

TWO NEW HERMIT CRABS OF THE GENUS  
*PAGURUS* (*PROVENZANOI* GROUP)  
 (CRUSTACEA, ANOMURA, PAGURIDAE)  
 FROM THE EASTERN PACIFIC, WITH  
 NOTES ON THEIR ECOLOGY

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**ABSTRACT.** During ecological studies of the shallow-water hermit crab fauna of the northwestern Gulf of California, Mexico, two new species of the *provenzano* group of *Pagurus* were recognized. Additional material has shown that one of these species, *P. vetaultae* n. sp., has been found as far south as Panama, whereas the second, *P. arenisaxatilis* n. sp., appears not only to be endemic to the northern Gulf of California, Mexico, but to be one of the most abundant hermit crabs in the region. It is the only species in the northern Gulf that commonly inhabits both rocky and sandy shores. Despite the broader distribution of *P. vetaultae* through shallow subtidal regions of Mexico and Central America, this species appears to be restricted to coarse gravel substrates. Both species are described and illustrated.

#### INTRODUCTION

Following the description of *Pagurus lepidus* (Bouvier, 1898) virtually all small intertidal pagurids from the Gulf of California, Mexico, and/or the west coast of Baja California, Mexico, were routinely assigned to this taxon or to a complex of species confounded under this name (e.g., Glassell, 1937; Haig *et al.*, 1970; Ball and Haig, 1974; McLaughlin, 1975; Snyder-Conn, 1980). Haig and McLaughlin (1990) recently reexamined the syntypes of Bouvier's (1898) species and provided a detailed redescription and illustrations of this taxon. For the first time it is now possible to accurately report on some of the other taxa in this species complex.

Field and laboratory studies by one of us (AWH) on the intertidal hermit crabs of the northern Gulf of California included three species previously assigned to the *Pagurus lepidus* complex. One has proved to be *P. lepidus* s.s.; the other two are new species described herein, together with brief summaries of their ecology. One of these species, *P. vetaultae* n. sp., was first found in the Bay of Panama by Carl Bovallius during a trip to the Pacific

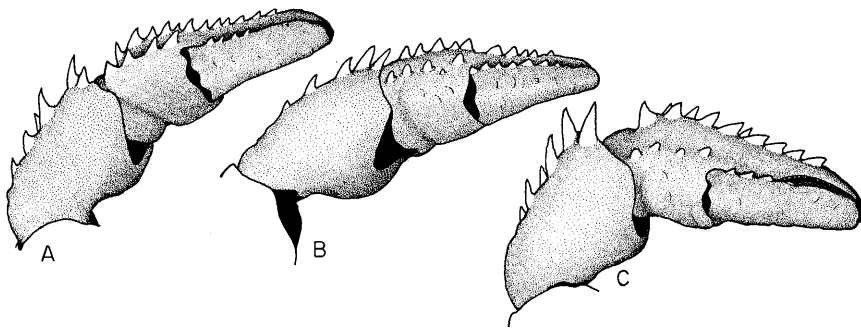
coast of Central America in 1882–83 but was never described. The other, although quite abundant on a variety of substrates in the intertidal region, appears restricted in its distribution to the Gulf of California.

As with Atlantic species of the *provenzano* group (see McLaughlin, 1975; Lemaitre *et al.*, 1982), Pacific representatives are morphologically difficult to distinguish from one another. One extensively used diagnostic character is the dorsomesial surface of the left chela. It is described either as horizontal (Fig. 1A) or sloping (Fig. 1B, C) and usually is not influenced by animal size. However in *P. vetaultae* n. sp., the slope of the dorsomesial face varies from slight to substantial. The armament of this surface may be so strong that it gives the slightly sloping surface the visual impression of being horizontal.

#### MATERIALS

Materials for this study have come from the Crustacea collections formerly of the Allan Hancock Foundation (AHF) (now part of the Crustacea collection of the Natural History Museum of Los Angeles County), National Museum of Natural History, Smithsonian Institution (USNM), Naturhistoriska Riksmuseet, Stockholm (NHRM), and from individual collectors. Specimens will be re-

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**Figure 1.** Lateral views of carpi and chelae of left chelipeds (setae omitted) depicting angulation of dorsomesial surface of chelae: **A**, *Pagurus lepidus* (Bouvier) with horizontal surface; **B**, *Pagurus vetaultae* n. sp. with weakly sloping surface; **C**, *Pagurus vetaultae* n. sp. with strongly sloping surface.

turned to their repositories of origin and/or deposited in these and the following museums: Rijksmuseum van Natuurlijke Historie, Leiden (RMNH), Natural History Museum of Los Angeles County (LACM), Museum National d'Histoire Naturelle (MNHN). Material formerly belonging to the Allan Hancock Foundation is indicated by an original AHF catalog number in addition to its current LACM number, which follows the AHF number in parentheses. One measurement, shield length (SL), provides an indication of size ranges of the specimens examined.

## DESCRIPTIONS

### *Pagurus arenisaxatilis* new species

Figure 2A–H

*Pagurus lepidus*: Chace, 1962:623, in part (by implication) (see remarks).

**HOLOTYPE.** Ovigerous ♀ (SL = 2.1 mm), USNM 243896. **Type locality.** Between Pelican Point and Choya Bay, Sonora, Mexico, February 3, 1988, collector A. Harvey.

**PARATYPES.** Baja California, Mexico: San Felipe Bay, 6 ♂, 2 ♀, 1 ovigerous ♀ (SL = 1.2, 2.4 mm), intertidal, January 1, 1976, collectors R. Brusca, B. Wallerstein, AHF 7615 (LACM 76-595.1); San Felipe Bay, 1 ♂ (SL = 1.9 mm), “Velero III” station 1071-40, 5 m, February 2, 1940, AHF 4015 (LACM 40-43.1); off Diggs Point, San Felipe Bay, 1 ♂, 1 ovigerous ♀ (SL = 1.5, 1.7 mm), 30 m, June 3, 1934, collector S. Glassell, USNM; off Willard Point, Bahia San Luis Gonzaga, 1 ♂ (SL = 2.1 mm), “Velero III” station 716-37, 3.5–5.5 m, March 23, 1937, AHF 3711 (LACM 37-119.6). Sonora, Mexico: Adair Bay, 1 ♂ (SL = 2.2 mm), Choya Bay Survey station 67041, 6 m, March 18, 1967, collectors Burch and Kawchak, AHF 675 (LACM 67-242.1); same locality, 1 ♂ (SL = 2.5 mm), Choya Bay Survey station 67042, 10 m, March 18, 1967, collectors Burch and Kawchak, AHF 678 (LACM 67-242.1); same locality, 4 ♂, 2 ♀ (SL = 0.9–2.1 mm), Choya Bay Survey station 70106, shore, July 18, 1970, collectors Burch and Seivings, AHF 709, 7010 (LACM 70-283.1); Pelican Point, 2 ♂ (SL = 1.8, 2.3 mm), Choya Bay Survey station 68045, shore, April 13, 1968, collectors Burch and Avery, AHF 6819 (LACM 68-384.1); between Pelican Point and Choya Bay, 6 ovigerous ♀ (SL = 1.5–2.1 mm), intertidal, February

3, 1988, collector A. Harvey, NHRM, RMNH; same locality, 4 ovigerous ♀ (SL = 1.7–2.7 mm), intertidal, January 19, 1988, collector A. Harvey, LACM 88-291.1; same locality, 5 ♂, 3 ♀, 1 ovigerous ♀ (SL = 0.9–2.6 mm), intertidal, July 26, 1988, collector A. Harvey, USNM; same locality, 2 ovigerous ♀ (SL = 1.7, 1.8 mm), intertidal, February 22, 1989, collector A. Harvey, MNHN; off Choya, 1 ♂ (SL = 2.0 mm), Choya Bay Survey station 67164, 17.5 m, November 4, 1967, collectors Burch, Hanson, and Skoglund, AHF 679 (LACM 67-243.1); sandy beach, Choya, 4 ♂, 1 ovigerous ♀ (SL = 1.7–2.1 mm), Choya Bay Survey station 66033, shore, August 15, 1966, collectors T. and B. Burch, AHF 6612 (LACM 66-355.1); same locality, 1 ♂ (SL = 1.7 mm), Choya Bay Survey station 66046, shore, October 14, 1966, collectors Burch, Avery, and Scott, AHF 6613 (LACM 66-356.1); Choya Bay, 16 mile reef, 1 ♀ (SL = 1.3 mm), station GA-72, March 1968, collectors G. and M. Avery, AHF 6818 (LACM 68-385.1); Puerto Peñasco, 1 ♂, 1 ♀, 5 juveniles (SL = 0.8–1.4 mm), November 23–26, 1955, collector E.P. Chace, USNM 211423; same locality, 2 ♂, 3 ♀, 2 ovigerous ♀ (SL = 2.0–2.9 mm), 1967, collector A. Havens, RMNH; same locality, 1 ♂, 3 ♀, 1 ovigerous ♀ (SL = 2.0–2.9 mm), intertidal, December 3, 1967, collector A. Havens (NHRM Cat. No. 4175); same locality, 1 ♂ (SL = 2.1 mm), Choya Bay Survey station 69030, shore, February 15, 1969, collectors Burch, Hanson, Bennett, and Schroder, AHF 6913 (LACM 69-229.1); off Rocky Point, 2 ♂ (SL = 1.8, 1.9 mm), “Velero III” station 1072-40, 20 m, February 2, 1940, AHF 4016 (LACM 40-44.6); inside Georges Island (just south of Bahia San Jorge), 1 ♂ (SL = 1.5 mm), “Velero III” station 1075-40, 21–23 m, February 3, 1940, AHF 4017 (LACM 40-47.1); south of Isla Tiburón, 1 ♂ (SL = 1.8 mm), “Velero III” station 731-37, 122.5 m, March 28, 1937, AHF 3712 (LACM 37-134); south side Isla Tiburón, 1 ♂ (SL = 3.2 mm), “Curry-Orca” Cruise station 194, 13 m, March 27, 1960, collector R.H. Parker, AHF 6055 (LACM 60-181.1).

**DIAGNOSIS.** Shield slightly longer than broad. Ocular peduncles one-half to two-thirds shield length. Articles of antennal flagella with irregularly alternated long and short setae. Carpus of right cheliped with irregular double row of spines on dorsomesial margin and 1 or 2 additional spines near distal margin. Left cheliped with dorsomesial face of palm strongly sloping; ischium with ventromesial margin unarmed or with few spinules.

Dactyli of ambulatory legs each with 8–13 corneous spines on ventral margin. Anterior lobe of sternite of 3rd pereopods subsemicircular. Posterior lobes of telson with simple to spinous lateral margins, without delimiting spine anteriorly. In life, chelipeds with distal halves of dactyli and fixed fingers white, palms and carpi tan to olive.

**DESCRIPTION.** Shield (Fig. 2A) slightly longer than broad, anterior margin between rostrum and lateral projections concave, anterolateral margins sloping; posterior margin subtruncate. Rostrum obsolete, unarmed. Lateral projections broadly rounded, with very small terminal spinule. Dorsal surface of shield with scattered tufts of setae (not illustrated).

Ocular peduncles (Fig. 2A) one-half to two-thirds shield length, broad basally and moderately stout, corneae slightly dilated. Ocular acicles subrectangular, multispinose (2–5 marginal or submarginal spines), separated basally by slightly more than one-half basal width of 1 acicle. Interocular lobes weakly developed.

Antennular peduncles (Fig. 2A) overreaching ocular peduncles by one-half to two-thirds length of ultimate segment. Ultimate segment with few setae on dorsodistal margin and scattered on dorsal and ventral margins (setae not shown). Penultimate segment with few setae ventrally. Basal segment with 1 acute spine on dorsolateral face.

Antennal peduncles (Fig. 2A) overreaching corneae by approximately one-half length of ultimate segment. Fifth and 4th segments with few tufts of setae. Third segment with small spinule at ventrodistal margin. Second segment with dorsolateral distal angle produced, terminating in acute spine, lateral and mesial margins with long or moderately long setae and occasionally small accessory spinule; dorsomesial distal angle with small spine, mesial face with long setae. First segment with small spine on lateral face distally, ventral margin produced and armed with 1 spine laterally. Antennal acicle somewhat arcuate, terminating in small spine, mesial margin with moderately long setae. Antennal flagellum usually with 2 or 3 moderately long (2–3 articles length) and usually 2–4 short setae or bristles per article, at least in proximal half.

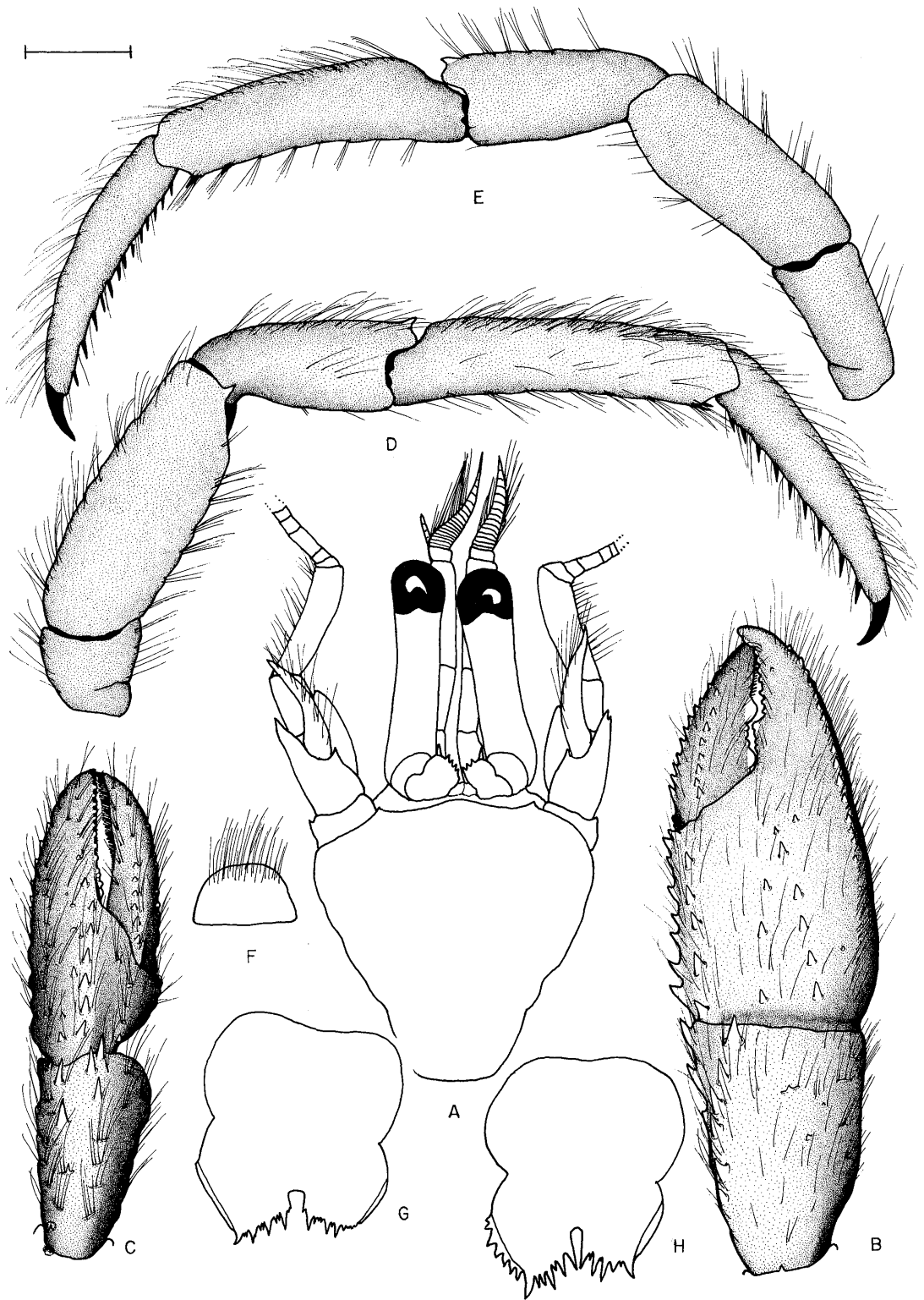
Mouthparts typical for species of the *provenzanoi* group as described by McLaughlin (1975) and Lemaitre *et al.* (1982).

Right cheliped (Fig. 2B) with dactylus approximately as long as palm, slightly overlapped by fixed finger. Cutting edge of dactylus with 1 or 2 strong and several small calcareous teeth in proximal half and row of small corneous teeth in distal half, terminating in small corneous claw. Cutting edge of fixed finger with 1 strong calcareous tooth in proximal half and small calcareous teeth interspersed with corneous teeth distally, terminating in corneous tip. Dorsomesial margin of dactylus with row of small acute spines, dorsal surface slightly elevated in midline and also armed with row of small spines and tufts of long stiff setae, dorsomesial mar-

gin with tufts of long stiff setae, ventral surface with few scattered setae. Palm slightly shorter than carpus; dorsomesial margin with irregular double row of spines and dense tufts of setae, dorsal surface with irregular rows of spines and tufts of long setae proximally and usually scattered small spines on fixed finger, dorsolateral margin with row of spines extending to tip of fixed finger and with tufts of long setae. Carpus approximately as long as merus; dorsomesial margin with irregular double row of spines, 1 or 2 spines on or near distal margin, dorsal surface with row of small spines laterad of midline and 2nd row near weakly delimited dorsolateral margin, ventrolateral margin with 1 or 2 small spines distally, dorsal surface with numerous long setae, lateral and mesial faces with scattered setae. Merus subtriangular; dorsal margin with few tufts of setae, distal margin with 1 small spine, ventromesial margin unarmed, ventrolateral margin with short row of small spines. Ischium unarmed.

Left cheliped (Fig. 2C) with dactylus and fixed finger somewhat spoon-shaped. Dactylus one-third to one-half times longer than palm; cutting edge with row of corneous teeth, terminating in corneous claw, dorsal midline and dorsomesial margin each with row of spines in proximal half, dorsal surface also with row of stiff setae near cutting edge and second row of longer setae in midline, mesial margin and ventral surface also with tufts of long setae. Palm one-half to two-thirds length of carpus; elevated in midline and armed with irregular double row of spines, extending nearly to tip of fixed finger, dorsolateral face strongly sloping ventrally, with row of small spines or spinules in ventral half and second row of protuberances or spines and tufts of long setae marginally, dorsomesial face strongly sloping, with few scattered spines or low protuberances and tufts of setae, dorsomesial margin not delimited. Carpus slightly shorter than merus; dorsomesial margin with row of numerous small spines, dorsolateral margin with row of few widely spaced strong spines, and both with tufts of long setae, distal margin with 1 strong spine, dorsal surface and mesial and lateral faces with scattered setae, laterodistal and ventrolateral margins each with acute spine. Merus subtriangular; dorsal margin with tufts of setae, ventrolateral margin with row of acute spines in distal half, ventromesial margin with short row of spines only on proximal half and with tufts of setae. Ischium unarmed or with few spinules on ventromesial margin.

Second and 3rd pereopods (Fig. 3D, E) similar. Dactyli one-half to two-thirds length of propodi, slightly less to slightly more than one-fifth as broad as long, terminating in strong curved corneous claw; dorsal, mesial, and lateral surfaces all with tufts of moderate to long setae, ventral margins each with row of 8–13 corneous spines and long setae. Propodi exceeding length of carpi by one-fourth to one-third own length; dorsal surfaces with tufts of long setae, ventral surfaces each with single or pair of corneous spines at distal margin and 1 or 2 ad-



**Figure 2.** *Pagurus arenisaxatilis* new species, paratype USNM 243893: A, shield and cephalic appendages; B, chela and carpus of right cheliped (dorsal view); C, chela and carpus of left cheliped (dorsal view); D, right 2nd pereopod (lateral view); E, left 3rd pereopod (lateral view); F, anterior lobe of sternite of 3rd pereopods; G, telson with simple lateral margins of posterior lobes. Paratype RMNH: H, telson with spinous lateral margin on right posterior lobe. Scale = 1 mm (A-E) or 0.5 mm (F-H).

ditional spines in distal third. Carpi approximately equaling length of meri; dorsodistal margins each with 1 small spine, dorsal surfaces with low, occasionally spinose, protuberances and tufts of long setae, mesial and lateral faces and ventral surfaces with scattered setae. Meri with tufts of long setae on dorsal and ventral margins, ventrolateral margins each with acute spine distally and frequently also 1–3 spines on ventral margin (2nd) or unarmed (3rd). Ischia with row of long setae on ventral margins.

Anterior lobe of sternite of 3rd pereopods (Fig. 2F) subsemicircular, unarmed. Fourth pereopods with small preungual process at base of claw; propodal rasp with 3–5 rows of corneous scales, dorsal margins of dactyli, propodi, carpi, and meri (distally) with long dense setae.

Exopod of left uropod with row of thick setae on inner margin. Telson (Fig. 2G, H) with posterior lobes subtriangular to subquadrate, terminal margins usually oblique, each armed with 3 or 4 strong spines, interspersed with smaller spines, lateral margins with narrow plate simple (Fig. 2G), or less frequently with row of spines (Fig. 2H); no anterior spine on lateral plate.

**COLOR** (in life). Antennal flagellum olive drab to brown with white in patterns of 2 dark–1 white, 3 dark–1 white, 4 dark–1 white, progressing distally. Shield with tan to brown splotches. Ocular peduncles, antennules, and antennae mottled or spotted with tan to olive. Right cheliped with distal half of dactylus and tip of fixed finger white, palm, carpus, and merus tan to olive. Left cheliped with tips of dactylus and fixed finger white, palm tan to olive with spines often white-tipped; carpus tan to olive; merus tan to olive with white band distally on mesial and lateral faces and dorsally separated from distal margin by dark patch. Ambulatory dactyli with 3 short olive to tan stripes proximally on white background; propodi with median band consisting of short tan to olive stripes; carpi with longitudinal tan to olive stripes on white background covering most of segment; meri with central band composed of tan to olive stripes (PAMcL, lab notes).

**DISTRIBUTION.** At present known only from the northern Gulf of California, Mexico, intertidal to 30 m.

**ETYMOLOGY.** The specific name is derived from the Latin *arena*, sand, and *saxatilis*, dwelling among stones, reflecting the mixed habitat of this species.

**AFFINITIES.** *Pagurus arenisaxatilis* is similar in general morphology to the other *Pagurus lepidus* complex species occurring in the Gulf of California. Like these other species, in life it is characterized by longitudinal stripes on the ambulatory legs. However, the irregular long and short setae on the articles of the antennal flagellum immediately distinguish this species from the others. In the absence of the antennal flagella, *P. arenisaxatilis* is best distinguished by a combination of characters, i.e., sloping dorsomesial face of left chela, long pereopodal dactyli with 8–13 ventral spines, and no de-

limiting spine on the anterior margin of the lateral telson plates. This species exhibits considerable variation in the development of the lateral plates of the posterior lobes of the telson. Although no anterior telsonal spine has been observed in any of the specimens examined, the plate may be undifferentiated, composed of partially to completely fused denticles (Fig. 2G) or differentiated into distinct small teeth (Fig. 2H). In the development of the multifid ocular acicles, this species also exhibits differences from the other Gulf species. The acicle tends to be ovate in shape with a single large spine usually prominent medially, and with one to four smaller spines developed mesiad of it. In most other species the multifid acicles are subrectangular in shape and consist of three to five equally strong spines.

**REMARKS.** One lot of specimens in the national collections from Puerto Peñasco, Mexico, identified as *P. lepidus* was used by Chace (1962) for comparison with specimens from Clipperton Island. Haig and McLaughlin (1990) reexamined this lot (USNM 99802) and found that only one of the eight specimens was referable to *P. lepidus*. The remainder are identifiable as *P. arenisaxatilis*.

**ECOLOGY.** *Pagurus arenisaxatilis* is one of the most abundant hermit crabs in the northern Gulf of California. Of the intertidal pagurid hermit crabs in the area, it has the broadest vertical range, extending from the upper midintertidal to the shallow subtidal, and is the only species commonly found on both rocky and sandy shores.

This small species uses a variety of shells, usually less than 20 mm in length, such as *Morula ferruginosa* (Reeve), *Anachis coronata* (Sowerby), *A. varia* (Sowerby), small specimens of *Cerithium stercusmuscarum* (Valenciennes), and *Olivella dama* (Wood). Local patterns of shell use may vary widely, however, depending on which shell species are locally common and perhaps also on the presence of other hermit crab species. Shells used by *P. arenisaxatilis* tend to be in poor condition; in a sample of 118 specimens collected during the winter of 1985, 74% of shells used were damaged, and 89% were at least partially encrusted by coralline algae. Other common encrustors included several bryozan species (36.4%) and spirorbid (29.7%) and serpulid (15.2%) polychaetes. Several non-encrusting epibionts are also commonly associated with *P. arenisaxatilis*-occupied shells. Most notably, the polychaete *Polydora* sp. (33.1%) is typically found in the apex of the shell, the slipper limpet *Crepidula* (20.3%), believed to be a new species, is found just inside the shell aperture, and a gammarid amphipod (seasonally variable, sometimes near 100%) is found deep inside the shell. Like most hermit crabs in the northern Gulf, *P. arenisaxatilis* is relatively free of the external parasites that infect hermit crabs in other regions. An abdominal bopyrid isopod, *Stegophryxus* n. sp. (J. Markham, personal communication), is rare (<1%); a single specimen, subsequently lost, carried an unidentified rhizocephalan.

## *Pagurus vetaultae* new species

Figures 1B, C; 3A–H

**HOLOTYPE.** ♂ (SL = 2.1 mm), USNM 243894. **Type locality.** Venecia Cove (near San Carlos and Guaymas, Sonora, Mexico), March 20, 1989, collector S. Vetault.

**PARATYPES.** Venecia Cove, Sonora, Mexico, 1 ♂, 2 ovigerous ♀ (SL = 1.7–1.8 mm), March 20, 1989, 3–7 m, collector S. Vetault, USNM 243895. Hymalaya Bay, Sonora, Mexico, 1 ♀ (SL = 1.4 mm), –1 m, November 24–26, 1988, collectors S. Vetault and A. Harvey, AHF 882 (LACM 88-292.1). Northeast of Bahia Santa Elena, Costa Rica, 1 ♂ (SL = 2.0 mm), “Searcher” station 384, 18 m, February 13, 1972, AHF 729 (LACM 72-8.1). Las Perlas, Pedro Gonzalez, Gulf of Panama, 5 ♂, 2 ♀ (SL = 1.3–2.3 mm), April 22–25, 1882, collector C. Bovallius, NHRM 7175, 7180.

**OTHER MATERIAL.** 8 ♂ (SL = 1.1–1.8 mm), “Searcher” station 471, north side Isla del Cano, Costa Rica, 9 m, March 14, 1972, AHF 2794-01 (LACM 72-63.1).

**DIAGNOSIS.** Shield as long or slightly longer than broad. Ocular peduncles three-fourths to four-fifths shield length. Articles of antennal flagella with very short setae. Carpus of right cheliped with 3 or 4 widely spaced spines on dorsomesial margin, distal margin with 2 or 3 strong spines. Left cheliped with dorsomesial surface of palm slightly to strongly sloping; ischium with acute spine at ventrolateral distal angle. Dactyli of ambulatory legs each with 6–9 corneous spines on ventral margin, dactylus of left 3rd pereopod four-fifths to nine-tenths length of propodus. Anterior lobe of sternite of 3rd pereopods subrectangular to subsemicircular. Posterior lobes of telson with lateral margins simple but delimited by spine anteriorly, at least on 1 side. In life, chelipeds each with 2 or 3 broad dark brown stripes on palms, dactyli and fixed fingers each with 1 stripe dorsally on cream base color; carpi with 2 dark brown stripes dorsally.

**DESCRIPTION.** Shield (Fig. 3A) as long as to slightly longer than broad, anterior margin between rostrum and lateral projections concave, anterolateral margins sloping, posterior margin truncate. Lateral projections broadly rounded, unarmed, overreaching obsolete unarmed rostrum. Dorsal surface of shield with scattered setae (not shown in illustration).

Ocular peduncles (Fig. 3A) three-fourths to four-fifths shield length, moderately slender, with corneae only slightly dilated. Ocular acicles subrectangular, multispinose (3–5 marginal or submarginal spines); separated basally by approximately one-half basal width of 1 acicle. Interocular lobes weakly developed.

Antennular peduncles (Fig. 3A) overreach ocular peduncles by one-third to one-half length of ultimate segment. Ultimate and penultimate segments with few scattered setae (not shown in illustration). Basal segment with 1 acute spine on lateral face.

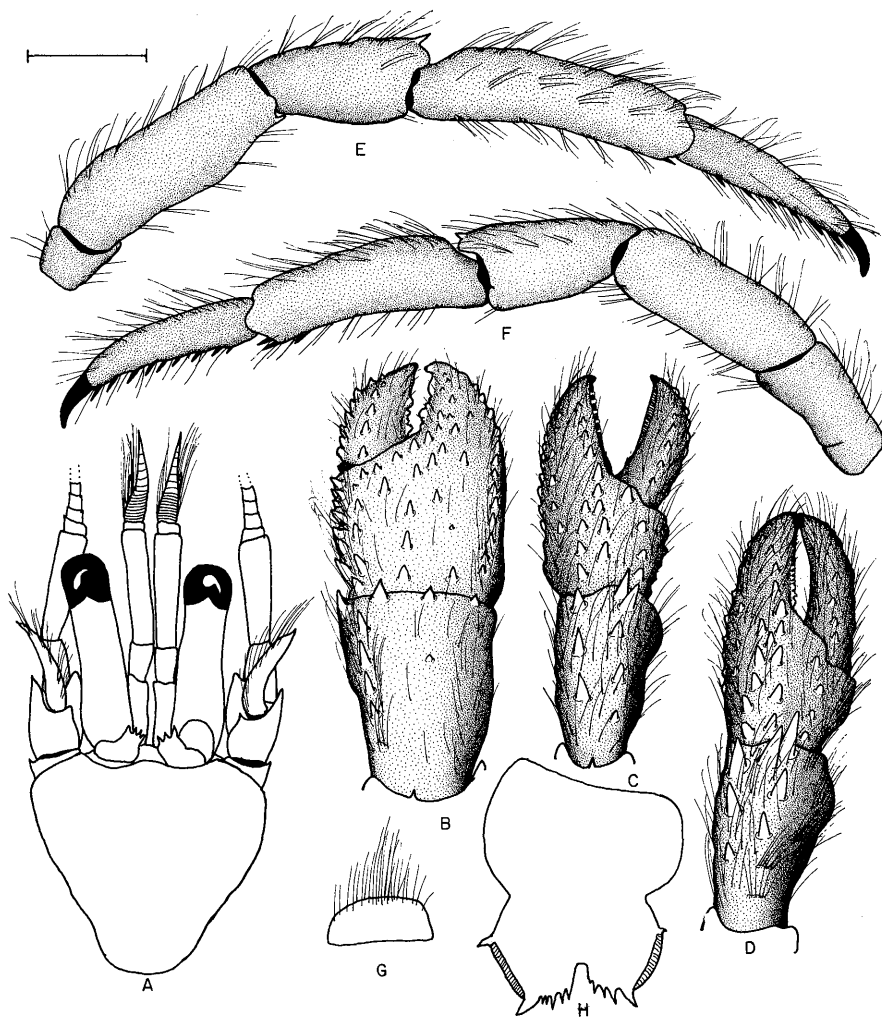
Antennal peduncles (Fig. 3A) overreaching corneae by one-fourth to one-third length of ultimate segment. Fifth and 4th segments with scattered setae. Third segment unarmed or with very small

spinule at ventrodial margin. Second segment with dorsolateral distal angle produced, terminating in acute spine, lateral margin with accessory spine and few long setae; dorsomesial distal angle unarmed or with small spinule, mesial face with long setae (not illustrated). First segment with small spine on lateral face distally, ventral margin produced and armed with 1 spine laterally. Antennal acicle somewhat arcuate, terminating in small spine, mesial margin with moderately long setae. Antennal flagellum reaching to or beyond tip of right cheliped, with 2 or 3 very short (<1 article length) setae every article.

Mouthparts typical for *provenzanoi* group species (cf. Lemaitre *et al.*, 1982).

Right cheliped (Fig. 3B) with dactylus approximately as long as palm, overlapped by fixed finger. Slight hiatus between dactylus and fixed finger. Cutting edge of dactylus with 1 or 2 strong and few smaller calcareous teeth in proximal half and row of small corneous teeth in distal half, terminating in small corneous claw. Cutting edge of fixed finger with 1–4 strong calcareous teeth in proximal half, smaller calcareous teeth interspersed with small corneous teeth in distal half, terminating in corneous tip. Dorsomesial margin of dactylus with row of small acute spines, dorsal surface slightly elevated in midline and also armed with row of more widely spaced spines and tufts of long setae, dorsomesial margin and ventral surface with tufts of long stiff setae. Palm slightly shorter than carpus; dorsomesial margin with irregular double row of spines, strongest proximally, dorsal surface with two widely separated rows of spines and long setae and numerous tufts of long stiff setae, few additional spines distally and on fixed finger, dorsolateral margin with low protuberances or small spines proximally increasing in size distally and on fixed finger. Carpus slightly shorter than or equal to length of merus; dorsomesial margin with row of 3 or 4 spines, dorsodistal margin with 1–3 acute spines, dorsal surface with row of small spines or tubercles laterad of midline and also numerous tufts of long setae, dorsolateral margin not delimited, distolateral margin with 0–3 small spines, lateral and mesial faces with scattered setae, ventrolateral distal angle with acute spine. Merus subtriangular; dorsal margin with few tufts of setae, dorsodistal margin with 1 spine, ventromesial margin unarmed or with row of low protuberances or spinules, sometimes 1 small spine distally, ventrolateral margin with 1–3 acute spines in distal half. Ischium unarmed or with small spine at ventrolateral distal angle.

Left cheliped (Figs. 1B, C; 3C, D) with dactylus and fixed finger somewhat spoon-shaped, with prominent hiatus. Dactylus longer than palm; cutting edge with row of corneous teeth, terminating in corneous claw, dorsal surface with row of spines in midline and row of spines or protuberances on dorsomesial margin, all surfaces with tufts of long setae. Palm one-half to two-thirds length of carpus; dorsal surface slightly elevated in midline, and armed



**Figure 3.** *Pagurus vetaultae* new species, paratype USNM 243895: **A**, shield and cephalic appendages; **B**, chela and carpus of right cheliped (dorsal view); **C**, chela and carpus of left cheliped; **D**, chela and carpus of left cheliped (dorsal view, Bay of Panama paratype NHRM 7175); **E**, right 2nd pereopod (lateral view); **F**, left 3rd pereopod (lateral view); **G**, anterior lobe of sternite of 3rd pereopods; **H**, telson. Scale = 1 mm (A–F) or 0.5 mm (G, H).

with double row of spines, extending onto the fixed finger as single or double row, dorsolateral face strongly sloping ventrally with row of small spines in ventral half and second row of spines marginally, dorsomesial face weakly to strongly sloping with few low protuberances or scattered spinules, dorsomesial margin indicated by row of small to moderately strong spines, all surfaces with numerous tufts of long stiff setae. Carpus shorter than merus; dorsomesial and dorsolateral margins each with row of strong spines and tufts of long setae, mesial and lateral faces each with short transverse ridges and long setae, laterodistal margin with acute spine dorsally and 2nd spine at ventral angle. Merus triangular; dorsal margin with tufts of setae and acute spine at distal margin, ventromesial and ventrolateral margins each with row of spines and tufts of

long setae. Ischium with acute spine at ventrolateral distal angle.

Second and 3rd pereopods (Fig. 3E, F) generally similar. Dactyli one-half to three-fourths length of propodi (2nd and 3rd right), or four-fifths to nine-tenths length of propodus (left 3rd); terminating in strong curved corneous claws, dorsal, mesial, and lateral surfaces all with tufts of moderate to long setae, ventral margins each with row of 6–9 corneous spines and long stiff setae. Propodi exceeding length of carpi by one-fourth to one-third own length; dorsal surfaces with tufts of long stiff setae, ventral surfaces each with 1 corneous spine at distal margin and usually 1 additional spine in distal third (2nd) or pair of spines at distal margin and 1 additional spine in distal quarter (3rd). Carpi slightly less than to approximately equaling length of meri;

dorsodistal margins each with 1 spine, dorsal surfaces with low protuberances and tufts of long setae, mesial and lateral faces and ventral surface with scattered setae. Meri with tufts of long setae on dorsal margins, ventral margins with small spine on ventrolateral margin distally (2nd) or with low protuberances and tufts of long setae (3rd). Ischia with row of long setae on dorsal and ventral margins.

Anterior lobe of sternite of 3rd pereopods (Fig. 3G) subrectangular to subsemicircular, slightly skewed, unarmed. Fourth pereopods with very small preungual process at base of claw; propodal rasp of 5 or 6 rows of corneous scales, dorsal and ventral margins of segments with long setae.

Exopod of left uropod with several thick setae on inner margin. Telson (Fig. 3H) with subrectangular posterior lobes; terminal margins oblique, each armed with row of spines, outermost strongest; lateral margins with narrow plate delimited anteriorly by small to moderately large spine at least on one side.

**COLOR** (in life). Carapace base color cream, with areas of light orange brown, sometimes with bluish tinge centrally, and darker brown patch on each side laterally. Ocular peduncles generally opaque with narrow white ring at base of corneae, reddish flecks and darker patch proximally and distally; corneae black with flecks of pink. Antennular peduncles transparent or with brownish tinge, each segment with proximal and subdistal white chromatophore and median black ring. Antennal peduncles transparent with longitudinal reddish-brown stripe dorsally and ventrally on 5th segment, 4th segment with white chromatophore distally and dark brown mesial and lateral patches; acicle light blue-gray with white chromatophores and brown bands; flagellum with 3 reddish-brown articles separated by 1 transparent article with white chromatophore. Chelae of chelipeds with 2 broad or 3 more narrow dark brown stripes proximally on palm and 1 stripe each on dactylus and fixed finger, otherwise cream-colored; carpi with 2 dark brown stripes dorsally, dark brown or black mesially and with dark and light stripe laterally; meri dark brown with cream-colored dorsal stripe and distal band. Dactyli of ambulatory legs cream-colored distally with 3 short dark brown stripes over bluish-gray base color proximally; propodi and carpi each with broad dark stripes, meri with dark dorsal stripe and lateral patch (PAMcL, lab notes; AWH, field notes).

**ETYMOLOGY.** This species (pronounced "və-tō'-ā") is named for its collector, Sarah Vetault.

**DISTRIBUTION.** San Carlos-Guaymas area of the Gulf of California, Mexico, to Bay of Panama, 1-7 m.

**AFFINITIES.** *Pagurus vetaultae* morphologically is most closely allied with *P. redondoensis* Wicksten from southern California. In both species the dorsomesial margin of the left chela slopes; however, it may only be weakly sloping and be so strongly armed with spines as to give the visual impression of a level surface. Both species also have

a similar number of corneous spines on the ventral margins of the dactyli of the 2nd and 3rd pereopods and similar armature of the dorsomesial margin of the carpus of the right cheliped. However, the two species may be easily separated by the length of the antennal flagella and the setation of the flagellar articles. We have reexamined the holotype of *P. redondoensis* (AHF 783) and several of Wicksten's nonparatypic specimens and found the flagella usually shorter than the right cheliped. Wicksten (1982) described the articles of the antennal flagella as having "1 or 2 short (1 or 2 articles in length) setae on each side." However, in addition to these short setae, one or two considerably longer setae also are present on at least every second article in the proximal half of the flagellum. Only very short (<1 article in length) setae are present on the flagellum of *P. vetaultae* over its entire length. In the absence of the antennal flagella, which Wicksten notes can be easily broken, the length ratios of the dactylus and propodus of the 3rd pereopod usually provide a reliable diagnostic character for separating the two taxa. In *P. vetaultae* the dactylus is nearly (four-fifths to nine-tenths) as long as the propodus. In *P. redondoensis* the dactylus is usually only two-thirds to three-fourths the length of the propodus, although this is not true of the holotype. In life *P. vetaultae* is easily distinguished by its distinctive coloration.

**DISCUSSION.** Although only the materials specified are paratypes, we have examined additional, but damaged, specimens from Costa Rica, whose disarticulated appendages clearly are referable to *P. vetaultae*.

**ECOLOGY.** This species was found at low densities in the shallow subtidal in the central Gulf of California primarily on coarse gravel substrates, in contrast to the sympatric *P. lepidus* and *P. galapagensis* (Boone), which prefer rocky substrates with dense patches of *Sargassum* (*P. lepidus* similarly favors *Sargassum* beds in the northern Gulf intertidal, where it co-occurs on rocky shores with the far more numerous *P. arenisaxatilis*). *Pagurus vetaultae* collected in Hymalaya Bay used *Morula ferruginosa* and *Anachis coronata* shells, which tended to be heavily encrusted with coralline algae but otherwise lacked the significant epibiont populations or physical damage that characterize the shells used by *P. galapagensis* and the more northern *P. arenisaxatilis*. One of the Costa Rican specimens was parasitized by an abdominal bopyrid isopod. The single female specimen was damaged and could only be identified as *Stegophpryxus* (n.?) sp. (J. Markham, personal communication).

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