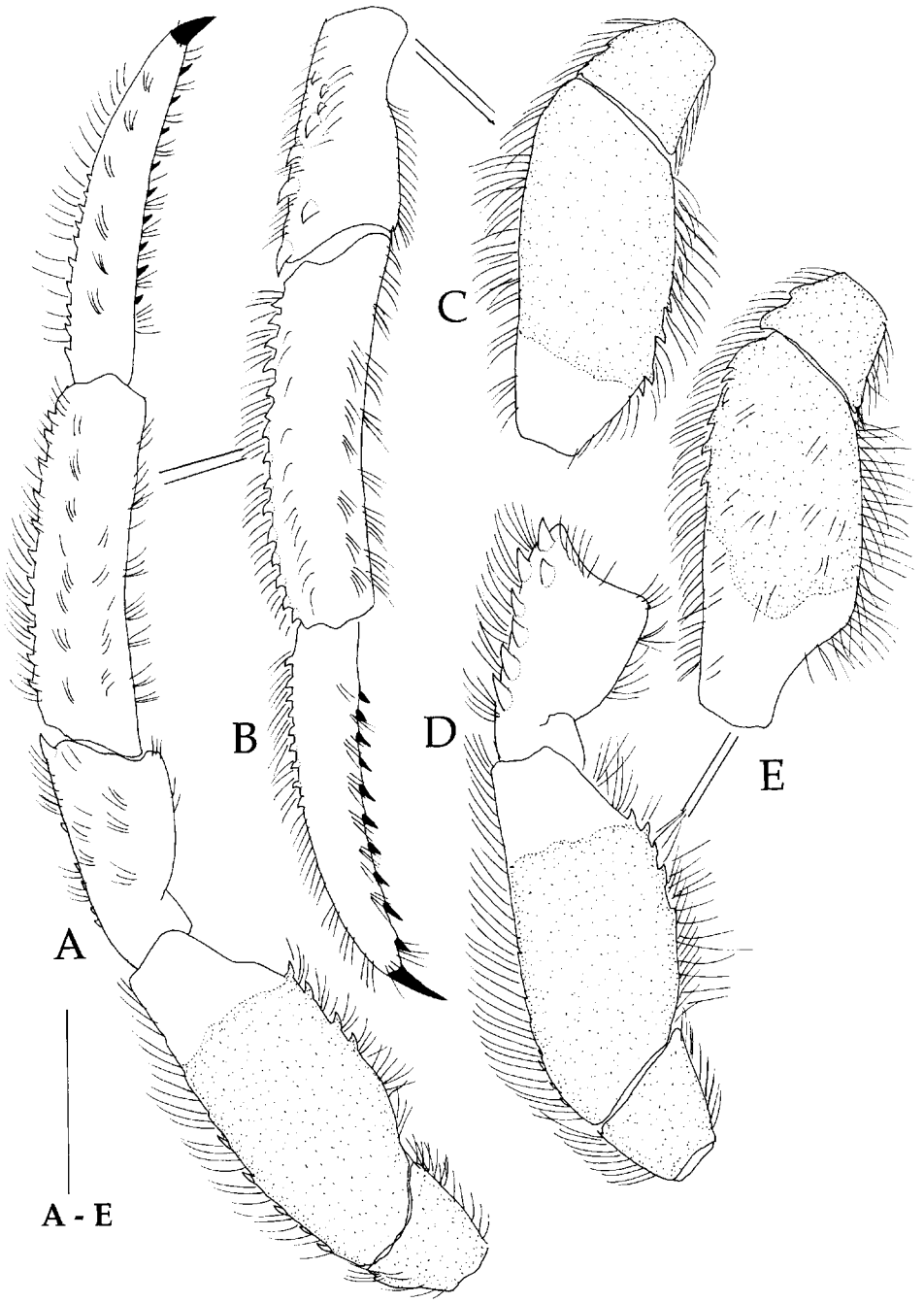

Fig. 5. *Pseudopaguristes shidarai*, new species: holotype male (CBM-ZC 6814), SL = 2.55 mm, Miyako Is., Okinawa. Right second pereopod: A, lateral; B, dactyl, propodus, and carpus, mesial; C, merus and ischium, mesial. Left second pereopod: D, carpus, merus and ischium, mesial; E, merus and ischium, lateral. Color pattern indicated in A–E. Scale equals 1 mm.

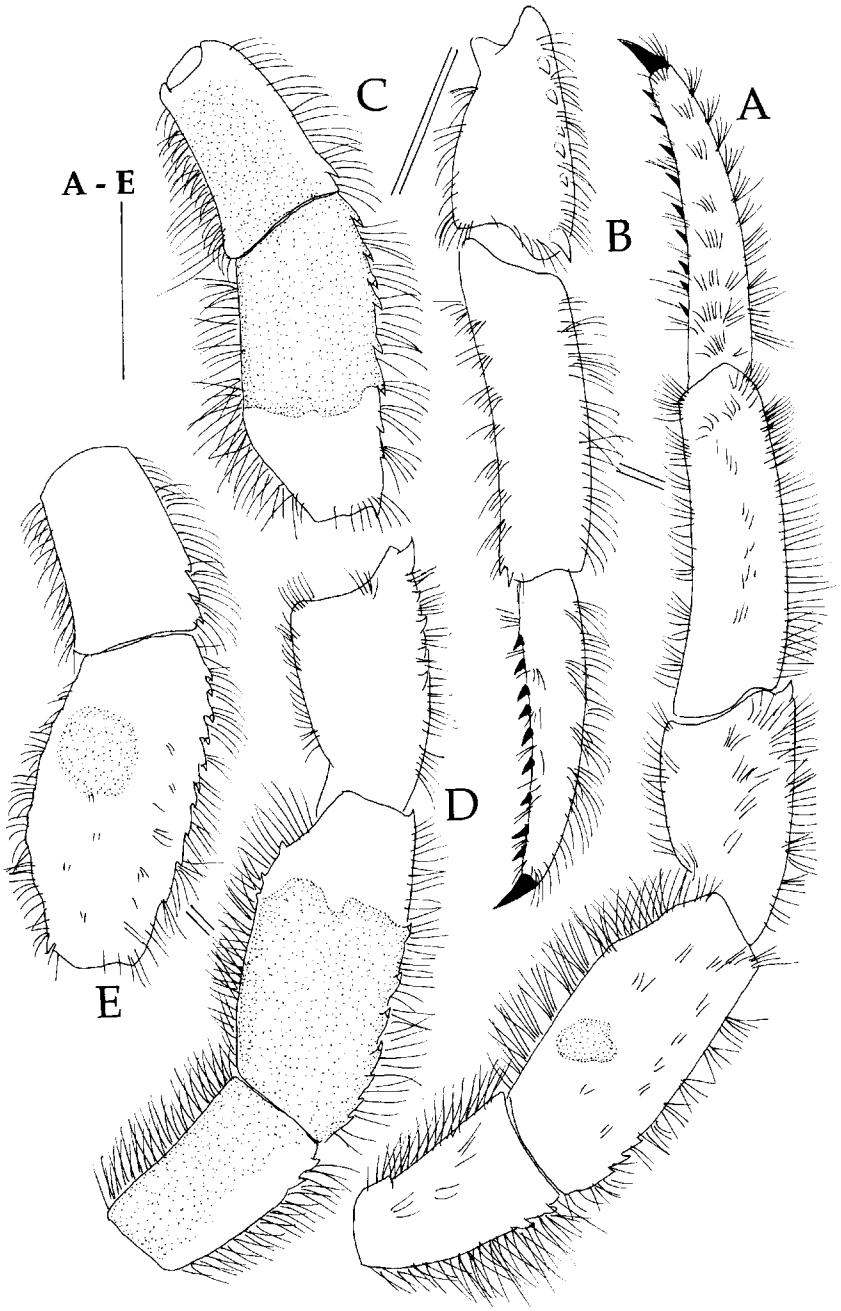

Fig. 6. *Pseudopaguristes shidarai*, new species: holotype male (CBM-ZC 6814), SL = 2.55 mm, Miyako Is., Okinawa. Left third pereopod: A, lateral; B, dactyl, propodus, and carpus, mesial; C, merus and ischium, mesial. Right third pereopod: D, carpus, merus and ischium, mesial; E, merus and ischium, lateral. Color pattern indicated in A–E. Scale equals 1 mm.

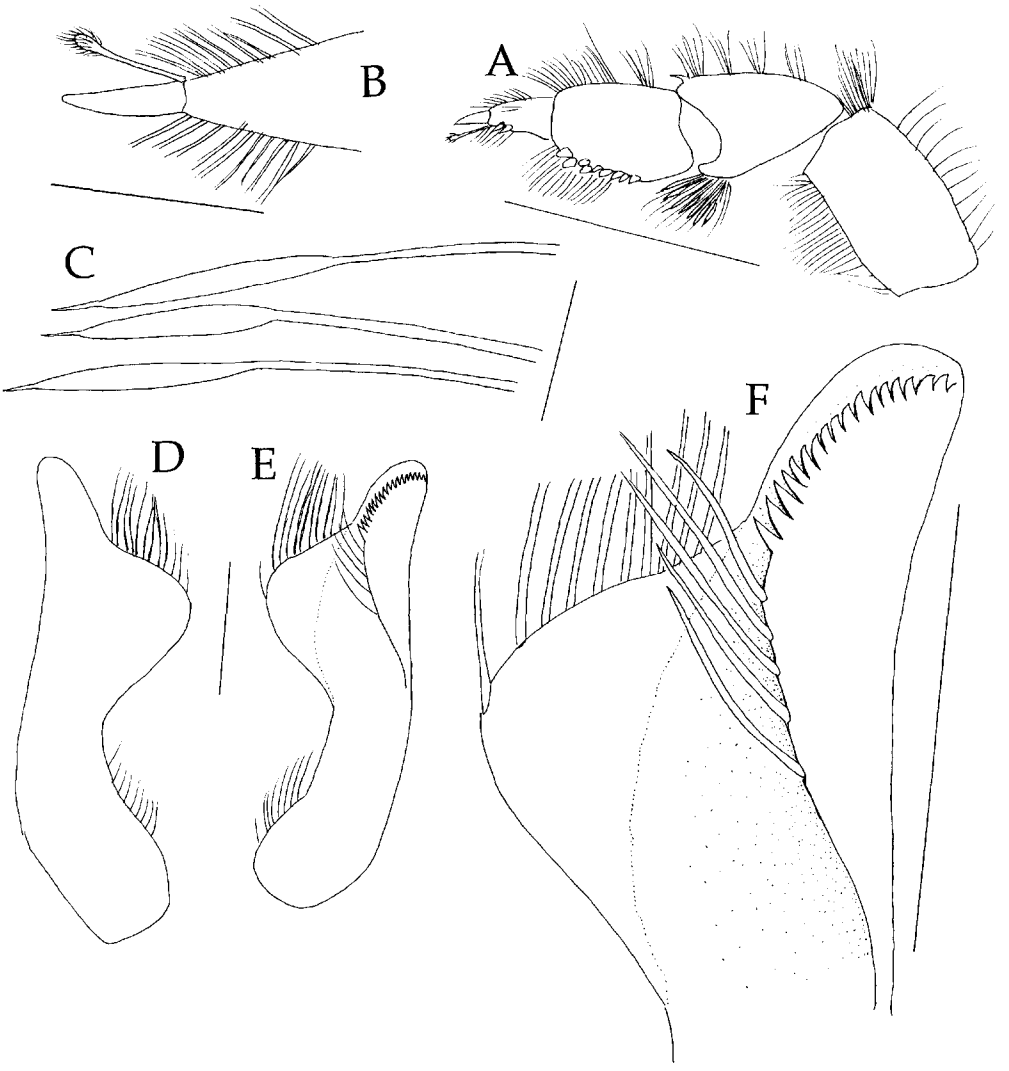

Fig. 7. *Pseudopaguristes shidarai*, new species: holotype male (CBM-ZC 6814), SL = 2.55 mm, Miyako Is., Okinawa. Left fourth pereopod: A, lateral; B, distal portion of dactyl, dorsal; C, ventral setae of carpus. Left first pleopod: D, external; E, internal; F, distal portion, internal, enlarged. Scales equal 1 mm (A) and 0.2 mm (B–E).

Mandible (Fig. 2F) without distinguishing characters. Maxillule (Fig. 2G, H) with external lobe of endopod well developed and recurved, internal lobe with 2 bristles. Maxilla (Fig. 2I) with moderately narrow scaphognathite. First maxilliped (Fig. 2J) with well developed, setose epipod. Second maxilliped (Fig. 2K) without distinguishing characters. Third maxilliped (Fig. 2L, M) with carpus bearing dorsodistal spine; merus with dorsodistal spine, ventral margin bearing 4 or 5 spines; ischium with strong ventrodistal and dorsodistal spines, crista dentata well-developed, no accessory tooth; basis with 2 sharp spines.

Male with both chelipeds bearing dense setae covering dorsal faces of dactyls, fixed fingers, palms and carpi and sometimes detritus densely accumulating on them resulting into yellow or yellowish brown colored appearance. Right cheliped (Fig. 3) stouter than, and dissimilar from, left; dactyl as

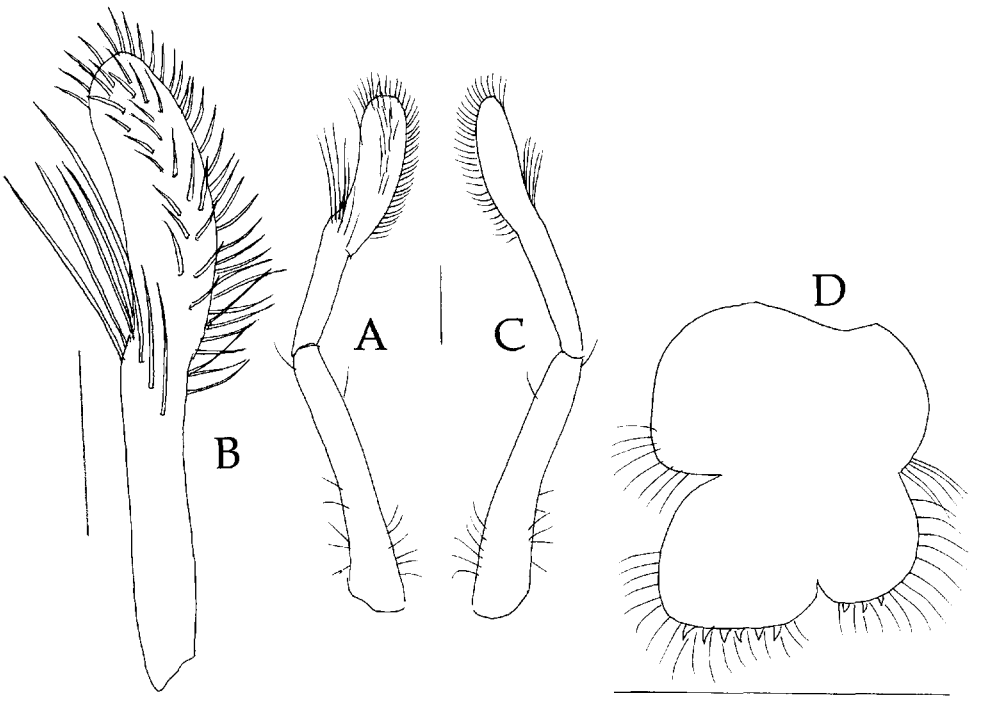

Fig. 8. *Pseudopaguristes shidarai*, new species: holotype male (CBM-ZC 6814), SL = 2.55 mm, Miyako Is., Okinawa. Left second pleopod: A, external; B, same, distal portion, enlarged; C, internal. D, telson. Scales equal 0.2 mm (A–C) and 1 mm (D).

long as palm, terminating in strong corneous claw; dorsal face flat, with 2 rows of large tubercles, dorsomesial margin with row of large tubercles; mesial face with 2 rows of tubercles; cutting edge with numerous corneous teeth on distal half and broad calcareous tooth medially. Fixed finger terminating in corneous claw; dorsal face flat, with scattered large tubercles; cutting edge with few corneous teeth distally. Palm 1.40–1.50 length of carpus; dorsal surface flat, with scattered large tubercles; dorsomesial margin with row of strong spines; dorsolateral margin of palm and fixed finger with row of strong spines. Carpus 0.40–0.50 length of merus; dorsal face flat, with few large tubercles or spines, dorsolateral and dorsomesial margins each with row of spines. Merus with dorsal face bearing large distal spine accompanied mesially with 1–3 small spines, subdistal transverse row of 3 or 4 spines, and, posterior to it, with dorsal longitudinal row of slender semitransparent-tipped spines; ventromesial margin with 3 or 4 strong spines, ventrolateral margin with row of 4 slender, semitransparent-tipped spines. Ischium unarmed. Coxa with spine ventromesially.

Left cheliped (Fig. 4) slender. Dactyl 1.25–1.35 length of palm, terminating in strong corneous claw; dorsal face with only few tubercles, dorsomesial margin with few tubercles; mesial face with few spiniform tubercles; cutting edge with numerous corneous teeth on distal half. Fixed finger terminating in corneous claw; dorsal face flat, with scattered large tubercles; cutting edge with several corneous teeth distally. Palm as long as carpus; dorsal surface flat, with scattered large tubercles; dorsomesial margin with row of strong spines; dorsolateral margin of palm and fixed finger with row of large tubercles. Carpus 0.45–0.55 length of merus; dorsal face flat, with few large tubercles or spines, dorsolateral and dorsomesial margins each with row of spines

or tubercles; lateral face with several tubercles. Merus with dorsal face bearing large distal spine, subdistal transverse row of 3 or 4 spines, and, posteriorly, dorsal longitudinal row of spines; ventromesial margin with 3 or 4 strong spines, ventrolateral margin with row of 3–5 slender spines. Ischium unarmed. Coxa with spine ventromesially.

Second and third pereopods with dense setae present on dorsal margins of each segment and sometimes detritus densely accumulating on them resulting in yellow stripe-like appearance.

Second pereopods (Fig. 5) with armature similar from left to right; right 1.10 length of left. Dactyls 0.90 (left) or 1.00 (right) length of propodi, each terminating in strong corneous claw; dorsal margins each with row of strong spines, larger proximally; ventral margins each with row of 9 or 10 strong corneous spines. Propodi 1.85–1.90 (left) or 1.80–1.85 (right) length of carpi, each with row of strong spines on dorsal margin; ventromesial distal margins with or without spine. Carpi 0.40–0.50 length of meri, dorsal margins each with row of strong spines. Meri each with row of spines on ventral margin; dorsal margins each with row of spines on proximal half. Ischia each with or without small spine dorsally. Coxae unarmed.

Third pereopods (Fig. 6) with armature similar from left to right, right 1.10 length of left. Dactyls 0.95–1.00 length of propodi, each terminating in strong corneous claw; dorsal margins unarmed; ventral margins each with row of 8 or 9 strong corneous spines. Propodi 1.75–1.80 (left) or 1.90–2.00 (right) length of carpi; dorsal faces unarmed; ventromesial distal angles each with 1 or 2 acute spines. Carpi 0.60–0.65 (left) or 0.55–0.65 (right) length of meri, each with strong spine at dorsodistal angle; dorsal margin with 3 or 4 small spines. Meri with ventral margins each bearing few small spines or unarmed; dorsal margins each with row of slender, semitransparent-tipped spines. Ischia each with 1 or 2 small dorsodistal spines. Coxae unarmed.

Sternite of third pereopods with anterior lobe rectangular, unarmed.

Fourth pereopod (Fig. 7A) subchelate. Dactyl terminating in strong corneous claw; prominent preungual process present at base of claw (Fig. 7B); ventral face with 1 or 2 corneous spines laterally. Propodal rasp with 1 or 2 rows of corneous scales. Carpus with acute dorsodistal spine; ventral face with clump of long capsulate setae (Fig. 7C).

Fifth pereopod chelate; dactyl and propodus with well-developed rasps.

Male first pleopods (Fig. 7D–F) paired, modified as gonopods; basal lobe with several setae at superior mesial angle; inferior lamella with distal margin bearing row of short spines, and lateral margin with several setae; internal lobe with row of setae on mesial margin; external lobe exceeding inferior lamella in distal extension. Male second pleopods (Fig. 8A–C) paired, modified as gonopods; basal segment with scattered setae proximally and few setae distally; endopod with several long setae; appendix masculina twisted; lateral and distal margins and inferior face with moderately long setae. Third to fifth left pleopods each with exopod well developed, endopod reduced.

Uropods asymmetrical, left larger than right; rasps of exopods and endopods well developed; protopods each with row of spines posteriorly.

Telson (Fig. 8D) with lateral constrictions; anterior portion unarmed; posterior lobes separated by deep median cleft, left lobe larger than right, terminal margins with 5 or 6 spines (left) or 2 or 3 spines (right).

Description of female paratype.—Female paratype differs from holotype and paratype males as follows: Chelipeds (Figs. 9, 10) subequal, right very slightly larger; armament generally similar. Dactyl as long as (right) or 1.10 length (left) of palm, terminating in strong corneous claw; dorsal faces of both chelipeds each with 6 large, spiniform tubercles (right) or 1 small spine (left), dorsomesial margins each with row of large

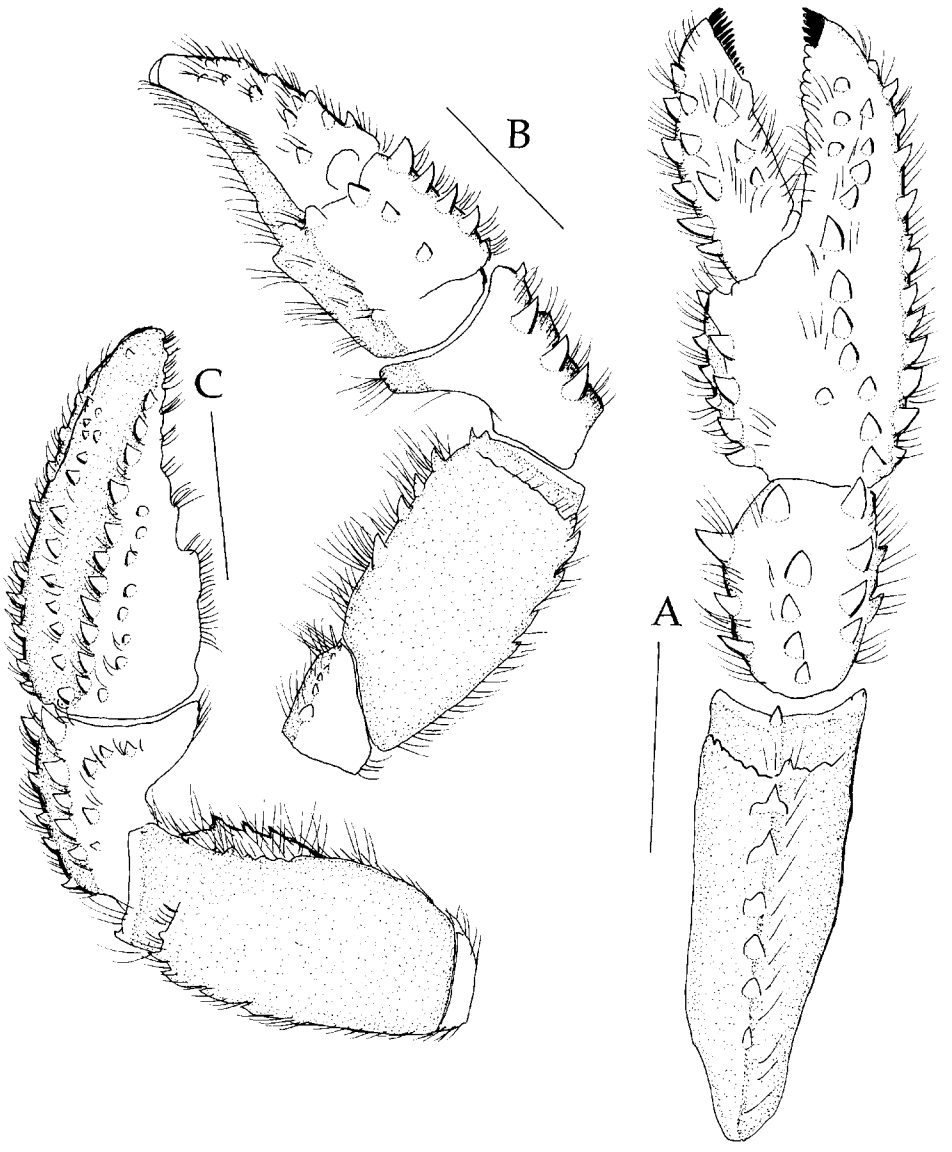

Fig. 9. *Pseudopaguristes shidarai*, new species: paratype female (CBM-ZC 6815), SL = 2.65 mm, Miyako Is., Okinawa. Right cheliped: A, dorsal; B, mesial; C, lateral. Color pattern indicated in A–C. Scales equal 1 mm.

(right) or small (left) spines; mesial faces with several spiniform tubercles or spines; cutting edges with numerous corneous teeth on distal halves. Fixed fingers each terminating in corneous claw; cutting edges with several corneous teeth distally. Palms 1.10 length of carpi; dorsal surfaces of palms and fixed fingers flat, each with row of strong spines, right, accompanied mesially by small tubercle on palm and row of 3 tubercles on fixed finger, dorsolateral margins of palms and fixed fingers each with row of strong spines, dorsomesial margins of palms each with row of strong spines; mesial faces each with few spines (right) or unarmed (left); lateral faces each with row of tubercles (right) or few spines (left). Carpus 0.50 (right) or 0.40 (left) length of mer-

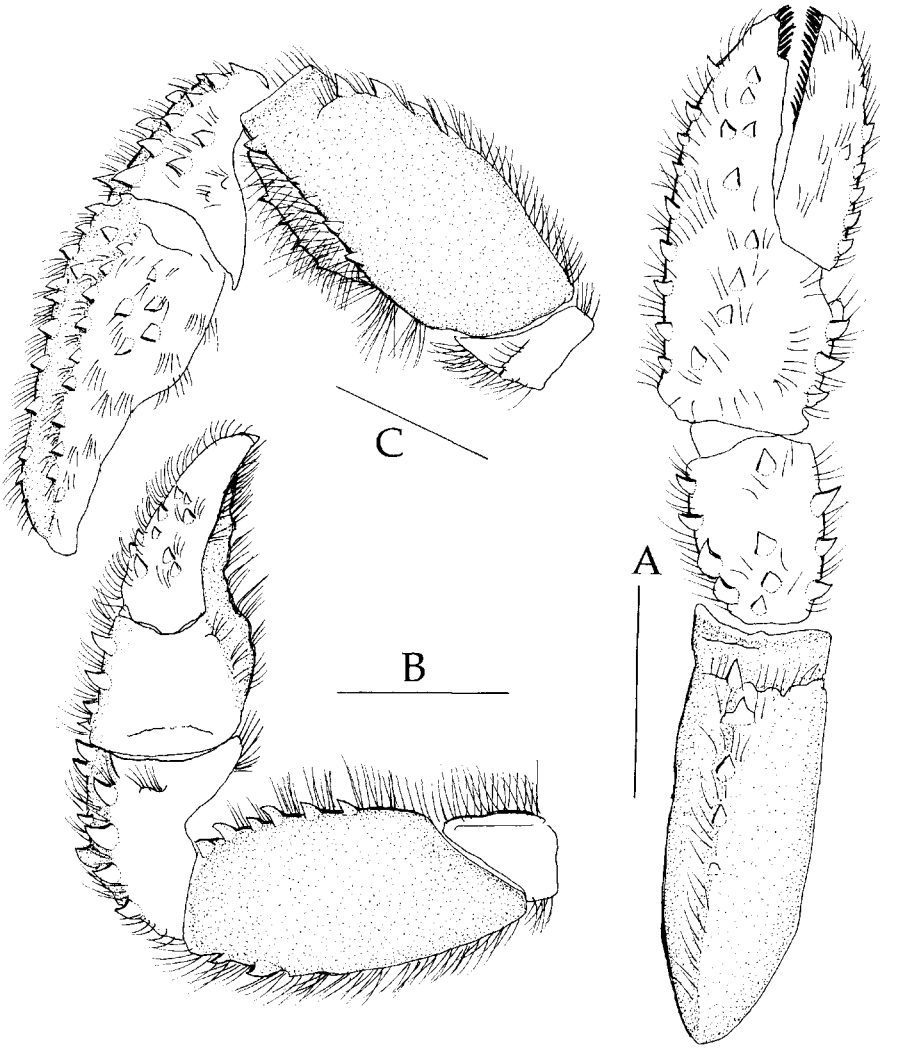

Fig. 10. *Pseudopaguristes shidarai*, new species: paratype female (CBM-ZC 6815), SL = 2.65 mm, Miyako Is., Okinawa. Left cheliped: A, dorsal; B, mesial; C, lateral. Color pattern indicated in A–C. Scales equal 1 mm.

us; dorsal faces flat, each with row of spines on midline, dorsolateral and dorsomesial margins each with row of strong spines; lateral faces with several spines or tubercles; mesial faces unarmed. Meri with dorsodistal spine developed (right) or vestigial (left); dorsal margins each with row of spines; ventromesial and ventrolateral margins each with row spines. Ischia each with row of small spines or tubercles on ventromesial margin. Coxae each with spine ventromesially.

Coxa of only left third pereopod with gonopore (Fig. 11B).

First abdominal somite with paired uniramous pleopods modified as gonopods (Fig. 11B); second through fourth abdominal somites each with unequally biramous left pleopod (Fig. 11C); fifth with exopod well developed, endopod rudimentary; brood pouch represented by row of setae.

Color in life (Fig. 12).—Shield cream, rostrum red; antennules with flagella semitransparent red, other surfaces uniformly

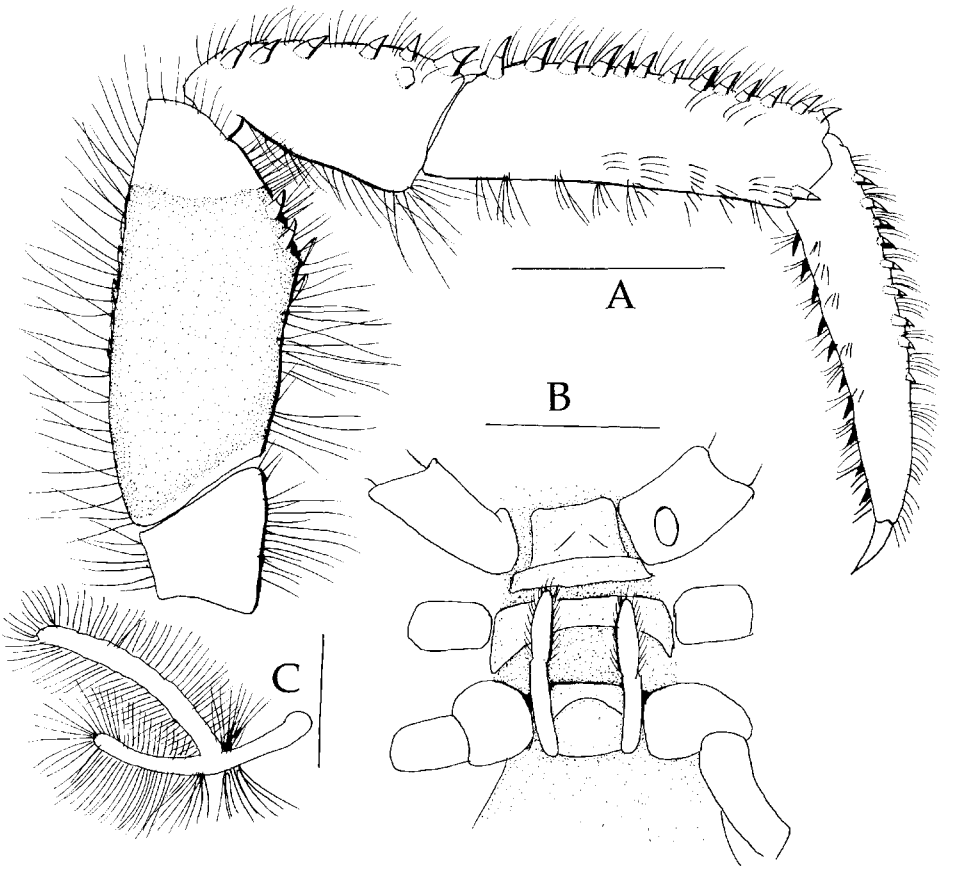

Fig. 11. *Pseudopaguristes shidarai,* new species: paratype female (CBM-ZC 6815), SL = 2.65 mm, Miyako Is., Okinawa. A, left second pereopod, mesial. B, coxae and sternites of third to fifth pereopods, first abdominal somite, and first pleopods. C, second pleopod.

red; antennas with flagella bearing alternative red and white bands, fifth segment with proximal 0.30–0.40 lighter red, other surfaces uniformly red; ocular peduncles uniformly red or with lighter red band on proximal 0.20; ocular acicles red except for lighter red distal spines; second and third maxillipeds uniformly red. Both chelipeds generally cream in males, but orange in female; meri red except for distal 0.10–0.25. Second pereopods generally cream; meri red except for distal 0.20–0.40; ischium lighter red. Third pereopods generally cream; meri with lateral face uniform cream or small light red patch, mesial face uniform red except for distal 0.30–0.40; ischium with lateral face uniform cream or very faint red, mesial face uniform lighter red.

Etymology.—This species is named for Mr. Hiroyuki Shidara, an amateur hermit crab collector and marine aquarist, who kindly made the specimens available for this study.

Distribution.—Known only from the type locality.

Remarks.—Despite their general similarities in morphology, the new species, *P. shidarai,* differs from the other three species of the genus in shape of telson. In *P. shidarai,* the terminal margins of the telson are horizontal, and each posterior lobe is armed with at most only 6 (left) or 3 (right) spines (Fig. 8D). In contrast, the terminal margins of the telson of the holotype of *P. bollandi,* and only known specimen, are oblique and the posterior lobes each is armed with 16

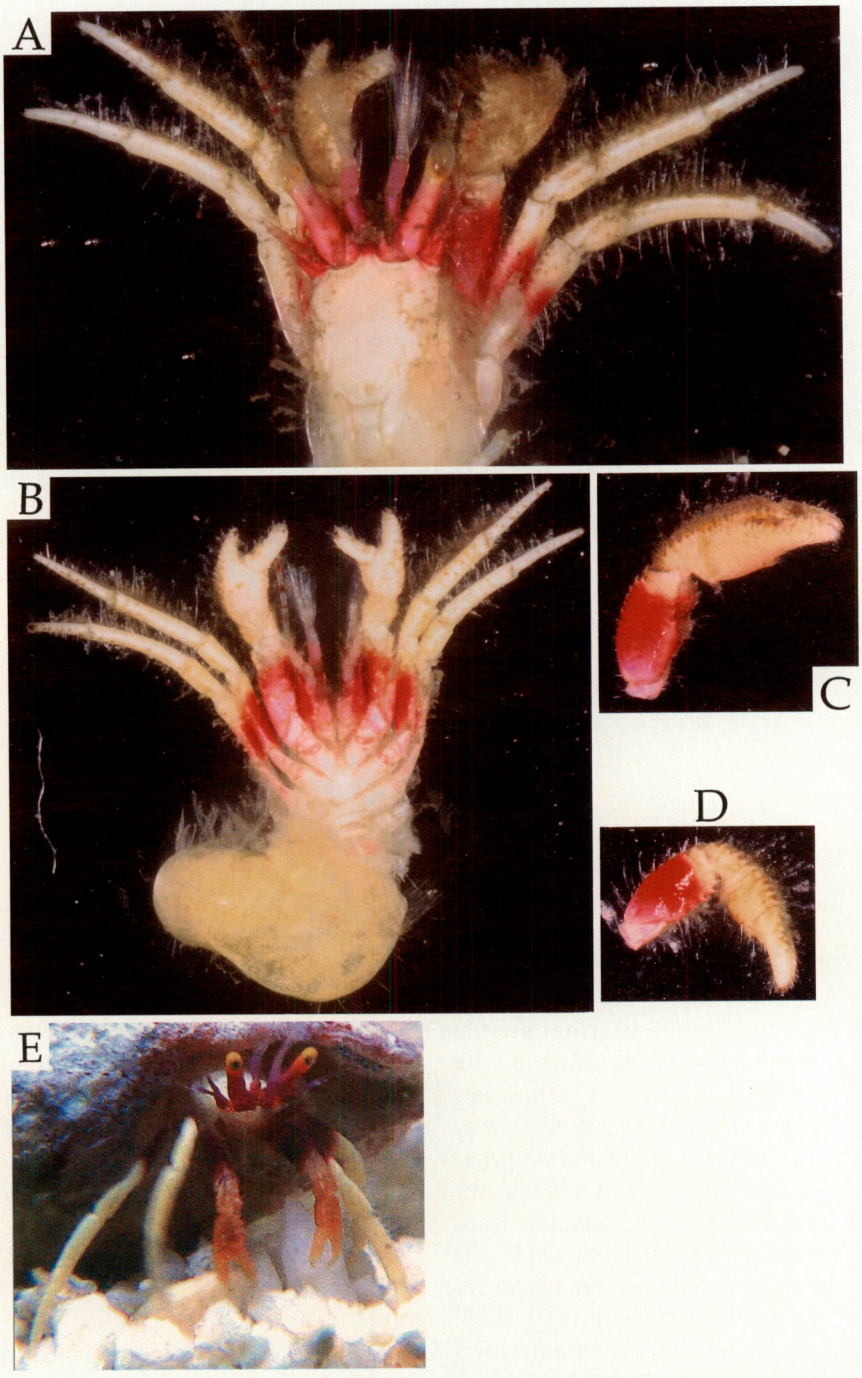

Fig. 12. *Pseudopaguristes shidarai,* new species: A–B, paratype male (CBM-ZC 6815); C–D, holotype male (CBM-ZC 6814); E, female. A, anterior half, dorsal. B, whole animal, ventral. C, right cheliped, lateral. D, left cheliped, mesial. E, living individual of female. Photos by Akira Asakura (A–D) and Kiyohiko Sakuma (E).

Table 1.—Color difference between *Pseudopaguristes shidarai*, new species and *P. janetkae* McLaughlin.

Character	*P. shidarai*	*P. janetkae*
Shield anterior margin	Cream	Cranberry red
Ocular peduncles	Uniform red or with lighter red band on proximal 0.20	Cranberry red on proximal 0.25–0.35, remainder yellow-orange
Antennule penduncles		
Ultimate segment	Red	Red-orange
Penultimate segment	Red	Cranberry red on proximal 0.5, remainder red-orange
Basal segment	Red	Cranberry red
Antennal peduncles		
Fifth segment	Red, with proximal 0.30–0.40 lighter red	Yellow
Fourth segment	Red	Yellow
Third segment	Red	Yellow
Second segment	Red	Cranberry red, with yellow produced dorsolateral distal angle
First segment	White	Cranberry red
Chelipeds		
Dactyl and fixed finger	Cream (male) Orange (female)	Tan tinged with cranberry red
Palm	Cream (male) Orange (female)	Cranberry red, becoming lighter distally
Carpus	Cream (male) Orange (female)	Cranberry red
Merus	Red, with distal 0.15–0.25 cream	Cranberry red
Third pereopods		
Merus lateral face	Uniformly cream or with only small, faint red patch	Cranberry red except cream distal portion

(left) or 13 (right) spines. Although McLaughlin (2002) made no mention of number of the telsonal terminal spinules in *P. janetkae,* it is 25 (left) or 13 (right) in the illustration of the holotype (McLaughlin 2002: Fig. 20). The terminal margins of the telson of *P. bicolor* are strongly oblique, and armed with 9 (left) or 6 (right) spines.

The armament of the antennas can separate *P. shidarai* from both *P. bicolor* and *P. janetkae.* Produced dorsolateral distal angles of the second segments of the antennas each has strong, dorsal, bifid spine and 3 or 4 strong lateral spines in *P. shidarai* (Figs. 1D, 2B). The same portions of both *P. bicolor* and *P. janetkae* are only armed with a dorsal bifid spine and have no lateral spines. The ventral margins of antennal acicles are each armed with a row of numerous spines in *P. shidarai* (Figs. 1D, 2D, E), but they are unarmed in *P. bicolor* and *P. janetkae.*

By differences in coloration in life, *P. shidarai* is readily distinguished from both *P. bicolor* and *P. bollandi.* The chelipeds and the second and third pereopods are uniformly red in *P. bollandi* and have alternating red and white bands in *P. bicolor.* In *P. shidarai,* these appendages are generally cream, with red areas on the meri.

Although the coloration of *P. shidarai* is somewhat similar to that of *P. janetkae* in having cream colored ambulatory pereopods with red proximal portions, many minor but apparent differences are seen as in Table 1. The chelipeds of males of this species are generally cream, with proximal red portions (Fig. 12A–D). However, those of

females are generally orange except for the proximal red portions (Fig. 12E). This may exhibit sexually dimorphic color of chelipeds in this species. However, since only a few specimens are examined, future collection effort will be needed to evaluate this point. McLaughlin (2002) made no mention on sexual difference in coloration of *P. janetkae.*

In addition to the differences in the telson and antennas as mentioned above, *P. shidarai* differs morphologically from *P. janetkae* in several important characters. The propodus of the second left pereopod of the female *P. janetkae* differs from the right and also from the propodi of the males in having scattered spinules on the mesial face. However, in *P. shidarai,* the armature of the propodi of the second pereopods is similar from left to right (Fig. 11A) and also similar to those of the males. In the female *P. shidarai,* the dorsal face of the palms of the chelipeds each bears a longitudinal row of spines. The same surfaces of *P. janetkae* are armed with widely-spaced and somewhat scattered, small spines.

Since so few specimens of each species have been collected in each species, future collection efforts will be needed to evaluate intraspecific variation and interspecific difference more precisely.

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Literature Cited

Asakura, A., & P. A. McLaughlin. 2003. *Pseudopaguristes bollandi,* new species, a distinct hermit crab (Crustacea: Decapoda: Diogenidae) from Japan.—Proceedings of the Biological Society of Washington 116:453–463.

———, & T. Kosuge. 2004. *Pseudopaguristes bicolor,* a new species of hermit crab (Crustacea: Decapoda: Diogenidae) from Japan, the third species of the genus.—Proceedings of the Biological Society of Washington 117:68–83.

McLaughlin, P. A. 1997. Crustacea Decapoda: hermit crabs of the family Paguridae from the KARUBAR cruise in Indonesia. *In* A. Crosnier & P. Bouchet, eds., Résultats des Campagnes MUSORSTOM, 16.—Mémoires du Muséum national d'Histoire naturelle 172:433–572.

———. 2000. Crustacea Decapoda: *Porcellanopagurus* Filhol and *Solitariopagurus* Türkay (Paguridae), from the New Caledonian area, Vanuatu and the Marquesas: new records, new species. *In* A. Crosnier, ed., Résultats des Campagnes MUSORSTOM, volume 21.—Mémoires du Muséum national d'Histoire naturelle, Paris, volume 184:389–414.

———. 2002. *Pseudopaguristes,* a new and aberrant genus of hermit crabs (Anomura: Paguridea: Diogenidae).—Micronesica 34:185–199.

———, & M. de Saint Laurent. 1998. A new genus for four species of hermit crabs formerly assigned to the genus *Pagurus* Fabricius (Decapoda: Anomura: Paguridae).—Proceedings of the Biological Society of Washington 111:158–187.