



A new genus and species of micro-pagurid hermit crab (Crustacea, Decapoda, Paguridae) from the rariphotic reef zone in Curaçao, Lesser Antilles, Caribbean Sea

RAFAEL LEMAITRE^{1*} & DARRYL L. FELDER²

¹Department of Invertebrate Zoology, National Museum of Natural History, Smithsonian Institution, 4210 Silver Hill Road, Suitland, MD 20746, USA. [✉ lemaitrr@si.edu](mailto:lemaitrr@si.edu); [ORCID http://orcid.org/0000-0003-2828-612X](http://orcid.org/0000-0003-2828-612X)

²Department of Biology and Laboratory for Crustacean Research, University of Louisiana at Lafayette, P.O. Box 42451, Lafayette, Louisiana 70504–2451, USA. [✉ dlf4517@louisiana.edu](mailto:dlf4517@louisiana.edu); [ORCID http://orcid.org/0000-0001-7679-7712](http://orcid.org/0000-0001-7679-7712)

*Corresponding author. [✉ lemaitrr@si.edu](mailto:lemaitrr@si.edu)

Abstract

During field investigations of deep-reefs off the coast of Curaçao in the Lesser Antilles, Caribbean Sea, a female specimen was collected of an undescribed micro-pagurid crab with striking dorso-ventral flattening of the right cheliped. It was further characterized by a reduced branchial formula, fourth pereopods with grasping-like spines instead of typically pagurid rasp-like scales, nearly symmetrical uropods and telson, and a minute pair of first pleopods (gonopods). The single specimen was discovered in samples from the rariphotic zone (~130–309 m) obtained using a suction sampler operated from the manned submersible R/V Curasub over cryptic habitats and surfaces populated by communities of sessile macro-organisms. As the specimen does not fit any known pagurid taxon, we regard it to represent a new monotypic genus. We fully describe this new micro-pagurid as *Raripagurus roseangelae* n. gen., n. sp. and also provide photographs of its live coloration. The CO1 barcode for the holotype in the Barcode of Life Database and GenBank accession number are included as part of the description for any future phylogenetic investigations.

Key words: Crustacea, Paguridae, micro-pagurid, new genus, new species, Caribbean Sea, Curaçao

Introduction

Field studies during the last decade that have focused on cryptic reef habitats from several regions of the Caribbean Sea in the Lesser Antilles (St. Martin, Dominica, Guadeloupe, and Curaçao), and along the western and southwestern Caribbean (Belize, Panama), have revealed a diverse fauna of minute hermit crabs that have recently been categorized as “micro-pagurids” (Lemaitre & Felder 2012; Lemaitre & Tavares, 2015; Lemaitre *et al.* 2017; Lemaitre 2020). Particularly productive in terms of discoveries of new taxa has been the study of collections obtained on dives aboard the manned submersible R/V Curasub, used during the Smithsonian Institution’s Deep Reef Observation Program (DROP) on the island of Curaçao, in the Lesser Antilles of the Caribbean Sea (Baldwin 2013). During the DROP investigations a team of ichthyologists showed the existence of a unique benthic assemblage of fish species in a zone of deep reefs between ~130 m and 309 m, depths below the mesophotic zone which they named “rariphotic” (Baldwin *et al.* 2018). In Curaçao, most of the deep-reef area to ~300 m in depth is characterized by vertical drop-offs beginning at 70–90 m and steep to moderately sloped cliffs interrupted by rubble and sand beaches. It is mostly in this rariphotic zone of Curaçao deep reefs where five new monotypic genera and seven new species of micro-pagurids have so far been documented from collections obtained by the R/V Curasub (Lemaitre *et al.* 2017; Lemaitre 2020).

Our ongoing study of the pagurid material collected from the R/V Curasub has now revealed yet another undescribed micro-pagurid species represented by a female specimen with an unusually smooth and strikingly flattened right cheliped, reduced branchial formula, fourth pereopods with grasping-like spines instead of rasp-like scales as in most pagurids, nearly symmetrical uropods and telson, and paired first pleopods (gonopods).

Clearly this specimen does not fit any known pagurid genus, so a new monotypic genus is herein diagnosed and its single new species described. The mitochondrial CO1 barcode data in the Barcode of Life Database (BOLD) and GenBank accession number for the nucleotide sequence of the holotype are included to facilitate future phylogenetic investigations. No evidence of housing was found with this specimen which was obtained while suctioning the surfaces of rubble-like substrates and sessile organisms (e.g., soft corals, crinoids), and the very small specimen was noticed only when samples were carefully examined under a stereoscope in the laboratory.

Material and methods

The holotype of *Raripagurus roseangelae* **n. gen., n. sp.** was obtained during a dive on the submersible R/V Curasub, as part of the Smithsonian Institution's Deep Reef Observation Project (DROP) and is deposited in the collections of the National Museum of Natural History, Smithsonian Institution, Washington D.C. (USNM). The tissue sample used to obtain the mitochondrial CO1 barcode is deposited in the USNM Biorepository. The barcode gene sequence was obtained by standard protocols applied in the Smithsonian Laboratories for Analytical Biology (see Evans & Paulay 2012). The specimen was collected using one of the flexible hydraulic arms that is equipped with a suction hose used to retrieve live specimens or substrates that may contain small specimens not easily visible by the naked eye from inside the submersible.

Morphological terminology is according to that used in the micro-pagurid study by Lemaitre *et al.* (2017). The ambulatory legs are equivalent to pereopods 2 and 3. Cephalothoracic somites and their sternites are numbered I–XIII (five cephalic and eight thoracic). The measurement indicated is of the cephalic shield length measured to the nearest 0.1 mm, from the tip of the rostrum to the midpoint of the posterior margin of the shield.

Taxonomy

Family Paguridae Latreille, 1802

Raripagurus **n. gen.**

Diagnosis. Eight pairs of biserial phyllobranch gills: 1 on maxillipeds 3, 1 on pereopods 1, 1 on pereopods 2, 2 on pereopods 3, and 3 on pereopods 4 (including 1 pleurobranch). Shield broader than long, glabrous; rostrum broadly triangular, distally rounded. Ocular acicles terminating in acute spine. Ischium of maxilliped 3 with accessory tooth. Chelipeds markedly unequal; carpus and propodus of right distinctly flattened dorsoventrally. Sternite of somite XII (thoracomere 6, pereopod 3) with ovate anterior lobe. Pereopod 4 semichelate, lacking propodal rasp; dactyl and propodus modified for grasping with small sharp spines distally, lacking preungual process. Pereopod 5 chelate, with few scales on rasp of dactyl and propodus. Male unknown. Female with paired gonopores; with paired first pleopods (gonopods) and unpaired left pleopod 2–5. Uropods and telson nearly symmetrical; telson lacking transverse sutures, terminal margin weakly subdivided into 2 broadly unarmed rounded lobes.

Species and distribution. Monotypic, with *R. roseangelae* **n. gen., n. sp.** known thus far from only Curaçao, Lesser Antilles, in the southeastern Caribbean.

Etymology. The generic name is derived from the genus name *Pagurus*, combined with the Latin prefix *rarus*, which denotes something scarce or rare, in reference to both the rareness of the morphology of the single species in this new genus and the rare, insufficiently explored rariphotic zone where this new species lives.

Remarks. The single species of this, for the time being monotypic genus, is distinct among the Paguridae in the flattened morphology of the right cheliped, grasping condition of the propodus and dactyl of pereopod 4, shape of telson, presence of paired first pleopods (gonopods) in the female, and having a reduced branchial formula of eight gills. Furthermore, the surfaces of carapace and thoracic appendages are unusually smooth, semi-transparent, unarmed, having only scattered setae. The flattened right cheliped and armature of the grasping spines on the propodus and dactyl of pereopod 4 is a unique condition among pagurids. However, other generic diagnostic characters are present in species of a few pagurid genera. In the single species of *Raripagurus* **n. gen.** the reduced gill formula with only eight pairs of gills is a character shared with species of *Decaphyllus* de Saint Laurent, 1968,

Paguriscus Lemaitre, Felder & Poupin, 2017, *Paguruncio* Lemaitre, Felder & Poupin, 2017, and *Pusillopagurus* Lemaitre, Felder & Poupin, 2017. The shape of the telson of the single species of *Raripagurus* n. gen., lacking a transverse suture and having a posterior margin without spines or teeth and at most obscurely divided, is similar in species of *Enallopaguropsis* McLaughlin, 1981. Finally, the presence in the single species of *Raripagurus* n. gen. of paired pleopods (gonopods) in females is a condition shared with all species of the 13 genera of the *Pylopagurus-Tomopagurus* group (Lemaitre & McLaughlin 2003). It would appear that none of these characters alone are indicative of close phylogenetic affinity.

***Raripagurus roseangelae* n. gen., n. sp.**

(Figs 1A–F, 2A–F, 3A, B)

Type material. Holotype: female, cephalic shield length 1.8 mm, CURI 17031, sta CURASUB17–33, 12°04.56'N, 68°53.51'W, Deep Reef Observation Project, Curaçao Sea Aquarium, E of downline, Bapor Kibra, Curaçao, 226–276 m, 3 Nov 2017, colls. L. Weigt, D.L. Felder, B. Brandt, K. Matterson, USNM 1554278.

Description. Shield (Figs. 1A, 3A) subtriangular, approximately 1.1 times as broad as long; dorsal surface weakly convex, glabrous, semi-translucent, lacking linea or grooves except for short linea-d; lateral lobe narrow, weakly delimited; anterior margin between rostrum and lateral projections weakly concave; anterolateral margins sloping; posterior margin roundly truncate. Rostrum rounded, reaching slightly beyond lateral projections. Lateral projections, broadly subtriangular, terminating bluntly.

Ocular peduncles stout, approximately 0.5 length of shield; dorsal surfaces naked except for short setae dorsodistally; corneas weakly dilated. Ocular acicles subtriangular, each terminating acutely.

Antennular peduncles exceeding distal margins of cornea when fully extended by nearly full length of segment 3 (ultimate). Segments naked or with scattered short setae; segment 1 (basal) with blunt ventromesial distal angle, and small spine on lateral face.

Antennal peduncles, when fully extended, exceeding distal margins of corneas by approximately one-third of segment 5. Segment 5 slender, approximately 4 times as long as wide, unarmed except for scattered short setae. Segment 4 unarmed except for scattered short setae. Segment 3 with blunt ventrodial angle. Segment 2 with dorsolateral distal angle produced into spine-like process with few short setae distolaterally; dorsomesial distal angle with small spine. Segment 1 unarmed, hidden by shield in dorsal view. Antennal acicles slender, straight, reaching forward to approximately distal two-thirds of corneas, each terminating in strong spine with tuft of setae distally. Flagellum reaching to tip of extended right cheliped, with few short setae 1 or less flagellar article in length.

Mouthparts not dissected. Maxilliped 3 ischium with crista dentata consisting of approximately 14 small subequal teeth, and accessory tooth. Sternite with strong spine on each side of midline.

Chelipeds strongly dissimilar in strength and shape, right distinctly larger and stronger than left. Right cheliped (Figs. 1B, C, 3A, B) dorsoventrally flattened, semi-translucent, dorsal and ventral surfaces of ischium to dactyl glabrous except for scattered setae. Chela ovate, approximately 1.7 times as long as broad; dactyl and fixed finger each terminating in inwardly curved blunt calcareous tip overlapping when closed. Dactyl about as long as palm; cutting edge with 3 subtriangular calcareous teeth approximately same size. Fixed finger cutting edge with 3 calcareous teeth increasing in size distally, becoming crenulate near fingertip. Palm slightly broader than long; dorsal surface slightly convex; ventral surface nearly flat; lateral and mesial margins with scattered short setae. Carpus ovate, dorsal surface slightly convex, ventral surface nearly flat; lateral and mesial margins well defined, each with row of short setae; dorsodistal margin unarmed. Merus subtriangular in cross-section and dorsal outline; dorsal margin rounded; dorsodistal margin unarmed; lateroventral and mesioventral margins weakly crenulate distally, setose. Ischium armed dorsally with blunt, setose spine; ventral margin sharply defined. Coxa with few setae on ventromesial distal angle.

Left cheliped (Figs. 1D, 3A, B) slender, somewhat dorsoventrally flattened, reaching to approximately midpoint of chela of right cheliped, with surfaces of ischium to dactyl glabrous except for scattered setae; fingers terminating in inwardly curved tips crossed when closed. Dactyl approximately as long as palm; dorsal surface slightly convex; cutting edge with row of minute corneous spinules; lateral margin rounded. Fixed finger with dorsal surface slightly convex; cutting edge minutely crenulate. Palm dorsal surface slightly convex; ventral surface nearly flat; lateral and mesial margins rounded. Carpus approximately as long as merus, dorsal surface slightly convex; ventral surface

nearly flat. Merus subtriangular in cross-section; lateroventral and mesioventral margins weakly crenulate, with few setae. Ischium with small blunt spine dorsally, ventral margin sharply defined. Coxa with few setae on ventromesial distal angle.

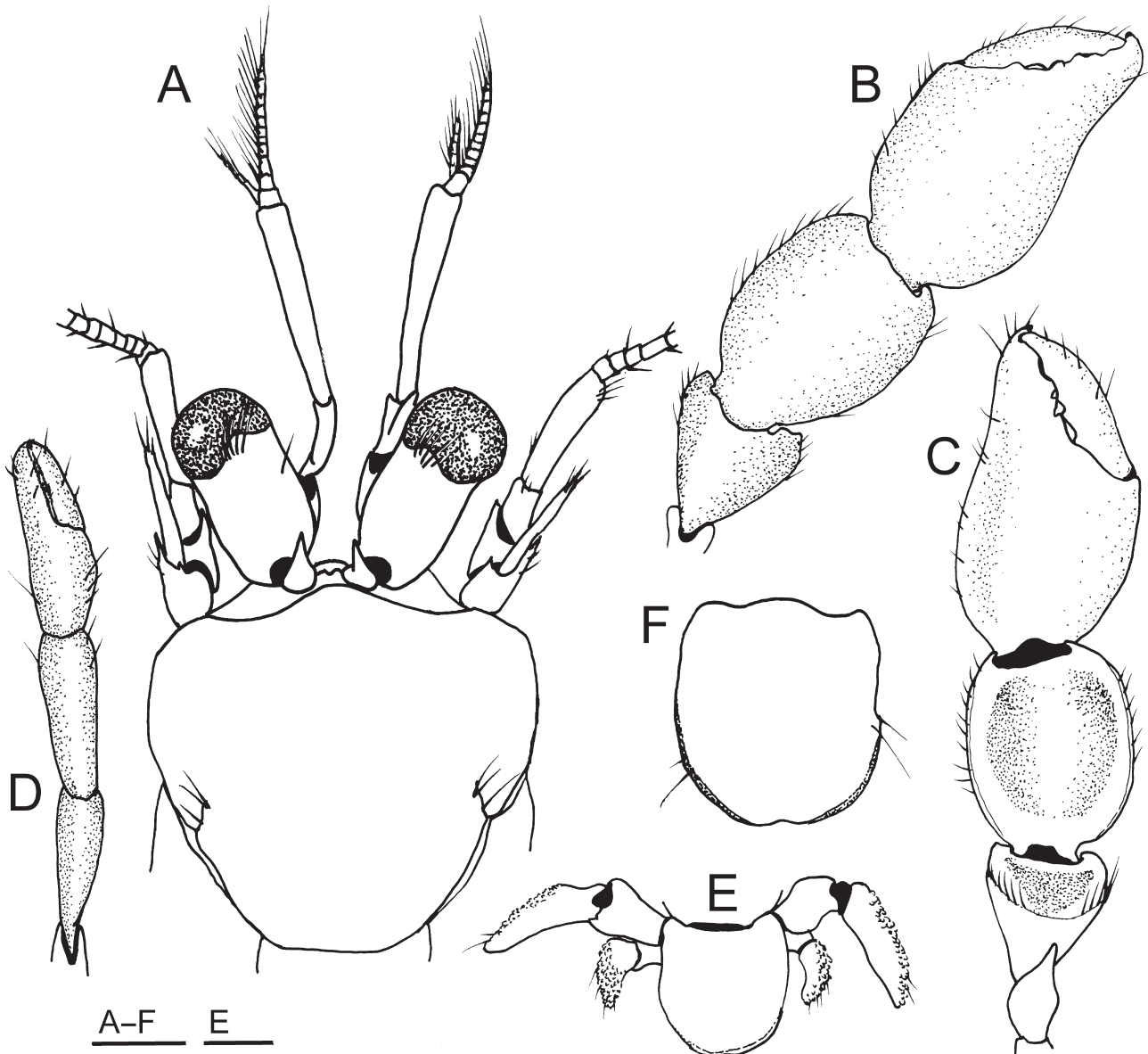


FIGURE 1. *Raripagurus roseangelae* n. gen., n. sp., female holotype, cephalic shield 1.8 mm, USNM 1554278: A, cephalic shield and cephalic appendages, dorsal; B, right cheliped, dorsal; C, same, ventral; D, left cheliped, dorsal; E, uropods and telson, dorsal; F, telson, dorsal. Scale bars = 0.5 mm (A); 1.0 mm (B–D); 0.25 mm (E); 0.2 mm (F).

Pereopods 2 and 3 (Fig. 2A, B) sparsely setose, subequal left from right. Dactyl straight, approximately 0.9 times as long as propodus, with scattered setae dorsally and ventrally, terminating in sharp corneous claw curving ventrally; ventromesial margin with row of 9 distinct corneous spinules. Propodus straight, surfaces smooth, approximately 1.8 times as long as carpus, unarmed except for few dorsal and ventral setae. Carpus with blunt dorsodistal angle, with scattered setae dorsally. Merus unarmed except for scattered setae dorsally and ventrally. Ischium unarmed. Anterior lobe of sternite XI (of pereopods 3; Fig. 2C) subovate, glabrous, lacking spines.

Pereopod 4 (Fig. 2D, E) semichelate, glabrous except for scattered setae. Dactyl nearly straight, terminating in small corneous spinule; lateral face lacking scales; cutting edge with 4 sharp corneous spinules distally. Propodus ovate (lateral view) lacking scales or rasp; with 4 sharp corneous spines on distal margin opposite to cutting edge of dactyl. Carpus unarmed except for scattered setae dorsally. Merus unarmed.

Pereopod 5 chelate (Fig. 2F). Dactyl with 2 minute scales dorsally. Propodus with row of 4 scales on dorsodistal margin. Coxae symmetrical.

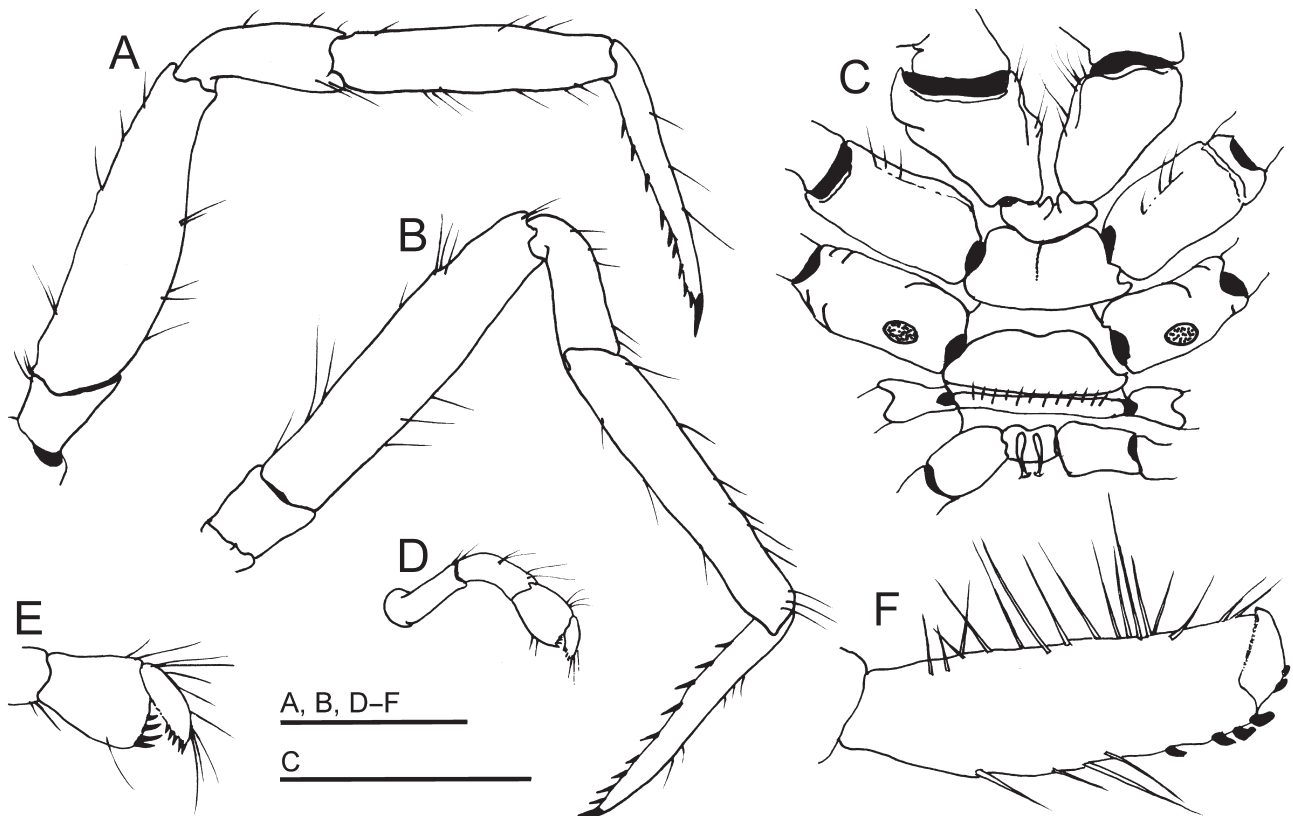


FIGURE 2. *Raripagurus roseangelae* n. gen., n. sp., female holotype, cephalic shield 1.8 mm, USNM 1554278: A, right pereopod 2, lateral; B, right pereopod 3, lateral; C, sternum, coxae of pereopods 1–5, and first pair of pleopods (gonopods); D, right pereopod 4, lateral; E, propodus and dactyl of same, lateral; F, propodus and dactyl of right pereopod 5, lateral. Scale bars = 1.0 mm (A–D); 0.4 mm (E, F).

Uropods (Fig. 1E) nearly symmetrical, with few short setae; exopods each with 2 or 3 rows of minute scales anterodorsally. Telson (Fig. 1F) symmetrical, without transverse suture; terminal margin unarmed, weakly divided medially into 2 broadly rounded lobes.

Males unknown. Females with paired gonopores; with paired first pleopods (gonopods), and unpaired left pleopods 2–5.

Genetic data. The barcode fragment of the cytochrome c oxidase subunit I (COI-5P) is provided under GenBank (www.ncbi.nlm.nih.gov/genbank) accession number OQ211624, BOLD (Barcode of Life Database) specimen number PAGNS9001-23 (dataset dx.doi.org/10.5883/DS-CRUSTACE).

Color (Fig. 3A, B). Overall semi-translucent; eyestalks pale rose pink with transverse ventrolateral slash of deep red near midlength, cornea turquoise with distinct spotting of deep red; chelipeds largely translucent, very pale yellow-orange cast darkest near margins of segments and joints, overall with scattered minute red spots; meri of chelipeds and pereopods 2 and 3 with pale bands of yellow-orange at proximal and distal ends in addition to another centered just beyond midlength; translucent anterior thorax with pale mottling of salmon pink to rose red, shield slightly more opaque and somewhat more yellowish with faint reddish spots and mottling; pleon translucent, faint reddish markings on pleopods and uropods.

Etymology. The species name is given to acknowledge and honor Rose Angela Gulledge (Museum Specialist, National Museum of Natural History, Smithsonian Institution), who has assisted the research of both authors in numerous ways during three decades.

Habitat. Found living in the rariphotic zone of the deep reefs of Curaçao, Lesser Antilles. Housing or associations unknown.

Distribution. Southeastern Caribbean Sea, known so far only from Curaçao, Lesser Antilles. Depth: 226–276 m.

Remarks. The dorsoventrally flattened condition of the segments of the right cheliped, in particular, the carpus and chela, as well as the presence of what appears to be grasping spinules on the propodus and dactyl of pereopod

4, are unique among the Paguridae. Regrettably, the single known specimen of this new species was found loose in the sample without any indication of housing or possible association with another organism. These morphological adaptations are intriguing, and any explanation of their function at present can only be speculative. The armature of the propodus and dactyl of pereopod 4, however, does suggest that this species may grasp onto some housing or perhaps a soft organism while alive in order to protect its pleon or camouflage the body. The virtually symmetrical uropods and telson might suggest a tubular type of housing or association. The semi-transparent cephalothorax and all appendages might represent an adaptation to adopt the color of a possible host or substrate.

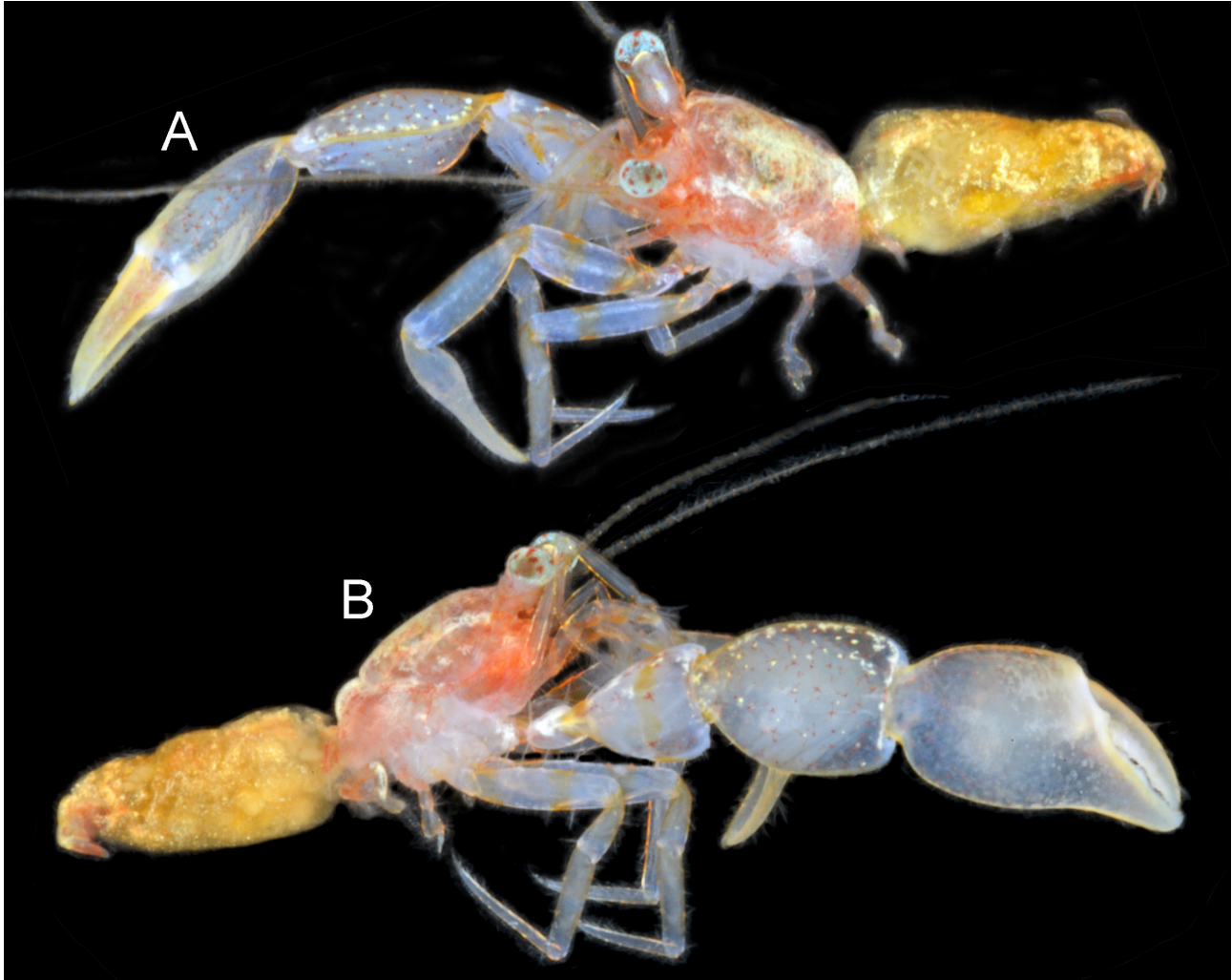


FIGURE 3. *Raripagurus roseangelae* n. gen., n. sp., female holotype cephalic shield 1.8 mm, USNM 1554278: A, left dorsolateral; B, right lateral.

The only female known of this new species and type specimen, has paired first pleopods (gonopods), a condition that is considered a defining characteristic of the species in the 13 genera of the *Pylopagurus-Tomopagurus* group of pagurids (Lemaitre & McLaughlin 2003). However, the reduced number of gills consisting of eight phyllobranchs in this new species, does not make it possible to assign it to any of the *Pylopagurus-Tomopagurus* group of genera, all of which have 11 pairs of gills.

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