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A new genus and species of hermit crab of the family Paguridae (Crustacea: Anomura: Paguroidea) from the Vanuatu Archipelago

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Abstract.—During a survey of the biodiversity of the southeastern part of Espiritu Santo, Vanuatu Archipelago, specimens of a tiny but distinctive new hermit crab species, referable to a new genus, were discovered in the shallow waters off the island. Herein, *Pumilopagurus tuberculomanus* new genus, new species, is described and illustrated. The genus is characterized by the development of a massive right cheliped, more than 0.7 total body length; male with a short left sexual tube directed from left to right across the ventral body surface and very short right sexual tube; and female with single left gonopore. Its relationship to other pagurid genera of comparable small body size is discussed.

The marine fauna of the Vanuatu Archipelago was extensively sampled during the French MUSORSTOM 8 expedition of 1994, with 57 of the 186 stations located around Espiritu Santo (Richer de Forges et al. 1996). However, the principal aim of that expedition was to survey the upper-bathyal zone on the slope of the islands and on the top of the Bougainville guyot with most samples collected between 300 and 1000 m. In contrast, the SANTO 2006 Expedition, organized by Muséum national d'Histoire naturelle, Paris (MNHN), Pro Natura International (PNI), and Institut de Recherche pour le Développement (IRD), focused on the biodiversity of Espiritu Santo exclusively. The marine biodiversity part of the expedition was specifically funded by grants from the Total and Sloan Foundations. Sixty-six percent of the benthic samples were collected at depths of less than 100 m, the remainder from 100 to 1285 m. More than two hundred of the samples contained hermit crabs and among these, four specimens representing a tiny but distinctive new hermit crab genus and species were found at shallow depths on substrates of coral, sand and gravel.

Materials and Methods

The holotype and paratypes are deposited in the collections of the Muséum national d'Histoire naturelle, Paris (MNHN, with the prefix Pg). Terminology for the diagnosis and description generally follows that of McLaughlin (2007), but McLaughlin (2003) for definition of male sexual tube lengths. Shield length (sl), measured from the tip of the rostrum to the midpoint of the posterior margin of the shield provides an indication of animal size; the abbreviation stn is used for station and R/V for Research Vessel. MUSORSTOM is the acronym for the joint expeditions of the MNHN and the Office de la Recherche scientifique et technique d'Outre-Mer (ORS-

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TOM), now IRD. Data for the stations were provided by the staff of the Département Systématique et Évolution, MNHN.

Family Paguridae Latreille, 1802

Pumilopagurus, new genus

Diagnosis.—Eleven pairs of biserial phyllobranchiate gills. Ocular peduncles stout basally, tapering to reduced corneas. Ultimate segments of antennular peduncles each with several long setae on dorsodistal margin. Antennal peduncles with supernumerary segmentation. Maxillule (Fig. 1a) with 1 stiff seta on slightly produced internal endopodal lobe, external lobe obsolete. Maxilla (Fig. 1b) with distal lobe of scaphognathite appreciably larger than proximal lobe. First maxilliped (Fig. 1c) with slender endopod. Second maxilliped (Fig. 1d) without distinctive characters. Third maxilliped (Fig. 1e) with crista dentata composed of several small teeth, 1 accessory tooth. Right cheliped with massive chela, similar in bulk to that of *Pygmaeopagurus* McLaughlin, 1986. Second and third pereopods each with dorsodistal carpal spine. Sternite of third pereopods (Fig. 1f) roundly subquadrate. Fourth pereopod (Fig. 1g) with single row of corneous scales in propodal rasp. Male with short sexual tube developed from coxa of left fifth pereopod (Fig. 1h) and directed from left to right across ventral body surface, coxa of right (Fig. 1h) with very short sexual tube directed anteriorly; unequally biramous pleopods 3 and 4, pleopod 5 uniramous. Female with single left gonopore; left unpaired pleopods 2–4 biramous, pleopod 5 uniramous. Uropods grossly asymmetrical. Telson (Fig. 1i) with spinose terminal margins.

Type species.—*Pumilopagurus tuberculomanus*, new species, by present designation.

Etymology.—From Latin *pumilus* meaning dwarf or pygmy, in combination with *pagurus*, meaning crab, and referring to the very small size of the type species; gender masculine.

Remarks.—*Pumilopagurus* most closely resembles the likewise tiny and monotypic *Pygmaeopagurus*, and at first glance might readily be mistaken for that genus. Both are defined by eleven pairs of biserial gills, basally stout and tapering ocular peduncles with reduced corneas, triangular rostra, an accessory tooth on the crista dentata of each third maxilliped, mammoth right chelipeds, more than half total body lengths; massive right chelae, each with somewhat depressed dorsomesial distal angle and adjoining dorsal surface; prominent right ventral carpal protuberances, small left chelipeds, a single row of scales on the propodal rasp of each fourth pereopod, males each with a short left sexual tube, and females each with a single left gonopore. While numerous specific characters define the respective type species, the genera are distinguished by the distinctly bilobed sternite of the fifth pereopods and absence of the male gonopore on the coxa of the right fifth pereopod in *Pygmaeopagurus*. Additionally, the left male sexual tube is directed toward the exterior, and the telsonal terminal margins are unarmed in *Pygmaeopagurus*. The male left sexual tube in *Pumilopagurus* is directed from left to right across the ventral body surface, a very short sexual tube is produced from gonopore on the right coxa, the sternite of the fifth pereopods is not prominently bilobed, and the terminal margins of the telson are provided with spines in this genus.

Pumilopagurus tuberculomanus, new species

Figs. 1, 2

Material examined.—Holotype. MNHN-Pg 7779, male sl = 1.4 mm, stn ED 11, South Segond Channel entrance,15°35.8′S, 167°06.7′E, 23–33 m, 15 Sep 2006.

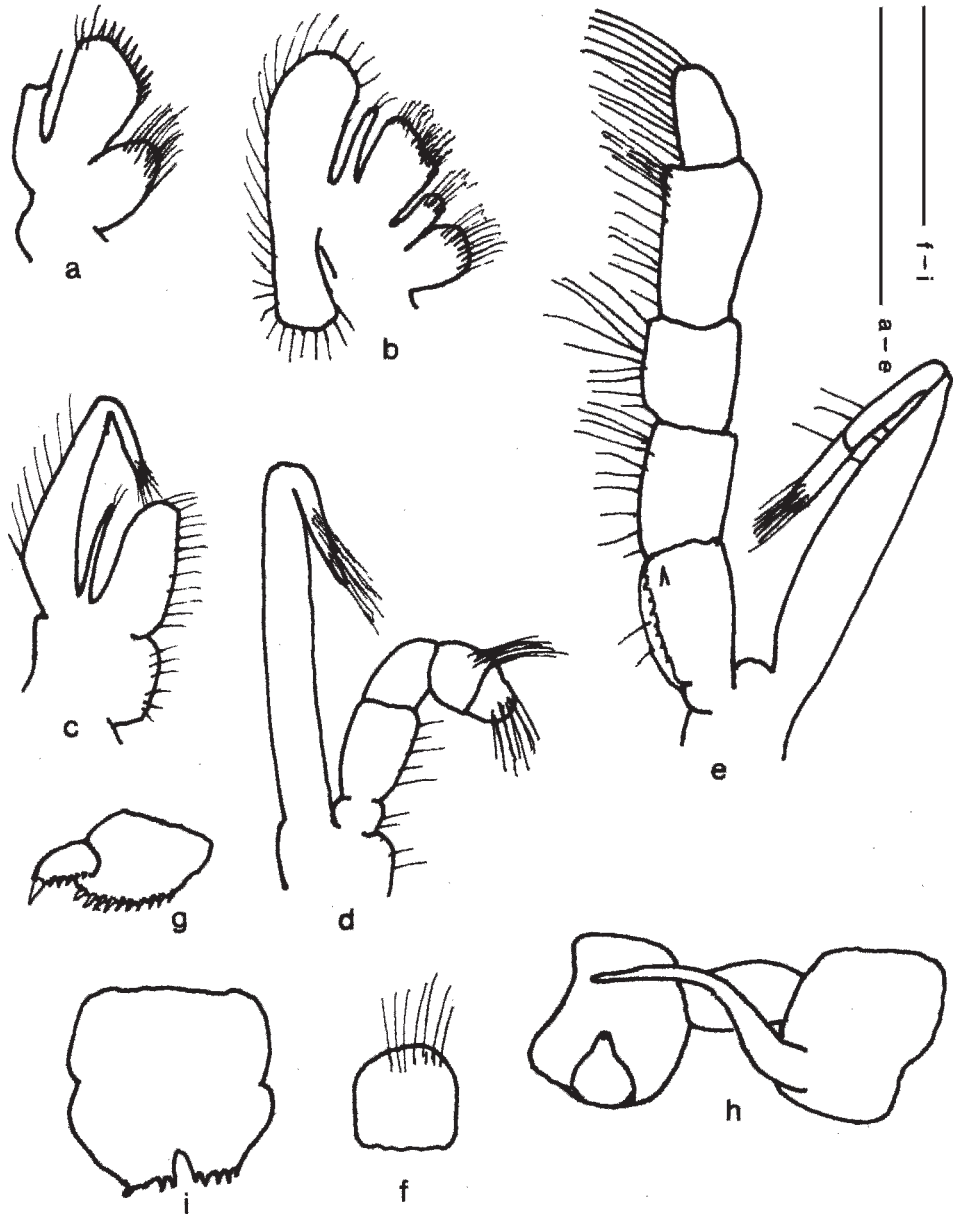

Fig. 1. *Pumilopagurus tuberculomanus*. a–e, paratype female, mouthparts, a–d, left, external view; e, left, internal view (MNHN-Pg 7780); f–i, holotype male (MNHN-Pg 7779). a, maxillule; b, maxilla, c, first maxilliped; d, second maxilliped; e, third maxilliped; f, sternite of third pereopods; g, dactyl and propodus of left fourth pereopod (setae omitted); h, sternite and coxae of fifth pereopods with sexual tubes; i, telson (dorsal view, setae omitted). Scales = 0.5 mm.

Paratypes.—MNHN-Pg 7780,1 female sl = 1.1 mm, stn DB 71, South Turtle Island, 15°21.6′S, 167°12.5′E, 7 m, 27 Sep 2006; MNHN-Pg 7781, 2 ovigerous females, sl = 1.1, 1.2 mm, stn ZS 25, Segond Channel, SW coast of Aoré Island, 15°35.1′S, 167°07.6′E, 36 m, 12 Oct 2006.

Description.—Shield (Fig. 2a) slightly longer than broad; anterior margin between rostrum and lateral projections concave, anterolateral margins sloping,

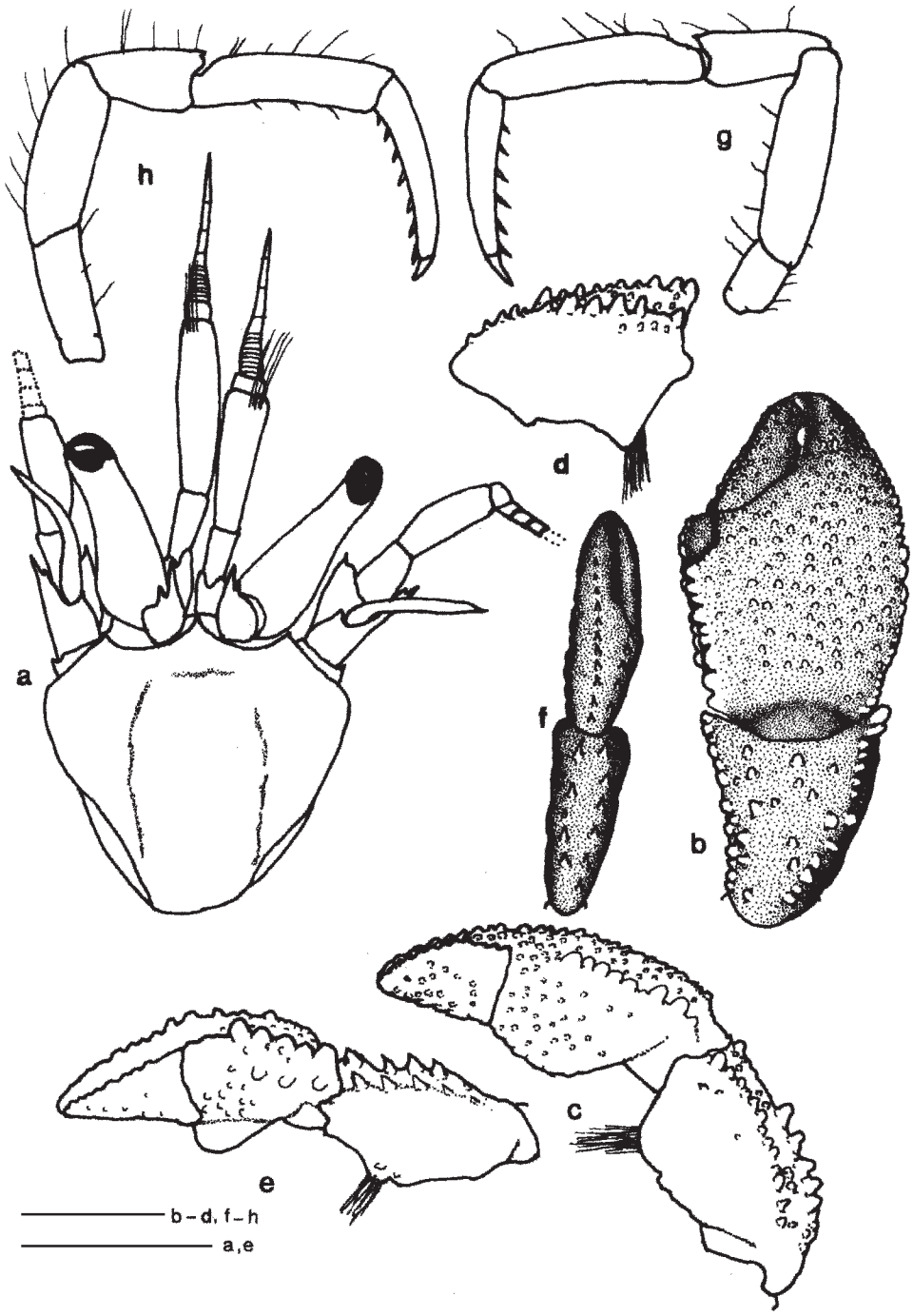

Fig. 2. *Pumilopagurus tuberculomanus*. a–d, f–h, holotype male (MNHN-Pg 7779); e, paratype female (MNHN-Pg 7780). a, shield and cephalic appendages (aesthetascs and most setae omitted); b, carpus and chela of right cheliped (dorsal view, setae omitted); c, e, carpus and chela of right cheliped (mesial view, most setae omitted); d, carpus of right cheliped (lateral view, most setae omitted); f, carpus and chela of left cheliped (dorsal view, setae omitted); g, left second pereopod (lateral view); h, right third pereopod (lateral view). Scales = 1.0 mm.

posterior margin truncate; dorsal surface with gastric region weakly delineated by lines of decalcification. Rostrum triangular, drawn out into acute tip and reaching nearly to midlength of ocular acicles in holotype, much shorter in paratypes. Lateral projections well developed, triangular, terminally acute.

Ocular peduncles with ultimate segments stout basally, tapering to reduced corneas, 0.7 length of shield; corneal diameter 0.2 of peduncular length, cornea tending toward ovately shaped. Ocular acicles bifid or each with prominent mesial spine and smaller accessory spine laterally (holotype); separated by approximately entire width of one acicle.

Antennular peduncles when fully extended overreaching distal corneal margins by 0.7 lengths of ultimate segments; ultimate segment with several long setae subdistally; penultimate segment unarmed; basal segment with spine on statocyst lobe.

Antennal peduncles slightly overreaching distal corneal margins. Fifth and fourth segments unarmed; third segment with small ventrodistal spine; second segment with dorsolateral distal angle produced, terminating in acute spine and with small accessory spinule on mesial margin, dorsomesial distal angle with small spine or spinule; first segment with small spine or spinule on distolateral margin, ventrolateral distal angle with spine. Antennal acicle reaching to or slightly beyond midlength of ultimate peduncular segment. Antennal flagella shorter than carapace, with 1–4 setae each article, shortest distally.

Right cheliped (Fig. 2b–d) massive, approximately 0.7 of total body length. Dactyl 0.7–0.9 length of palm, articulating obliquely; cutting edge with row of moderately small calcareous teeth, terminating in small calcareous claw; mesial face moderately broad proximally, narrowing distally, surface weakly to distinctly tuberculate; dorsomesial and ventromesial margins each with row of tubercles; dorsal surface convex and with scattered tubercles or somewhat elevated in midline and with row of tubercles; ventral surface weakly tuberculate, at least in holotype. Palm subrectangular, equal to or noticeably shorter than carpus; dorsomesial margin tuberculate and adjacent dorsal surface level distally at articulation with dactyl, remaining dorsomesial margin prominently elevated and with row of blunt and somewhat flattened tubercles, convex dorsal surface with numerous scattered tubercles, dorsolateral margin with row of tubercles continued nearly to tip of fixed finger, dorsal surface of fixed finger roundly elevated in midline and with scattered tubercles, cutting edge with row of calcareous teeth, generally fused in holotype, more distinct in female paratypes; lateral face broad and somewhat concave with tuberculate ventrolateral margin in female paratypes, slightly rounded in holotype; mesial face broad, slightly concave, weakly to prominently tuberculate, ventromesial margin with row of tubercles; ventral surface with median region protuberant, more prominent and tuberculate in females. Carpus 1.2 to nearly twice length of merus; dorsomesial margin with row of tubercles, more spiniform in female paratypes, dorsal surface with scattered tubercles or small spines, dorsolateral margin with irregular row of tubercles or spines; ventral surface with distal tuft of moderately sparse, long setae, ventromesial margin with 2 or 3 tubercles in females, rounded in male holotype; ventrolateral margin (Fig. 2e) with protuberance, most prominent in holotype. Merus with few setae on dorsal surface, ventromesial and ventrolateral margins unarmed. Ischium unarmed.

Left cheliped (Fig. 2f) small and slender. Dactyl approximately as long as palm, surfaces unarmed but with few sparse setae dorsally and ventrally; cutting edge with row of fine corneous teeth,

terminating in tiny corneous claw. Palm triangular in cross-section, with midline elevated but not forming keel or crest, approximately half length of carpus; dorsomesial margin with row of small spines, dorsal midline also with row of spines extending onto fixed finger, but not to tip, dorsolateral margin microscopically granular or minutely tuberculate; ventral surface with scattered moderately long setae. Carpus slightly longer than merus, with row of spines on dorsomesial and on dorsolateral margin, most distal pair largest; ventral surface with scattered, moderately long setae. Merus with few short setae on dorsal surface and dorsodistal margin; distomesial margin ventrally and ventromesial margin distally each with row of long setae; ventrolateral margin with 3 prominent spines distally. Ischium unarmed.

Second and third pereopods (Fig. 2g, h) similar. Dactyls equal to or slightly shorter than propodi; in dorsal view straight, in lateral view nearly straight, terminating in corneous claws; ventral margins each with 6 or 7 prominent corneous spines. Propodi each with row of widely-spaced sparse setae dorsally and ventrally. Carpi each with very small dorsodistal spine and few setae on dorsal surface. Meri each with few setae dorsally and ventrally. Ischia also with few setae dorsally and ventrally. Sternite of third pereopods with tuft of setae on roundly subquadrate anterior lobe. Fourth pereopod without preungual process at base of claw.

Telson with transverse indentations delineating anterior and posterior portions, posterior lobes separated by moderately large, U-shaped median cleft; terminal margins straight or somewhat oblique, each with 3–5 small spines.

Coloration in life.—Shield mottled orange and creamy-white. Ocular peduncles and acicles, antennules and antennae all yellow with patches and blotches of dark red. Right cheliped generally red-dish-orange; spines of carpus lighter. Left cheliped yellow with spots and blotches of dark red. Segments of ambulatory legs yellow with spots and patches of dark red and irregular fainter bands and/or patches of bluish-gray, particularly noticeable on carpi and meri. Fourth and fifth pereopods generally bluish-gray with few spots or patches of dark red (from photo of holotype by Dr. Masako Mitsuhashi).

Habitat.—Inhabiting tiny gastropod shells, on substrates of coral, gravel and sand.

Distribution.—Southwest of Espiritu Santo in Segond Channel and off Turtle Island, Vanuatu Archipelago; 7–36 m.

Remarks.—As is apparent in the description, there are several morphological differences between the male holotype and the three smaller female paratypes. The rostrum of the holotype is appreciably longer and more acute and the ocular acicles are not just terminally bifid, but developed with a long mesial spine and somewhat shorter lateral spine. The sculpturing and armature of the right chela is much more prominent in the female paratypes, whereas the spines of the palm and carpus of the left cheliped are better developed in the male holotype. Whether these differences reflect growth related changes or true sexual dimorphism can not be determined with the present limited sample size.

Although as type species, *Pumilopagurus tuberculomanus* and *Pygmaeopagurus hadrochirus* McLaughlin, 1986 share several generic characters, they differ markedly in specific characters. For example, while the ocular peduncles of both species are swollen basally and tapered to reduced corneas, the corneas of *Pumilopagurus tuberculomanus* are ovate, but bluntly cone-shaped in *Pygmaeopagurus hadrochirus*. The ocular acicles of the new species are bifid or consist of a pair of spines, whereas they are small and simple in *P. hadrochirus*. The shape and contours of the right chela are similar in the two

species, but *Pumilopagurus tuberculomanus*, as its name implies, is much more tuberculate. However, the dorsal surface of the carpus in this species lacks the row of prominent spines present in *Pygmaeopagurus hadrochirus*. Differences in the left chela and carpus are more profound in the two taxa. Both segments are unarmed in *Pygmaeopagurus hadrochirus*, but each is armed with two rows of spines in *Pumilopagurus tuberculomanus*.

Etymology.—From the Latin *tuberosus* meaning full of bumps or protuberances and *manus* meaning hand, referring to the covering of tubercles on the right chela.

Discussion

McLaughlin (1986) characterized the three new Hawaiian genera she described, *Pygmaeopagurus*, *Micropagurus* McLaughlin, 1986, and *Nanopagurus* McLaughlin, 1986, as extremely small and with specialized development of a male sexual tube. At the time, all three were thought to be monotypic. Although sexual tube development in paguroids was first reported by H. Milne Edwards (1837), it has been only recently that the variety and complexity of these structures has been recognized (McLaughlin 2003, Tudge & Lemaitre 2004).

Of McLaughlin's (1986) three genera, *Nanopagurus* males possessed a right sexual tube, whereas the sexual tubes of males of *Pygmaeopagurus* and *Micropagurus* developed as extensions of the vas deferens from the left gonopore, but only in *Pygmaeopagurus* was there abnormal enlargement of the right cheliped. Subsequent studies by Gunn & McLaughlin (1988), Haig & Ball (1988), and Asakura (2005) added additional species to *Micropagurus*, and McLaughlin & Sandberg (1995) found *Nanopagurus* to be a junior synonym of *Anapagrides* de Saint Laurent-Dechancé, 1966. Only *Pygmaeopagurus* remained monotypic and unusual in the development of the right chela.

A second and superficially very similar genus, *Scopaeopagurus* McLaughlin & Hogarth, 1998, was subsequently described from shallow waters of the Seychelles. In addition to sharing a very small body size and mammoth right cheliped with *Pygmaeopagurus*, *Scopaeopagurus megalochirus* McLaughlin & Hogarth, 1998 was described as having basally swollen ocular peduncles that tapered to reduced corneas and fourth pereopods in which the propodal rasps each consisted of a single row of scales. Males of that species had a short left sexual tube, but did exhibit a right gonopore; females had only a left gonopore. However, *Scopaeopagurus* lacked a pleurobranch above the fourth pereopod and an accessory tooth on the reduced crista dentata of the third maxilliped.

An additional genus was described by Osawa & Okuno (2003) for another quite small-sized species, *Hachijopagurus rubrimaculatus* Osawa & Okuno, 2003 from Japan. Although this species is described as having a large right cheliped, it is apparently not as massive as the chelae seen in *Pygmaeopagurus*, *Scopaeopagurus*, and *Pumilopagurus*, and lacks the prominent ventral carpal protuberances of these taxa. The structures of the sternites of the third and fifth pereopods, as well as the development of the male right sexual tube, also differentiate *Pumilopagurus* from *Hachijopagurus*. Osawa & Okuno (2003) remarked that the "concavity" at the dorsodistal angle of the palm of the right cheliped appeared to be unique to *H. rubrimaculatus*; however, the dorsomesial distal angle is similarly structured on the palm of the right chelae of *Pumilopagurus* and *Pygmaeopagurus* as well, although it is perhaps more descriptive to say that the dorsomesial margin and adjacent dorsal surface are deeply depressed or the adjoining margins elevated in these species.

With the discovery of *Pumilopagurus tuberculomanus*, a trilogy of very small

pagurids with abnormally large, fist-like chelae has been formed. Despite the difference in gill number and accessory tooth development, it seems unlikely that they do not share certain mutually exclusive genetic attributes that, if explored, might aid in better establishing at least some morphological character polarities.

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