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Crustacea Decapoda: A review of the species of the genus *Parapagurus* Smith, 1879 (Parapaguridae) from the Pacific and Indian Oceans

Rafael LEMAITRE

Department of Invertebrate Zoology
National Museum of Natural History
Smithsonian Institution
Washington, D.C. 20560, USA

ABSTRACT

A review of the deep-water hermit crab species of the genus *Parapagurus* Smith, 1879 from the Indian and Pacific Oceans is presented based on abundant samples obtained during French expeditions to the New Caledonia region, and supplemented with extensive material deposited in various major museums and institutions throughout the world. A total of 14 species were found to occur in the Indian and Pacific Oceans. Of these seven are new, *P. richeri* sp. nov., *P. furici* sp. nov., *P. stenorhinus* sp. nov., *P. saintlaurentae* sp. nov., *P. janetae* sp. nov., *P. foraminosus* sp. nov., and *P. wolffi* sp. nov.; and three, *P. abyssorum* (Filhol, 1885), *P. bouvieri* Stebbing, 1910, and *P. andreui* Macpherson, 1984, include parts of the Atlantic Ocean in their distribution. The new species are fully described and illustrated; all previously known species are diagnosed or in the case of one obscurely defined species, *P. holthuisi* Lemaitre, 1989, redescribed. Information on morphological variations is included for the most abundant species, and a key to aid in the identification of all 14 species is given. Of the seven new species, *P. richeri* sp. nov. and *P. furici* sp. nov., were found in the New Caledonia region but are also distributed elsewhere in the Indo-Pacific; *P. saintlaurentae* sp. nov. and *P. stenorhinus* sp. nov., have been found exclusively in the Indian Ocean; and *P. janetae* sp. nov., *P. foraminosus* sp. nov., and *P. wolffi* sp. nov., exclusively in the eastern Pacific. As result of this study, the genus now contains 17 species, of which *P. pilosimanus* Smith, 1879, *P. nudus* (A. Milne-Edwards, 1891), and *P. alaminos* Lemaitre, 1986, are so far known only from the Atlantic Ocean. The bathymetric distribution of all species in the genus is summarized.

RÉSUMÉ

Crustacea Decapoda: Révision des espèces du genre *Parapagurus* Smith, 1879 (Parapaguridae) des océans Indien et Pacifique.

Une révision des bernard-l'ermite du genre *Parapagurus* Smith, 1879, des océans Indien et Pacifique est présentée. Elle est basée sur les nombreuses récoltes faites durant diverses expéditions françaises dans la région de la Nouvelle-Calédonie, complétées par un abondant matériel se trouvant dans divers grands Muséums et Institutions à travers

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le monde. Au total, 14 espèces ont été répertoriées dans les océans Indien et Pacifique. Sept d'entre elles sont nouvelles : *P. richeri* sp. nov., *P. furici* sp. nov., *P. stenorhinus* sp. nov., *P. saintlaurentae* sp. nov., *P. janetae* sp. nov., *P. foraminosus* sp. nov., et *P. wolffi* sp. nov.; et trois, *P. abyssorum* (Filhol, 1885), *P. bouvieri* Stebbing, 1910, et *P. andreui* Macpherson, 1984, sont également présentes dans certaines parties de l'océan Atlantique. Les espèces nouvelles sont décrites en détail et figurées, tandis qu'une diagnose est fournie pour les espèces déjà connues, sauf dans le cas de *P. holthuisi* Lemaitre, 1989, qui, insuffisamment définie jusquà présent, est redécrite. Des informations sur la variabilité des espèces sont fournies pour les plus abondantes d'entre elles. Par ailleurs une clé d'identification couvrant les 14 espèces est proposée. Parmi les sept nouvelles espèces *P. richeri* sp. nov. et *P. furici* sp. nov. ont été trouvées dans la région néo-calédonienne mais également ailleurs dans l'Indo-Pacifique; *P. saintlaurentae* sp. nov. et *P. stenorhinus* sp. nov. n'ont été récoltées que dans l'océan Indien, et *P. janetae* sp. nov., *P. foraminosus* sp. nov., et *P. wolffi* sp. nov., que dans le Pacifique oriental. Après cette révision, le genre *Parapagurus* comprend 17 espèces, parmi lesquelles *P. pilosimanus* Smith, 1879, *P. nudus* (A. Milne-Edwards, 1891), et *P. alaminos* Lemaitre, 1986, ne sont encore connues que de l'océan Atlantique. La distribution bathymétrique de toutes les espèces du genre est indiquée.

INTRODUCTION

Among the hermit crab species of the family Parapaguridae currently classified in ten genera (see LEMAITRE, 1996), those of the genus *Parapagurus* Smith, 1879 are particularly difficult to define. The genus was revised by LEMAITRE (1989) and restricted to a group of ten very similar and morphologically variable species, including the type of the genus, *P. pilosimanus* Smith, 1879. Species of this genus frequently live symbiotically with members of the Anthozoa (zoanthids), typically have broad distributions, and are found at depths greater than 1000 m, deeper than most other parapagurids. Morphologically, *Parapagurus* species are characterized primarily by the presence of gills consisting of series of four filamentous or flattened branches arranged along the axis, reduced ocular peduncles and corneae, considerable elongation of antennular and antennal peduncles, palm of right cheliped with rounded mesial and lateral faces, and presence in males of well developed paired first and second pleopods (gonopods). Six species occur in the Atlantic Ocean and have been discussed in detail by LEMAITRE (1986, 1989, 1990): *P. pilosimanus*, *P. abyssorum* (Filhol, 1885a), *P. nudus* (A. Milne-Edwards, 1891), *P. alaminos* Lemaitre, 1986, *P. bouvieri* Stebbing, 1910, and *P. andreui* Macpherson, 1984. Of these, *P. andreui* and *P. bouvieri* have been reported also from the southwestern Indian Ocean (LEMAITRE, 1990). One species, *P. latimanus* Henderson, 1888, known until now only from off New Zealand, was discussed by LEMAITRE and MCLAUGHLIN (1992). However, the remaining species of the genus, believed to be distributed exclusively in the Indo-Pacific or eastern Pacific, have remained poorly defined.

During a study of the extensive parapagurid material obtained by various French expeditions to New Caledonia and adjacent waters, two very abundant species of *Parapagurus* suspected to be new were found. Comparison with types and numerous supplemental specimens of previously known species deposited in many museums and institutions, confirmed that the two species from New Caledonia were undescribed. The study of numerous specimens deposited in museums and institutions also revealed the existence of four additional undescribed species that had been confounded with previously known species, or in some cases misidentified. In light of the striking similarities observed among species of this genus, and their frequent high degree of overlap in their ranges of morphological variations, it became clear that descriptions of the new species required detailed comparisons with other species from the Indo-Pacific and eastern Pacific regions. Given that most of the previously known species were poorly defined, it was necessary to present a review of all species of the genus from the entire Indian and Pacific Oceans.

As result of this study, 14 species of *Parapagurus* are now recognized from the Pacific and Indian Oceans, seven of which are new. Of the 14, nine are found in the Indo-Pacific, three of which are present in the New Caledonia region, and five exclusively in the eastern Pacific. The new species are described, and those previously known are diagnosed. One obscurely defined species, *P. holthuisi* Lemaitre, 1989, is redescribed; the name of this species was proposed by LEMAITRE (1989) as a replacement for *P. abyssorum* Henderson, 1888, which is a junior homonym of *P. abyssorum* (Filhol, 1885a). Figures are included for all species based on specimens examined during this study or, in some cases, on published illustrations. In the case of species where abundant material has been

available, a section on morphological variations is included. A key to all the species that occur in the Pacific and Indian Oceans is presented as an aid in the identification, and is designed to be used in combination with the descriptive text and illustrations.

Species of *Parapagurus* are in most cases distinguished by a number of subtle diagnostic characters. Particularly useful are characters derived from the ocular and antennal acicles, ambulatory legs, propodal rasp of fourth pereopod, exopod of uropods, and telson. Some species can be separated also by marked differences in the proportions of the segments (i.e., merus, propodus, dactyl) of the ambulatory legs or those of the left exopod of the uropods. In addition, the relative size or proportions of other structures, such as the shield, and ocular and antennular peduncles, can frequently be helpful in determining the identity of specimens. In contrast, other structures, such as the mouthparts, are virtually identical in all species, and only minor differences can be observed in the number of setae on the distal end of the endopod of the maxillule, or number of teeth of the crista dentata of the third maxilliped. However, only a limited number of specimens have been dissected, and whether or not these differences are stable cannot be assured. A full set of mouthparts is illustrated as an example for only one species, *P. richeri* sp. nov.

The right chelipeds of *Parapagurus* species from the Pacific and Indian Oceans exhibit a range of morphological variations very similar to those described for the Atlantic representatives of the genus (LEMAITRE, 1986, as the *P. pilosimanus* complex). Especially prevalent on this cheliped is variability in the dimension and sometimes armature of segments, which is attributable to size and sexual dimorphism. Such variability makes characters derived from this cheliped virtually useless for diagnostic purposes at the specific level. The often striking elongation of carpus and palm is a predictable condition that has been observed in virtually every species in which enough specimens of different sizes are available. The spines on the surfaces of carpus and palm of this cheliped are frequently smaller, and less densely arranged, in larger males.

The general hermit crab terminology used in this study follows MCLAUGHLIN (1974), with the exception of the condition of the fourth pereopod, where *subchelate* is used following the definition of MCLAUGHLIN (1997: 435). Terms for parapagurid morphology are used according to the definitions provided by LEMAITRE (1989), although the second and third pereopods are here referred to as the *first and second ambulatory legs* respectively. The type of gill in species of *Parapagurus* has previously been described as trichobranchiate (e.g., SMITH, 1882; DE SAINT LAURENT, 1972; LEMAITRE, 1989). Recently, however, MCLAUGHLIN and DE SAINT LAURENT (1998: 161, fig. 1) have shown that gill type is not determined by shape of the gill elements, but by the arrangement and insertion of the elements on the rachis of the gill, and pointed out that there are many types of true trichobranch and phyllobranch gills. In true trichobranchiate gills the tubular elements are inserted in order or disorder around the axis, or in regular transverse rows along the axis. Accordingly, the gills in species of *Parapagurus*, which consist of series of four filamentous elements arranged around the axis (see LEMAITRE, 1989: 8, fig. 2L-M), are not true trichobranchiae. MCLAUGHLIN and DE SAINT LAURENT (1998) defined the term *"quadriserial"* for a gill structure equivalent to LEMAITRE's (1989) "trichobranchiate" and "intermediate" conditions used for the Parapaguridae. The term "quadriserial" is adopted here to describe the gills of *Parapagurus* species, and is considered a type of phyllobranch gill.

The measurements used for different structures are defined in Fig. 1, and should be taken to the nearest 0.1 mm. In the MATERIAL EXAMINED sections, one measurement indicative of size, i.e. length of shield, is included following the number and sex of specimens. The section on SIZE RANGE for each species is based on the materials used for this study as well as from all available materials previously reported by LEMAITRE (1986, 1989, 1990, 1997) and LEMAITRE and MCLAUGHLIN (1992).

The shape of the scales on the propodal rasp of the fourth pereopod is of considerable diagnostic importance. The shape of the scales as well as the number of rows of scales can best be observed in a ventrolateral view. Almost invariably, the proximal portion of the rasp exhibits more rows than the distal portion; it is the number of rows on the distal portion that is most useful in the identification of specimens. Examples of *ovate*, *conical*, and *lanceolate* scales are shown in Fig. 2 (see also micrographs in LEMAITRE, 1986: 534, fig. 5). The ovate (Fig. 2a-b) and conical (Fig. 2c) type of scales are easily distinguished; the lanceolate scales (Fig. 2d-e) are narrow, and terminate in curved margins tapering to a pointed or blunt end.

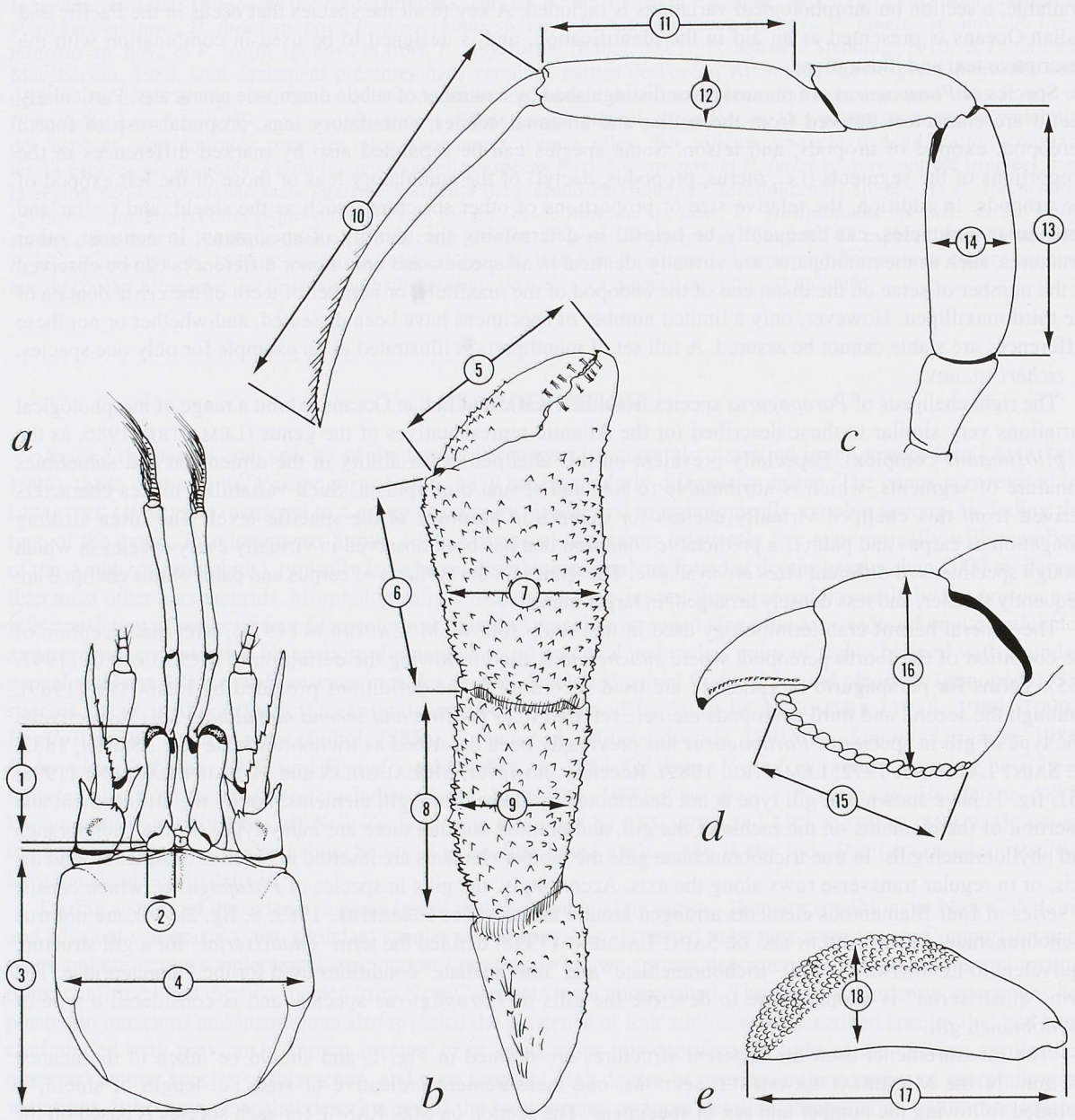

FIG. 1. — Diagrammatic *Parapagurus*, showing measurements used in text. **a**, shield and cephalic appendages: 1, ocular peduncle length; 2, ocular acicle width; 3, shield length; 4, shield width. **b**, cheliped: 5, dactyl length (from proximal end to tip of dactyl); 6, palm length; 7, palm width (maximum); 8, carpus length; 9, carpus width (maximum). **c**, ambulatory leg: 10, dactyl length; 11, propodus length (dorsal margin, excluding proximal portion curving down to carpus); 12, propodus height; 13, merus length; 14, merus height. **d**, propodus and dactyl of fourth pereopod: 15, propodal rasp length; 16, propodus height. **e**, left exopod of uropods: 17, exopod length; 18, exopod width.

The core of the materials used for this study remain deposited in the Muséum national d'Histoire naturelle, Paris (MNHN), the National Museum of Natural History, Smithsonian Institution, Washington D.C. (USNM), and the Zoologisk Museum, Copenhagen (ZMK). However, numerous other materials, including types, deposited in other museums and institutions throughout the world were also used, and are abbreviated as follows:

AM. — Australian Museum, Sydney, Australia.
CBM. — Natural History Museum and Institute, Chiba, Japan.
ICM. — Instituto de Ciencias del Mar (formerly Instituto de Investigaciones Pesqueras), Barcelona, Spain.
IORAN. — Institute of Oceanology, Russian Academy of Sciences.
LACM. — Natural History Museum of Los Angeles County, USA.
MCZ. — Museum of Comparative Zoology, Harvard University, Cambridge, Massachusetts, USA.
NHM. — The Natural History Museum [formerly British Museum (Natural History)], London, England.
NMV. — National Museum of Victoria, Melbourne, Australia.
NMNZ. — Museum of New Zealand Te Papa Tongarewa (formerly National Museum of New Zealand), Wellington.
NTOU. — National Taiwan Ocean University, Keelung, Taiwan.
QM. — Queensland Museum, Brisbane, Australia.
SAM. — South African Museum, Cape Town.
SAMA. — South Australian Museum, Adelaide, Australia.
SIO. — Scripps Institute of Oceanography Invertebrate Collection, University of California, San Diego, USA.
SMF. — Senckenberg Museum, Frankfurt a. M., Germany.
ZMA. — Zoölogisch Museum, Amsterdam, The Netherlands.
ZMUM. — Zoological Museum, Moscow State University.
ZRC. — Zoological Reference Collection, Department of Zoology, National University of Singapore.

Other abbreviations used are: immat, immature (sex undetermined); ♂, male(s); ♀, female(s); stn, station; CP, Waren dredge; DW, beam trawl; CC, shrimp trawl; JCU, James Cook University, Townsville, Australia; NZOI, New Zealand Oceanographic Institute (now part of National Institute of Water and Atmospheric Research), Wellington.

The specimens examined are listed by geographic area, and within areas by cruise, vessel, and station number. Information on stations is listed following the format of the original cruise data, that is, longitudes and latitudes are cited in degrees and decimals, or degrees and fractions of minutes, all depths are cited in meters.

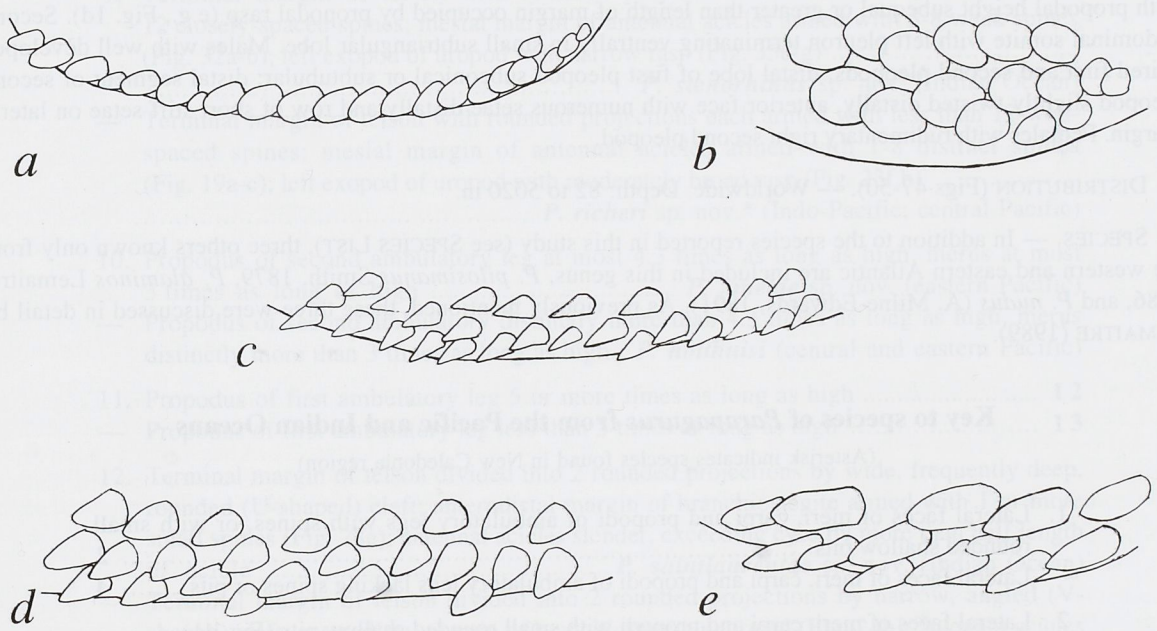

FIG. 2. — Portion of propodal rasp of fourth pereopod, showing examples of shapes of scales referred to in text: **a-b**, ovate; **c**, conical; **d-e**, lanceolate. (a, lateral view; b-e, ventrolateral view).

SPECIES LIST

(Asterisk indicates species found in New Caledonia region)

P. latimanus Henderson, 1888*
P. abyssorum (Filhol, 1885a)
P. bouvieri Stebbing, 1910
P. andreui Macpherson, 1984
P. microps de Saint Laurent, 1972
P. benedicti de Saint Laurent, 1972
P. holthuisi Lemaitre, 1989
P. richeri sp. nov.*
P. furici sp. nov.*
P. saintlaurentae sp. nov.
P. stenorhinus sp. nov.
P. janetae sp. nov.
P. foraminosus sp. nov.
P. wolffi sp. nov.

SYSTEMATIC ACCOUNT

Family PARAPAGURIDAE Smith, 1882

Genus *PARAPAGURUS* Smith, 1879

Parapagurus Smith, 1879: 50. — DE SAINT LAURENT, 1972: 101 (in part). — LEMAITRE, 1989: 11, fig. 2A-C, L-M.

TYPE SPECIES. — *Parapagurus pilosimanus* Smith, 1879 by monotypy. Gender: masculine.

DIAGNOSIS. — Eleven pairs of quadriserial gills, lacking vestigial pleurobranchiae on last thoracic somite; gills each consisting of series of 4 long filamentous or flattened branches arranged along axis. Shield usually well calcified. Ocular peduncles (including corneae) typically half or less than half length of shield; corneae at most weakly dilated. Antennal peduncles and acicles distinctly overreaching ocular peduncles. Fourth segment of antennal peduncle unarmed. Epistomial spine, when present, short and straight. Right cheliped elongate; palm rounded mesially and laterally. Left cheliped well calcified. Ambulatory legs long, dactyls curved. Fourth pereopod with propodal height subequal or greater than length of margin occupied by propodal rasp (e.g., Fig. 1d). Second abdominal somite with left pleuron terminating ventrally in small subtriangular lobe. Males with well developed paired first and second pleopods; distal lobe of first pleopod subconical or subtubular; distal segment of second pleopod slightly twisted distally, anterior face with numerous setae distally and row of short stiff setae on lateral margin. Females with rudimentary right second pleopod.

DISTRIBUTION (Figs 47-50). — Worldwide. Depth: 82 to 5020 m.

SPECIES. — In addition to the species reported in this study (see SPECIES LIST), three others known only from the western and eastern Atlantic are included in this genus, *P. pilosimanus* Smith, 1879, *P. alaminos* Lemaitre, 1986, and *P. nudus* (A. Milne-Edwards, 1891). As previously mentioned, these three were discussed in detail by LEMAITRE (1989).

Key to species of *Parapagurus* from the Pacific and Indian Oceans

(Asterisk indicates species found in New Caledonia region)

1. Lateral faces of meri, carpi and propodi of ambulatory legs with spines, or with small rounded shallow pits **2**
— Lateral faces of meri, carpi and propodi of ambulatory legs lacking spines or pits **4**

2. Lateral faces of meri, carpi and propodi with small rounded shallow pits (Fig. 41) .... ***P. foraminosus*** sp. nov. (eastern Pacific)
— Lateral faces of meri, carpi and propodi lacking pits, with spines **3**

3. Anterodistal margin of branchiostegite armed with small spines; propodal rasp of fourth pereopod consisting of 2 or 3 rows of lanceolate scales .... ***P. abyssorum*** (Atlantic; western and southeastern Pacific)
— Anterodistal margin of branchiostegite unarmed; propodal rasp of fourth pereopod consisting of 1 row (at least distally) of ovate scales ..... ***P. microps*** (eastern Pacific)

4. Lateral faces of meri of ambulatory legs weakly calcified medially, weak calcification more pronounced on second (Fig. 7d-f); length of ocular peduncles (including corneae) distinctly more than half length of shield .... ***P. bouvieri*** (southeastern Atlantic; Indo-Pacific)
— Lateral faces of meri of ambulatory legs well calcified; length of ocular peduncles (including corneae) half or less length of shield **5**

5. Ventral margins of meri of ambulatory legs armed with spines (stronger on second leg) **6**
— Ventral margins of meri of ambulatory legs unarmed **7**

6. Dorsal margins of carpi of ambulatory legs armed with spines (Fig. 45); propodal rasp of fourth pereopod with 1 row of ovate scales (at least distally); shield about as broad as long; ocular acicles terminating in simple spine .... ***P. wolffi*** sp. nov. (eastern Pacific)
— Dorsal margins of carpi of ambulatory legs unarmed; propodal rasp of fourth pereopod with 2-4 rows of ovate scales (at least distally); shield distinctly broader than long; ocular acicles most frequently terminating in bifid spine ..... ***P. benedicti*** (eastern Pacific)

7. Propodal rasp of fourth pereopod consisting of ovate scales (Fig. 2a-b) **8**
— Propodal rasp of fourth pereopod consisting of conical (Fig. 2c) or lanceolate (Fig. 2d-e) scales **11**

8. Left exopod of uropods broad, 2.3 times or less as long as broad **9**
— Left exopod of uropods elongate, more than 2.3 times as long as broad **10**

9. Terminal margin of telson with rounded projections each armed with more than 12 closely-spaced spines; mesial margin of antennal acicles armed with 5-8 weak spines (Fig. 32a-b); left exopod of uropod with narrow rasp (Fig. 35e-g) .... ***P. stenorhinus*** sp. nov. (Indian Ocean)
— Terminal margin of telson with rounded projections each armed with less than 12 well-spaced spines; mesial margin of antennal acicles armed with 1-8 distinct spines (Fig. 19a-c); left exopod of uropod with moderately broad rasp (Fig. 23f,h) .... ***P. richeri*** sp. nov.* (Indo-Pacific; central Pacific)

10. Propodus of second ambulatory leg at most 4.3 times as long as high, merus at most 3 times as long as high ..... ***P. janetae*** sp. nov. (eastern Pacific)
— Propodus of second ambulatory distinctly more than 4.3 times as long as high, merus distinctly more than 3 times as long as high . ***P. holthuisi*** (central and eastern Pacific)

11. Propodus of first ambulatory leg 5 or more times as long as high **12**
— Propodus of first ambulatory leg less than 5 times as long as high **13**

12. Terminal margin of telson divided into 2 rounded projections by wide, frequently deep, rounded (U-shaped) cleft; anterodistal margin of branchiostegite armed with 1 or more small spines (Fig. 28e); antennal acicles slender, exceeding eyes by more than half length of acicle ..... ***P. saintlaurentae*** sp. nov. (Indian Ocean)
— Terminal margin of telson divided into 2 rounded projections by narrow, angled (V-shaped) cleft; anterodistal margin of branchiostegite unarmed (Fig. 24b); antennal acicles moderately slender, exceeding eyes by half or less than half length of acicle .... ***P. furici*** sp. nov.* (Indo-Pacific)

13. Propodi of first and second ambulatory legs more than 4 times as long as high; mesial margin of antennal acicles unarmed ..... ***P. andreui*** (southeastern Atlantic; southwestern Indian Ocean)

— Propodi of first and second ambulatory legs less than 4 times as long as high; mesial margin of antennal acicles armed with up to 6 small spines ..... ***P. latimanus**** (Indo-Pacific)

Parapagurus latimanus Henderson, 1888

Figs 3, 47-48

Parapagurus latimanus Henderson, 1888: 91, pl. 9, fig. 2 (type locality: *"Challenger"*, stn 167A, New Zealand). — Murray, 1895: 597. — Alcock, 1905: 172. — Gordan, 1956: 338 (lit.). — Lemaitre, 1986: 526; 1989: 11; 1997: 575. — Lemaitre & McLaughlin, 1992: 762, fig. 9.

Parapagurus pilosimanus pilosimanus - de Saint Laurent, 1972: 102 (in part, see Remarks).

Parapagurus pilosimanus latimanus - de Saint Laurent, 1972: 103, pl. 1, fig. 5.

?*Parapagurus pilosimanus* - Takeda, 1982: 65, unnumbered color fig. (see Remarks).

Material examined.

Japan. RV *"Tansei-Maru"*: off Taito-saki, Boso Peninsula, 35°07.8'N, 140°49'E, 400-416 m, 26.04.1995, coll. T. Komai: 1 ov. ♀ 13.3 mm (CBM-ZC 2038).

Indonesia. *"Galathea"*, stn 453, Makassar Strait, 3°65'S, 118°26'E, 2034 m, 24.08.1951: 1 ♂ 6.6 mm (ZMK).

New Caledonia. Bathus 3: stn CP 844, 23°06'S, 166°45'E, 908 m, 1.12.1993: 1 ♂ 6.6 mm, 2 ov. ♀ 4.0, 4.1 mm (MNHN-Pg 5575).

Volsmar: stn DW 25, 22°22,80'S, 171°21,50'E, 940 m, 4.06.1989: 1 ov. ♀ 6.6 mm (MNHN-Pg 5576).

Vanuatu. Musorstom 8: stn CP 1075, 15°33'S, 167°27'E, 956-944 m, 4.10.1994: 1 ♂ 5.6 mm (MNHN-Pg 5579).

Wallis and Futuna. Musorstom 7: stn CP 564, 11°46.1'S, 178°27.4'W, 1015-1020 m, 20.05.92: 1 ♂ 11.2 mm (MNHN-Pg 5577). — Stn DW 620, 12°34.4'S, 178°11.0'W, 1280 m, 28.05.92: 1 ♂ 10.3 mm (MNHN-Pg 5578).

Australian region. *New South Wales*. FRV *"Kapala"*: stn K77-23-12, E of Broken Bay, 33°35-33'S, 152°00-02'E, 823 m, 8.12.1977: 1 ♀ 9.0 mm (AM P52737); Stn K80-20-06, between Sydney and Newcastle, 33°38'S, 152°02'E, 960-988 m, 9.12.1980, coll. R.T. Springthorpe: 1 ♂ 5.5 mm (AM P40411); Stn K83-12-02, E of Eden, 37°36'S, 150°21'E, 860-960 m, 26.09.1983: 1 ♂ 7.8 mm (AM P40396). — ORV *"Franklin"*: stn Slope 58, 56 km ENE of Nowra, 34°43.95'S, 151°14.74'E, 1009-817 m, 22.10.1988: 1 ♂ 7.9 mm, 1 ♀ 7.8 mm (NMV J44913), 2 ♂ 4.8, 4.9 mm, 1 ♀ 6.3 mm, 1 ov. ♀ 7.5 mm (USNM 276125).

Tasmania. ORV *"Franklin"*: stn Slope 81, 48 km ENE of Cape Tourville, 42°00.25'S, 148°43.55'E, 1264 m, 30.10.1988, coll. G.C.B. Poore: 1 ♀ 7.2 mm (NMV J40403).

Tasman Sea. ORV *"Franklin"*: Fro 05/89 stn 17, Lord Howe Rise, 29°42.06'S, 159°48.31'E, 2450 m, 3.05.1989: 1 ♂ 5.7 mm (AM P40432).

Great Australian Bight. *"Galathea"*: stn 554, 37°28'S, 138°55'E, 1320-1360 m, 5.12.1951: 4 ♂ 3.3-9.5 mm, 5 ♀ 6.3-7.5 mm (ZMK); 1 ♀ 8.2 mm (ZMK). — *"Dmitry Mendeleev"*: stn DM 1373, 33°49-46'S, 127°9-27'E, 1080-1100 m, 28.02.1976: 6 ♂ 5.6-10.0, 2 ♀ 5.2, 7.3 mm, 2 ♀ ov. 7.0, 8.0 mm (AM P21966), 3 ♂ 5.7-10.0 mm (NMV J16194). — FV *"Saxon Progress"*: ~120 nautical miles (222.2 km) SW of Cape Adieu, 33°58'S, 131°22'E, 1000 m, Nov 1989, coll. D.W. Leenan: 1 ♂ 7.0 mm [in zoanthid *Epizoanthus incrustatus* (Duben & Koren)] (SAMA C5823). — FV *"Longra III"*: stn 84, ~120 nautical miles (222.2 km) SSE of Euda, 33°37'S, 129°53'E, 930-1030 m, 17.04.1990, coll. K. Gowlett-Holmes: 1 ♂ 14.8 mm (in zoanthid *E. paguriphilus* Verrill) (SAMA C5824), 1 ♀ 11.9 mm (in zoanthid *E. incrustatus*) (SAMA C5825).

New Zealand. *"Shinkai Maru"*: cruise II, stn 77, northern Chatham Rise, 42°47.5'S, 178°22.0'E, 939-920 m, 15.11.1975: 1 ♂ 8.9 mm (NMNZ Cr 3198). — RV *"Acheron"*: stn BS 353, 37°30'S, 179°22'E, 1134-1207 m, 7.02.1974: 1 ♂ 15.9 mm (NMNZ Cr 3202), 1 ♀ 7.6 mm (NMNZ Cr 8431), 1 ♂ 9.6 mm, 1 ♀ 9.1 mm, 1 ov. ♀ 12.2 mm (NMNZ Cr 8477). — RV *"Tangaroa"*: BS 690, stn R48, 37°22.1'S, 178°26.9'E, 2027-1952 m, 18.01.1979: 1 ♂ 8.9 mm (NMNZ Cr 3200); BS 760, stn R118, ~22 km E of Alderman Islands, 36°57.3'S, 176°21.5'E, 803-846 m, 24.01.1979: 2 ov. ♀ 11.5, 12.2 mm (NMNZ Cr 3199); BS 771, stn R129, ~39 km E of Portland Island, Mahia Peninsula, 39°15.4'S, 178°19.3'E, 413-453 m, 26.01.1979: 1 ov. ♀ 11.0 mm (NMNZ Cr 3201). — RV *"James Cook"*: stn J6/12/81, SE of East Cape, 37°46.3'S, 178°57.4'E, 829-928 m, 16.04.1981: 1 ♂ 11.6 mm (NMNZ Cr 8484); Stn J19/9/84, Challenger Plateau, 40°06.3'S, 167°57.9'E, 960-982 m, 13.11.1984: 1 ♂ 8.2 mm, 1 ov. ♀ 8.3 mm (NMNZ Cr 8452); Stn J19/011/84, Challenger Plateau, 40°03.2'S, 167°53.3'E, 912-940 m, 13.11.1984: 2 ♂ 10.3, 13.4 mm (NMNZ Cr 8447); Stn J9/42/89, 39°29.5'S, Ritchie Bank, Hawkes Bay, 178°18.9'E, 823-870 m, 27.09.1989: 1 ♂ 15.8 mm (NMNZ Cr 8485); Stn J9/49/89, E of Ritchie Bank, 39°32.8'S, 178°16.5'E, 880-857 m, 29.09.1989: 1 ♂ 10.6 mm

(NMNZ Cr 8453). — FV *"Kalinovo"*: stn K/40/81, near Antipodes Islands, 40°51.5'S, 176°57.9'E, 1125-1150 m, 28.11.1981: 2 ♂ 8.5, 10.0 mm (NMNZ Cr 8429). — RV *"Washington"*: stn Rock Dredge 41(D5), 34°28.8'S, 178°52.3'E, 2500 m, 12.02.1986: 1 ov. ♀ 12.2 mm (SIO C9546). — FV *"Arrow"*: stn A01/37/87, Ritchie Bank, Harkes Bay, 39°24.5'S, 178°19.9'E, 921-981 m, 26.06.1987: 1 ov. ♀ 10.9 mm (NMNZ Cr. 4819); Stn A01/41/87, 39°38.5'S, 178°19.9'E, 906-924 m, 26.06.1987: 1 ♂ 13.0 mm (NMNZ Cr 4820). — FV *"Cordella"*: stn C01/23/88, N of Chatham Islands, 42°48.1'S, 176°47.7'E, 975-974 m, 16.07.1988: 2 ov. ♀ 11.0, 11.1 mm (NMNZ Cr 6052). — FV *"Amaltal Explorer"*: stn AEX 2/11/89, N of Antipodes Islands, 48°31.56'S, 179°03.11'E, 660-675 m, 20.11.1989: 1 ♂ 16.0 mm (NMNZ Cr 8425).

Western Indian Ocean. Off Kenya. *"Galathea"*: stn 241, 4°00'S, 41°27'E, 1510 m, 15.3.1951: 1 ♂ 8.9 mm (ZMK).

TYPES. — *Holotype*: ♂ 6.6 mm, New Zealand, *"Challenger"*, stn 167A, 18 m (depth questionable, see LEMAITRE & MCLAUGHLIN, 1992: 764), 27.06.1874 (NHM 1888:33).

DIAGNOSIS. — Shield (Fig. 3a) about as broad as long, dorsal surface well calcified; lateral projections broadly rounded. Rostrum broadly rounded, with short mid-dorsal ridge. Ocular peduncles (including corneae) less than half length of shield, inflated basally; width of cornea about same as distal width of ocular peduncle. Ocular acicles subtriangular, terminating in simple strong spine (rarely bifid on one or both sides). Antennular peduncle exceeding eyes by nearly entire length of penultimate segment; lateral face of basal segment with statocyst lobe having subrectangular distal lobe armed with 2 spines, and 1 spine proximally. Antennal peduncle (Fig. 3b) exceeding eyes by nearly entire length of fifth antennal segment; flagellum with numerous setae 1-4 flagellar articles in length; acicle straight or weakly curved in dorsal view, exceeding distal margin of cornea by half length of acicle, with proximal half of mesial margin armed with 1 to 6 small blunt to sharp spines or tubercles (acicle rarely unarmed). Epistomial spine usually absent. Sternite of third maxillipeds with strong spine on each side of midline. Left cheliped (Fig. 3c) well calcified, densely setose; carpus with irregular row of small spines or tubercles on dorsal margin. Ambulatory legs (Fig. 3e-f) with meri, carpi and propodi unarmed except for small dorsodistal spine on each carpus; meri each about 3.3 (first leg) or 2.9 (second leg) times as long as high. Anterior lobe of sternite of second ambulatory legs subsemicircular, setose, armed with small subterminal tubercle or spine. Fourth pereopod (Fig. 3g-h) with propodal rasp consisting of 2 (rarely 3) often irregular rows of lanceolate or conical scales. Fifth pereopod with propodal rasp less than half length of propodus. Telson and uropods (Fig. 3i-j) asymmetrical. Terminal margin of telson divided into 2 rounded projections by angled (V-shaped) cleft; rounded projections armed distally with moderately long, evenly-spaced corneous spines (approximately 15 to 26 left, 8 to 13 right), spines on left side frequently extending anteriorly nearly to midlength of lateral margin of telson. Left exopod (Fig. 3i) of uropod elongate, about 2.8 to 3.0 times as long as broad; with broad rasp.

SIZE RANGE. — Males, SL 3.3 to 16.0 mm. Females 5.2 to 11.9 mm. Ovigerous females 4.0 to 13.3 mm.

VARIATIONS. — The spines on the dorsomedian surface of the palm of the right cheliped can be arranged irregularly, or frequently in more or less straight rows.

HABITAT. — Usually found living in shelters formed by zoanthids, probably species of *Epizoanthus* [e.g. *E. paguriphilus* Verrill, *E. incrustatus* (Duben & Koren)].

DISTRIBUTION (Figs 47-48). — Indo-Pacific: Japan; Indonesia; New Caledonia region; southern Australia; New Zealand. Western Indian Ocean: off Kenya. Depth: 400 to 2500 m.

AFFINITIES. — This species resembles *P. andreui* and to a lesser extent *P. pilosimanus*. The three are usually found living in shelters associated with zoanthids (*Epizoanthus* spp.). There are differences in distribution and morphology among the three. *Parapagurus latimanus* occurs in the Indo-Pacific, *P. andreui* in the southeastern Atlantic and southwestern Indian Ocean, and *P. pilosimanus* only in the Atlantic. Morphological characters that differentiate *P. latimanus* from *P. andreui* can be found in the antennal acicles (armed in *P. latimanus*, unarmed in *P. andreui*); the scales of the propodal rasp of the fourth pereopod (lanceolate in *P. latimanus*, conical in *P. andreui*); and the meri of the ambulatory legs (2.9 to 3.3 times as long as high in *P. latimanus*, 3.5 to 4 times as long as high in *P. andreui*). The shape of the telson can serve to separate *P. latimanus* from both *P. andreui* and

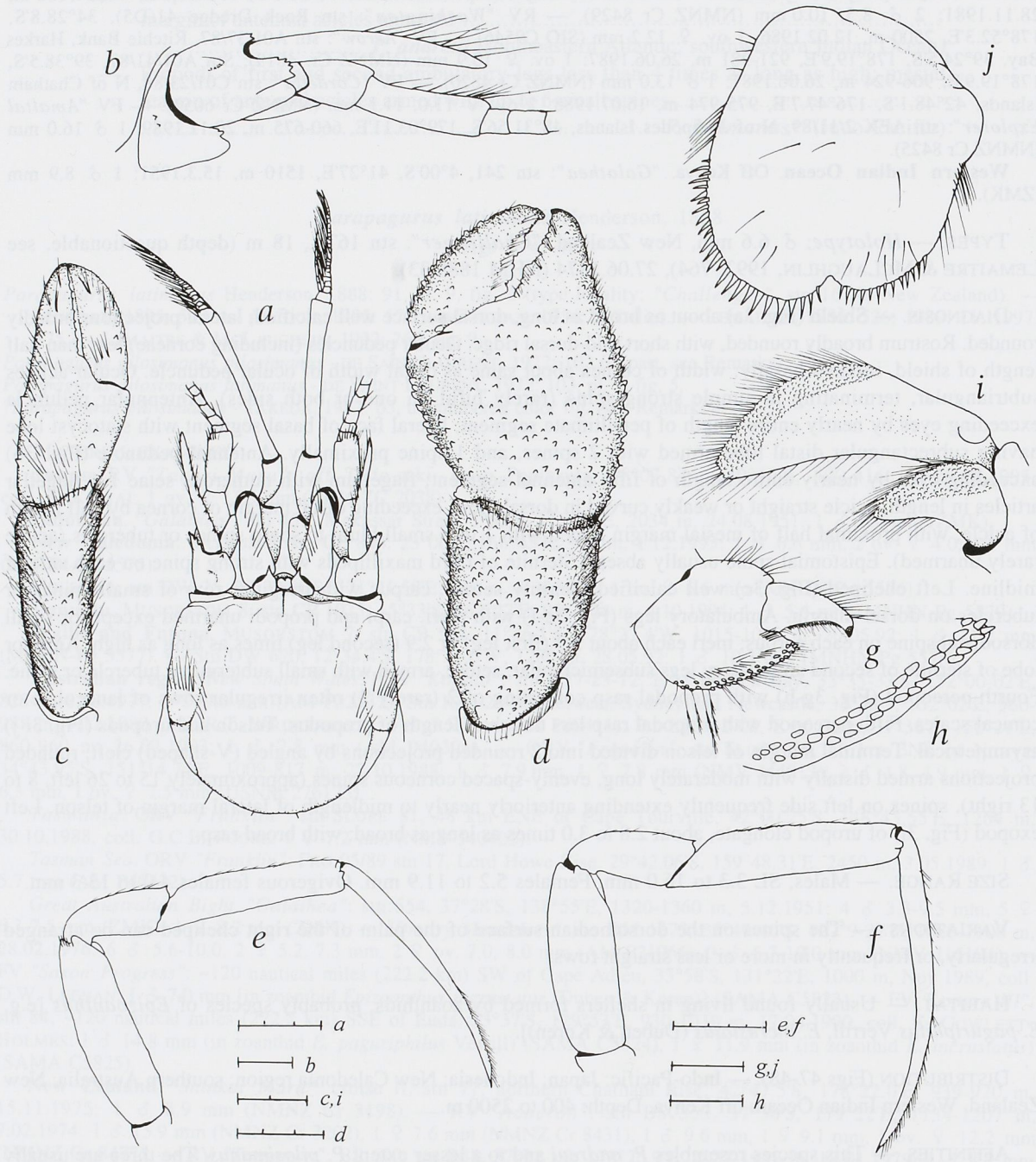

FIG. 3. — *Parapagurus latimanus* Henderson, 1888, *"Eltanin"*, stn 2198, 43°48'S, 174°24'W: ♂ 7.5 mm (USNM 256845). **a**, shield and cephalic appendages; **b**, right antennal peduncle, lateral view; **c**, left chela and carpus (most setae omitted); **d**, right chela and carpus (setae omitted); **e**, right first ambulatory leg, lateral view; **f**, right second ambulatory leg, lateral view; **g**, propodus and dactyl of right fourth pereopod, lateral view; **h**, propodal rasp of same (setae omitted), ventrolateral view; **i**, left exopod and endopod of uropods, dorsal view; **j**, telson, dorsal view.

Scales equal 3 mm (a), 1 mm (b), 2 mm (c,i), 3 mm (d), 5 mm (e-f), 1 mm (g,j), and 0.5 mm (h). (From LEMAITRE & MCLAUGHLIN, 1992).

P. pilosimanus. The terminal margin of the telson is divided into two asymmetrical rounded projections by a broad cleft in *P. latimanus* and *P. andreui*; the terminal margin is divided into two symmetrical rounded projections by a narrow cleft in *P. pilosimanus*.

REMARKS. — DE SAINT LAURENT (1972: 103) questionably included the western Indian Ocean in the distribution of *Parapagurus pilosimanus pilosimanus*, based on material from the *"Galathea"* expedition collected at stn 241, off Kenya. That material has been examined and found to represent *P. latimanus*.

TAKEDA (1982) published a color photo of a specimen identified as *Parapagurus pilosimanus*. However, as previously mentioned, that species occurs only in the Atlantic Ocean (LEMAITRE, 1989). TAKEDA's specimen has not been available for examination, and from the photograph alone, the identity of the specimen cannot be determined with certainty. It is questionably assigned to *P. latimanus*.

Parapagurus abyssorum (Filhol, 1885a)

Figs 4-6, 47, 49-50

Parapagurus pilosimanus - SMITH, 1884: 354 (in part); 1886: 607 (in part). — A. MILNE-EDWARDS & BOUVIER, 1892a: 1 (in part); 1892b: 204 (in part). (See Remarks).
Pagurus abyssorum Filhol, 1885a: 152, fig. 1; 1885b: 131, fig. 41. (See Remarks).
Parapagurus abyssorum - HENDERSON, 1888: 87 (in part), not pl. 9, fig. 2 (= *Parapagurus holthuisi* Lemaitre, 1989). — WOOD-MASON & ALCOCK, 1891: 199. — ALCOCK, 1894: 242. — MURRAY, 1896: 388 (in part). — GORDAN, 1956: 337 (lit.). (See Remarks).
Parapagurus abyssorum var. *scabra* Henderson, 1888: 89, pl. 9, fig. 3. — MURRAY, 1895: 257. — ALCOCK, 1905: 172. — GORDAN, 1956: 338 (lit.).
Parapagurus pilosimanus Var. *Scabra* - A. MILNE-EDWARDS & BOUVIER, 1892a: 2.
Parapagurus scabra - A. MILNE-EDWARDS & BOUVIER, 1892a: 13.
Parapagurus pilosimanus var. *abyssorum* - A. MILNE-EDWARDS & BOUVIER, 1892a: 13; 1892b: 205; 1899: 55, pl. 1, fig. 1; 1900: 191, pl. 24, figs 4-6. — ALCOCK, 1905: 172. — GORDAN, 1956: 338 (lit.).
?*Parapagurus pilosimanus* - PORTER, 1906: 129. — HAIG, 1955: 17. (See Remarks).
Parapagurus pilosimanus Var. *Abyssorum* - NOBRE, 1931: 201, fig. 110; 1936: 126, fig. 103.
Parapagurus pilosimanus scaber - DE SAINT LAURENT, 1972: 102, pl. 1, fig. 3; 1985: 475. — MIYAKE, 1978: 72 (lit.); 1982: 196 (lit.). (See Remarks).
Parapagurus scaber - LEMAITRE, 1986: 533, figs 1G-H, 3F-J, 4I-J, 5G-H, 6A-C,K-L, 7D,H-I, 8F-G, 9C.
Parapagurus abyssorum - LEMAITRE, 1989: 30, figs 5D-E, 12-14; 1990: 220. — INGLE, 1993: 19.
Not *Parapagurus pilosimanus abyssorum* - FAXON, 1895: 68 (= *Parapagurus foraminosus* sp. nov., see Remarks under that new species).

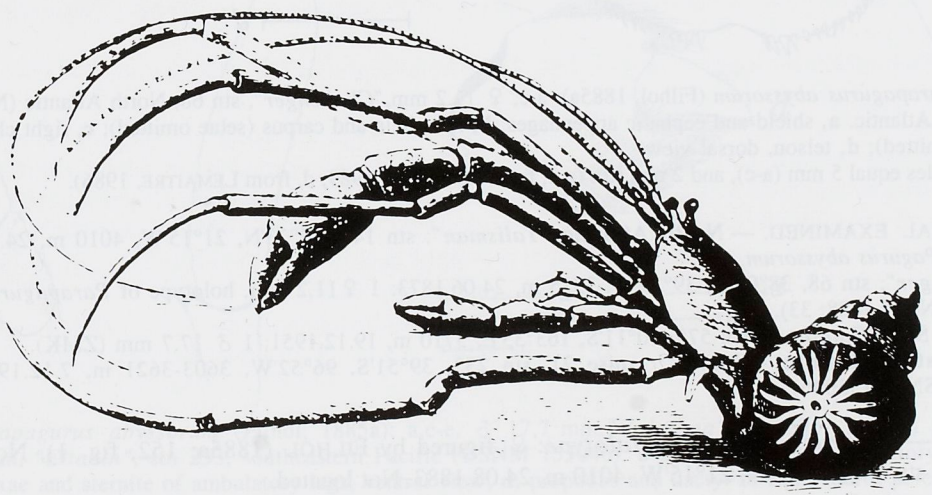

FIG. 4. — *Parapagurus abyssorum* (Filhol, 1885a): ♀ holotype figured by FILHOL (1885a: 132, fig. 1).

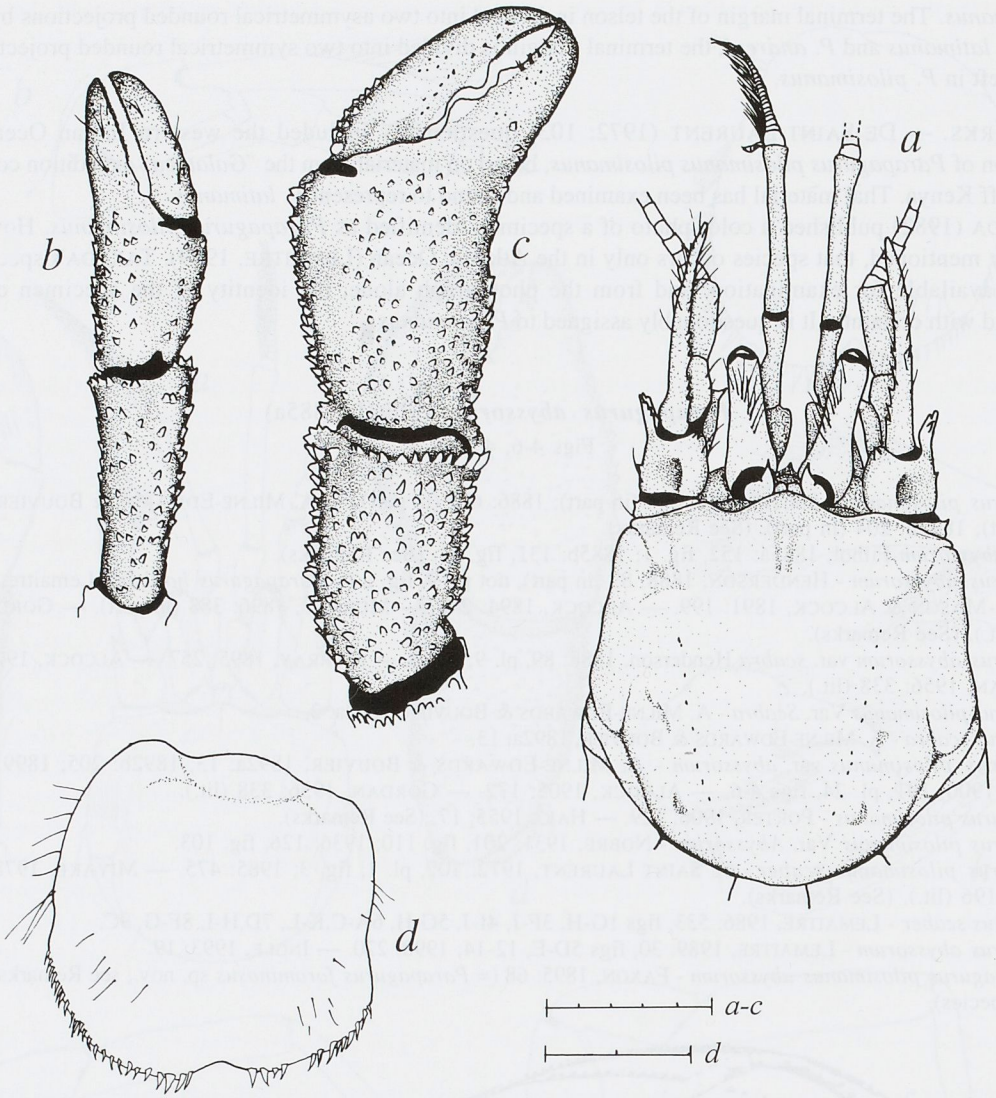

FIG. 5. — *Parapagurus abyssorum* (Filhol, 1885a): a-c, ♀ 11.2 mm,*"Challenger"*, stn 68, North Atlantic (NHM 1888:33); d, North Atlantic. **a**, shield and cephalic appendages; **b**, left chela and carpus (setae omitted); **c**, right chela and carpus (setae omitted); **d**, telson, dorsal view.

Scales equal 5 mm (a-c), and 2 mm (d). (a-c, from LEMAITRE, 1989; d, from LEMAITRE, 1986).

MATERIAL EXAMINED. — **North Atlantic**. *"Talisman"*: stn 148, 42°23'N, 21°15'W, 4010 m, 24.08.1883: 1 ♀, holotype of *Pagurus abyssorum*.

"Challenger": stn 68, 38°03'N, 39°19'W, 3915 m, 24.06.1873: 1 ♀11,2 mm, holotype of *Parapagurus abyssorum* var. *scabra* (NHM 1888: 33).

Tasman Sea. *"Galathea"*: stn 575, 40°11'S, 163°35'E, 3710 m, 19.12.1951: 1 ♂ 17.7 mm (ZMK).

Southeastern Pacific. *"Eltanin"*: cruise 21, stn 233, 39°51'S, 96°52'W, 3603-3621 m, 7.12.1965: 2 ♂ 6.6, 11.3 mm (USNM 155046).

TYPES. — *Pagurus abyssorum*. *Holotype*: ♀ figured by FILHOL (1885a: 152, fig. 1), North Atlantic, *"Talisman"*, stn 148, 42°23'N, 21°15'W, 4010 m, 24.08.1883. Not located.

Parapagurus abyssorum var. *scabra*. *Holotype*: ♀ 11,2 mm, North Atlantic, *"Challenger"*, stn 68, 38°03'N, 39°19'W, 3915 m, 24.06.1873 (NHM 1888: 33).

DIAGNOSIS. — Shield (Fig. 5a) about as broad as long, dorsal surface well calcified; lateral projections broadly rounded. Rostrum broadly subtriangular, rounded distally and with low mid-dorsal ridge. Anterodistal margin of the branchiostegite armed with small spines. Ocular peduncles (including corneae) less than half length of shield, inflated basally; width of cornea about same as distal width of ocular peduncle. Ocular acicles subtriangular, terminating in strong simple spine. Antennular peduncle exceeding distal margin of cornea by nearly entire length of penultimate segment; lateral face of basal segment with statocyst lobe having subrectangular distal lobe armed with 1 or more small spines, and 1 spine proximally. Antennal peduncle exceeding distal margin of cornea by nearly entire length of fifth antennal segment; flagellum with few setae about 1 flagellar article in length or less; acicle nearly straight in dorsal view, exceeding distal margin of cornea by half or more than half length of acicle, mesial and dorsomesial distal margin armed with 5-25 small spines. Epistomial spine usually absent. Sternite of third maxillipeds with strong spine on each side of midline. Left cheliped (Fig. 5b) well calcified, with moderately dense setation; carpus with tubercles or spines on lateral and dorsal faces. Ambulatory legs (Fig. 6a-b) very spinose; dactyls each with dorsal row of small spines; meri, carpi, and propodi each armed on mesial, lateral,

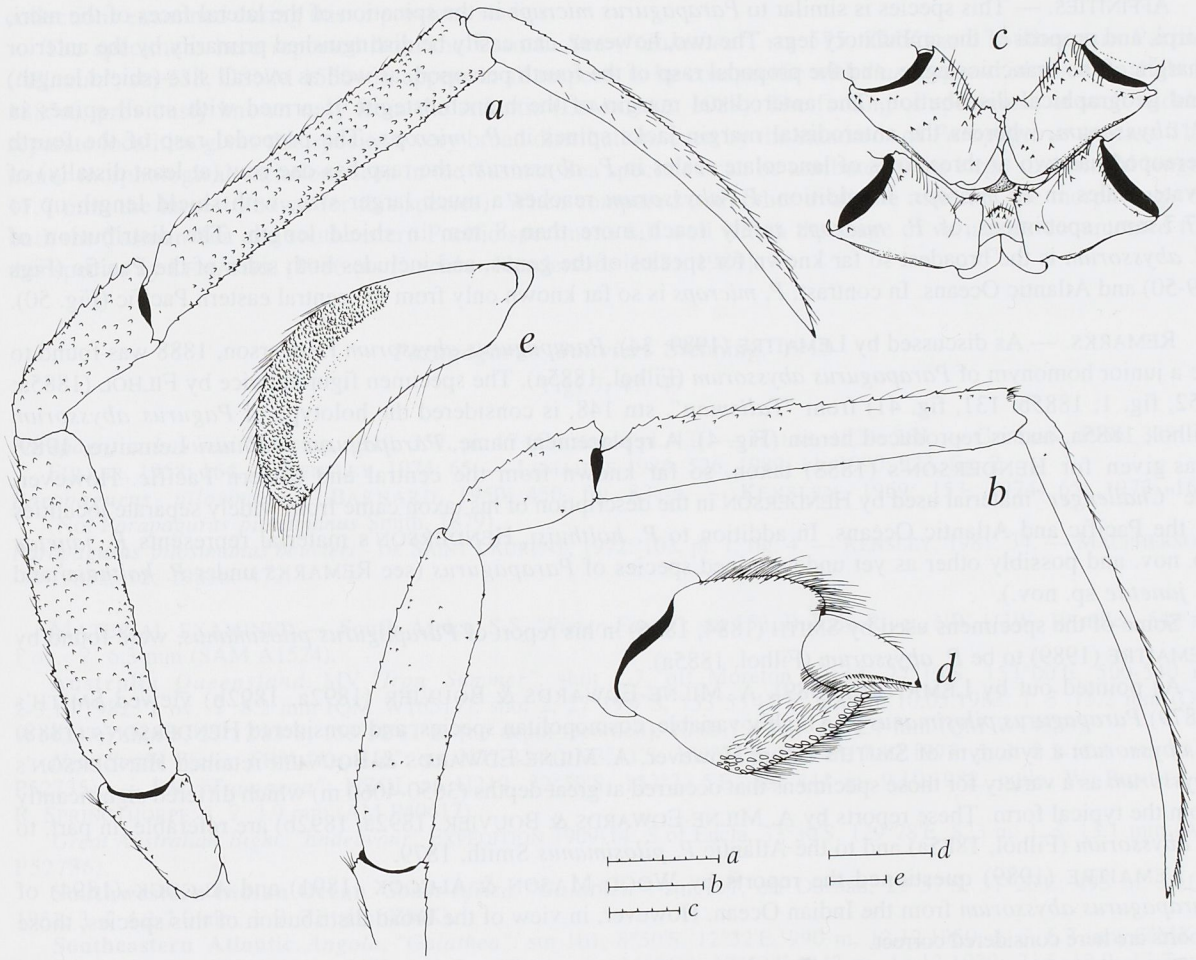

FIG. 6. — *Parapagurus abyssorum* (Filhol, 1885a): a,c-e, ♂ 17.7 mm,*"Galathea"*, stn 575, Tasman Sea (ZMK); d, ♂ 6.6 mm, *"Eltanin"*, stn 233, southeastern Pacific (USNM 155046). **a-b**, right second ambulatory leg, lateral view; **c**, coxae and sternite of ambulatory legs, ventral view; **d**, propodus and dactyl of right fourth pereopod, lateral view; **e**, left exopod of uropods, dorsal view.

Scales equal 10 mm (a), 3 mm (b), 5 mm (c), 2 mm (d), and 1 mm (e).

dorsal, and ventral faces with numerous small spines (less numerous in small specimens SL < 7.0 mm, e.g., Fig. 6b); meri each about 4.1 (first leg) or 3.5 (second leg) times as long as high. Anterior lobe of sternite of second ambulatory legs (Fig. 6c) subsemicircular, setose, armed with 1-5 small subterminal spines. Fourth pereopod (Fig. 6d) with propodal rasp consisting of 2-3 irregular rows of lanceolate scales. Fifth pereopod with propodal rasp less than half length of propodus. Telson (Fig. 5d) and uropods asymmetrical. Terminal margin of telson divided into 2 rounded projections by shallow, rounded (U-shaped) cleft; rounded projections armed distally with short corneous spines. Left exopod (Fig. 6e) of uropod elongate, 2.2 to 2.8 times as long as broad; with broad rasp.

SIZE RANGE. — Males, SL 7.4 to 17.7 mm. Females 7.3 to 13.5 mm. Ovigerous females 8.0 to 13.8 mm.

DISTRIBUTION (Figs 47, 49-50). — North Atlantic, including northeastern coast of the United States; in the eastern Atlantic, from the Azores to Cape Verde Islands. In the western and southeastern Pacific known only from single specimens, one from the Tasman Sea and one from approximately 1930 km west of Chile. Depth: 2500 to 4360 m.

AFFINITIES. — This species is similar to *Parapagurus microps* in the spination of the lateral faces of the meri, carpi, and propodi of the ambulatory legs. The two, however, can easily be distinguished primarily by the anterior margin of the branchiostegite, and the propodal rasp of the fourth pereopod, as well as overall size (shield length) and geographical distribution. The anterodistal margin of the branchiostegite is armed with small spines in *P. abyssorum*, whereas the anterodistal margin lacks spines in *P. microps*. The propodal rasp of the fourth pereopod has two or three rows of lanceolate scales in *P. abyssorum*; the rasp has one row (at least distally) of ovate scales in *P. microps*. In addition, *P. abyssorum* reaches a much larger size, with shield length up to 17.7 mm; specimens of *P. microps* rarely reach more than 8 mm in shield length. The distribution of *P. abyssorum* is the broadest so far known for species of the genus, and includes both sides of the Pacific (Figs 49-50) and Atlantic Oceans. In contrast, *P. microps* is so far known only from the central eastern Pacific (Fig. 50).

REMARKS. — As discussed by LEMAITRE (1989: 34), *Parapagurus abyssorum* Henderson, 1888 was found to be a junior homonym of *Parapagurus abyssorum* (Filhol, 1885a). The specimen figured twice by FILHOL (1885a: 152, fig. 1; 1885b: 131, fig. 41) from *"Talisman"*, stn 148, is considered the holotype of *Pagurus abyssorum* Filhol, 1885a, and is reproduced herein (Fig. 4). A replacement name, *Parapagurus holthuisi* Lemaitre, 1989, was given for HENDERSON's (1888) taxon, so far known from the central and eastern Pacific. However, the *"Challenger"* material used by HENDERSON in the description of his taxon came from widely separate localities in the Pacific and Atlantic Oceans. In addition to *P. holthuisi*, HENDERSON's material represents *P. janetae* sp. nov. and possibly other as yet undetermined species of *Parapagurus* (see REMARKS under *P. holthuisi* and *P. janetae* sp. nov.).

Some of the specimens used by SMITH (1884, 1886) in his report of *Parapagurus pilosimanus,* were found by LEMAITRE (1989) to be *P. abyssorum* (Filhol, 1885a).

As pointed out by LEMAITRE (1989), A. MILNE-EDWARDS & BOUVIER (1892a, 1892b) viewed SMITH's (1879) *Parapagurus pilosimanus* as a highly variable, cosmopolitan species, and considered HENDERSON's (1888) *P. abyssorum* a synonym of SMITH's taxon. However, A. MILNE-EDWARDS & BOUVIER retained HENDERSON's *abyssorum* as a variety for those specimens that occurred at great depths (3650-4060 m) which differed significantly from the typical form. These reports by A. MILNE-EDWARDS & BOUVIER (1892a, 1892b) are referable, in part, to *P. abyssorum* (Filhol, 1885a) and to the Atlantic *P. pilosimanus* Smith, 1879.

LEMAITRE (1989) questioned the reports by WOOD-MASON & ALCOCK (1891) and ALCOCK (1894) of *Parapagurus abyssorum* from the Indian Ocean. However, in view of the broad distribution of this species, those reports are here considered correct.

PORTER (1906) reported *Parapagurus pilosimanus* Smith, 1879, from Los Vilos, Chile, in the eastern Pacific. PORTER, however, expressed some doubt in his identification, which was later questioned by HAIG (1955) because the specimens did not come from deep-water. Furthermore, SMITH's species is now known to occur only in the Atlantic (LEMAITRE, 1989). Unfortunately PORTER's material has not been available for examination and he did

not provide sufficient information to ascertain the identity of his material. If PORTER's material is indeed of a species of *Parapagurus*, it most likely could represent any of three species known to occur in the area, i.e. *P. abyssorum* (Filhol, 1885a), *P. holthuisi* Lemaitre, 1989, or *P. janetae* sp. nov.

In HAIG's (1955) aforementioned publication on the Anomura from Chile, she included *Parapagurus pilosimanus* from off Port Otway and Juan Fernández Islands, based on HENDERSON's (1888) *"Challenger"* material reported as *Parapagurus abyssorum* Henderson, 1888 (= *P. holthuisi*). HAIG (1955) considered HENDERSON's (1888) *P. abyssorum* a synonym of SMITH's (1879) *P. pilosimanus*. Examination of HENDERSON's (1888) material, however, has shown that the single specimen obtained by the *"Challenger"* from Port Otway actually is *P. janetae* sp. nov., and the specimens from Juan Fernández Islands represent *P. holthuisi*.

Based on the literature, GORDAN (1956) listed *Parapagurus abyssorum*, and *P. abyssorum* var. *abyssorum*, and as such refer to *P. holthuisi* Lemaitre, 1989, and *P. abyssorum* (Filhol, 1885a) respectively.

DE SAINT LAURENT (1972) included the Indo-Pacific in the distribution of *Parapagurus pilosimanus scaber* [= *P. abyssorum* (Filhol, 1885a)], but did not list any specimens or indicate exact localities. MIYAKE (1978, 1982), based on DE SAINT LAURENT (1972), listed *P. p. scaber* from Japan, without examining any specimens. Although *P. abyssorum* could possibly occur in Japan, no specimens have been found from this region in any of the collections examined during this or previous studies.

The specimens here reported from the Tasman Sea (*"Galathea"*, stn 575, ZMK) and southeastern Pacific (*"Eltanin"*, stn 233, USNM 155046), appear in all respects to be conspecific with *Parapagurus abyssorum* (Filhol, 1885a), previously known only from the Atlantic (LEMAITRE, 1989). The finding of specimens at such widely separate localities gives this species a very broad distribution, even by the standards of *Parapagurus* species. The minor morphological variations seen in the Tasman Sea specimen can be attributed to its large size (shield length 17.7 mm, the largest known for this species). When compared with other available material, the morphology of both the Tasman Sea and southeastern Pacific specimens fall well within the range of variations documented for this species by LEMAITRE [1986 (as *P. scaber* Henderson, 1888), 1989].

Parapagurus bouvieri Stebbing, 1910

Figs 7, 47, 49

Parapagurus bouvieri Stebbing, 1910: 357, pl. 17 (Crustacea pl. 43). — BALSS, 1924: 768. — GORDAN, 1956: 338. — FÜLLER, 1958: 164. — KENSLEY, 1974: 65. — LEMAITRE 1986: 526; 1989: 11; 1990: 223, fig. 2.

Parapagurus pilosimanus - BARNARD, 1950: 450, fig. 83a-b. — KENSLEY, 1969: 153; 1974: 65; 1977: 161. (Not *Parapagurus pilosimanus* Smith, 1879).

Parapagurus pilosimanus bouvieri - DE SAINT LAURENT, 1972: 103, pl. 1, fig. 4. — KENSLEY, 1981: 34. — MACPHERSON, 1983a: 12; 1983b: 472.

MATERIAL EXAMINED. — **South Africa**. S.S. *"Pieter Faure"*: stn 153, Buffalo River, NW 1/2W, 19 miles, 549 m: 1 ov. ♀ 6.3 mm (SAM A1524).

Australia. *Queensland*. MV *"Iron Summer"*: shot 1-7, off Moreton Island, 27°13'S, 153°00'E, 500-540 m, 2-3.10.1982: 1 ov. ♀ 8.2 mm (QM W16517); shot 2, 27°19'9"S, 153°53'47"E, 600 m, 10.05.1983: 1 ♂ 15.2 mm (QM W14337); shot 3, 27°12'83"S, 153°52'87"E, [no depth recorded], 10.05.1983: 1 ♂ 12.1 mm (QM W14333).

New South Wales. FRV *"Kapala"*: stn K77-23-10, 33°11'S, 152°24'E, 732 m, 7.12.1977: 5 ♂ 8.5-12.1 mm (AM P52735). — RV *"Tangaroa"*: NZOI stn U219, 32°59'S, 152°33.5'E, 381-444 m, 9.10.1982, colls. W. PONDER & R. SPRINGTHORPE: 1 ♀ 3.9 mm (AM P40417).

Great Australian Bight. "Endeavour" EXPEDITION 1909-14: S of Eucla, 33°30'S, 129°28'E, 823 m: 1 ♂ 13.1 mm (AM P52736).

Southwestern Indian Ocean. *South Africa. "Galathea"*: stn 197, off Durban, 29°57'S, 31°26'E, 495 m, 14.02. 1951: 3 ♂ 4.2-7.0 mm, 1 ♀ 7.8 mm (ZMK).

Southeastern Atlantic. *Angola. "Galathea"*: stn 101, 8°50'S, 12°32'E, 990 m, 12.12.1950: 1 ♂ 6.7 mm (ZMK).

South Africa. "Pickle": stn 1483, off Cape Peninsula, 34°06'S, 17°53'E, 247 m, 13.12.1929: 2 ♂ 12.0, 12.2 mm (ZMK).

TYPES. — *Lectotype*: ov. ♀ 6.3 mm (selected by LEMAITRE, 1990: 223), South Africa, S.S. *"Pieter Faure"*, stn 153, Buffalo River, NW 1/2W, 19 miles, 549 m (SAM A1524).

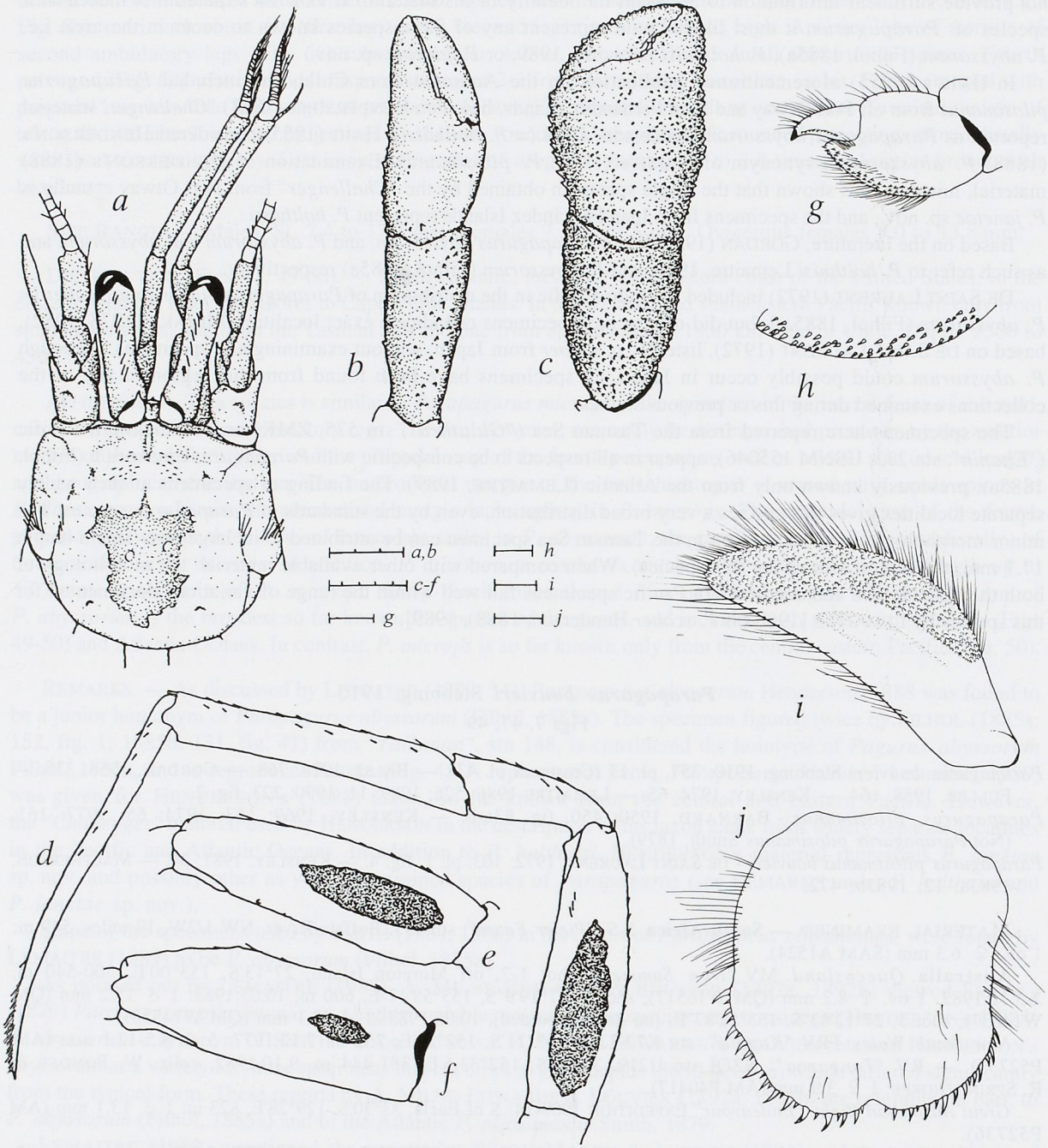

FIG. 7. — *Parapagurus bouvieri* Stebbing, 1910. a-h, southeastern Atlantic: a-c, ♂ 8.2 mm; d, ♂ 10.8 mm; e-f, ov. ♀ 10.0 mm; i-j, ♂ 12.1 mm, Australia, Queensland (QM W14333). **a**, shield and cephalic appendages; **b**, left chela and carpus (setae omitted); **c**, right chela and carpus (setae omitted); **d**, left first ambulatory leg, lateral view; **e**, merus of left first ambulatory leg, lateral view; **f**, merus of left second ambulatory leg, lateral view; **g**, propodus and dactyl of left fourth pereopod, lateral view; **h**, propodal rasp of same (setae omitted), ventrolateral view; **i**, left exopod of uropods, dorsal view; **j**, telson, dorsal view.

Scales equal 3 mm (a-b), 5 mm (c-f), 1 mm (g), 0.5 mm (h), 1 mm (i), and 0.5 mm (j). (a-g, from LEMAITRE, 1990).

DIAGNOSIS. — Shield (Fig. 7a) about as broad as long, dorsal surface well calcified or weakly calcified medially; lateral projections broadly rounded. Rostrum broadly subtriangular, rounded distally; with short mid-dorsal ridge. Ocular peduncles more than half length of shield, weakly inflated basally; width of cornea about same or slightly more than distal width of ocular peduncle. Ocular acicles subtriangular, terminating in strong simple spine (rarely bifid). Antennular peduncle exceeding distal margin of cornea by half length of penultimate segment; lateral face of basal segment with statocyst lobe having subrectangular distal lobe armed with 1 or 2 spines, and 1 spine proximally. Antennal peduncle exceeding distal margin of cornea by at most half length of fifth segment; flagellum with setae 1 to 2 flagellar articles in length; acicle weakly curved in dorsal view, exceeding distal margin of cornea by at most half length of acicle, mesial margin armed with 5 to 10 small spines. Epistomial spine usually present. Sternite of third maxillipeds with strong spine on each side of midline. Left cheliped (Fig. 7b) well calcified, densely setose; carpus with irregular rows of small spines on dorsal margin. Ambulatory legs (Fig. 7d-f) with meri, carpi and propodi unarmed except for small dorsodistal spine on each carpus; meri each about 3.5 (first leg) or 2.9 (second leg) times as long as high, with lateral and mesial faces weakly calcified medially (weak calcification more pronounced on second leg; Fig. 7d-e). Anterior lobe of sternite of second ambulatory legs subsemicircular, setose, armed with small subdistal spine. Fourth pereopod (Fig. 7g-h) with propodal rasp consisting of 2 or 3 rows of conical scales. Fifth pereopod with propodal rasp less than half length of propodus. Telson (Fig. 7j) and uropods asymmetrical. Terminal margin of telson divided into 2 rounded projections by shallow, rounded (U-shaped) cleft; rounded projections armed distally with alternating short and long corneous spines (approximately 15 to 20 left, 10 to 17 right). Left exopod (Fig. 7i) of uropod elongate, about 3.0 times as long as broad; with broad rasp.

SIZE RANGE. — Males, SL 4.0 to 15.2 mm. Females 3.9 to 11.0 mm. Ovigerous females 6.3 to 12.2 mm.

COLOR (from BARNARD, 1950: 451, as *Parapagurus pilosimanus*). — "Body pinkish, basal joints of chelipeds with reddish patches, 2nd and 3rd legs red, with a conspicuous white band along the upper and lower margins, cornea dark crimson, antenna 1 pink with white band along upper margin of last peduncular joint, antenna 2 pink."

VARIATIONS. — The weakly calcified area on the lateral and mesial faces of the meri of the ambulatory legs usually can be recognized by a dark, brownish coloration. The area is often slender, and occasionally is absent on the first leg.

HABITAT. — Usually found living in shelters formed by zoanthid species, probably *Epizoanthus* sp.

DISTRIBUTION (Figs 47, 49). — Southeastern Atlantic and southwestern Indian Ocean: off Angola to South Africa, and northward to off Natal. Western Pacific: Australia. Depth: 247 to 990 m.

REMARKS. — This species can be distinguished from all others in the genus by the weak calcification (usually marked by a dark, brown area) present on the lateral and mesial faces of the meri of the ambulatory legs, and the greater development of the ocular peduncles. In *P. bouvieri*, the length of the ocular peduncles (including corneae) is distinctly more than half the length of the shield, whereas in all other species of *Parapagurus* the ocular peduncles are half or less than half the length of the shield. The reduction of the ocular peduncles in *P. bouvieri* has not been as strong as in other species of the genus, and is a condition that can perhaps be attributed to the relatively shallower depth range at which this species lives compared to other species in the genus (Fig. 47). In other crustaceans, a reduction of eyes with increasing depth has also been documented (e.g., MENZIES *et al.*, 1973; MARSHALL, 1979), and is an evolutionary trend that evidently has occurred independently in many groups.

Parapagurus andreui Macpherson, 1984

Figs 8-9, 47, 49

Parapagurus andreui Macpherson, 1984: 81, figs 24-27. — LEMAITRE, 1986: 526; 1989: 11; 1990: 221, fig. 1. — LEMAITRE & MCLAUGHLIN, 1992: 763.

MATERIAL EXAMINED. — **Southeastern Atlantic**. VALDIVIA 1: stn P-5, Valdivia bank, 25°34.5'S, 6°04'E, 930-933 m, 17.05.1983: 1 ♂ 14.4 mm, 1 ov. ♀ 14.8 mm, paratypes (USNM 240164).

Western Indian Ocean. *La Réunion. "Marion Dufresne"*: cruise MD32, stn CP 103, 20°41.6'S, 54°56.8'E, 2950-2970 m, 29.08.1982: 2 ♂ 12.2, 14.2 mm (MNHN-Pg 5646).

South Africa. "Galathea": stn 190, off Durban, 29°42'S, 33°19'E, 2720 m, 3.02.1951: 1 ♂ (damaged) 9.5 mm (ZMK).

TYPES. — All from Valdivia Bank. *Holotype*: ov. ♀ 14.0 mm, VALDIVIA 1: stn P-4, 25°32'S, 6°06.9'E, 904-959 m (ICM-D 204/1991). *Paratypes*: 1 ♂, 1 ov. ♀, VALDIVIA 1: stn P-4, 25°32'S, 6°06.9'E, 904-959 m (ICM). — 4 ♂, 4 ov. ♀ (ICM); 1 ♂ 14.4 mm, 1 ov. ♀ 14.8 mm (USNM 240164), VALDIVIA 1: stn P-5, 25°34.5'S, 6°04'E, 933 m, 17.05.1983. — 1 ♂, VALDIVIA 1: stn P-9, 25°35'S, 6°09.3'E, 922 m (ICM). — 4 ♂, 3 ♀, 3 ov. ♀, VALDIVIA 1: stn P-10, 25°29.3'S, 6°07.5'E, 900-915 m (ICM).

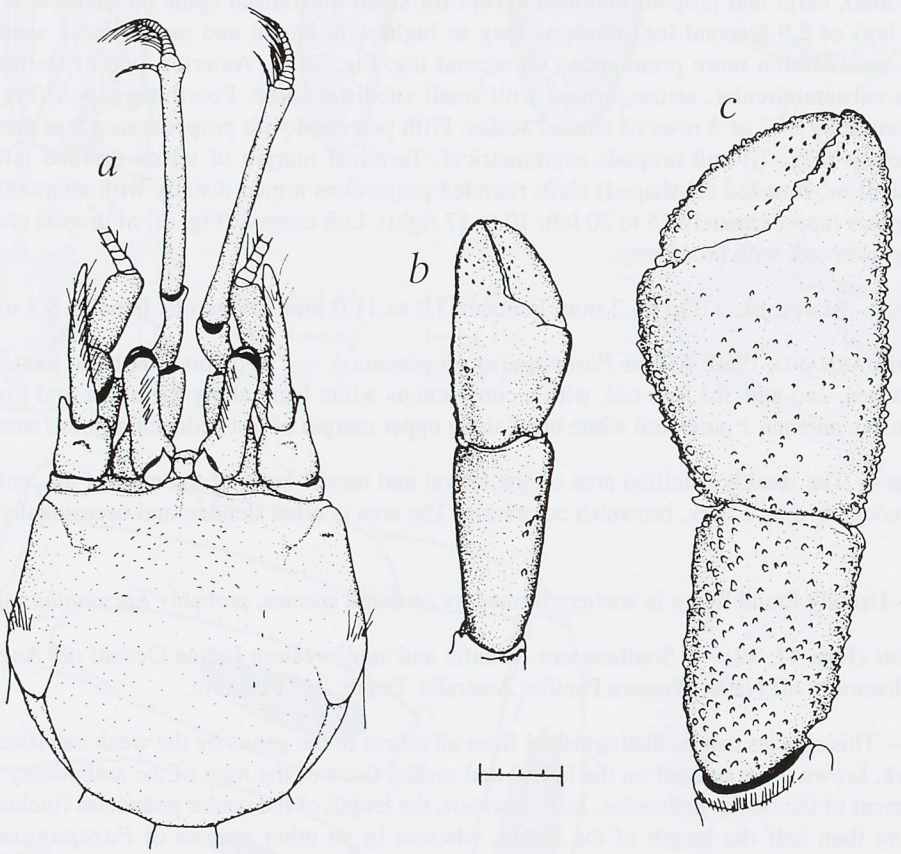

FIG. 8. — *Parapagurus andreui* Macpherson, 1984, southeastern Atlantic: **a**, shield and cephalic appendages; **b**, left chela and carpus (setae omitted); **c**, right chela and carpus (setae omitted).
Scale equals 4 mm. (From LEMAITRE, 1990).

DIAGNOSIS. — Shield (Fig. 8a) about as broad as long, dorsal surface well calcified or with weakly calcified areas medially; lateral projections broadly rounded. Rostrum broadly subtriangular, rounded distally; with short mid-dorsal ridge. Anterolateral margin of branchiostegite unarmed. Ocular peduncles less than half length of shield, inflated basally; width of cornea about same as distal width of ocular peduncle. Ocular acicles subtriangular, terminating in simple strong spine (rarely bifid). Antennular peduncle exceeding distal margin of cornea by nearly entire length of penultimate segment; lateral face of basal segment with statocyst lobe having subrectangular distal lobe armed with 1 or 2 spines, and 1 spine proximally. Antennal peduncle exceeding distal margin of cornea by

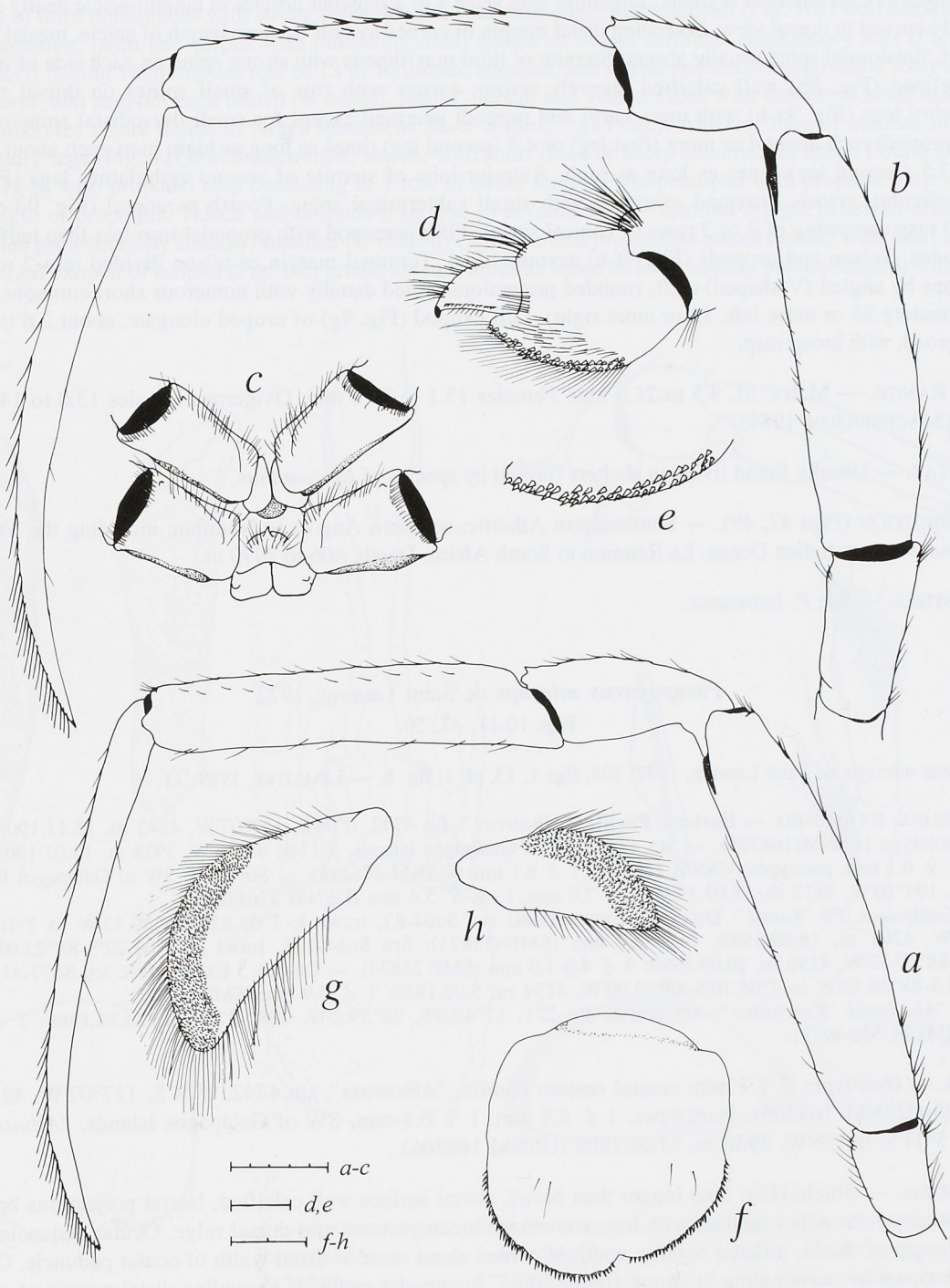

FIG. 9. — *Parapagurus andreui* Macpherson, 1984, western Indian Ocean, La Réunion, *"Marion Dufresne"*, stn CP 103: ♂ 14.2 mm (MNHN-Pg 5646). **a**, left first ambulatory legs, lateral view; **b**, left second ambulatory leg, lateral view; **c**, coxae and sternites of ambulatory legs, ventral view; **d**, propodus and dactyl of left fourth pereopod, lateral view; **e**, propodal rasp of same (setae omitted), ventrolateral view; **f**, telson, dorsal view; **g-h**, left (g) and right (h) exopod of uropods, dorsal view. Scales equal 5 mm (a-c), 1 mm (d), 0.5 mm (e), and 2 mm (f-h).

entire length of fifth antennal segment; flagellum with setae 1 to 2 flagellar articles in length; acicle nearly straight or weakly curved in dorsal view, exceeding distal margin of cornea by half or more length of acicle, mesial margin unarmed. Epistomial spine usually absent. Sternite of third maxillipeds with strong spine on each side of midline. Left cheliped (Fig. 8b) well calcified, densely setose; carpus with row of small spines on dorsal margin. Ambulatory legs (Fig. 9a-b) with meri, carpi and propodi unarmed except for small dorsodistal spine on each carpus; propodi each about 4 or more (first leg) or 4.5 (second leg) times as long as high; meri each about 4 (first leg) or 3.5 (second leg) times as long as high. Anterior lobe of sternite of second ambulatory legs (Fig. 9c) subsemicircular, setose, unarmed or armed with small subterminal spine. Fourth pereopod (Fig. 9d-e) with propodal rasp consisting of 2 or 3 rows of conical scales. Fifth pereopod with propodal rasp less than half length of propodus. Telson and uropods (Fig. 9f-h) asymmetrical. Terminal margin of telson divided into 2 rounded projections by angled (V-shaped) cleft; rounded projections armed distally with numerous short corneous spines (approximately 25 or more left, 15 or more right). Left exopod (Fig. 9g) of uropod elongate, about 2.6 times as long as broad; with broad rasp.

SIZE RANGE. — Males, SL 9.5 to 21.0 mm. Females 13.1 to 20.0 mm. Ovigerous females 13.0 to 14.4 mm or more (MACPHERSON, 1984).

HABITAT. — Usually found living in shelters formed by species of *Epizoanthus*.

DISTRIBUTION (Figs 47, 49). — Southeastern Atlantic: southern Angola to Namibia, including the Valdivia Bank. Southwestern Indian Ocean: La Réunion to South Africa. Depth: 406 to 2970 m.

AFFINITIES. — See *P. latimanus*.

Parapagurus microps de Saint Laurent, 1972

Figs 10-11, 47, 50

Parapagurus microps de Saint Laurent, 1972: 104, figs 1, 13, pl. 1, fig. 8. — LEMAITRE, 1989: 11.

MATERIAL EXAMINED. — **Eastern Pacific**. *"Albatross"*: stn 4742, 0°04'S, 117°07'W, 4243 m, 15.11.1905: 1 ♂ 8.7 mm, holotype (USNM 168305). — Stn 4717, SW of Galápagos Islands, 5°11'S, 98°56'W, 3938 m, 13.01.1905: 1 ♂ 5.8 mm, 1 ♀ 6.1 mm, paratypes (USNM 168306), 1 ♂ 6.1 mm (USNM 276115). — Stn 4721, SW of Galápagos Islands, 8°07'30"S, 104°10'W, 3812 m, 15.01.1905: 1 ♀ 7.0 mm, 1 ov. ♀ 5.4 mm (USNM 276116).

S of Galápagos. FS *"Sonne"*. DISCOL 2 EXPEDITION: stn So64-83, trawl 4, 7°08.83'S-88°30.13'W to 7°10.65'S-88°29.00'W, 4261 m, 16.09.1989: 1 ♂ 7.7 mm (SMF 23873); Stn So64-115, trawl 5, 7°01.22'S-88°23.07'W to 7°08.68'S-88°20.37'W, 4196 m, 20.09.1989: 5 ♂ 4.0-7.0 mm (SMF 23874). — DISCOL 3 EXPEDITION: stn So77-41, trawl 7, 7°08.58'S-88°26.10'W to 7°05.70'S-88°27.00'W, 4154 m, 5.02.1989: 1 ♂ 4.9 mm (SMF 23875).

Perú. *"Akademik Kurchatov"*: 4th cruise, stn 271, 17°42.0'S, 78°59.2'W, 3080-2710 m, 20.10.1968: 2 ♂ 5.0, 6.7 mm (ZMUM Ma-4979).

TYPES. — *Holotype*: ♂ 8.7 mm, central eastern Pacific, *"Albatross"*, stn 4742, 0°04'S, 117°07'W, 4243 m, 15.11.1905 (USNM 168305). *Paratypes*: 1 ♂ 5.8 mm, 1 ♀ 6.1 mm, SW of Galápagos Islands, *"Albatross"*, stn 4717, 5°11'S, 98°56'W, 3938 m, 13.01.1905 (USNM 168306).

DIAGNOSIS. — Shield (Fig. 10a) longer than broad, dorsal surface well calcified; lateral projections broadly rounded. Rostrum broadly rounded; with low, sometimes inconspicuous mid-dorsal ridge. Ocular peduncles less than half length of shield, inflated basally; width of cornea about same as distal width of ocular peduncle. Ocular acicles subtriangular, terminating in strong simple spine. Antennular peduncle exceeding distal margin of cornea by full length of penultimate segment; lateral face of basal segment with statocyst lobe having subrectangular distal lobe armed usually with 1 small spine, and 1 spine proximally. Antennal peduncle (Fig. 10b) exceeding distal margin of cornea by half length of fifth antennal segment; flagellum with scattered setae about 1 to 2 flagellar articles in length; acicle nearly straight in dorsal view, exceeding distal margin of cornea by 0.3 to 0.5 length of acicle, mesial margin unarmed or with 1-3 small spines proximally. Epistomial spine usually present.

Sternite of third maxillipeds with strong spine on each side of midline. Left cheliped (Fig. 10c) well calcified, with sparse setation; palm and carpus with numerous small spines on dorsal surfaces. Ambulatory legs (Fig. 11a-e) with dactyl having ventromesial row of 13 to 16 minute spinules, and dorsal and dorsomesial distal rows of setae; meri, carpi, and propodi each armed on mesial, lateral, dorsal, and ventral faces with numerous small spines and sharp tubercles (more dense in larger specimens SL > 8 mm, Fig. 11a,c). Anterior lobe of sternite of second ambulatory legs (Fig. 11f) subsemicircular, setose, with short blunt or sharp subterminal spine. Fourth pereopod (Fig. 11g-h) with propodal rasp consisting of 1 row of ovate scales. Fifth pereopod with propodal rasp less than half length of propodus. Telson and uropods (Fig. 10e-g) asymmetrical. Terminal margin of telson divided into 2 rounded projections by shallow, rounded (U-shaped) cleft; rounded projections armed distally with short corneous spines. Left exopod of uropod (Fig. 10f) broad, about 2 times as broad as long, usually paddle-shaped; with narrow rasp.

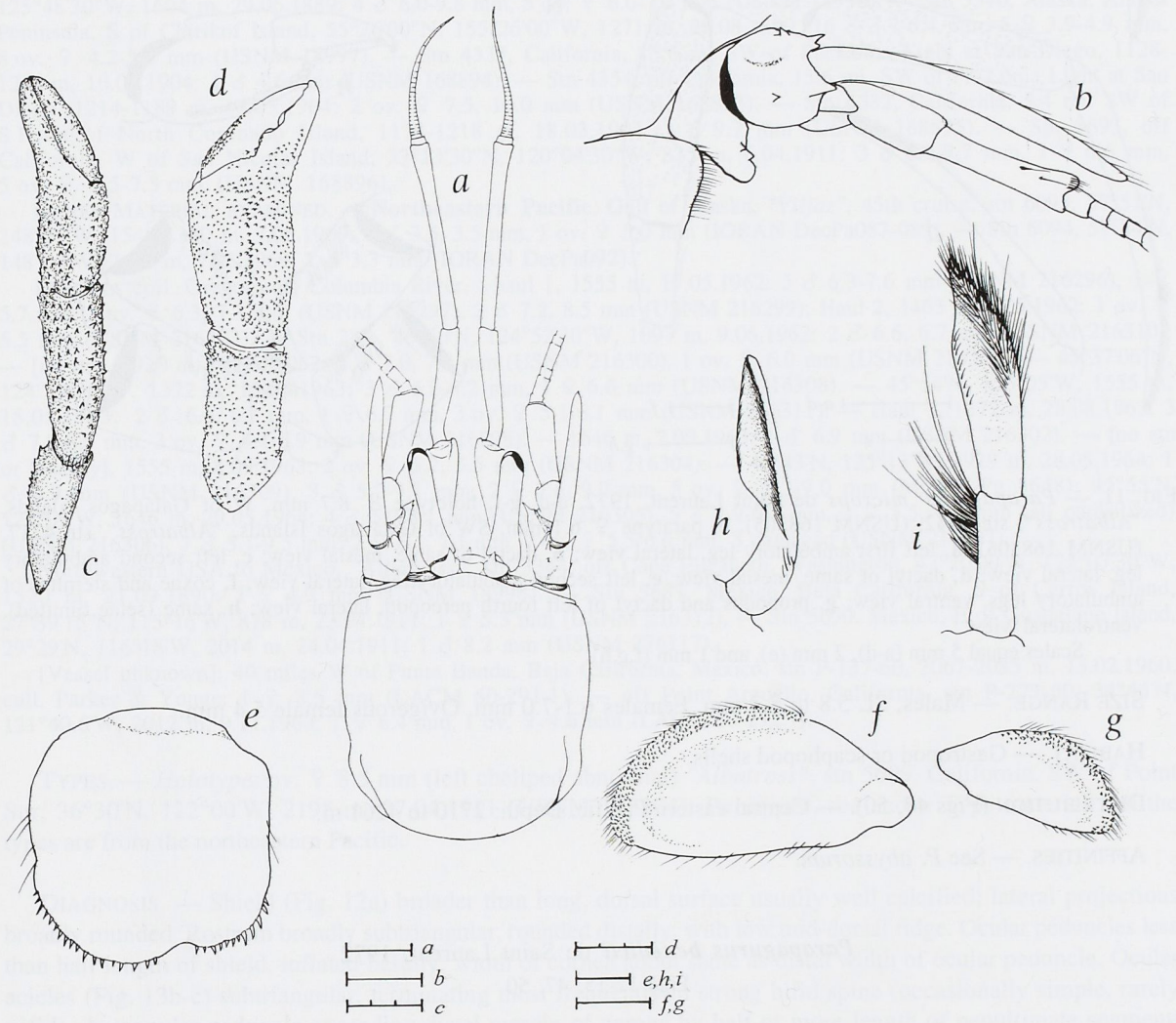

FIG. 10. — *Parapagurus microps* de Saint Laurent, 1972. a-g, holotype ♂ 8.7 mm , W of Galápagos Islands, *"Albatross"*, stn 4742 (USNM 168305); h-i, ♂ 6.1 mm, SW of Galápagos Islands, *"Albatross"*, stn 4717 (USNM 276115). **a**, shield and cephalic appendages; **b**, right antennal peduncle, lateral view; **c**, left cheliped (setae omitted); **d**, right chela and carpus (setae omitted); **e**, telson, dorsal view; **f-g**, left (f) and right (g) exopod of uropods, dorsal view; **h**, male left first pleopod; **i**, male left second pleopod.

Scales equal 1 mm (a-b,f-g), 3 mm (c-d), and 0.5 mm (e,h-i). (a,d, from DE SAINT LAURENT, 1972).

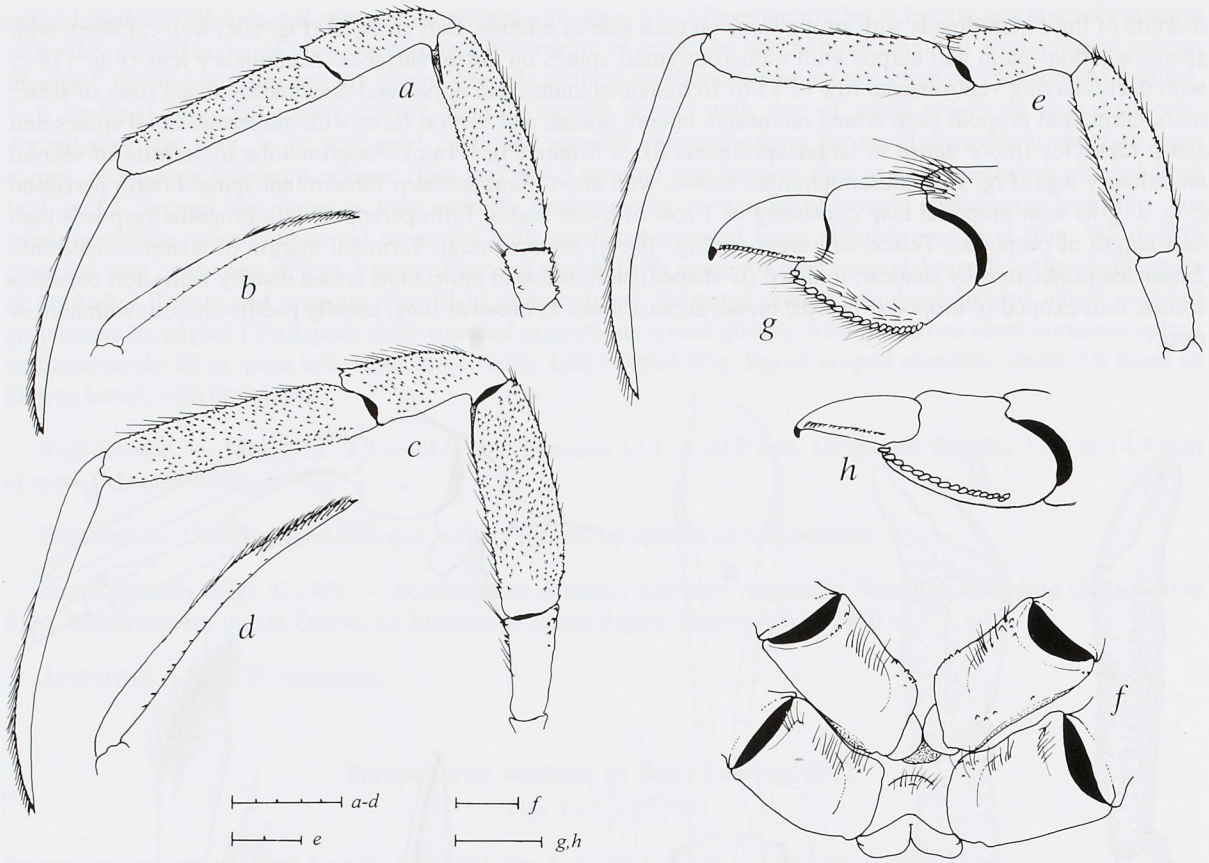

FIG. 11. — *Parapagurus microps* de Saint Laurent, 1972. a-d, g-i, holotype ♂ 8.7 mm, W of Galápagos Islands, *"Albatross"*, stn 4742, (USNM 168305); e, paratype ♀ 6.1 mm, SW of Galápagos Islands, *"Albatross"*, stn 4717, (USNM 168306). **a**, left first ambulatory leg, lateral view; **b**, dactyl of same, mesial view; **c**, left second ambulatory leg, lateral view; **d**, dactyl of same, mesial view; **e**, left second ambulatory leg, lateral view; **f**, coxae and sternites of ambulatory legs, ventral view; **g**, propodus and dactyl of left fourth pereopod, lateral view; **h**, same (setae omitted), ventrolateral view.

Scales equal 5 mm (a-d), 2 mm (e), and 1 mm (f,g,h).

SIZE RANGE. — Males, SL 5.8 to 8.7 mm. Females 6.1-7.0 mm. Ovigerous female 5.4 mm.

HABITAT. — Gastropod or scaphopod shells.

DISTRIBUTION (Figs 47, 50). — Central eastern Pacific. Depth: 2710 to 4261 m.

AFFINITIES. — See *P. abyssorum*.

Parapagurus benedicti de Saint Laurent, 1972

Figs 12-15, 47, 50

Parapagurus sp. indet. - RATHBUN, 1904: 162; 1910: 162.

Parapagurus armatus - REINHART, 1944: 56, fig. 7A. — REISCHMAN, 1959: 409 (nomen nudum, see Remarks).

?*Parapagurus pilosimanus* - MAKAROV, 1938: 223, fig. 74; 1941: 139; 1962: 212, fig. 74. — VINOGRADOV, 1950: 240 (key), pl. 27, fig. 113. — BIRSHTEIN & VINOGRADOV, 1951: 60. — KOBJAKOVA, 1958: 221 (list). — BIRSHTEIN & ZARENKOV, 1972: 442 (see Remarks).

Parapagurus pilosimanus benedicti de Saint Laurent, 1972: 103, pl. 1, fig. 6. — McLaughlin, 1974: 371, figs 100-101. — Hart, 1982: 108, fig. 38.
Parapagurus benedicti - Lemaitre, 1989: 11.
Not *Parapagurus armatus* - Ross, 1967: 306 [= *Sympagurus trispinosus* (Balss, 1911), see Remarks].

Material examined. Type Material. — **Northeastern Pacific**. *Holotype*: ov. ♀ 8.5 mm (left cheliped abnormal, see Variations and abnormalities), *"Albatross"*, stn 5699, California, SW of Point Sur, 36°30'N, 122°00'W, 2195 m, 27.04.1911: (USNM 168304).

Probable paratypes (see Remarks). *"Albatross"*: stn 2839, California, Channel Islands, North of San Clemente Island, 33°08'00"N, 118°40'00"W, 757 m, 8.05.1888: 1 ♂ 8.7 mm (USNM 18992). — Stn 2860, Canada, British Columbia, Queen Charlotte Island, Kunghit Island, S of Cape St. James, 51°23'00"N 130°34'00"W, 1602 m, 31.08.1888: 1 ♂ 9.4 mm (USNM 18993). — Stn 2923, California, San Diego, 32°40'30"N, 117°31'30"W, 1503 m, 19.01.1889: 1 ♂ 8.2 mm, 3 ov. ♀ 6.0-7.5 mm (USNM 18994). — Stn 2928, California, San Diego, 32°47'30"N, 118°10'00"W, 763 m, 23.01.1889: 6 ♂ 5.2-8.1 mm, 1 ov. ♀ 6.1 mm (USNM 18995). — Stn 3074, Washington, Sea Lion Rocks, 47°22'00"N, 125°48'30"W, 1604 m, 29.06.1889: 4 ♂ 6.0-9.8 mm, 5 ov. ♀ 6.0-7.2 mm (USNM 18996). — Stn 3340, Alaska, Alaska Peninsula, S of Chirikof Island, 55°26'00"N, 155°26'00"W, 1271 m, 29.08.1890: 16 ♂ 3.7-6.4 mm, 5 ♀ 3.9-4.9 mm, 8 ov. ♀ 4.2-5.8 mm (USNM 18997). — Stn 4337, California, 15.6 mi SW of Pt. Loma Light at San Diego, 1128-1244 m, 10.03.1904: 1 ♂ 4.6 mm (USNM 168894). — Stn 4354, off California, 15.6 mi. SW of Pt. Loma Light at San Diego, 1214-1189 m, 14.03.1904: 2 ov. ♀ 7.5, 10.0 mm (USNM 168893). — Stn 4382, California, 5.4 mi. SW of S Point of North Coronado Island, 1174-1218 m, 18.03.1904: 1 ♂ 9.7 mm (USNM 168895). — Stn 5693, off California, W of San Nicolas Island, 33°13'30"N, 120°04'30"W, 825 m, 6.04.1911: 3 ♂ 6.1-9.7 mm, 1 ♀ 6.6 mm, 5 ov. ♀ 5.5-7.5 mm (USNM 168896).

Other Material examined. — **Northeastern Pacific**. Gulf of Alaska, *"Vitjaz"*, 45th cruise: stn 6093, 57°51'N, 148°57'W, 1540-1340 m, 7.05.1969: 2 ♂ 3.5, 3.5 mm, 1 ov. ♀ 5.0 mm (IORAN DecPa087-089). — Stn 6094, 57°44'N, 148°37'W, 2400 m, 7.05.1969: 1 ♂ 3.3 mm (IORAN DecPa092).

Pereyra coll.: Oregon, off Columbia River, : haul 1, 1555 m, 17.05.1962: 3 ♂ 6.3-7.6 mm (USNM 216296), 1 ♀ 5.7 mm, 2 ov. ♀ 6.3, 7.3 mm (USNM 216297), 2 ♂ 7.2, 8.5 mm (USNM 216299); Haul 2, 1463 m, 7.05.1962: 1 ov. ♀ 5.5 mm (USNM 216303). — Stn 23A, 45°50'N, 124°52'30"W, 1097 m, 9.06.1962: 2 ♂ 6.6, 6.7 mm (USNM 216310). — [no stn], 1920 m, 10.06. 1962: 2 ♂ 7.0, 7.8 mm (USNM 216300), 1 ov. ♀ 6.0 mm (USNM 216301). — 45°37'06"N, 124°54'36"W, 1372 m, 15.05.1963: 3 ♂ 6.0-8.2 mm, 1 ♀ 6.6 mm (USNM 216308). — 45°54'N, 125°05'W, 1555 m, 15.05.1963: 2 ♂ 6.6, 6.7 mm, 1 ♀ 6.7 mm, 3 ov. ♀ 5.1-6.1 mm (USNM 216311). — Haul 1, 1372 m, 28.08.1963: 3 ♂ 7.0-8.5 mm, 3 ov. ♀ 5.4-6.9 mm (USNM 216298). — 1646 m, 2.09.1963: 1 ♂ 6.9 mm (USNM 216302). — [no stn or locality], 1555 m, 8.09.1963: 2 ov. ♀ 5.2, 5.5 mm (USNM 216304). — 45°43'N, 125°13'W, 1929 m, 28.05.1964: 1 ♂ 9.9 mm (USNM 216309), 3 ♂ 5.2-9.1 mm, 2 ♀ 7.6, 9.0 mm, 5 ov. ♀ 5.2-9.0 mm (MNHN-Pg 5648); 45°55'N, 125°09'W, 1646 m, 29.05.1964: 4 ♂ 5.2-8.1 mm (USNM 216305), 5 ♂ 4.9-6.7 mm, 2 ♀ 5.5, 6.0 mm (all parasitized) (USNM 216306), 7 ♂ 5.1-9.5 mm, 2 ♀ 6.1, 7.1 mm, 7 ov. ♀ 5.5-6.6 mm, 3 damaged (USNM 216307).

Northwestern USA to Mexico. *"Albatross"*: stn 3344, off Cape Elizabeth, Washington, 47°20'00"N, 125°07'30"W, 1520 m, 21.09.1890: 1 ♀ 4.9 mm (USNM 18998). — Stn 5687, Mexico, Baja California, S of Cerros Island, 27°39'15"N, 115°16'W, 878 m, 23.04.1911: 1 ♀ 5.3 mm (USNM 216312). — Stn 5690, Mexico, E of Guadalupe Island, 29°29'N, 116°18'W, 2014 m, 24.04.1911: 1 ♂ 8.2 mm (USNM 276117).

[Vessel unknown]: 40 miles W of Punta Banda, Baja California, Mexico, stn P-137-60, 2067-2085 m, 13.02.1960, coll. Parker & Yonge: 1 ♀ 8.5 mm (LACM 60-291.1). — off Point Arguello, California, stn P-273-60, 34°46'N, 121°40.6'W, 2012 m, 9.11.1960: 1 ♀ 6.4 mm, 1 ov. ♀ 4.6 mm (LACM 60-292.1).

Types. — *Holotype*: ov. ♀ 8.5 mm (left cheliped abnormal) *"Albatross"*, stn 5699, California, SW of Point Sur, 36°30'N, 122°00'W, 2195 m, 27.04.1911 (USNM 168304). *Paratypes*, see above Type material. All the types are from the northeastern Pacific.

Diagnosis. — Shield (Fig. 12a) broader than long, dorsal surface usually well calcified; lateral projections broadly rounded. Rostrum broadly subtriangular, rounded distally; with low mid-dorsal ridge. Ocular peduncles less than half length of shield, inflated basally; width of cornea about same as distal width of ocular peduncle. Ocular acicles (Fig. 13b-c) subtriangular, terminating most frequently in strong bifid spine (occasionally simple, rarely trifid). Antennular peduncle exceeding distal margin of cornea by half or more length of penultimate segment; lateral face of basal segment with statocyst lobe having subrectangular distal lobe armed with 1-3 small spines, and 1 spine proximally. Antennal peduncle (Fig. 13a) exceeding distal margin of cornea by about 0.6 length of fifth antennal segment; flagellum with scattered short setae about 1 flagellar article in length or less; second segment with dorsolateral distal angle produced into strong, broad multifid spine usually with somewhat concave dorsal

face; first segment with 1-4 spines on lateral face; acicle weakly curved in dorsal view, exceeding distal margin of cornea by 0.3 to 0.5 length of acicle, mesial margin armed with 4-12 small spines (2 or 3 spines in small specimens SL 4.0 mm). Epistomial spine usually present, simple or occasionally bifid. Sternite of third maxillipeds with strong spine on each side of midline. Left cheliped (Fig. 12c) well calcified, with dense setation on carpus and chela; palm armed with irregular rows of spines on dorsolateral and dorsomesial faces; carpus with numerous spines on dorsal surface. Ambulatory legs (Figs 12e, 14a-d) with dactyls each having ventromesial row of 8 to 12 minute spinules, and dorsal and dorsomesial distal rows of setae; lateral and mesial faces of segments smooth, except for scattered short setae; first leg with ischium and merus (Fig. 14a,c) armed with irregular rows of small spines on ventral margins; second leg with merus armed with irregular row of small spines (less distinct and numerous than on first leg) on ventral margin (Fig. 14b,d), ischium unarmed or with a few small blunt spines on

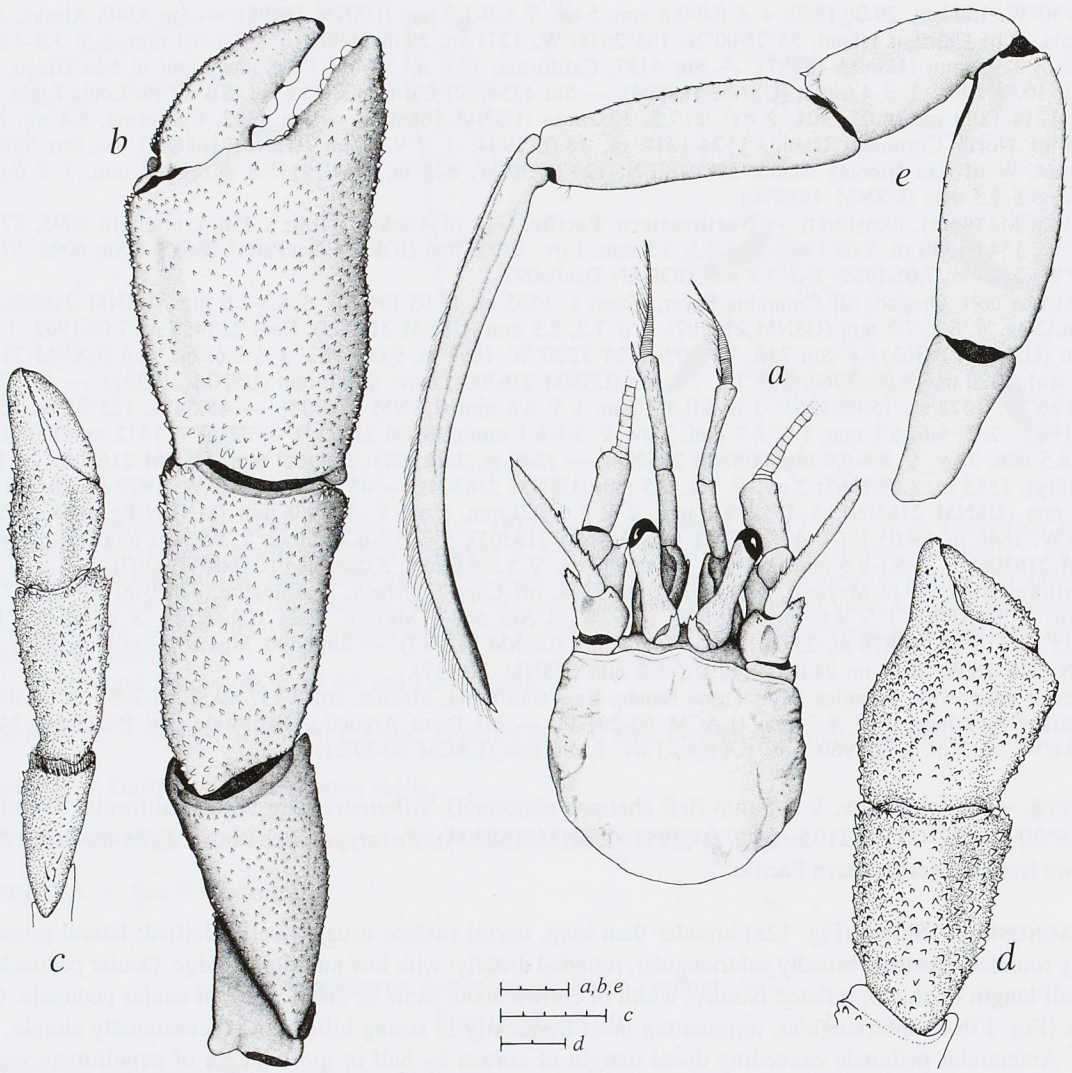

FIG. 12. — *Parapagurus benedicti* de Saint Laurent, 1972. a-b,e, NE Pacific; c, ov. ♀ 10.0 mm, NE Pacific, *"Albatross"*, stn 4354, (USNM 168893); d, holotype ov. ♀ 8. 5 mm, NE Pacific, *"Albatross"*, stn 5699 (USNM 168304). **a**, shield and cephalic appendages; **b**, right cheliped (setae omitted); **c**, left cheliped (setae omitted); **d**, left cheliped of holotype (setae omitted); **e**, left second ambulatory leg, lateral view.

Scales equal 3 mm (a-b,e), 5 mm (c), and 2 mm (d). (a,b,e, from MCLAUGHLIN, 1974).

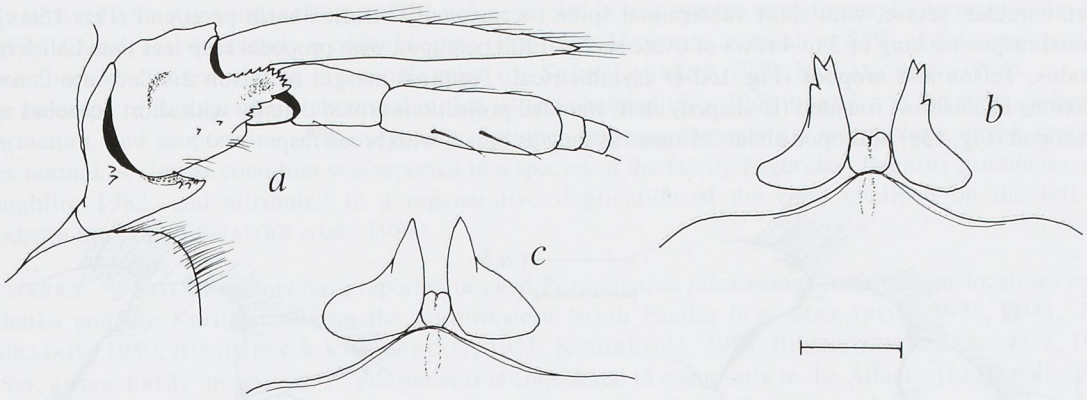

FIG. 13. — *Parapagurus benedicti* de Saint Laurent, 1972, NE Pacific. a-b, ♀ 7.3 mm, off Columbia River (USNM 216297); c, ov. ♀ 5.5 mm (USNM 216304). **a**, right antennal peduncle, lateral view; **b-c**, ocular acicles and rostrum, dorsal view.

Scale equals 1 mm.

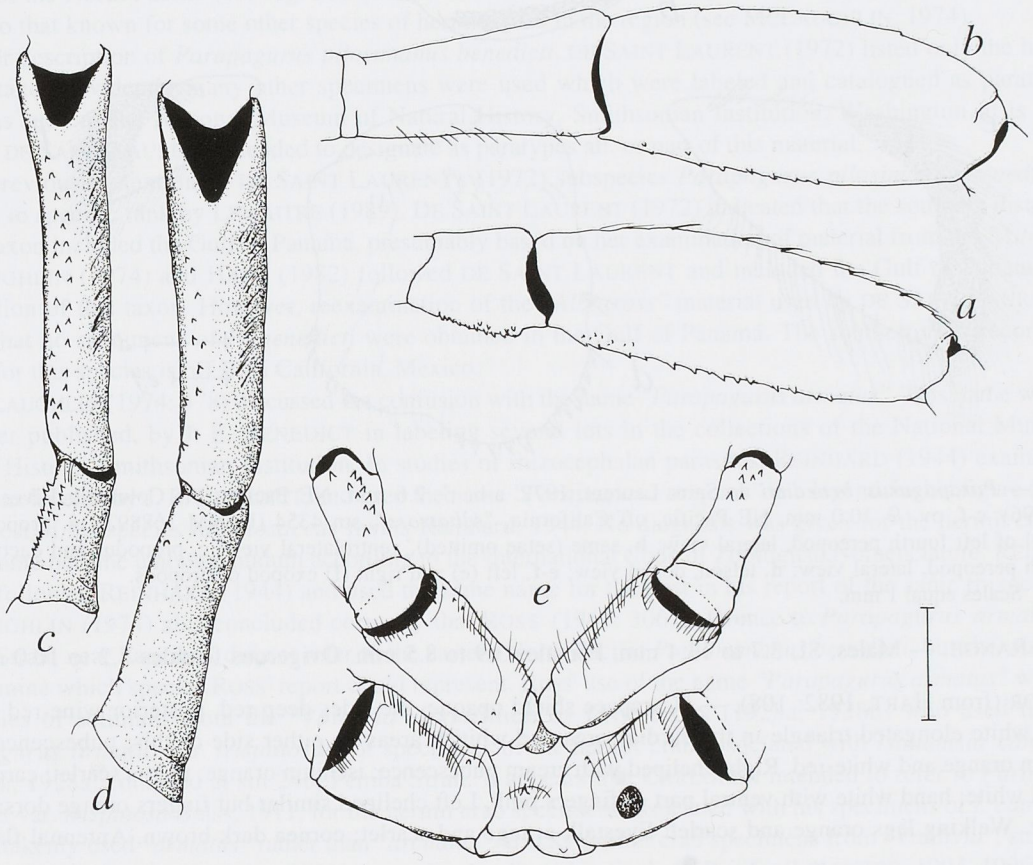

FIG. 14. — *Parapagurus benedicti* de Saint Laurent, 1972, ov. ♀ 10.0 mm, NE Pacific, off California, *"Albatross"*, stn 4354, (USNM 168893): **a-b**, ischium and merus of right first (a) and second (b) ambulatory legs, lateral view; **c-d**, same of first (c) and second (d) ambulatory legs, ventral view; **e**, coxae and sternites of ambulatory legs, ventral view (ischia shown for first legs).

Scale equals 3 mm.

ventral margin distally. Anterior lobe of sternite of second ambulatory legs (Fig. 14e) with anterior lobe subsemicircular, setose, with short subterminal spine (occasionally bifid). Fourth pereopod (Fig. 15a-c) with propodal rasp consisting of 2 to 4 rows of ovate scales. Fifth pereopod with propodal rasp less than half length of propodus. Telson and uropods (Fig. 15d-f) asymmetrical. Terminal margin of telson divided into 2 rounded projections by shallow, rounded (U-shaped) cleft; rounded projections armed distally with short corneous spines. Left exopod (Fig. 15e) of uropod about 2.1 times as long as broad, with broad rasp.

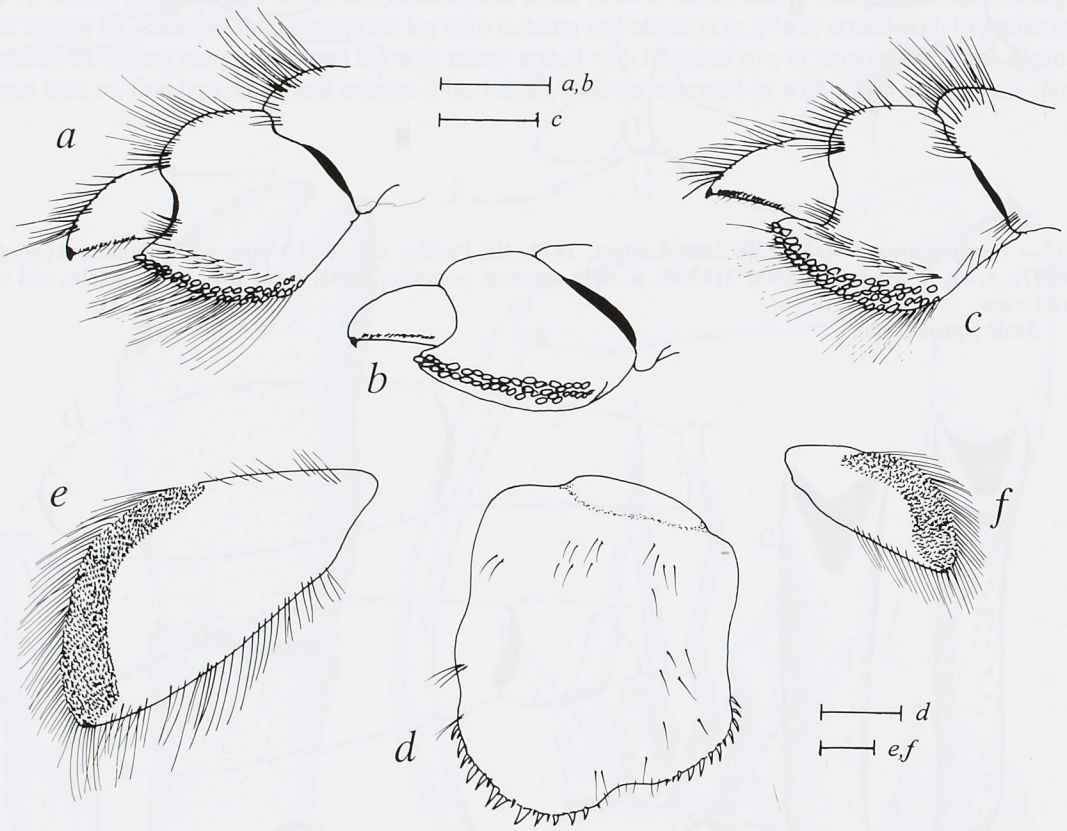

FIG. 15. — *Parapagurus benedicti* de Saint Laurent, 1972. a-b, ♂ 7.6 mm, NE Pacific, off Columbia River (USNM 216296); c-f, ov. ♀ 10.0 mm, NE Pacific, off California, *"Albatross"*, stn 4354 (USNM 168893). **a**, propodus and dactyl of left fourth pereopod, lateral view; **b**, same (setae omitted), ventrolateral view; **c**, propodus and dactyl of left fourth pereopod, lateral view; **d**, telson, dorsal view; **e-f**, left (e) and right (f) exopod of uropods.
Scales equal 1 mm.

SIZE RANGE. — Males, SL 3.7 to 13.4 mm. Females 3.9 to 8.5 mm. Ovigerous females 4.2 to 10.0 mm.

COLOR (from HART, 1982: 108). — "Carapace shield opaque, the sides deep red, posterior wine-red with an opaque, white elongated triangle in the cardiac area and whitish areas on either side of this; pubescence white. Abdomen orange and white-red. Right cheliped with cream pubescence; ischium orange; merus scarlet; carpus pale pink and white; hand white with ventral part of fingers pink. Left cheliped similar but fingers orange dorsally and ventrally. Walking legs orange and scarlet. Eyestalk orange and scarlet; cornea dark brown. Antennal flagellum orange."

HABITAT. — Gastropod shells with or without actinian entirely covering shell.

DISTRIBUTION (Figs 47, 50). — Northeastern Pacific: from Alaska to Baja California; possibly northwestern Pacific (see Remarks). Depth: 757 to 2400 m.

VARIATIONS AND ABNORMALITIES. — The ocular acicles in this species most frequently terminate in a bifid spine (Fig. 12a) or less frequently a multifid spine (Fig. 13b). However, as much as 25% of the specimens in a series can have acicles terminating in a simple spine (DE SAINT LAURENT, 1972; MCLAUGHLIN, 1974).

The holotype of this species is abnormal in that its left cheliped (Fig. 12d) is similar to the right cheliped in size, armature, and proportions of the segments. In other respects, the external morphology of the specimen appears normal. A similar condition was reported in a species of the family Paguridae, *Pagurus protuberocarpus* McLaughlin, 1982, and attributed to a regenerative duplication of the right cheliped on the left side (MCLAUGHLIN, 1982; LEMAITRE *et al.*, 1982).

REMARKS.—- Several authors have reported or cited *Parapagurus pilosimanus* from various localities east of Kamchatka and the Kuril Islands, in the northwestern North Pacific (e.g. MAKAROV, 1938, 1941, 1962; VINOGRADOV, 1950; BIRSHTEIN & VINOGRADOV, 1951; KOBJAKOVA, 1958; BIRSHSTEIN & ZARENKOV, 1972). However, as previously mentioned, *P. pilosimanus* is considered to occur only in the Atlantic (LEMAITRE, 1989). The specimens reported by these authors from the northwestern North Pacific have not been examined, and their identity cannot be established with certainty based on the information included in their publications. No reports of other *Parapagurus* species are known from the norhwestern North Pacific, north of Japan. The specimens reported by these authors might represent *P. benedicti*, the only species so far known to occur in the extreme northeastern portion of the North Pacific (see Fig. 50). It is possible that this species might have an amphi-Pacific distribution similar to that known for some other species of hermit crabs in the region (see MCLAUGHLIN, 1974).

In her description of *Parapagurus pilosimanus benedicti*, DE SAINT LAURENT (1972) listed only the holotype for her taxon. Evidently many other specimens were used which were labeled and catalogued as paratypes in museums such as the National Museum of Natural History, Smithsonian Institution, Washington. It is unclear whether DE SAINT LAURENT intended to designate as paratypes all, or part of this material.

As previously mentioned, DE SAINT LAURENT's (1972) subspecies *Parapagurus pilosimanus benedicti* was elevated to specific rank by LEMAITRE (1989). DE SAINT LAURENT (1972) indicated that the southern distribution of this taxon included the Gulf of Panamá, presumably based on her examination of material from the *"Albatross"*. MCLAUGHLIN (1974) and HART (1982) followed DE SAINT LAURENT and included the Gulf of Panamá in the distribution of this taxon. However, reexamination of the *"Albatross"* material used by DE SAINT LAURENT has shown that no specimens of *P. benedicti* were obtained in the Gulf of Panamá. The southernmost record so far known for this species is off Baja California, Mexico.

MCLAUGHLIN (1974: 378) discussed the confusion with the name *"Parapagurus armatus"*. This name was used, but never published, by J. E. BENEDICT in labeling several lots in the collections of the National Museum of Natural History, Smithsonian Institution. In studies of rhizocephalan parasites, REINHARD (1944) examined the specimens labeled by J. E. BENEDICT, and used the name *"Parapagurus armatus"* in a legend for his figure (fig. 7A) of the host of his species *Angulosaccus tenuis* Reinhard, 1944. No diagnosis was given for the hermit crab host, so the name became a nomen nudum according to the International Code of Zoological Nomenclature. REISCHMAN (1959) followed REINHARD (1944) and used the same name for the host in his report of the same rhizocephalan. MCLAUGHLIN (1974) also concluded correctly that ROSS' (1967: 306) reference to *Parapagurus armatus* from Pemba Strait, near Zanzibar, did not refer to the eastern North Pacific *P. pilosimanus benedicti*, but she was unable to determine which species ROSS' report could represent. Ross' use of the name *"Parapagurus armatus"* was based on studies of actinians from the *"Valdivia"* Expedition by CARLGREN (1928a, 1928b) who used the name *Parapagurus armatus* var. *trispinosus* for specimens of the hermit crab associated with *Isadamsia cancrisocia* Carlgren, 1928a, collected at stn 246, Pemba Strait. It appears that CARLGREN intended to refer to *Parapagurus arcuatus* var. *trispinosa* Balss, 1911, for the hermit crab specimens associated with his specimens of *I. cancrisocia*, and mistakenly used *"armatus"* rather than *"arcuatus"*. BALSS' hermit crab specimens from *"Valdivia"*, stn 246 are of *Sympagurus trispinosus* (Balss, 1911), a species distributed in the Indo-Pacific (LEMAITRE, 1994, 1996).

Parapagurus benedicti can be separated from all other species of the genus known to occur in the eastern Pacific, by the spines present on the ventral margins of the meri of the first and second ambulatory legs (Fig. 14a-d); and the dorsolateral distal angle of the second antennal segment (Fig. 13a), which is distinctly more strongly developed than in other species of the genus, and terminates in a multifid spine with a slightly concave

dorsal face. The bifid or less frequently multifid condition of the ocular acicles of *P. benedicti* also is a useful diagnostic character. However, as mentioned under "Variations and Abnormalities", the ocular acicles are variable and can terminate in a simple spine in a significant number of specimens.

Parapagurus holthuisi Lemaitre, 1989

Figs 16-18, 47, 49-50

Parapagurus abyssorum Henderson, 1888: 87 (in part), pl. 9, fig. 2. — MURRAY, 1895: 1129 (in part); 1896: 388 (in part). — GORDAN, 1956: 337 (lit.). [Not *Parapagurus abyssorum* (Filhol, 1885a); see Remarks].

?*Parapagurus pilosimanus* - HAIG, 1955: 17. — PORTER, 1906: 129. [See Remarks under *Parapagurus abyssorum* (Filhol, 1885a)].

Parapagurus pilosimanus abyssorum - DE SAINT LAURENT, 1972: 103 (in part), ?not pl. 1, fig. 7 (see Remarks).

Parapagurus holthuisi Lemaitre, 1989: 34. [Replacement name for *Parapagurus abyssorum* Henderson, 1888, junior homonym of *Parapagurus abyssorum* (Filhol, 1885a)].

MATERIAL EXAMINED. — **Eastern Pacific**. *"Challenger"*, stn 300, W of Valparaiso, Chile, 33°42'S, 78°18'W, 2515 m, 17.12.1875: ♂ 14.9 mm , holotype (NHM 1888:33), 5 ♂ 11.8-13.3 mm, 1 ♀ 7.8 mm, 2 ov. ♀ 8.1, 11.4 mm , paratypes (NHM 1888:33). — Stn 3374, Galápagos Islands, 2°35'N, 83°53'W, 3334 m, 3.03.1891: 1 ov. ♀ 6.3 mm (USNM 42625). — Stn 4647, off Perú, 4°33'S, 87°42'30"W, 3667 m, 9.11.1904: 10 ♂ 5.9-10.0 mm, 6 ♀ 5.1-7.0 mm (USNM 276114); 2 ♂ 8.8, 9.4 mm, 2 ov. ♀ 5.7, 6.0 mm (MNHN-Pg 5649).

"Challenger". Chile. Juan Fernández Island, [no stn number], 2115 m: 1 ♂ 13.3 mm, 3 ov. ♀ 10.0-10.4 mm (USNM 15298). — Off Juan Fernández Island, [no stn number], 2115 m: 3 ♂ 8.5-12.8 mm (ZMK). — Off Valparaiso, [no stn number or other data]: 1 ♀ 11.2 mm, 1 ov. ♀ 10.7 mm (USNM 156411).

Central Pacific. *Magellan Rise.* POSSE EXPEDITION, *"Alvin"*, dive 1816, 7°00'N, 177°00'W, 3150 m, 17.03.1987, coll. K. SMITH: 1 ♂ 12.2 mm (SIO C9941).

TYPES. — *Holotype* : ♂ 14.9 mm (Holotype of *Parapagurus abyssorum* Henderson, 1888), *"Challenger"*, stn 300, W of Valparaiso, Chile, 33°42'S, 78°18'W, 2515 m, 17.12.1875 (NHM 1888:33). *Paratypes*: 5 ♂ 11.8-13.3 mm, 1 ♀ 7.8 mm, 2 ov. ♀ 8.1, 11.4 mm, same data as holotype (NHM 1888:33).

REDESCRIPTION. — Shield (Fig. 16a) about as long as broad; dorsal surface usually well calcified, with scattered short setae; anterior margin weakly concave; lateral projections broadly rounded; anterolateral margin sloping. Rostrum broadly subtriangular, rounded distally, overreaching lateral projections; often with inconspicuous low mid-dorsal ridge. Anterodistal margin of branchiostegite (Fig. 16b) unarmed, setose.

Ocular peduncles (including corneae) distinctly less than half length of shield, each with rows of setae dorsally; peduncles inflated basally, slightly constricted medially. Ocular acicles subtriangular, terminating in strong simple spine; separated basally by slightly less than basal width of one acicle.

Antennular peduncles slender, long, exceeding distal margins of corneae by 0.8 or more length of penultimate segments. Ultimate and penultimate segments with scattered setae. Ultimate segment nearly twice as long as penultimate. Basal segment with ventromesial distal spine; mesial face unarmed; lateral face with statocyst lobe having subrectangular distal lobe armed with 1-3 small spines, and 1 spine proximally.

Antennal peduncles (Fig. 16b) exceeding distal margins of cornea by about 0.8 or more length of fifth segments. Fifth segment with scattered setae on lateral and mesial margins. Fourth segment with scattered setae. Third segment with strong ventromesial distal spine. Second segment with dorsolateral distal angle produced, terminating in strong multifid spine; mesial margin with spine on dorsodistal angle. First segment unarmed on lateral face; ventromesial angle produced, with row of small spines. Antennal acicles weakly curved in dorsal view, setose; exceeding distal margin of cornea by about half or less length of acicle; mesial margin armed usually with 4 to 8 (range 1 to 10) small spines. Flagellum distinctly overreaching extended right cheliped, with sparse short setae less than 1 flagellar articles in length.

Mandible, maxilla, and first and second maxillipeds typical of species in genus (e.g. Fig. 20). Maxillule (Fig. 16c-d) with external lobe of endopod weakly developed, internal lobe with long terminal seta and 4 subterminal setae. Third maxilliped with crista dentata consisting of about 19 corneous-tipped teeth. Sternite of third maxilliped with spine on each side of midline. Epistomial spine usually present.

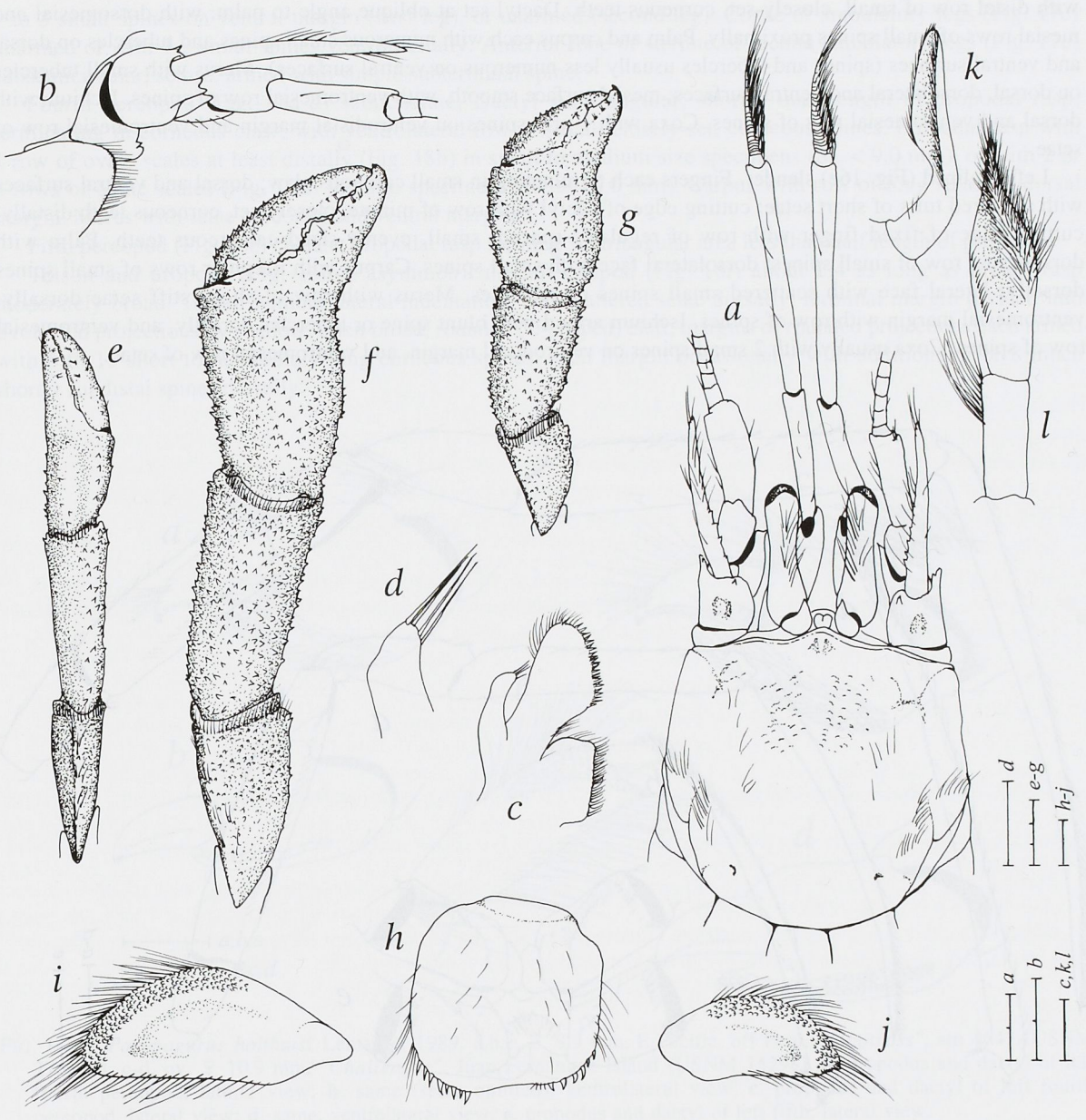

FIG. 16. — *Parapagurus holthuisi* Lemaitre, 1989, NE Pacific, off Perú, *"Albatross"*, stn 4647 (USNM 276114): a-b,e-f, h-j, ♂ 8.9 mm; c,d,k,l, ♂ 9.6 mm; g, ov. ♀ 7.0 mm. **a**, shield and cephalic appendages; **b**, right antennal peduncle and anterolateral margin of branchiostegite, lateral view; **c**, left maxillule, internal view; **d**, distal end of endopod of same; **e**, left cheliped (setae omitted); **f**, right cheliped (setae omitted); **g**, right cheliped (setae omitted); **h**, telson, dorsal view; **i-j**, left (i) and right exopod of uropods, dorsal view; **k**, male left first pleopod, mesial view; **l**, male second pleopod, anterior view.

Scales equal 2 mm (a-b), 1 mm (c-d,k-l), 3 mm (e-g), and 0.5 mm (h-j).

Chelipeds markedly dissimilar, each with dorsal surfaces of carpus and chela covered with moderately dense setation; proportions of carpus and chela influenced by size and sexual dimorphism (see Variations). Right cheliped (Fig. 16f-g) with fingers bent inwards at tips, each terminating in small corneous claw; with tufts of setae on dorsal and ventral surfaces; cutting edges each with irregularly-sized calcareous teeth; cutting edge of dactyl also

with distal row of small, closely-set, corneous teeth. Dactyl set at oblique angle to palm, with dorsomesial and mesial rows of small spines proximally. Palm and carpus each with numerous small spines and tubercles on dorsal and ventral surfaces (spines and tubercles usually less numerous on ventral surfaces). Merus with small tubercles on dorsal, dorsolateral and ventral surfaces; mesial surface smooth, with ventromesial row of spines. Ischium with dorsal and ventromesial row of spines. Coxa with 1 or 2 spines on ventrodistal margin and ventromesial row of setae.

Left cheliped (Fig. 16e) slender. Fingers each terminating in small corneous claw; dorsal and ventral surfaces with scattered tufts of short setae; cutting edge of dactyl with row of minute, closely-set, corneous teeth distally; cutting edge of fixed finger with row of regularly-spaced, small, evenly-sized calcareous teeth. Palm with dorsomesial row of small spines; dorsolateral face with small spines. Carpus with irregular rows of small spines dorsally; lateral face with scattered small spines or tubercles. Merus with row of short, stiff setae dorsally; ventromesial margin with row of spines. Ischium armed with blunt spine or tubercles dorsally, and ventromesial row of spines. Coxa usually with 2 small spines on ventrodistal margin, and ventromesial row of setae.

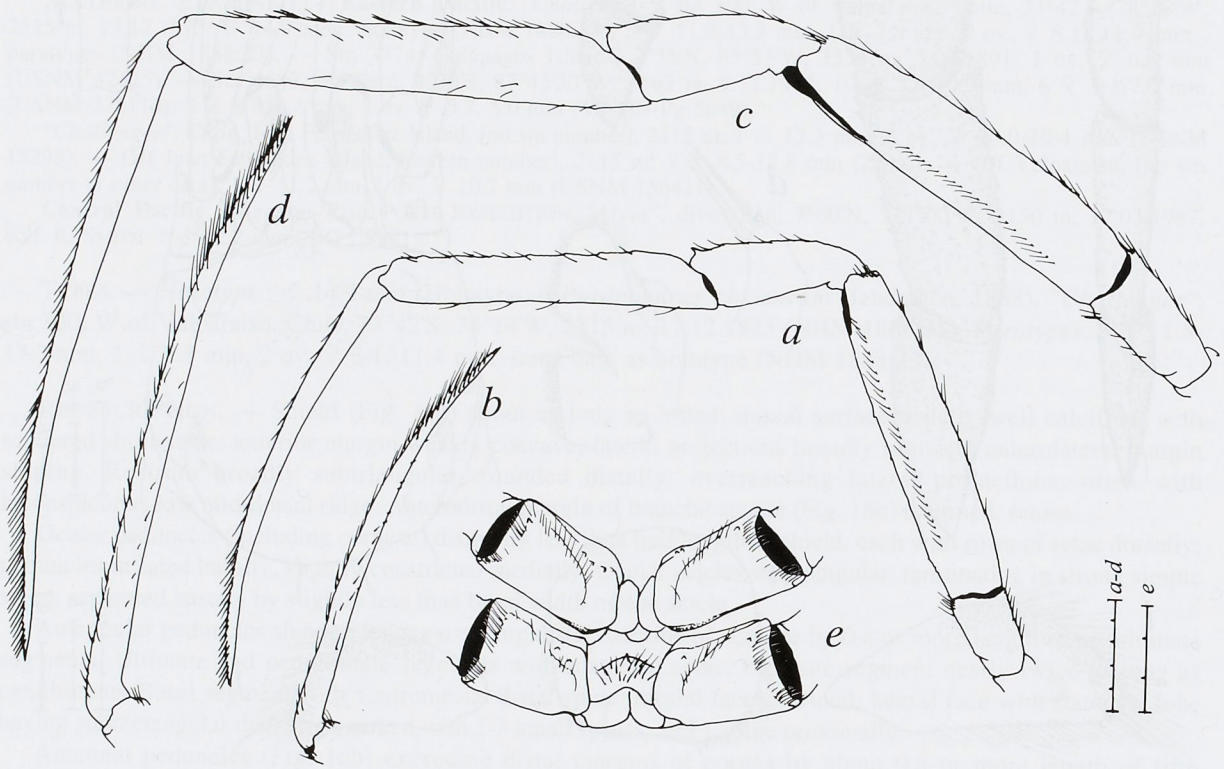

FIG. 17. — *Parapagurus holthuisi* Lemaitre, 1989, ♂ 8.9 mm, E Pacific, off Perú, *"Albatross"*, stn 4647 (USNM 276114): **a**, first ambulatory leg, lateral view; **b**, dactyl of same, mesial view; **c**, second ambulatory leg, lateral view; **d**, dactyl of same, mesial view; **e**, coxae and sternites of ambulatory legs, ventral view.
Scales equal 5 mm (a-d), and 3 mm (e).

Ambulatory legs (Fig. 17a-d) similar from right to left (except slightly longer segments on right), slender, long, distinctly overreaching right cheliped. Dactyl 1.3 to 1.5 times as long as propodus; with dorsal and ventromesial distal row of setae; ventromesial margin with row of about 8 or more minute corneous spinules. Merus, carpus, and propodus each with short stiff setae on dorsal margin (setae on propodus usually arranged in short transverse rows). Propodus 6 or more times as long as high. Carpus with dorsodistal spine. Merus of first ambulatory leg about 4.5 times as long as high; with longitudinal row of short setae on lateral face. Ischium with

1 to 3 small spines on ventral margin (first leg), or unarmed (second leg). Coxae of ambulatory legs (Fig. 17e) unarmed or with 1-3 small spines ventromesially. Anterior lobe of sternite of second ambulatory legs (Fig. 17e) subsemicircular, setose, armed with simple subterminal spine.

Fourth pereopod (Fig. 18a-d) semichelate. Dactyl subtriangular; shorter than length of propodal rasp, terminating in corneous claw; with ventrolateral row of small, closely-set, corneous spines. Propodal rasp with 1 row of ovate scales at least distally (Fig. 18b) in small to medium size specimens (SL < 9.0 mm), or with 2 or 3 rows of ovate scales (Fig. 18d) in large specimens (SL > 10.0 mm). Carpus with row of long setae on dorsal margin. Merus with setae on dorsal and ventral margins.

Fifth pereopod (Fig. 18e) chelate; propodal rasp forming subtriangular area less than half length of propodus.

Telson and uropods (Fig. 16h-j) asymmetrical. Left exopod (Fig. 16i) about 2.4 as long as broad; rasp moderately broad. Telson without lateral indentation, and scattered setae dorsally; terminal margin divided into 2 rounded projections by shallow, often broad, rounded (U-shaped) cleft; margins of rounded projections each armed with 6 to 15 short to moderately long corneous spines, each margin occasionally with additional 7 or 8 much shorter subdistal spines dorsally.

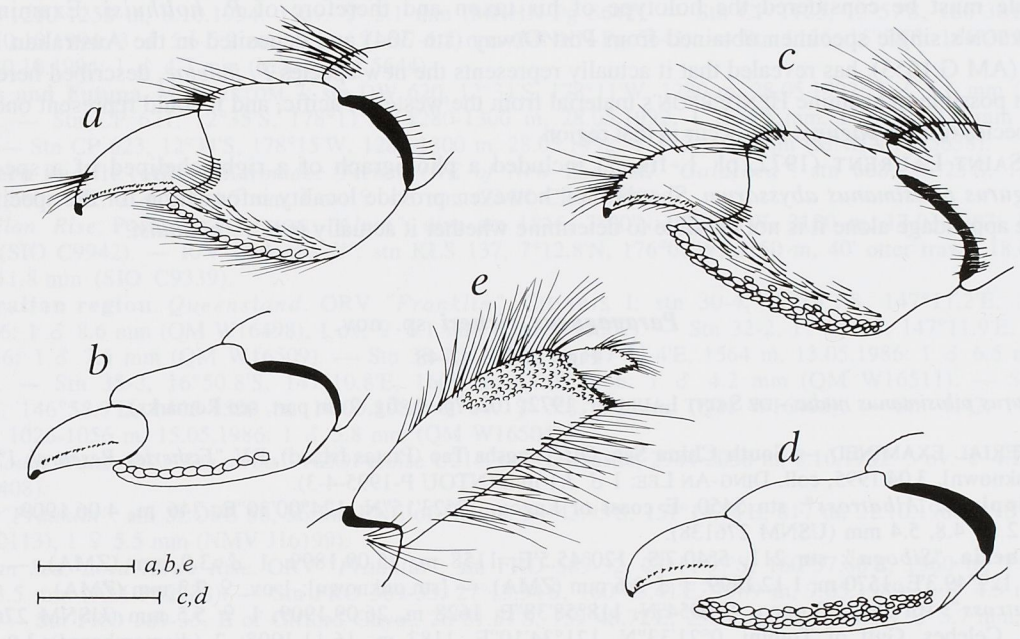

FIG. 18. — *Parapagurus holthuisi* Lemaitre, 1989. a,b,e, ♂ 8.9 mm, E Pacific, off Perú, *"Albatross"*, stn 4647 (USNM 276114); c-d, ov. ♀ 10.9 mm, *"Challenger"*, Juan Fernández Island (USNM 15298). **a**, propodus and dactyl of left fourth pereopod, lateral view; **b**, same (setae omitted), ventrolateral view; **c**, propodus and dactyl of left fourth pereopod, lateral view; **d**, same, ventrolateral view; **e**, propodus and dactyl of left fifth, lateral view.
Scales equal 1 mm.

SIZE RANGE. — Males, SL 5.9 to 14.9 mm. Females 5.1 to 11.2 mm. Ovigerous females 8.1 to 11.4 mm.

VARIATIONS. — Males with palm and carpus of right cheliped (Fig. 16f) longer than broad: palm as much as 1.3 times as long as broad, carpus as much as 2.2 times as long as broad. Females with palm (Fig. 16g) about as long as broad, carpus about 1.5 times as long as broad.

HABITAT. — Has been found living in anthozoans (actinians).

DISTRIBUTION (Figs 47, 49, 50). — Central Pacific: Magellan Rise. Eastern Pacific: Galápagos Islands; off Perú; and off Chile, including Juan Fernández Island. Depth: 2115 to 3667 m.

AFFINITIES. — This species is similar to *P. saintlaurentae* sp. nov.; however, the two differ in several characters. The scales of the propodal rasp of the fourth pereopod are ovate in *P. hothuisi*, whereas the scales are lanceolate or conical in *P. saintlaurentae* sp. nov. The terminal margin of the telson is divided into two rounded projections by a shallow cleft in *P. holthuisi* (Fig. 16h); the telson is divided by a deep cleft in *P. saintlaurentae* sp. nov. (Fig. 31f,i). The antennal scales are usually armed with four or more strong spines, and exceed the distal margin of the cornea by half or less than half the length of the acicles in *P. holthuisi* (Fig. 16a); the acicles are usually unarmed or with one or two weak spines, and exceed the distal margin of the corneae by more than half the length of the acicles in *P. saintlaurentae* sp. nov. (Fig. 28a-b).

REMARKS. — As previously mentioned, *Parapagurus holthuisi* Lemaitre, 1989, is a replacement name proposed by LEMAITRE (1989) for *P. abyssorum* Henderson, 1888, a junior homonym of *P. abyssorum* (Filhol, 1885a). The *"Challenger"* material used by HENDERSON (1888) to describe his *P. abyssorum* included specimens from the Atlantic (Bermuda; Sierra Leone; Tristan da Cunha), western Pacific (Banda, Indonesia; Philippines; north of Papua New Guinea; Yokohama, Japan), and eastern Pacific (west of Valparaiso, and Port Otway, Chile). HENDERSON indicated that his description was based on a male specimen from west of Valparaiso (stn 300); thus, that male must be considered the holotype of his taxon and therefore of *P. holthuisi*. Examination of HENDERSON's single specimen obtained from Port Otway (stn 304) and deposited in the Australian Museum, Sydney (AM G.1653), has revealed that it actually represents the new species *P. janetae*, described herein. It has not been possible to examine HENDERSON's material from the western Pacific, and it could represent one or more of the species of *Parapagurus* that occur in that region.

DE SAINT LAURENT (1972, pl. 1, fig. 7) included a photograph of a right cheliped of a specimen of *Parapagurus pilosimanus abyssorum*. She did not, however, provide locality information for the specimen, and from the appendage alone it is not possible to determine whether it actually is of *P. holthuisi*.

Parapagurus richeri sp. nov.

Figs 19-23, 47-48

Parapagurus pilosimanus nudus - DE SAINT LAURENT, 1972: 102, ?pl. 1, fig. 2 (in part, see Remarks).

MATERIAL EXAMINED. — **South China Sea**. Off Tungsha Tao (Pratas Island), RV *"Fisheries Research I"*, trawled, [depth unknown], 3.04.1995, coll. DING-AN LEE: 1 ♂ 7.1 mm (NTOU P-1995-4-3).

Philippines. *"Albatross"*: stn 5450, E coast of Luzon, 13°23'15"N, 124°00'30"E, 746 m, 4.06.1909: 4 ♂ 4.8-5.4 mm, 2 ♀ 4.8, 5.4 mm (USNM 276138).

Indonesia. *"Siboga"*: stn 211, 5°40.7'S, 120°45.5'E, 1158 m, 25.09.1899: 1 ♂ 3.9 mm (ZMA). — Stn 241, 4°24.3'S, 129°49.3'E, 1570 m, 1.12.1899: 1 ♂ 3.6 mm (ZMA). — [stn unknown]: 1 ov. ♀ 7.3 mm (ZMA).

"Albatross": stn 5582, Borneo, 4°19'54"N, 118°58'38"E, 1628 m, 26.09.1909: 1 ♀ 5.5 mm (USNM 276144). — Stn 5605, Celebes, Gulf of Tomini, 0°21'33"N, 121°34'10"E, 1183 m, 16.11.1908: 2 (dismembered) 3.9, 6.0 mm (USNM 276132). — Stn 5606, 0°16'28"N, 121°33'30"E, 1525 m, 17.11.1909: 1 ♂ 4.6 mm, 1 ov. ♀ 4.5 mm (USNM 276133). — Stn 5613, Celebes, Gulf of Tomini, 0°42'00"S, 121°44'00"E, 1375 m, 20.11.1909: 1 ♀ 4.2 mm (USNM 276134). — Stn 5648, Buton Strait, 5°35'00"S, 122°20'00"E, 1022 m, 16.11.1909: 2 ♀ 4.2, 5.8 mm (USNM 276135). — Stn 5651, Celebes, Gulf of Bone, 4°43'50"N, 121°23'24"E, 1280 m, 17.12.1909: 1 ♀ 5.5 mm (USNM 276136). — Stn 5660, Flores Sea, 5°36'30"S, 120°49'00"E, 1266 m, 20.12.1909: 2 ♂ 3.7, 5.7 mm (USNM 276137).

New Caledonia. BIOCAL: stn CP 05, 21°16'S, 166°44'E, 2340 m, 11.08.1985: 4 ♂ 3.7-5.1 mm (USNM 276139). — Stn CP 17, 20°35'S, 167°25'E, 3680 m, 14.08.1985: 4 ♂ 2.2-5.4 mm, 1 ♀ 2.8 mm, 1 ov. ♀ 3.9 mm (MNHN-Pg 5615). — Stn CP 23, 22°46'S, 166°20'E, 2040 m, 28.08.1985: 8 ♂ 2.1-4.3 mm, 1 ♀ 2.8 mm, 1 ov. ♀ 3.1 mm (MNHN-Pg 5616). — Stn CP 26, 22°39.45'S, 166°27.41'E, 1618-1640 m, 28.08.1985: 5 ♂ 3.4-6.1 mm, 1 ♀ 3.4 mm, 3 ov. ♀ 3.1-4.2 mm (MNHN-Pg 5617). — Stn CP 27, 22°05.52'S, 166°25.90'E, 1850-1900, 28.08.1985: 3 ♂ 2.2-3.7 mm, 1 ♀ 5.4 mm, 1 ov. ♀ 4.1 mm (MNHN-Pg 5618). — Stn CP 57, 23°43.26'S, 166°58.06'E, 1490-1620 m, 1.09.1985: 4 ♂ 3.3-3.7 mm, 2 ♀ 3.0, 3.4 mm, 1 ov. ♀ 3.7 mm (MNHN-Pg 5619). — Stn CP 60, 24°01.45'S, 167°08.43'E, 1480-1530 m, 2.09.1985: 2 ♂ 1.5, 5.1 mm (MNHN-Pg 5620). — Stn CP 62, 24°19.06'S, 167°48.65'E, 1395-1410 m, 2.09.1985: 1 ♀ 3.4 mm (MNHN-Pg 5621). — Stn CP 63, 24°28.69'S, 168°07.72'E, 2160 m, 2.09.1985: 1 ♂ 3.2 mm, 1 ♀ 3.3 mm (MNHN-Pg 5622). — Stn CP 72, 22°09.02'S, 167°33.18'E, 2100-2110 m, 4.09.1985: 1 ♀ 4.3 mm (MNHN-Pg 5623).

BIOGEOCAL: stn CP 214, 22°43.09'S, 166°27.19'E, 1665-1590 m, 9.04.1987: 9 ♂ 3.1-5.4 mm, 2 ♀ 2.5, 3.3 mm, 1 ov. ♀ 3.3 mm (USNM 276140). — Stn CP 216, 22°50.67'S, 166°22.75'E, 2175-2250 m, 10.04.1987: 1 ov. ♀

3.8 mm (NMNH-Pg 5624). — Stn CP 250, 21°24.63'S, 166°28.21'E, 2350 m, 15.04.1987: 1 ♂ 4.6 mm (MNHN-Pg 5625). — Stn CP 260, 21°00.00'S, 167°58.34'E, 1820-1980 m, 17.04.1987: 5 ♂ 2.8-4.3 mm, 4 ♀ 3.0-4.0, 7 ov. ♀ 3.0-4.0 mm (MNHN-Pg 5626). — Stn CP 265, 21°04.09'S, 167°00.40'E, 1760-1870 m, 18.04.1987: 1 ♂ 4.0 mm, 1 ov. ♀ 3.9 mm (MNHN-Pg 5627). — Stn CP 266, 21°04.85'S, 167°57.14'E, 2100-1990 m, 18.04.1987: 3 ♂ 2.7-3.3 mm, 2 ov. ♀ 3.6, 4.3 mm (MNHN-Pg 5628). — Stn 272, 21°00.04'S, 166°56.94'E, 1615-1710 m, 20.04.1987: 10 ♂ 3.0-6.1 mm, 2 ♀ 3.3, 3.7 mm, 5 ov. ♀ 3.4-4.0 mm, 1 immat. 1.7 mm (MNHN-Pg 5629). — Stn 272, 21°00.04'S, 166°56.94'E, 1615-1710 m, 20.04.1987: 1 ♂ 4.9 mm (MNHN-Pg 5614). — Stn 273, 21°01.53'S, 166°57.41'E, 1920-2040 m, 20.04.1987: 6 ♂ 2.7-4.6 mm, 2 ♀ 4.5, 4.6 mm, 4 ov. ♀ 3.1-4.8 mm (MNHN-Pg 5630); 2 ♂ 3.7, 5.2 mm (USNM 276141). — Stn 317, 20°48.12'S, 166°53.16'E, 1630-1620 m, 2.05.1987: 2 ♂ 2.4, 3.7 mm, 3 ♀ 2.5-4.0 mm, 3 ov. ♀ 3.3-5.0 mm (MNHN-Pg 5631). — Stn CP 321, 21°12.00'S, 166°59.85'E, 2190-2205 m, 3.05.1987: 3 ♂ 2.7-4.4 mm, 2 ♀ 3.3, 4.1 mm, 2 ov. ♀ 4.2,4.5 mm (MNHN-Pg 5632). — Stn CP 329, 21°09.05'S, 166°40.08'E, 2315-2310 m, 4.05.1987: 1 ♂ 3.2 mm (MNHN-Pg 5633). — Stn 341, 21°29.73'S, 166°47.37'E, 2334 m, 6.05.1987: 1 ♂ 3.7 mm, 1 ♀ 4.0 mm, 2 ov. ♀ 3.3, 4.5 mm (MNHN-Pg 5634).

BATHUS 3: stn CP 844, 23°06'S, 166°45'E, 908 m, 1.12.1993: 1 ♂ 4.5 mm (MNHN-Pg 5635).

HALIPRO 1: stn CC 856, 21°44'S, 166°37'E, 311-365 m, 20.03.1994: 1 ov. ♀ 4.1 mm (MNHN-Pg 5636).

Vanuatu. MUSORSTOM 8: stn CP 956, 20°33'S, 169°35'E, 1175-1210 m, 20.09.1994: 1 ♂ 3.9 mm (MNHN-Pg 5639). — Stn 1109, 14°52'S, 167°18'E, 1550-1620 m, 8.10.1994: 1 ♀ 3.7 mm, 1 ov. ♀ 5.1 mm (MNHN-Pg 5640). — Stn CP 1110, 14°49'S, 167°15'E, 1360 m, 8.10.1994: 1 ov. ♀ 4.0 mm (MNHN-Pg 5641). — Stn CP 1111, 14°51'S, 167°14'E, 1210-1250 m, 8.10.1994: 1 ov. ♀ 5.1 mm (MNHN-Pg 5642). — Stn CP 1125, 15°57'S, 166°38'E, 1160-1220 m, 10.10.1994: 3 ♂ 5.6-5.9 mm, 2 ov. ♀ 5.7-6.2 mm (MNHN-Pg 5643). — Stn 1126, 15°58'S, 166°39'E, 1210-1260 m, 10.10.1994: 1 ♂ 4.7 mm (MNHN-Pg 5644).

Wallis and Futuna. MUSORSTOM 7: stn DW 620, 12°34'S, 178°11'W, 1280 m, 28.05.1992: 1 ♂ 6.6 mm (MNHN-Pg 5637). — Stn CP 621, 12°35'S, 178°11'W, 1280-1300 m, 28.05.1992: 1 ♂ 4.5 mm, 1 ov. ♀ 4.6 mm (USNM 276142). — Stn CP 623, 12°34'S, 178°15'W, 1280-1300 m, 28.05.1992: 4 ♂ 2.1-2.6 mm (MNHN-Pg 5638).

Western Pacific (other). *Kermadec Trench (NE of New Zealand)*. *"Galathea"*: stn 668, 36°23'S, 177°41'E, 2640 m, 29.02.1952: 2 ♂ 3.1, 4.3 mm, 1 ov. ♀ 4.3 mm (ZMK CRU-3389).

Magellan Rise. POSSE EXPEDITION: *"Alvin"*, dive stn 1816, 7°00'N, 177°00'W, 3150 m, 17.03.1987: 1 ov. ♀ 11.0 mm (SIO C9942). — R/V *"Atlantis II"*, stn KLS 137, 7°12.8'N, 176°07'W, 3150 m, 40' otter trawl, 18.03.1987: 3 ♂ 6.6-11.8 mm (SIO C9339).

Australian region. *Queensland*. ORV *"Franklin"*. CIDARIS I: stn 30-4, 17°19.1'S, 147°11.2'E, 1403 m, 12.05.1986: 1 ♂ 8.6 mm (QM W16498), 1 ov. ♀ 6.1 mm (QM W16507). — Stn 32-2, 17°05.9'S, 147°11.9'E, 1517 m, 13.05.1986: 1 ♂ 7.5 mm (QM W16509). — Stn 33-1, 16°58.7'S, 147°11.4'E, 1564 m, 13.05.1986: 1 ♂ 6.5 mm (QM W16510). — Stn 35-3, 16°50.8'S, 147°10.8'E, 1609 m, 14.05.1986: 1 ♂ 4.2 mm (QM W16511). — Stn 37-1, 17°01.7'S, 146°58.9'E, 1405-1500 m, 14.05.1986: 2 ov. ♀ 5.8, 6.2 mm (QM W16495). — Stn 41-2, 17°33.3'S, 146°60'E, 1026-1056 m, 15.05.1986: 1 ♂ 5.8 mm (QM W16504).

New South Wales. RV *"Tangaroa"*. NZOI cruise U214, off Newcastle, 2984-3058 m, 8.10.1982: 3 ov. ♀ 4.2-5.1 mm (AM P40408).

ORV *"Franklin"*: stn SLOPE 58, 56 km ENE of Nowra, 34°43.95'S, 151°14.74'E, 817 m, 22.10.1988: 1 ♂ 8.2 mm (NMV J40113), 1 ♀ 5.5 mm (NMV J16199).

Tasman Sea, Lord Howe Rise. ORV *"Franklin"*: stn FRO 589-32, 27°11.97'S, 160°37.80'E, 1960 m, 7.05.1989: 1 ov. ♀ 3.5 mm (AM P52738). — Stn FRO 589-33, 27°13.34'S, 160°43.41'E, 1989 m, 7.05.1989: 1 ♂ 4.5 mm (AM P39445). — Stn FRO 589-35, E of Gifford Guyot, 26°51.57'S, 159°48.72'E, 2500 m, 8.05.1989: 1 ♂ 5.7 mm, 1 ov. ♀ 6.1 mm (AM P52739).

Western Indian Ocean. *Cape Town to Durban*. *"Galathea"*: stn 178, 35°07'S, 30°35'E, 4470 m, 23.01.1951: 2 ♂ 4.8, 7.2 mm, 2 ov. ♀ 4.9, 5.2 mm (ZMK CRU-3386). — Stn 190, 29°42'S, 33°19'E, 2790 m, 3.02.1951: 1 ♂ 3.2 mm (ZMK CRU-3387). — Stn 198, 30°22'S, 34°27'E, 2765 m, 15.02.1951: 1 ♂ 3.5 mm (ZMK CRU-3388).

TYPES. — *Holotype*: ♂ 4.9 mm, New Caledonia. BIOGEOCAL, stn 272, 21°00.04'S, 166°56.94'E, 1615-1710 m, 20.04.1987 (MNHN-Pg 5614). *Paratypes*: All the others specimens mentioned above.

DESCRIPTION. — Shield (Fig. 19a) about as long as broad; dorsal surface usually well calcified, with rows of short setae posteriorly on each side of midline; anterior margin weakly concave; lateral projections broadly rounded; anterolateral margin sloping. Rostrum broadly subtriangular, rounded distally, slightly overreaching lateral projections; with low mid-dorsal ridge. Anterodistal margin of branchiostegite (Fig. 19d) rounded, unarmed, setose.

Ocular peduncles (including corneae) about half length of shield, each with dorsal longitudinal row of setae; peduncles inflated basally. Ocular acicles subtriangular, terminating in strong spine (rarely bifid); separated basally by slightly less than basal width of one acicle.

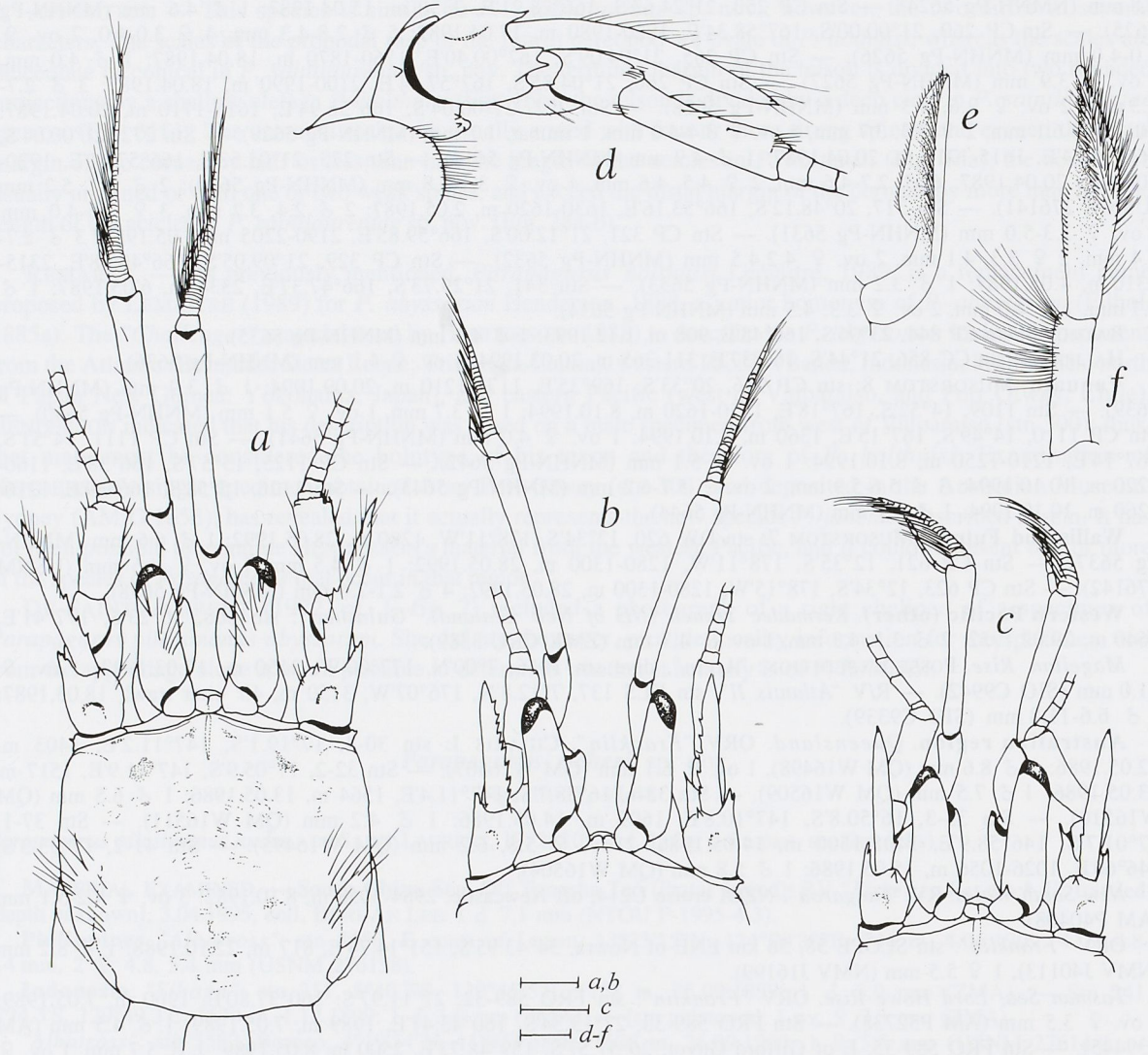

FIG. 19. — *Parapagurus richeri* sp. nov., New Caledonia. a,d, BIOGEOCAL stn 272, holotype ♂ 4.9 mm (MNHN-Pg 5614); b, BIOGEOCAL stn CP 266, paratype ♂ 4.6 mm (MNHN-Pg 5628); c, BIOCAL stn CP 17, paratype ♂ 3.6 mm (MNHN-Pg 5615); **e-f**, BIOGEOCAL stn 272, ♂ 5.4 mm (MNHN-Pg 5629). **a**, shield and cephalic appendages; **b-c**, anterior portion of shield and cephalic appendages (setae omitted); **d**, right antennal peduncle and anterolateral margin of branchiostegite, lateral view; **e**, male first pleopod, mesial view; **f**, male second pleopod, anterior view.
Scales equal 1 mm (a-c), and 0.5 mm (d-f).

Antennular peduncles slender, long, exceeding distal margins of corneae by at least 0.25 length of penultimate segments. Ultimate and penultimate segments with scattered setae. Ultimate segment nearly twice as long as penultimate. Basal segment with ventromesial distal spine; mesial face unarmed; lateral face with statocyst lobe having subrectangular distal lobe armed with 2 small spines, and 1 spine proximally.

Antennal peduncles (Fig. 19d) exceeding distal margins of corneae by about half length of fifth segments. Fifth segment with setae on lateral and mesial margins. Fourth segment with scattered setae. Third segment with strong ventromesial distal spine. Second segment with dorsolateral distal angle produced, terminating in strong multifid spine; mesial margin with spine on dorsodistal angle. First segment with small spine on lateral face; ventromesial angle produced, with row of small spines. Antennal acicles (Fig. 19a-c) nearly straight in dorsal view, setose;

exceeding distal margin of cornea by 0.2 or more length of acicle; mesial margin usually armed on proximal half with 1-3 spines, occasionally with up to 8 spines (Fig. 19b). Flagellum distinctly overreaching extended right cheliped; articles with setae less than 1 to 2 flagellar articles in length.

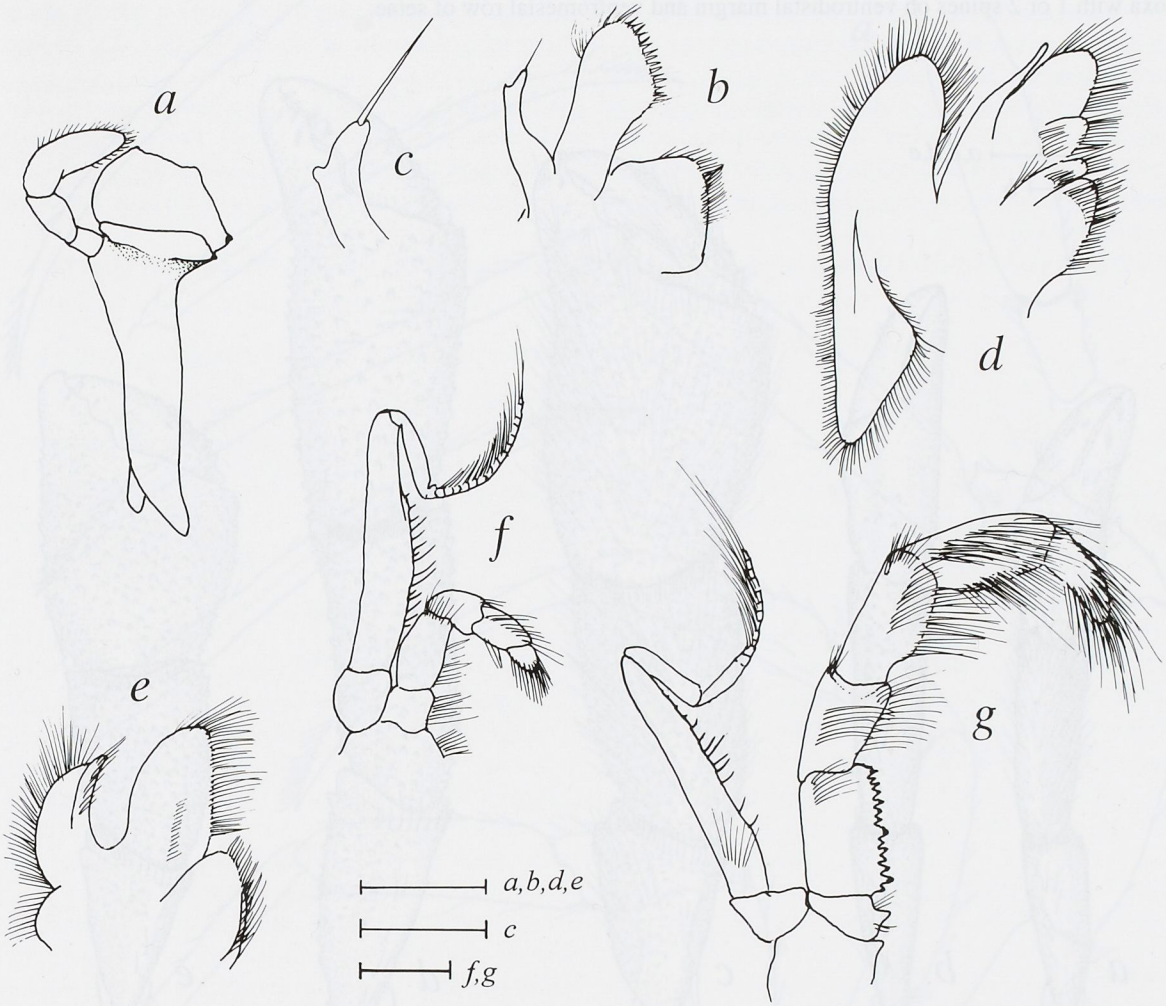

FIG. 20. — *Parapagurus richeri* sp. nov., New Caledonia, BIOGEOCAL stn 272, paratype ♂ 5.4 mm (MNHN-Pg 5629). Left mouthparts, internal view: **a**, mandible; **b**, maxillule; **c**, distal end of endopod of same; **d**, maxilla; **e**, first maxilliped; **f**, second maxilliped; **g**, third maxilliped. Scales equal 1 mm (a,b,d,e-g), and 0.5 mm (c).

Mandible (Fig. 20a) as figured. Maxillule (Fig. 20b-c) with external lobe of endopod weakly developed, internal lobe with long seta. Maxilla (Fig. 20d) with endopod exceeding distal margin of scaphognathite. First maxilliped (Fig. 20e) with endopod exceeding exopod in distal extension. Second maxilliped (Fig. 20f) without distinguishing characters. Third maxilliped (Fig. 20g) with crista dentata consisting of about 14 small corneous teeth; basis with 1 tooth mesially. Sternite of third maxilliped with spine on each side of midline. Epistomial spine usually present.

Chelipeds markedly dissimilar, each with dorsal surfaces of carpus and chela covered with moderately dense setation. Right cheliped (Fig. 21c-e) with proportions of carpus and chela influenced by size and sexual dimorphism (see Variations). Fingers bent inwards at tips, each terminating in small corneous claw; with few tufts of setae on dorsal and ventral surfaces; cutting edges each with irregularly-sized calcareous teeth; cutting edge of dactyl also with distal row of small, closely-set, corneous teeth. Dactyl set at slightly oblique angle to palm, with

dorsomesial and mesial row of small spines proximally. Palm and carpus each with numerous small, closely-set, spines and tubercles on dorsal surface; ventral surfaces of palm and carpus also with spines and tubercles but less numerous or sometimes few and scattered. Merus with small tubercles on dorsal, dorsolateral and ventral surfaces; mesial surface smooth, with ventromesial row of spines. Ischium with dorsal and ventromesial row of spines. Coxa with 1 or 2 spines on ventrodistal margin and ventromesial row of setae.

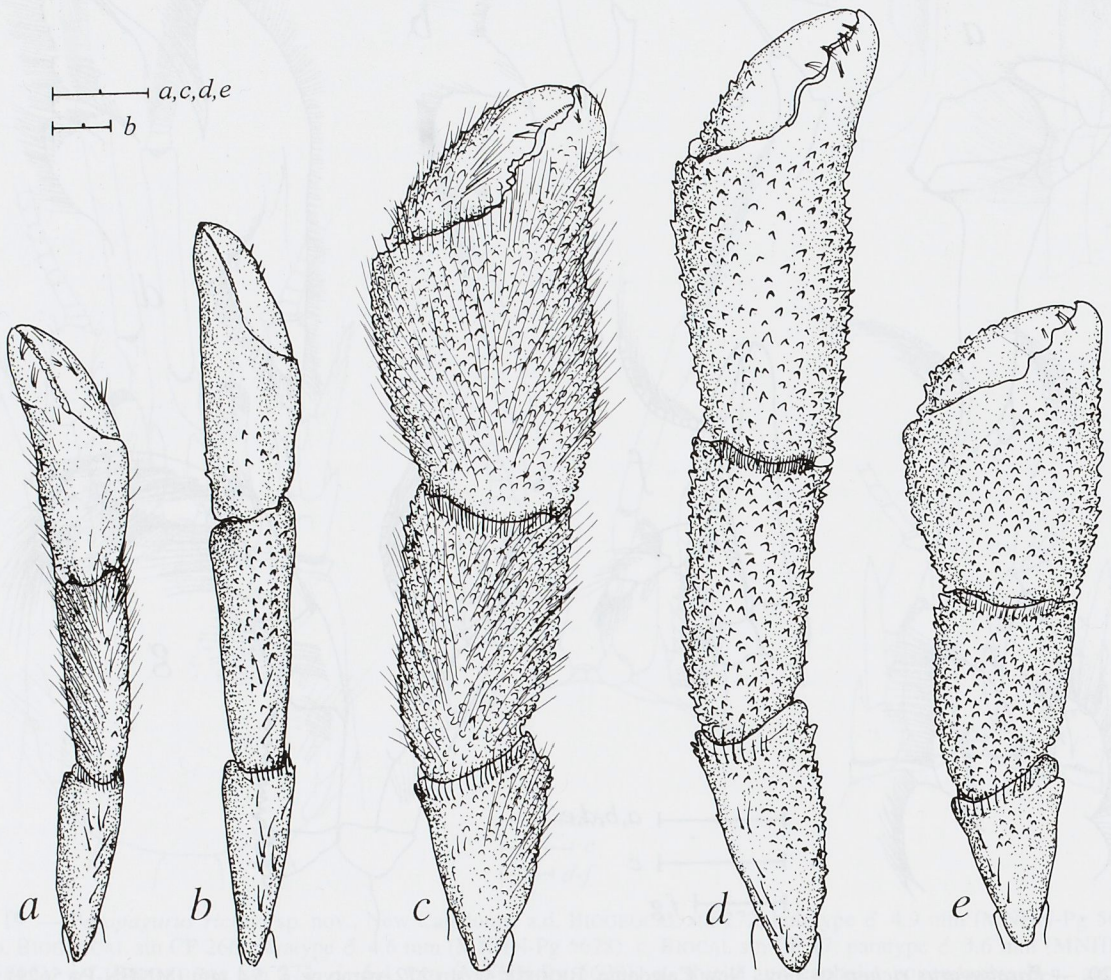

FIG. 21. — *Parapagurus richeri* sp. nov. a,c, New Caledonia, BIOGEOCAL stn 272, holotype ♂ 4.9 mm (MNHN-Pg 5614); b, ORV *"Franklin"*, stn 30-4, ♂ 8.6 mm (QM W16498); d, New Caledonia, BIOCAL stn CP 17, ♂ 5.2 mm (MNHN-Pg 5615); e, New Caledonia, BIOCAL stn CP 26, ov. ♀ 3.1 mm (MNHN-Pg 5617). **a-b**, left chelipeds (setae omitted in b); **c-e**, right chelipeds (setae omitted in d,e).
Scales equal 2 mm.

Left cheliped (Fig. 21a-b) slender. Fingers each terminating in small corneous claw; dorsal and ventral surfaces with scattered tufts of short setae; cutting edge of dactyl with row of minute, closely-set, corneous teeth distally; cutting edge of fixed finger with row of regularly-spaced, small, evenly-sized calcareous teeth. Palm unarmed except for few small dorsomesial tubercles. Carpus armed with an irregular row or several rows of small spines or tubercles dorsally. Merus unarmed except for row of bristles on dorsal margin. Ischium with small, blunt setose tubercles on dorsal margin; usually with small spine on ventromesial margin proximally. Coxa usually with 2 small spines on ventrodistal margin, and ventromesial row of setae.

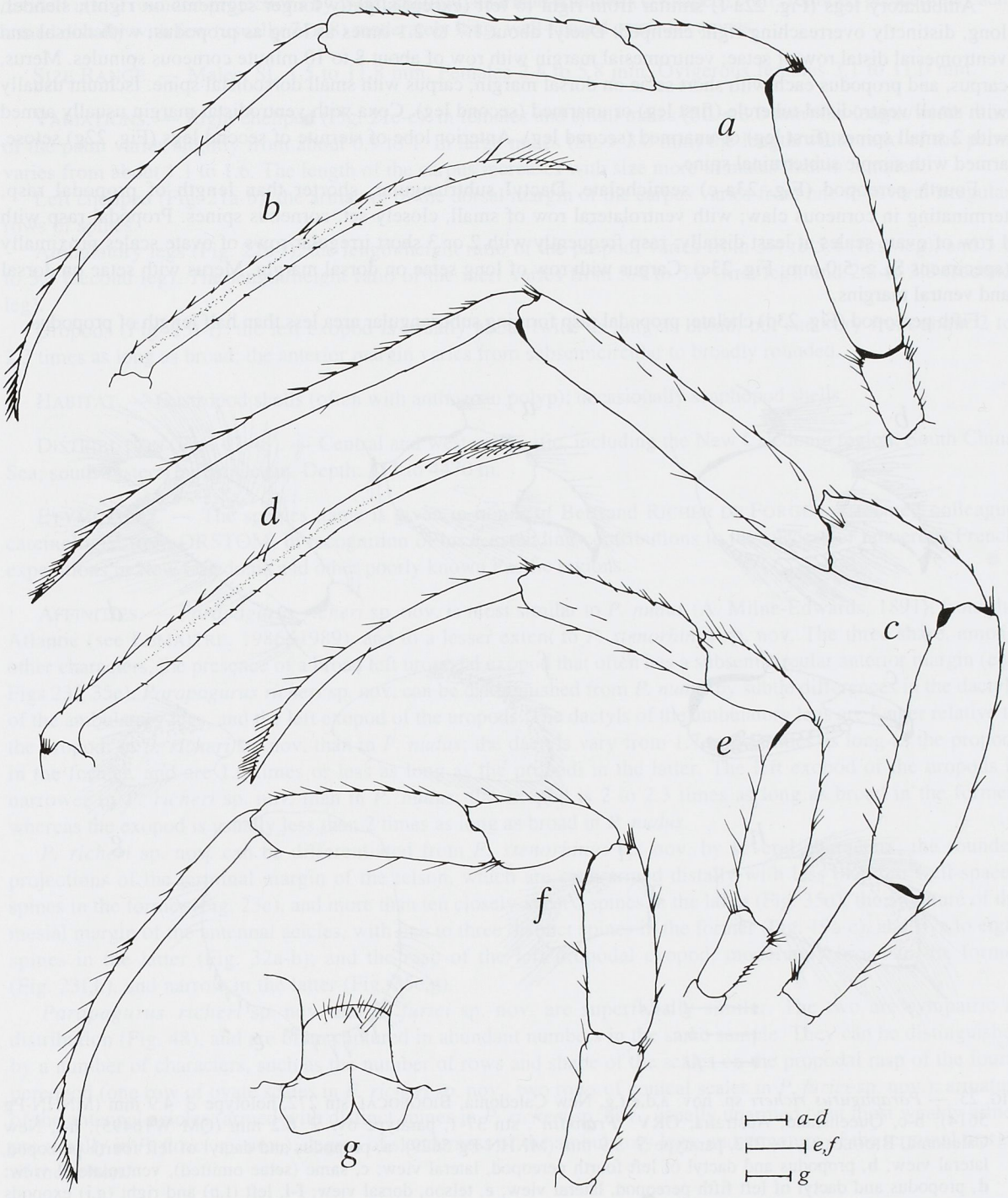

FIG. 22. — *Parapagurus richeri* sp. nov., New Caledonia: a-d,e, BIOGEOCAL stn 272, holotype ♂ 4.9 mm (MNHN-Pg 5614); e,f, BIOCAL stn CP 17, paratype ♂ 3.6 mm (MNHN-Pg 5615). **a**, first ambulatory leg, lateral view; **b**, dactyl of same, mesial view; **c**, second ambulatory leg, lateral view; **d**, dactyl of same, mesial view; **e**, first ambulatory leg, lateral view; **f**, second ambulatory leg, lateral view; **g**, sternite of second ambulatory legs, ventral view.
Scales equal 1 mm (a-f), and 0.5 mm (g).

Ambulatory legs (Fig. 22a-f) similar from right to left (except slightly longer segments on right), slender, long, distinctly overreaching right cheliped. Dactyl about 1.7 to 2.1 times as long as propodus; with dorsal and ventromesial distal row of setae; ventromesial margin with row of about 8 to 10 minute corneous spinules. Merus, carpus, and propodus each with short setae on dorsal margin; carpus with small dorsodistal spine. Ischium usually with small ventrodistal tubercle (first leg) or unarmed (second leg). Coxa with ventrodistal margin usually armed with 2 small spines (first leg) or unarmed (second leg). Anterior lobe of sternite of second legs (Fig. 22g) setose, armed with simple subterminal spine.

Fourth pereopod (Fig. 23a-c) semichelate. Dactyl subtriangular, shorter than length of propodal rasp, terminating in corneous claw; with ventrolateral row of small, closely-set, corneous spines. Propodal rasp with 1 row of ovate scales at least distally; rasp frequently with 2 or 3 short irregular rows of ovate scales proximally (specimens SL > 5.0 mm; Fig. 23c). Carpus with row of long setae on dorsal margin. Merus with setae on dorsal and ventral margins.

Fifth pereopod (Fig. 23d) chelate; propodal rasp forming subtriangular area less than half length of propodus.

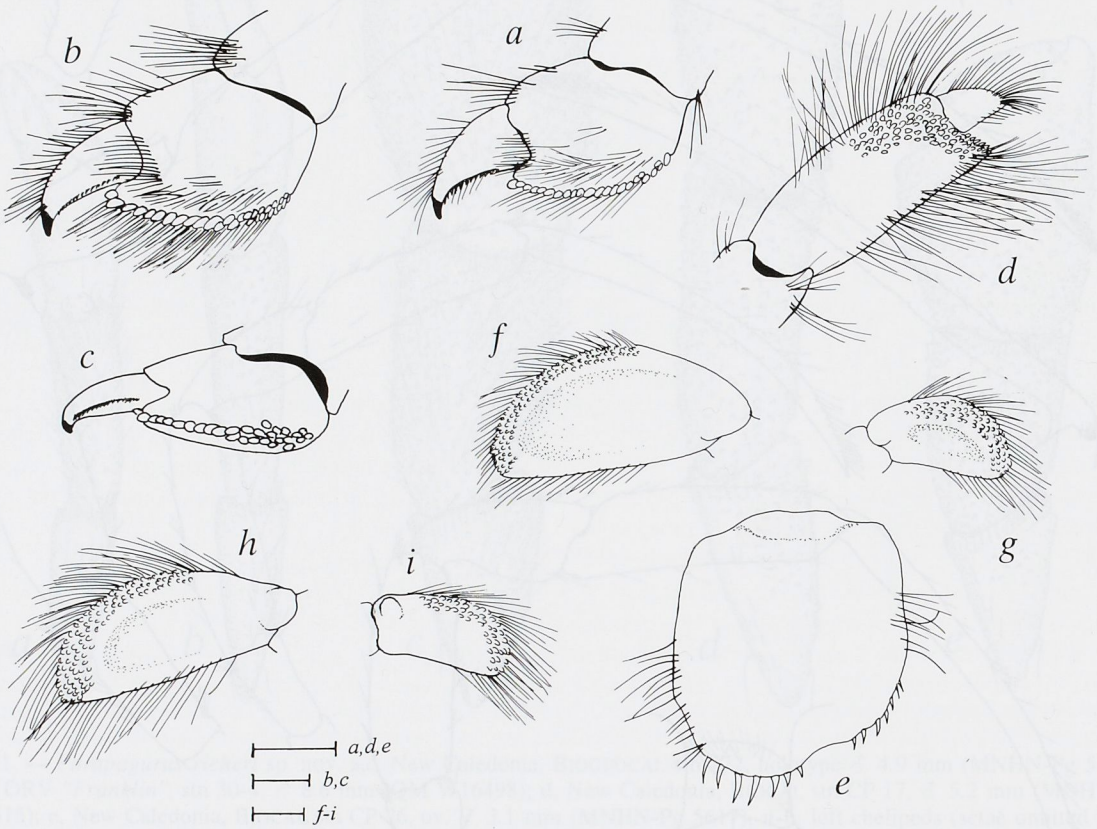

FIG. 23. — *Parapagurus richeri* sp. nov. a,d,e,f,g, New Caledonia, BIOGEOCAL stn 272, holotype ♂ 4.9 mm (MNHN-Pg 5614); b-c, Queensland, Australia, ORV *"Franklin"*, stn 37-1, paratype ov. ♀ 6.2 mm (QM W16495); h-i, New Caledonia, BIOGEOCAL stn 272, paratype ♀ 3.9 mm (MNHN-Pg 5629). **a**, propodus and dactyl of left fourth pereopod, lateral view; **b**, propodus and dactyl of left fourth pereopod, lateral view; **c**, same (setae omitted), ventrolateral view; **d**, propodus and dactyl of left fifth pereopod, lateral view; **e**, telson, dorsal view; **f-i**, left (f,h) and right (g,i) exopods of uropods, dorsal view. Scales equal 0.5 mm.

Telson and uropods (Fig. 23e-i) asymmetrical (weakly asymmetrical in specimens living in scaphopod shells). Left exopod (Fig. 23f,h) relatively short, broad, often paddle-shaped, with moderately broad rasp (see Variations). Telson without lateral indentations; with scattered setae dorsally, and rows of long setae laterally; terminal margin

divided into 2 rounded projections by wide, shallow, unarmed rounded (U-shaped) cleft; rounded projections each armed distally with few (usually 7 or 8) moderately long, well-spaced corneous spines.

SIZE RANGE. — Males, SL 1.5 to 11.8 mm. Females 2.5 to 5.8 mm. Ovigerous females 3.1 to 11.0 mm.

VARIATIONS. — Right cheliped (Fig. 21c-e): in females and small males (SL < 3.0 mm) the length/width ratio of the palm varies slightly from about 0.9 to 1. In large males (SL > 3.0 mm) the length/width ratio of the palm varies from about 1.1 to 1.6. The length of the carpus increases with size more in males than in females.

Left cheliped (Fig. 21a-b): the armature of the dorsal margin of the carpus varies from one to several irregular rows of spines.

Ambulatory legs (Fig. 22a-f): the length/height ratio of the propodi varies from 3.4 to 5.4 (first leg), and 3.1 to 5.3 (second leg). The length/height ratio of the meri varies from 3.4 to 3.9 (first leg), and 2.8 to 3.3 (second leg).

Uropods (Fig. 23f-i): the left exopod is usually about twice as long as broad, but can vary from about 2 to 2.3 times as long as broad; the anterior margin varies from subsemicircular to broadly rounded.

HABITAT. — Gastropod shells (often with anthozoan polyp); occasionally scaphopod shells.

DISTRIBUTION (Figs 47-48). — Central and western Pacific, including the New Caledonia region; South China Sea; southwestern Indian Ocean. Depth: 311 to 4470 m.

ETYMOLOGY. — The species name is given in honor of Bertrand RICHER DE FORGES, esteemed colleague carcinologist from ORSTOM, in recognition of his outstanding contributions to the success of numerous French expeditions in New Caledonia and other poorly known Pacific regions.

AFFINITIES. — *Parapagurus richeri* sp. nov. is most similar to *P. nudus* (A. Milne-Edwards, 1891), from the Atlantic (see LEMAITRE, 1986, 1989), and to a lesser extent to *P. stenorhinus* sp. nov. The three share, among other characters, the presence of a broad left uropodal exopod that often has a subsemicircular anterior margin (e.g. Figs 23f, 35e). *Parapagurus richeri* sp. nov. can be distinguished from *P. nudus* by subtle differences in the dactyls of the ambulatory legs, and the left exopod of the uropods. The dactyls of the ambulatory legs are longer relative to the propodi in *P. richeri* sp. nov. than in *P. nudus*; the dactyls vary from 1.7 to 2.1 times as long as the propodi in the former, and are 1.6 times or less as long as the propodi in the latter. The left exopod of the uropods is narrower in *P. richeri* sp. nov. than in *P. nudus*; the exopod is 2 to 2.3 times as long as broad in the former, whereas the exopod is usually less than 2 times as long as broad in *P. nudus*.

P. richeri sp. nov. can be differentiated from *P. stenorhinus* sp. nov. by several characters: the rounded projections of the terminal margin of the telson, which are each armed distally with less than ten well-spaced spines in the former (Fig. 23e), and more than ten closely-spaced spines in the latter (Fig. 35d); the armature of the mesial margin of the antennal acicles, with one to three distinct spines in the former (Fig. 19a-c), and five to eight spines in the latter (Fig. 32a-b); and the rasp of the left uropodal exopod, moderately broad in the former (Fig. 23f,h), and narrow in the latter (Fig. 35e,g).

Parapagurus richeri sp. nov. and *P. furici* sp. nov. are superficially similar. The two are sympatric in distribution (Fig. 48), and are often captured in abundant numbers in the same sample. They can be distinguished by a number of characters, such as the number of rows and shape of the scales on the propodal rasp of the fourth pereopod (one row of ovate scales in *P. richeri* sp. nov., two rows of conical scales in *P. furici* sp. nov.); armature of the antennal acicles (armed with distinct spines in *P. richeri* sp. nov., usually unarmed or at most weakly armed proximally in *P. furici* sp. nov.); degree of slenderness of the ambulatory legs; and armature of the terminal margin of the telson.

REMARKS. — DE SAINT LAURENT (1972) considered that the distribution of *Parapagurus pilosimanus nudus* included the Indo-Pacific and the Atlantic. However, when LEMAITRE (1989) elevated *P. p. nudus* to specific rank he determined that this taxon occurred only in the Atlantic. Examination of the Indo-Pacific specimens used by DE SAINT LAURENT (1972) in her report of *P. p. nudus* has shown that she confounded that subspecies with the two new species *P. richeri* and *P. stenorhinus*.

Parapagurus furici sp. nov.

Figs 24-27, 47-48

Parapagurus pilosimanus - ALCOCK, 1901: 218; 1902: 133, 273, fig. 67 (See Remarks).

MATERIAL EXAMINED. — **Japan**. *"Albatross"*: stn 4975, 33°21'30"N, 135°38'50"E, 1302-997 m, 31.08.1906: 1 ♂ 8.3 mm (USNM 276130). — Stn 4980, Kobe to Yokohama, 34°09'N, 137°55'E, 927 m, 1.09.1906: 2 ♂ 7.0, 9.5 mm (USNM 276131). — Stn 5082, 34°05'N, 137°59'E, 1210 m, 20.10.1906: 3 ♀ 8.7-11.5 mm (USNM 276129).

RV *"Tansei-Maru"*: off Taito-saki, Boso Peninsula, 35°07'N, 140°55'E, 1351-1454 m, 24.04.1995, coll. T. KOMAI: 1 ♂ 7.2 mm (USNM 276118).

South China Sea. *Taiwan*. RV *"Fisheries Research I"*, off Tungsha Tao (Pratas Island), trawled, 1520 m, 25.04.1996, coll. DING-AN LEE: 1 ♂ 7.0 mm (NTOU 1996-4-25).

Philippines. RV*"Fishery Researcher I"*, stn 5-95, Lagonoy Gulf, 13°21.32'N, 124°12.26'E, 1037-1100 m, 24.09.1995: 1 ♂ 8.3 mm (ZRC 1998.54), 1 ♀ 6.3 mm (ZRC 1998.5).

Indonesia. *Celebes Sea*. *"Siboga"*: stn 208, 5°39'S, 122°12'E, 1866 m, 22.09.1899: 1 ♂ 7.0 mm (ZMA). — Stn 210a, 5°26'S, 121°18'E, 1944 m, 24.09.1899: 1 ♂ 7.2 mm (ZMA).

New Caledonia. BIOCAL: stn CP 05, 21°16.49'S, 166°43.56'E, 2340 m, 11.08.1985: 1 ov. ♀ 5.7 mm (MNHN-Pg 5581). — Stn CP 23, 22°45.84'S, 166°20.33'E, 2040 m, 28.08.1985: 1 ♂ 5.5 mm, 3 ov. ♀ 4.2-6.1 mm (MNHN-Pg 5582). — Stn CP 26, 22°39.66'S, 166°27.41'E, 1618-1640 m, 28.08.1985: 3 ♂ 4.2-5.7 mm, 1 ♀ 3.7 mm, 1 ov. ♀ 4.9 mm (USNM 276128). — Stn CP 27, 22°05.52'S, 166°26.41'E, 1850-1900 m, 28.08.1985: 2 ♂ 4.3, 5.2 mm, 4 ♀ 3.4-4.3 mm, 1 ov. ♀ 3.7 mm (MNHN-Pg 5583). — Stn CP 30, 23°08.44'S, 166°40.83'E, 1140 m, 29.08.1985: 1 ov. ♀ 4.2 mm (MNHN-Pg 5584). — Stn CP 57, 23°43.26'S, 166°58.06'E, 1490-1620 m, 1.09.1985: 3 ♂ 3.3-5.2 mm, 2 ♀ 3.9, 4.8 mm, 3 ov. ♀ 3.6, 4.6 mm (MNHN-Pg 5585). — Stn CP 62, 24°19.06'S, 167°48.65'E, 1395-1410 m, 2.09.1985: 2 ♂ 4.0, 4.5 mm, 1 ov. ♀ 6.9 mm (USNM 276127). — Stn CP 63, 24°28.69'S, 168°07.72'S, 2160 m, 2.09.1985: 3 ♂ 3.2-4.9 mm (MNHN-Pg 5586). — Stn CP 72, 22°09.02'S, 167°33.18'E, 2100-2110 m, 4.09.1985: 2 ♂ 4.09, 6.7 mm, 2 ♀ 4.0, 4.5 mm, 4 ov. ♀ 4.8-6.0 mm (USNM 276143).

BIOGEOCAL: stn CP 214, 22°43.09'S, 166°27.19'E, 1665-1590 m, 9.04.1987: 1 ♂ 3.2 mm, 1 ov. ♀ 4.6 mm (MNHN-Pg 5587). — Stn CP 243, 21°27.35'S, 166°25.76'E, 1820 m, 15.04.1987: 1 ♂ 5.8 mm, 1 ov. ♀ 5.2 mm (MNHN-Pg 5588). — Stn CP 250, 21°24.63'S, 166°28.21'E, 2350 m, 15.04.1987: 2 ov. ♀ 5.4, 5.5 mm (MNHN-Pg 5589). — Stn CP 260, 21°00.00'S, 167°58.34'E, 1820-1980 m, 17.04.1987: 2 ♂ 4.6, 6.7 mm, 2 ♀ 5.5, 6.1 mm, 4 ov. ♀ 5.2-6.0 mm (MNHN-Pg 5590). — Stn CP 265, 21°04.09'S, 167°00.40'E, 1760-1870 m, 18.04.1987: 3 ♂ 3.0-7.0 mm, 3 ov. ♀ 4.9-5.7 mm (MNHN-Pg 5591). — Stn CP 266, 21°04.85'S, 167°57.14'E, 2100-1990 m, 18.04.1987: 2 ♂ 6.0, 6.1 mm, 1 ♀ 5.1 mm, 1 ov. ♀ 4.5 mm (MNHN-Pg 5592). — Stn 272, 21°00.04'S, 166°56.94'E, 1615-1710 m, 20.04.1987: 2 ♀ 3.7, 5.7 mm (MNHN-Pg 5593). — Stn 273, 21°01.53'S, 166°57.41'E, 1920-2040 m, 20.04.1987: 7 ♂ 3.0-7.1 mm, 4 ♀ 4.0-4.6 mm, 4 ov. ♀ 4.2-4.8 mm (MNHN-Pg 5594). — Stn CP 283, 21°22.25'S, 166°31.07'E, 2375-2370 m, 26.04.1987: 3 ♂ 5.8-6.6 mm, 1 ov. ♀ 4.3 mm (MNHN-Pg 5595). — Stn DW 296, 20°38.35'S, 167°10.32'E, 1230-1270 m, 28.04.1987: 1 ♀ 3.0 mm (MNHN-Pg 5596). — Stn CP 317, 20°48.12'S, 166°53.16'E, 1630-1620 m, 2.05.1987: 1 ♂ 5.5 mm, 4 ov. ♀ 5.1-6.3 mm (USNM 276127). — Stn CP 321, 21°12.00'S, 166°59.85'E, 2190-2205 m, 3.05.1987: 1 ♂ 5.5 mm (MNHN-Pg 5597). — Stn CP 329, 21°09.05'S, 166°40.08'E, 2315-2310 m, 4.05.1987: 1 ♂ 6.7 mm (MNHN-Pg 5580); 1 ♂ 5.4 mm (MNHN-Pg 5598). — Stn CP 336, 21°12.22'S, 166°22.51'E, 2370-2380 m, 5.05.1987: 1 ♂ 5.1 mm (MNHN-Pg 5599). — Stn CP 341, 21°29.73'S, 166°47.37'E, 2334 m, 6.05.1987: 2 ♂ 4.7, 6.6 mm, 1 ov. ♀ 5.1 mm (MNHN-Pg 5600).

BATHUS 1: stn CP 651, 21°41'S, 166°40'E, 1080-1180 m, 11.03.1993: 4 ♂ 4.6-5.2 mm, 2 ♀ 5.9, 6.1 mm (MNHN-Pg 5601). — Stn CP 660, 21°10'S, 165°53'E, 786-800 m, 13.03.1993: 1 ov. ♀ 6.0 mm (MNHN-Pg 5602).

BATHUS 3: stn CP 822, 23°19'S, 167°57'E, 950-980 m, 29.11.1993: 1 ov. ♀ 5.6 mm (MNHN-Pg 5603). — Stn CP 844, 23°06'S, 166°45'E, 908 m, 1.12.1993: 10 ♂ 6.4-6.6 mm, 8 ov. ♀ 3.7-5.6 mm (MNHN-Pg 5604).

HALIPRO 1: stn CC 856, 21°44'S, 166°37'E, 311-365 m, 20.03.1994: 1 ♂ 6.1 mm (MNHN-Pg 5605). — Stn CH 876, 23°10'S, 166°49'E, 870-1000 m, 31.03.1994: 2 ♂ 5.6, 6.5 mm, 3 ov. ♀ 4.6, 5.4 mm (MNHN-Pg 5606).

Vanuatu. MUSORSTOM 8: stn CP 956, 20°33'S, 169°35'E, 1175-1210 m, 20.09.1994: 3 ♂ 3.9-6.0 mm, 2 ♀ 2.9-5.2 mm, 1 ov. ♀ 3.7 mm (MNHN-Pg 5608). — Stn DW 987, 19°23'S, 169°35'E, 1050-1040 m, 23.09.1994: 1 ov. ♀ 5.3 mm (MNHN-Pg 5609). — Stn CP 1037, 18°03'S, 168°54'E, 1058-1086 m, 29.09.1994: 1 ♀ 7.5 mm (MNHN-Pg 5610). — Stn CP 1076, 15°53'S, 167°30'E, 1100-1191 m, 4.10.1994: 1 ♂ 10.5 mm (MNHN-Pg 5611). — Stn CP 1125, 15°57'S, 166°38'E, 1160-1220 m, 10.10.1994: 4 ♂ 6.4-10.1 mm (MNHN-Pg 5612). — Stn CP 1126, 15°58'S, 166°39'E, 1210-1260 m, 10.10.1994: 5 ♂ 3.5-6.5 mm, 6 ov. ♀ 5.2-7.5 mm (MNHN-Pg 5613).

Wallis and Futuna. MUSORSTOM 7: stn CP 623, 12°34'S, 178°15'W, 1280-1300 m, 28.05.1992: 1 ♀ 4.0 mm (MNHN-Pg 5607).

Tasman Sea. ORV *"Franklin"* (coll. J.K. LOWRY): stn FRO 589-17, 29°42.06'S, 159°48.31'E, 2450 m, 3.05.1989: 1 ♂ 8.8 mm, 1 ov. ♀ 9.6 mm (AM P39450). — Stn FRO 589-32, 27°11.97'S, 160°37.80'E, 1960 m, 7.05.1989: 2 ♂

7.8, 9.5 mm, 1 ♂ 5.5 mm, 2 ov. ♀ 7.0, 7.1 mm (AM P39448). — Stn FRO 589-35, 26°51.57'S, 159°48.72'E, 2500 m, 8.05.1989: 2 ♂ 5.8, 9.2 mm, 5 ♂ 4.6-6.3 mm, 5 ov. ♀ 4.9-6.7 mm (AM P39449).

Arabian Sea. *"Investigator"*, [stn unknown], 1289-2195 m, [date unknown]: 1 ♂ 7.9 mm (AM P2623).

TYPES. — *Holotype*: ♂ 6.7 mm, BIOGEOCAL, stn CP 329, 21°09.05'S, 166°40.08'E, 2315-2310 m, 4.05. 1987 (MNHN-Pg 5580). *Paratypes*: All the others specimens mentioned above.

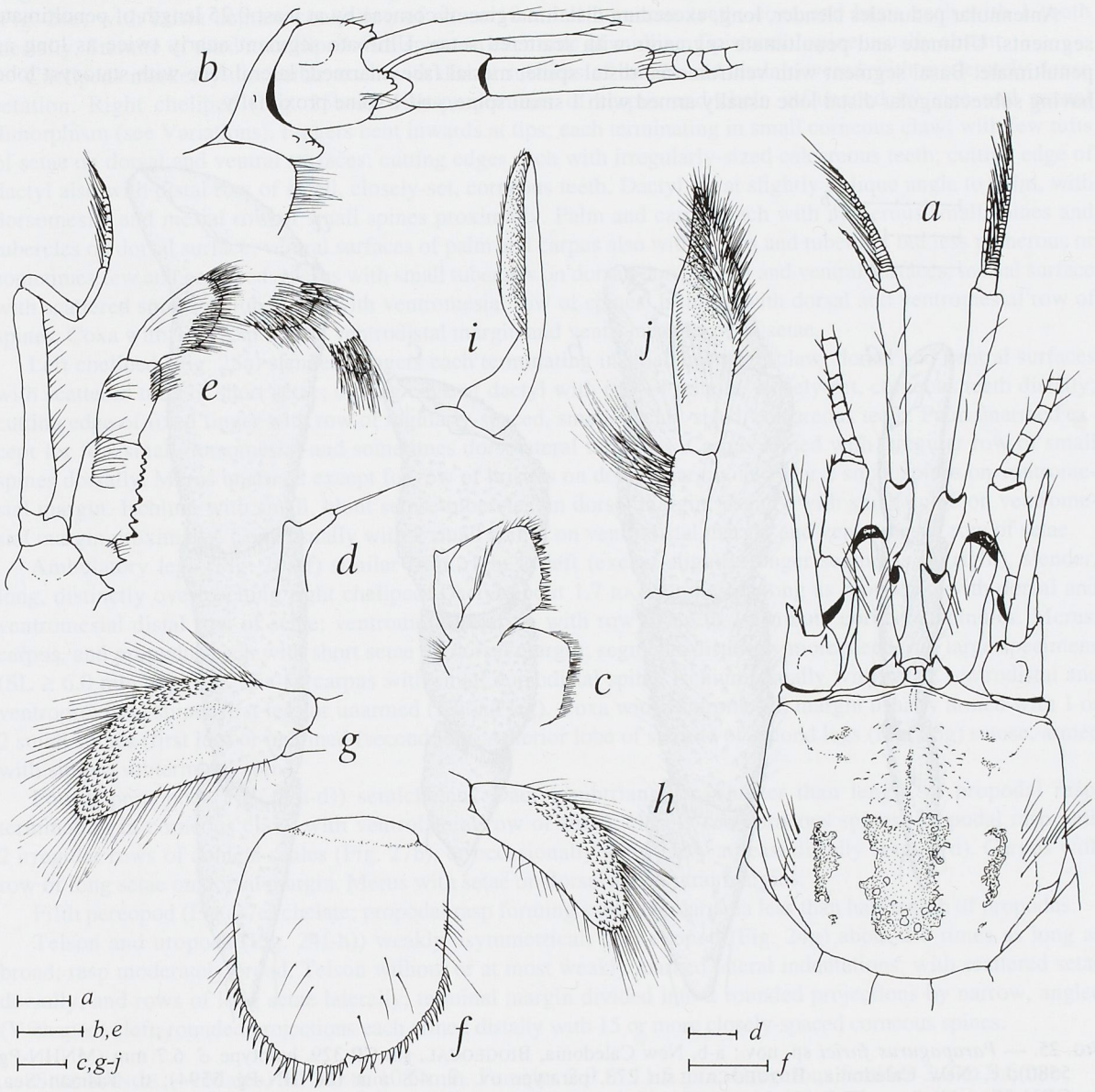

FIG. 24. — *Parapagurus furici* sp. nov., New Caledonia, BIOGEOCAL stn CP 329: a,b,f-h, holotype ♂ 6.7 mm (MNHN-Pg 5580); c-e,i,j, paratype ♂ 5.4 mm (MNHN-Pg 5598). **a**, shield and cephalic appendages; **b**, right antennal peduncle and anterolateral margin of branchiostegite, lateral view; **c**, left maxillule, internal view; **d**, distal end of endopod of same; **e**, left third maxilliped, internal view; **f**, telson, dorsal view; **g-h**, left (g) and right (h) exopods of uropods, dorsal view; **i**, male first pleopod, mesial view; **j**, male second pleopod, anterior view.

Scales equal 1 mm (a,b,e), 0.5 mm (c,g-j,f), and 0.25 mm (d).

DESCRIPTION. — Shield (Fig. 24a) about as long as broad; dorsal surface usually well calcified, with rows of short setae posteriorly on each side of midline; anterior margin weakly concave; lateral projections broadly rounded; anterolateral margin sloping. Rostrum broadly triangular, rounded distally, slightly overreaching lateral projections; with low mid-dorsal ridge. Anterodistal margin of branchiostegite (Fig. 24b) rounded, unarmed, setose.

Ocular peduncles (including corneae) about half length of shield, each with dorsal longitudinal row of setae; peduncles inflated basally. Ocular acicles subtriangular, terminating in strong spine; separated basally by slightly less than basal width of 1 acicle.

Antennular peduncles slender, long, exceeding distal margins of corneae by at least 0.25 length of penultimate segments. Ultimate and penultimate segments with scattered setae. Ultimate segment nearly twice as long as penultimate. Basal segment with ventromesial distal spine; mesial face unarmed; lateral face with statocyst lobe having subrectangular distal lobe usually armed with 1 small spine, and 1 spine proximally.

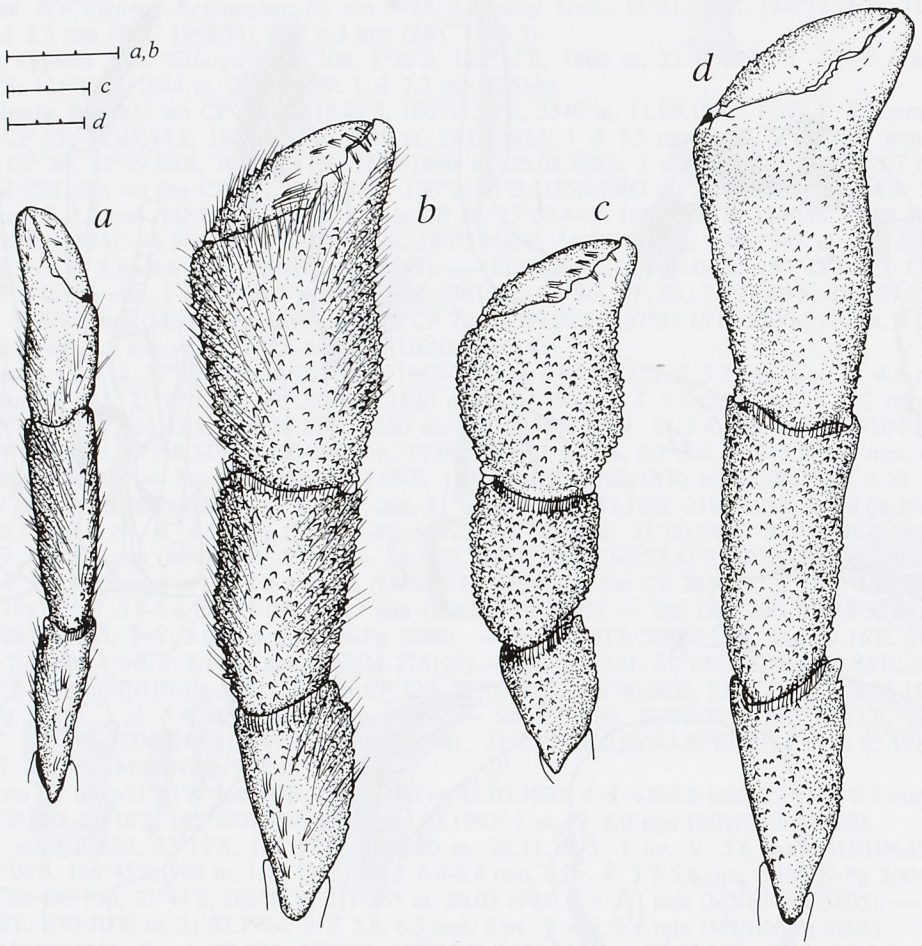

FIG. 25. — *Parapagurus furici* sp. nov.: a-b, New Caledonia, BIOGEOCAL, stn CP 329, holotype ♂ 6.7 mm (MNHN-Pg 5580); c, New Caledonia, BIOGEOCAL, stn 273, paratype ov. ♀ 4.8 mm (MNHN-Pg 5594); d, Tasman Sea, ORV *"Franklin"*, stn FRO 589-35, ♂ 9.2 mm (AM P39449). **a**, left cheliped; **b-d**, right chelipeds (setae omitted in c-d). Scales equal 3 mm (a, b, d), and 2 mm (c).

Antennal peduncles (Fig. 24b) exceeding distal margins of corneae by about half length of fifth segments. Fifth segment with setae on lateral and mesial margins. Fourth segment with scattered setae. Third segment with strong ventromesial distal spine. Second segment with dorsolateral distal angle produced, terminating in strong multifid

spine; mesial margin with spine on dorsodistal angle. First segment with or without small blunt spine on lateral face; ventromesial angle produced, with row of small spines. Antennal acicles nearly straight in dorsal view, setose; exceeding distal margin of cornea by 0.3 or more length of acicle; mesial margin usually unarmed, or at most with 1-3 small spines on proximal half. Flagellum distinctly overreaching extended right cheliped; articles with setae less than 1 to 2 flagellar articles in length.

Mandible, maxilla, and first and second maxillipeds typical of species in genus (e.g. Fig. 20). Maxillule (Fig. 24c-d) with external lobe of endopod weakly developed, internal lobe with long seta. Third maxilliped (Fig. 24e) with crista dentata consisting of about 10 small corneous teeth; coxa and basis each with 1 tooth mesially. Sternite of third maxilliped with spine on each side of midline. Epistomial spine usually absent.

Chelipeds markedly dissimilar, each with dorsal surfaces of carpus and chela covered with moderately dense setation. Right cheliped (Fig. 25b-d) with proportions of carpus and chela influenced by size and sexual dimorphism (see Variations). Fingers bent inwards at tips; each terminating in small corneous claw; with few tufts of setae on dorsal and ventral surfaces; cutting edges each with irregularly-sized calcareous teeth; cutting edge of dactyl also with distal row of small, closely-set, corneous teeth. Dactyl set at slightly oblique angle to palm, with dorsomesial and mesial row of small spines proximally. Palm and carpus each with numerous small spines and tubercles on dorsal surface; ventral surfaces of palm and carpus also with spines and tubercles but less numerous or sometimes few and scattered. Merus with small tubercles on dorsal, dorsolateral and ventral surfaces; mesial surface with scattered spines or tubercles, with ventromesial row of spines. Ischium with dorsal and ventromesial row of spines. Coxa with 1 or 2 spines on ventrodistal margin and ventromesial row of setae.

Left cheliped (Fig. 25a) slender. Fingers each terminating in small corneous claw; dorsal and ventral surfaces with scattered tufts of short setae; cutting edge of dactyl with row of minute, closely-set, corneous teeth distally; cutting edge of fixed finger with row of regularly-spaced, small, evenly-sized, calcareous teeth. Palm unarmed except for few small dorsomesial and sometimes dorsolateral tubercles. Carpus armed with irregular row of small spines dorsally. Merus unarmed except for row of bristles on dorsal margin, and 1 or 2 small spines on ventromesial margin. Ischium with small, blunt setose tubercles on dorsal margin; usually with small spine on ventromesial margin proximally. Coxa usually with 2 small spines on ventrodistal margin and ventromesial row of setae.

Ambulatory legs (Fig. 26a-f) similar from right to left (except slightly longer segments on right), slender, long, distinctly overreaching right cheliped. Dactyl about 1.7 to 1.9 times as long as propodus; with dorsal and ventromesial distal row of setae; ventromesial margin with row of up to 12 minute corneous spinules. Merus, carpus, and propodus each with short setae on dorsal margin; segments distinctly more slender in large specimens (SL ≥ 6.0 mm, e.g. Fig. 26a-f); carpus with small dorsodistal spine. Ischium usually with small ventrodistal and ventroproximal spine (first leg) or unarmed (second leg). Coxa with ventromesial margin usually armed with 1 or 2 small spines (first leg) or unarmed (second leg). Anterior lobe of sternite of second legs (Fig. 26g) setose, armed with simple subterminal spine.

Fourth pereopod (Fig. 27a-d)) semichelate. Dactyl subtriangular, shorter than length of propodal rasp, terminating in corneous claw; with ventrolateral row of small, closely-set, corneous spines. Propodal rasp with 2 irregular rows of conical scales (Fig. 27b), or occasionally with 1 row at least distally (Fig. 27d). Carpus with row of long setae on dorsal margin. Merus with setae on dorsal and ventral margins.

Fifth pereopod (Fig. 27e) chelate; propodal rasp forming subtriangular area less than half length of propodus.

Telson and uropods (Fig. 24f-h)) weakly asymmetrical. Left exopod (Fig. 24g) about 2.6 times as long as broad; rasp moderately broad. Telson without or at most weakly marked lateral indentations; with scattered setae dorsally, and rows of long setae laterally; terminal margin divided into 2 rounded projections by narrow, angled (V-shaped) cleft; rounded projections each armed distally with 15 or more closely-spaced corneous spines.

SIZE RANGE. — Males, SL 3.0 to 10.5 mm. Females 2.9 to 11.5 mm. Ovigerous females 3.6 to 9.6 mm.

VARIATIONS. — Right cheliped: in males the length/width ratio of the palm varies from about 1.2 to 1.7 (Fig. 25b,d); in females the palm is usually about as long as wide or slightly wider than long (Fig. 25c). The length of the carpus increases with size more in males than in females. Ambulatory legs (Fig. 26a-f): the length/height ratio of the propodi varies from 5.2 to 7.9 (first leg), and 5.0 to 7.0 (second leg). The length/height ratio of the meri varies from 4.0 to 5.1 (first leg), and 3.4 to 4.4 (second leg).

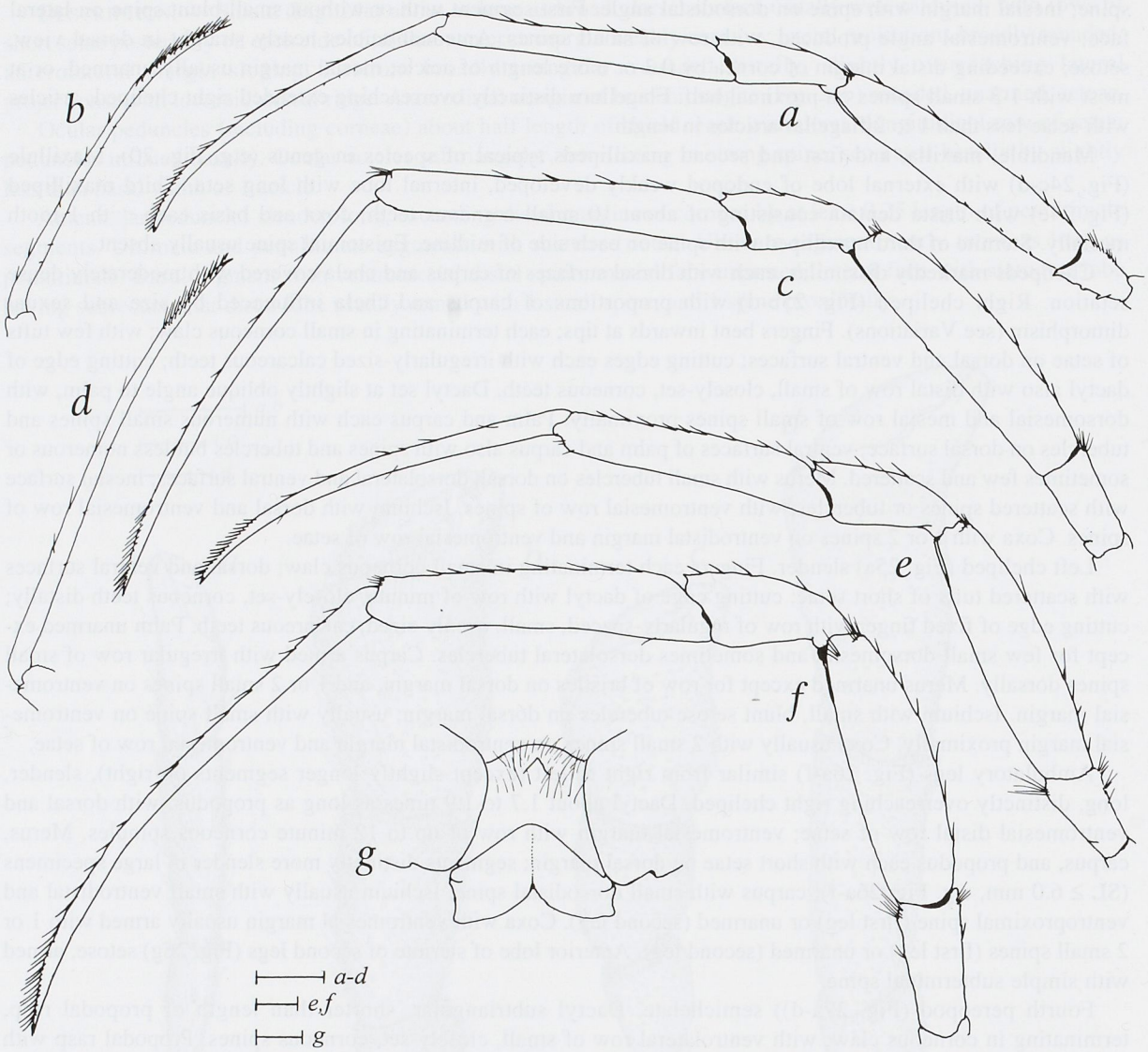

FIG. 26. — *Parapagurus furici* sp. nov., New Caledonia: a-d,g, BIOGEOCAL stn CP 329, holotype ♂ 6.7 mm (MNHN-Pg 5580); e-f, BIOGEOCAL stn 273, paratype ov. ♀ 4.8 mm (MNHN-Pg 5594). **a**, left first ambulatory leg, lateral view; **b**, dactyl of same, mesial view; **c**, left second ambulatory leg, lateral view; **d**, dactyl of same, mesial view; **e**, left first ambulatory leg, lateral view; **f**, left second ambulatory leg, lateral view; **g**, sternite of second ambulatory legs, ventral view.

Scales equal 3 mm (a-d), 1 mm (e,f), and 0.5 mm (g).

HABITAT. — Usually found living in shelters formed by zoanthids.

DISTRIBUTION (Figs 47-48). — Western Pacific, including the New Caledonia region; Arabian Sea. Depth: 311 to 2500 m.

ETYMOLOGY. — The species is dedicated to Pierre FURIC, captain of the French research vessels N.O. *"Vauban"* and N.O. *"Alis"* during many MUSORSTOM deep-sea expeditions. The success of these expeditions was largely due to his expertise.

AFFINITIES. — As previously mentioned, *P. furici* sp. nov. and *P. richeri* sp. nov. are superficially similar but can be distinguished by differences in the armature of antennal acicles, slenderness of ambulatory legs, number of rows and shape of scales of the propodal rasp of the fourth pereopod, and armature of the terminal margin of the telson (see Affinities under *P. richeri* sp. nov.).

Compared to other *Parapagurus* species, the degree of slenderness of the ambulatory legs exhibited in specimens of *P. furici* sp. nov. is often quite striking. The length/width ratios of the meri and propodi of these appendages in this new species frequently serve as useful characters for identification of specimens.

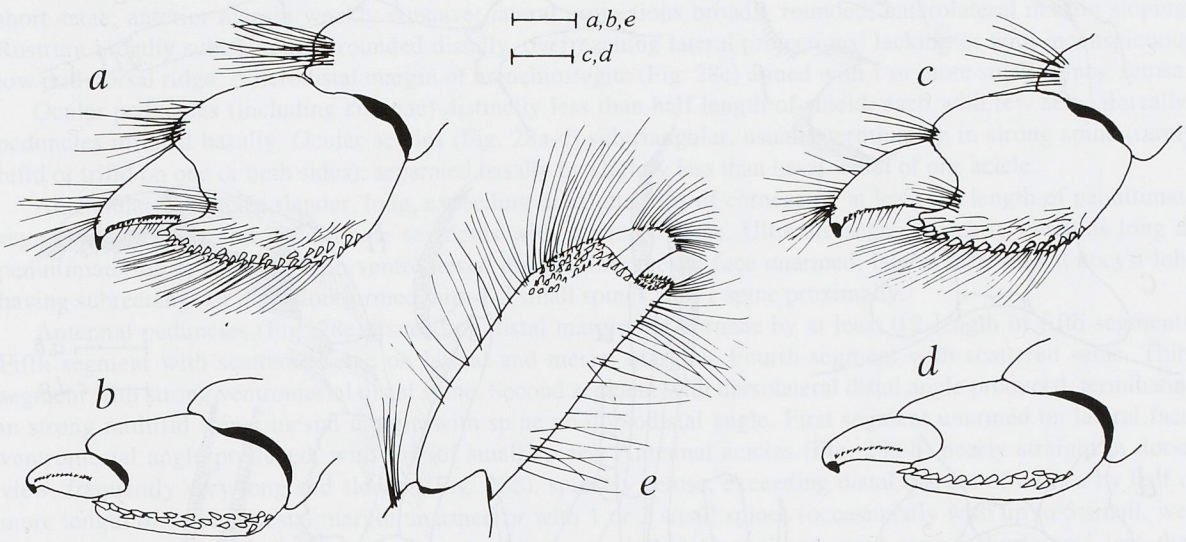

FIG. 27. — *Parapagurus furici* sp. nov., New Caledonia: a-b,e, BIOGEOCAL stn CP 329, holotype ♂ 6.7 mm (MNHN-Pg 5580); c-d, BIOGEOCAL stn CP 260, paratype ♂ 4.6 mm (MNHN-Pg 5590). **a**, propodus and dactyl of left fourth pereopod, lateral view; **b**, same (setae omitted), ventrolateral view; **c**, propodus and dactyl of left fourth pereopod, lateral view; **d**, same (setae omitted), ventrolateral view; **e**, propodus and dactyl of left fifth pereopod, lateral view. Scales equal 0.5 mm (a,b,e), and 0.25 mm (c,d).

REMARKS. — ALCOCK (1901) reported many specimens collected on the *"Investigator"* as *Parapagurus pilosimanus*. ALCOCK (1902) mentioned and depicted the same taxon in a general account of the deep sea fauna from Indian Seas based on samples obtained during the cruises of the *"Investigator"*. One of ALCOCK's specimens, a male collected in the Arabian Sea and deposited in the Australian Museum (AM P2623), has been examined; it represents the new species *P. furici*. The remaining specimens need to be located and studied in order to determine whether they also represent this or possibly other species.

Parapagurus saintlaurentae sp. nov.

Figs 28-31, 47, 49

Parapagurus pilosimanus pilosimanus - DE SAINT LAURENT, 1972: 102 (in part, see Remarks).
Parapagurus pilosimanus scaber - DE SAINT LAURENT, 1972: 102 (in part, see Remarks).

MATERIAL EXAMINED. — **Indian Ocean**.

Mozambique Channel. *"Galathea"*: stn 217, 14°20'S, 45°09'E, 3390 m, 27.02.1951: 2 ♂ 12.7, 15.5 mm (ZMK CRU-3390, 3391).

N of Madagascar. *"Galathea"*: stn 231, 8°52'S, 49°25'E, 5020 m, 7.03.1951: 1 ov. ♀ 11.9 mm (ZMK CRU-3392). — Stn 232, 9°03'S, 49°22'E, 4930 m, 8.03.1951: 1 ♂ 9.5 mm, 1 ov. ♀ 10.0 mm (ZMK CRU-3393, 3394). — Stn 233, 7°24'S, 48°24'E, 4730 m, 9.03.1951: 2 ♂ 11.6, 12.1 mm, 2 ♀ 7.5, 10.1 mm, 2 ov. ♀ 9.8, 10.1 mm (ZMK CRU-3395).

— Stn 234, 5°25'S, 47°09'E, 4820 m, 10.03.1951: 6 ♂ 5.4-14.7 mm, 4 ♀ 8.3-9.7 mm, 5 ov. ♀ 10.4-12.1 mm (ZMK CRU-3396). — Stn 235, 4°47'S, 46°19'E, 4810 m, 11.03.1951: ♂ 13.0 mm (ZMK CRU-3397); 24 ♂ 9.1-13.7 mm, 10 ♀ 9.1-11.6 mm, 32 ov. ♀ 8.8-10.7 mm (ZMK CRU-3398, 3399, 3400), 4 ♂ 12.5-13.4 mm, 1 ♀ 11.2 mm, 3 ov. ♀ 10.0-10.7 mm (USNM 276123).

SE Îles Glorieuses. BENTHEDI: stn BENT 90-CH, 11°44'S, 47°30'E, 3700 m, 4.04.1977: 1 ♀ 7.8 mm (MNHN-Pg 5645).

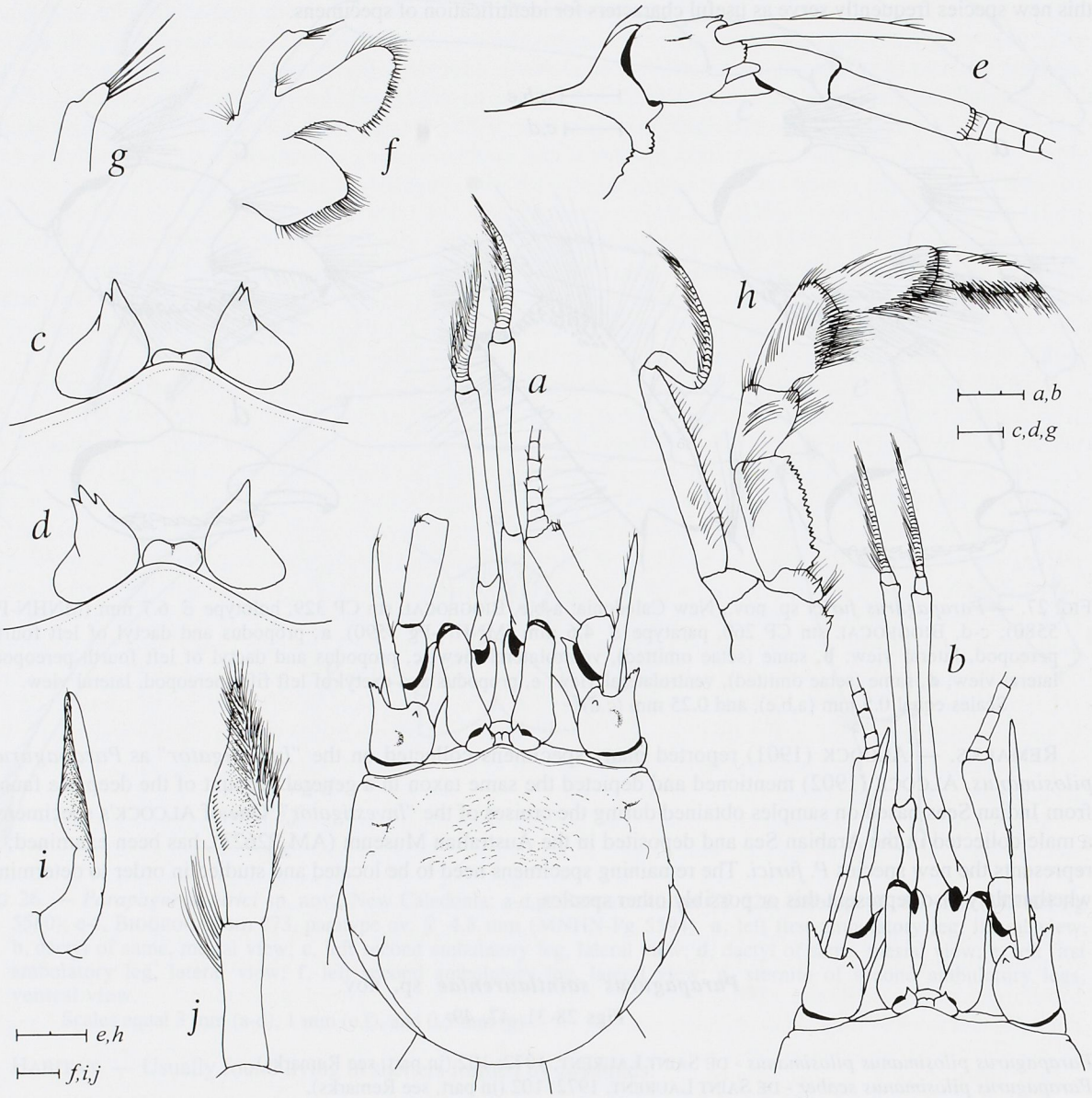

FIG. 28. — *Parapagurus saintlaurentae* sp. nov., Indian Ocean, *"Galathea"*, stn 235: a,e, holotype ♂ 13.0 mm (ZMK CRU-3397); b, paratype ♂ 12.4 mm (ZMK CRU-3398); c, paratype ♀ 11.1 mm (ZMK CRU-3398); d, paratype ♀ 11.0 mm (ZMK CRU-3398); f-j, paratype ♂ 12.2 mm (ZMK CRU-3398). **a**, shield and cephalic appendage; **b**, anterior portion of shield and cephalic appendages; **c-d**, ocular acicles, dorsal view; **e**, right antennal peduncle and anterolateral margin of branchiostegite, lateral view; **f**, left maxillule, internal view; **g**, distal end of endopod of same; **h**, left third maxilliped, internal view; **i**, male left first pleopod, mesial view; **j**, male left second pleopod, anterior view.

Scales equal 3 mm (a,b), 0.5 mm (c,d,g), 2 mm (e,h), and 1 mm (f,i,j).

Kenya. *"Galathea"*: stn 238, 3°23'S, 44°04'E, 3960 m, 13.03.1951: 5 ♂ 6.3-9.2 mm, 4 ♀ 5.7-7.9 mm, 3 ov. ♀ 7.2-8.0 mm (ZMK CRU-3401).

SW of Sri Lanka (Ceylon).*"Galathea"*: stn 279, 1°00'N, 76°17'E, 4320 m, 8.04.1951: 4 ♂ 6.0-12.0 mm, 1 ov. ♀ 9.2 mm (ZMK CRU-3402). — Stn 282, 5°32'N, 78°41'E, 4040 m, 11.04.1951: 1 ♂ 8.5 mm, 1 ♀ 12.1 mm (ZMK CRU-3403).

TYPES. — *Holotype*: ♂ 13.0 mm,*"Galathea"*, stn 235, N of Madagascar, 4°47'S, 46°19'E, 4810 m, 11.03.1951 (ZMK CRU-3397). *Paratypes*: All the others specimens mentioned above.

DESCRIPTION. — Shield (Fig. 28a) about as long as broad; dorsal surface usually well calcified, with scattered short setae; anterior margin weakly concave; lateral projections broadly rounded; anterolateral margin sloping. Rostrum broadly subtriangular, rounded distally, overreaching lateral projections; lacking or with inconspicuous low mid-dorsal ridge. Anterodistal margin of branchiostegite (Fig. 28e) armed with 1 or more small spines, setose.

Ocular peduncles (including corneae) distinctly less than half length of shield, each with few setae dorsally; peduncles inflated basally. Ocular acicles (Fig. 28a-d) subtriangular, usually terminating in strong spine (rarely bifid or trifid on one or both sides); separated basally by slightly less than basal width of one acicle.

Antennular peduncles slender, long, exceeding distal margins of corneae by at least 0.8 length of penultimate segments. Ultimate and penultimate segments with scattered setae. Ultimate segment nearly twice as long as penultimate. Basal segment with ventromesial distal spine; mesial face unarmed; lateral face with statocyst lobe having subrectangular distal lobe armed with 1-3 small spines, and 1 spine proximally.

Antennal peduncles (Fig. 28e) exceeding distal margins of corneae by at least 0.2 length of fifth segments. Fifth segment with scattered setae on lateral and mesial margins. Fourth segment with scattered setae. Third segment with strong ventromesial distal spine. Second segment with dorsolateral distal angle produced, terminating in strong multifid spine; mesial margin with spine on dorsodistal angle. First segment unarmed on lateral face; ventromesial angle produced, with row of small spines. Antennal acicles (Fig. 28a-b) nearly straight in dorsal view, frequently very long and slender (Fig. 28b), sparsely setose; exceeding distal margin of cornea by half or more length of acicle; mesial margin unarmed or with 1 or 2 small spines (occasionally with up to 5 small, well spaced spines). Flagellum distinctly overreaching extended right cheliped, with sparse short setae less than 1 flagellar articles in length.

Mandible, maxilla, and first and second maxillipeds typical of species in genus (e.g. Fig. 20). Maxillule (Fig. 28f-g) with external lobe of endopod weakly developed, internal lobe with long terminal seta and 4 subterminal setae. Third maxilliped (Fig. 28h) with crista dentata consisting of about 20 small corneous teeth; coxa and basis each with 1 tooth mesially. Sternite of third maxilliped with spine on each side of midline. Epistomial spine usually absent.

Chelipeds markedly dissimilar, each with dorsal surfaces of carpus and chela covered with moderately dense setation; proportions of carpus and chela influenced by size and sexual dimorphism (see Variations). Right cheliped (Fig. 29c-e) with fingers bent inwards at tips, each terminating in small corneous claw; with tufts of setae on dorsal and ventral surfaces; cutting edges each with irregularly-sized calcareous teeth; cutting edge of dactyl also with distal row of small, closely-set, corneous teeth. Dactyl set at oblique angle to palm, with dorsomesial and mesial row of small spines proximally. Palm and carpus each with numerous small spines and tubercles on dorsal and ventral surfaces (spines and tubercles usually less numerous on ventral surfaces). Merus with small tubercles on dorsal, dorsolateral and ventral surfaces; mesial surface smooth; with ventromesial row of spines. Ischium with dorsal and ventromesial row of spines. Coxa with 1 or 2 spines on ventrodistal margin and ventromesial row of setae.

Left cheliped (Fig. 29a-b) slender, more so in males than in females. Fingers each terminating in small corneous claw; dorsal and ventral surfaces with scattered tufts of short setae; cutting edge of dactyl with row of minute, closely-set, corneous teeth distally; cutting edge of fixed finger with row of small regularly-spaced and evenly-sized calcareous teeth. Palm with dorsomesial row of small spines; dorsolateral face with small spines. Carpus with irregular row of small spines dorsally; lateral face with scattered small spines or tubercles. Merus with row of setae dorsally; ventromesial margin with row of spines. Ischium armed with blunt spines or tubercles dorsally, and ventromesial row of spines. Coxa usually with 2 small spines on ventrodistal margin and ventromesial row of setae.

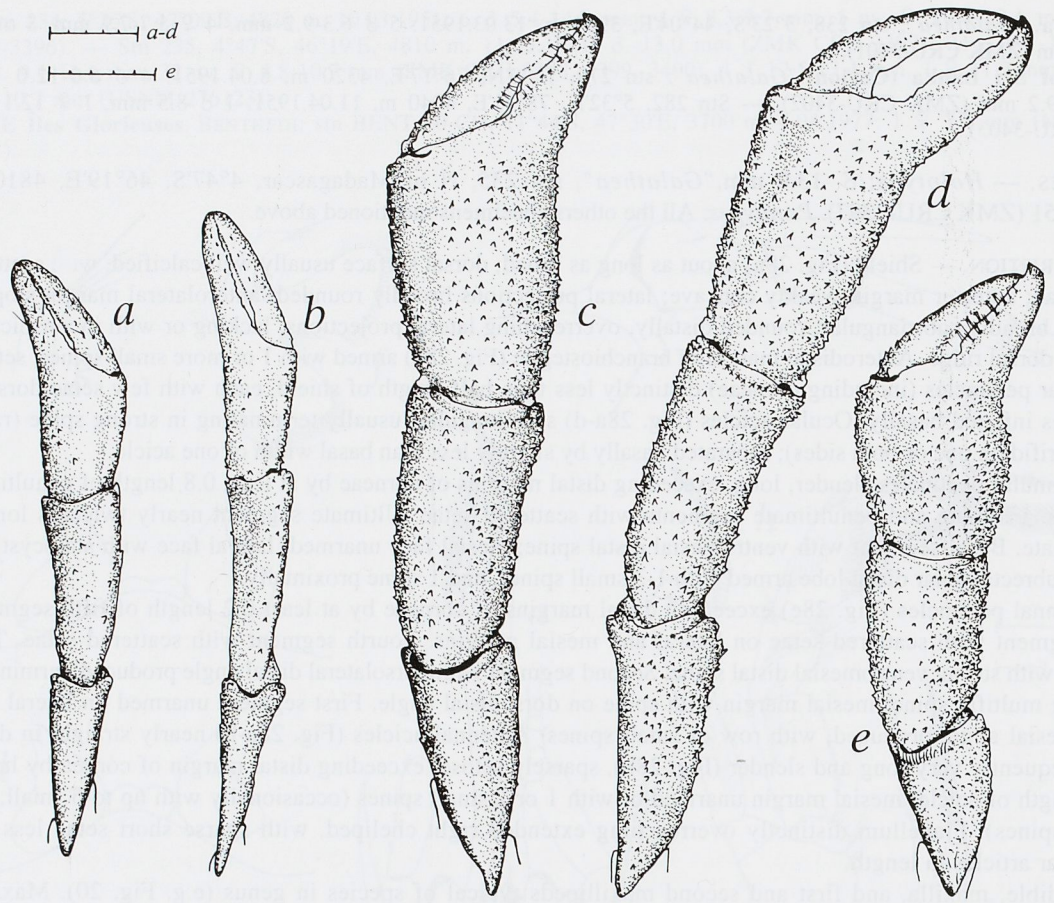

FIG. 29. — *Parapagurus saintlaurentae* sp. nov., Indian Ocean, *"Galathea"*, stn 235: a,c, holotype ♂ 13.0 mm (ZMK CRU-3397); b,d, paratype ♂ 13.5 mm (ZMK CRU-3398); e, paratype ♀ 10.7 mm (ZMK CRU-3398). **a-b**, left chelipeds (setae omitted); **c-e**, right chelipeds (setae omitted). Scales equal 5 mm.

Ambulatory legs (Fig. 30a-f) similar from right to left (except slightly longer segments on right), slender, long, distinctly overreaching right cheliped. Dactyl about 1.5 times as long as propodus; with dorsal and ventromesial distal row of setae (missing in holotype, Fig. 30a-b,e-f); ventromesial margin with row of about 7 to 15 minute corneous spinules. Meri, carpi, and propodi each with small low tubercles bearing short stiff setae on dorsal margin. Meri and carpi each usually with dorsal margin ridge-like (e.g., Fig. 30c-d); merus 4.7 (first leg) or 3.9 (second leg) times as long as high. Carpus with rounded or often somewhat subglobular dorsodistal region marked by shallow oblique depression and with 1-3 small spines (Fig. 30c-d). Ischium with ventrodistal row of small spines (first leg), or small setose distal tubercle (second leg). Coxae of legs (Fig. 30g-h) each with ventromesial margin forming a lobe proximally, lobe often strongly produced and armed with 1 or more small spines. Anterior lobe of sternite of second legs (Fig. 30g-h) setose, armed with simple subterminal spine.

Fourth pereopod (Fig. 31a-d) semichelate. Dactyl subtriangular; shorter than length of propodal rasp, terminating in corneous claw; with ventrolateral row of small, closely-set, corneous spines. Propodal rasp usually with 2 (Fig. 31b) or occasionally 3 (Fig. 31a) irregular rows of lanceolate or conical scales. Carpus with row of long setae on dorsal margin. Merus with setae on dorsal and ventral margins.

Fifth pereopod (Fig. 31e) chelate; propodal rasp forming subtriangular area less than half length of propodus.

Telson and uropods (Fig. 31f-i) weakly asymmetrical. Left exopod (Fig. 31g) elongate, about 2.6 times as long as broad; rasp moderately broad. Telson without or at most with weak lateral indentations, and scattered setae

dorsally; terminal margin divided into 2 rounded projections by wide, often deep rounded (U-shaped cleft); rounded projections each armed distally with moderately long corneous spines (about 15 left, 12 right).

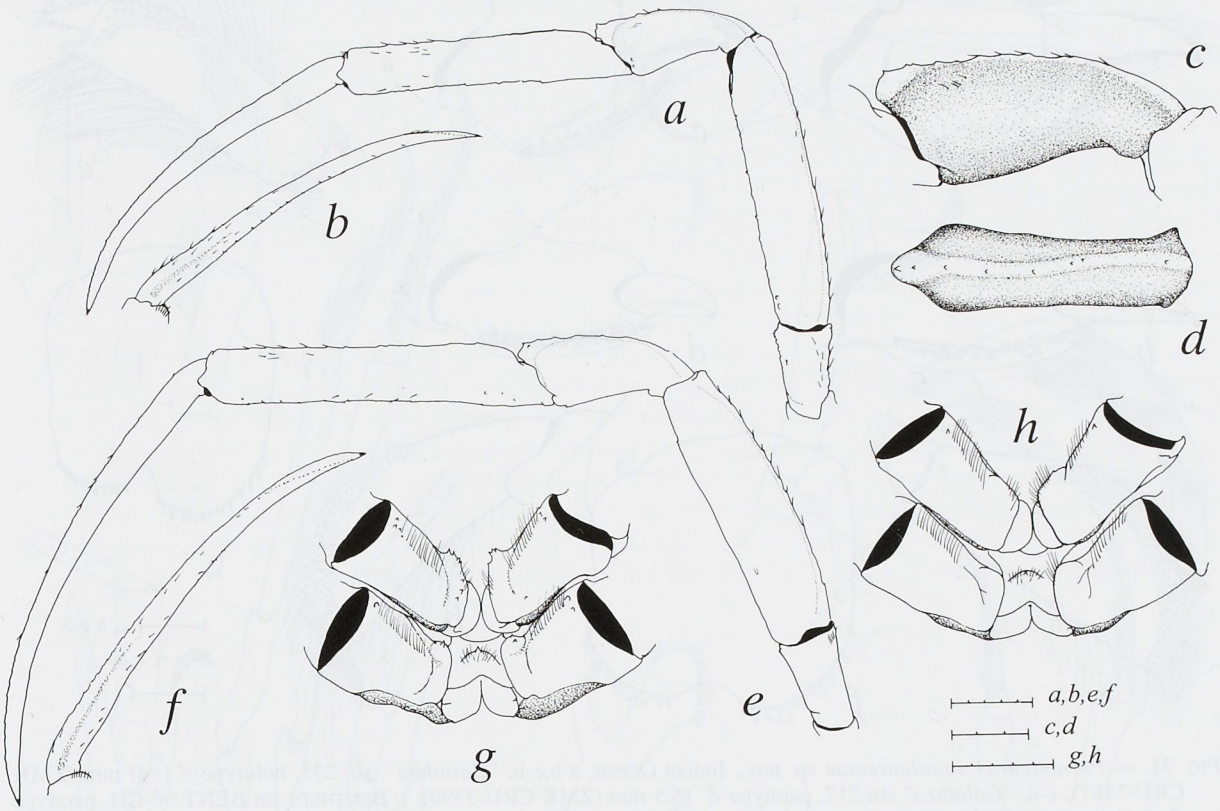

FIG. 30. — *Parapagurus saintlaurentae* sp. nov., Indian Ocean, *"Galathea"*, stn 235: a-g, holotype ♂ 13.0 mm (ZMK CRU-3397); h, paratype ♂ 13.6 mm (ZMK CRU-3398). **a**, left first ambulatory leg, lateral view; **b**, dactyl of same, mesial view; **c**, carpus of same, lateral view; **d**, same, dorsal view; **e**, left second ambulatory leg, lateral view; **f**, dactyl of same, mesial view; **g-h**, coxae and sternites of ambulatory legs, ventral view.
Scales equal 5 mm (a,b,e,f-h), and 3 mm (c,d).

SIZE RANGE. — Males, SL 5.4 to 15.5 mm. Females 5.7 to 12.1 mm. Ovigerous females 7.2 to 12.1 mm.

VARIATIONS. — The fingers of the right cheliped in large specimens (SL >13.0 mm) often leave a wide hiatus when closed (Fig. 29d). In males (Fig. 29c-d), the length/width ratio of the palm varies from 1.4 to 1.7; in females (Fig. 29e), the palm is usually about as long as wide. The length of the carpus increases with size more in males than in females.

HABITAT. — Found living in zoanthids, or actinians that secrete a chitinous carcinoecia.

DISTRIBUTION (Figs 47, 49). — Known so far only from the Indian Ocean, north of Madagascar, and southwest of Sri Lanka (Ceylon). Depth: 3390 to 5020 m.

ETYMOLOGY. — The specific name is given in honor of the eminent French carcinologist, Mme Michèle DE SAINT LAURENT, in recognition of her many important contributions to our knowledge of decapod crustaceans in general, and of parapagurids in particular.

AFFINITIES. — See *P. holthuisi*.

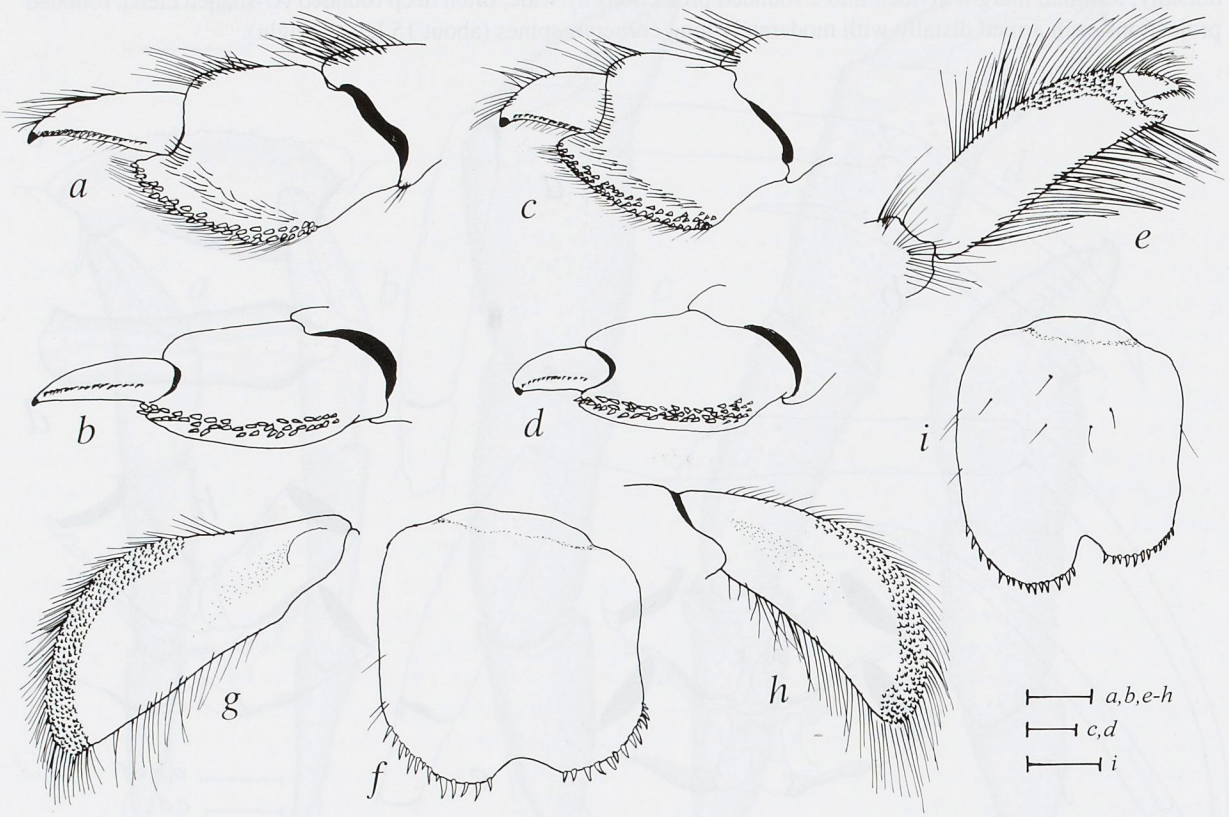

FIG. 31. — *Parapagurus saintlaurentae* sp. nov., Indian Ocean: a-b,e-h, *"Galathea"*, stn 235, holotype ♂ 13.0 mm (ZMK CRU-3397); c-d, *"Galathea"* stn 217, paratype ♂ 15.5 mm (ZMK CRU-3390); i, BENTHEDI stn BENT 90-CH, paratype ♀ 7.8 mm (MNHN-Pg 5645). **a**, propodus and dactyl of left fourth pereopod, lateral view; **b**, same (setae omitted), ventrolateral view; **c**, propodus and dactyl of left fourth pereopod, lateral view; **d**, same (setae omitted), ventrolateral view; **e**, propodus and dactyl of left fifth pereopod, lateral view; **f**, telson, dorsal view; **g-h**, left (g) and right (h) exopod of uropods, dorsal view; **i**, telson, dorsal view. Scales equal 1 mm.

REMARKS. — Examination of the Indo-Pacific material used by DE SAINT LAURENT (1972) in her report of *P. p. pilosimanus* and *P. p. scaber*, has shown that she confounded it with three species. DE SAINT LAURENT's Indo-Pacific material of *P. p. pilosimanus* actually contains specimens of *P. saintlaurentae* sp. nov. and, as previously mentioned, specimens of *P. latimanus*. DE SAINT LAURENT's Indo-Pacific material of *P. p. scaber* contains specimens of the new species *P. saintlaurentae* and *P. stenorhinus*.

Parapagurus stenorhinus sp. nov.

Figs 32-35, 47, 49

Parapagurus pilosimanus scaber - DE SAINT LAURENT, 1972: 102 (in part, see Remarks).
Parapagurus pilosimanus nudus - DE SAINT LAURENT, 1972: 102 (in part, see Remarks under *Parapagurus richeri* sp. nov.).

MATERIAL EXAMINED. — **Indian Ocean**.
South Africa. *"Galathea"*: stn 192, off Durban., 32°00'S, 32°41'E, 3530 m, 5.02.1951: 1 ♂ 6.4 mm (ZMK CRU-3405).
N of Madagascar. *"Galathea"*: stn 232, 9°03'S, 49°22'E, 4930 m, 8.03.1951: 1 ov. ♀ 5.5 mm (ZMK CRU-3404).
Kenya. *"Galathea"*: stn 238, 3°23'S, 44°04'E, 3960 m, 13.03.1951: 9 ♂ 3.6-7.5 mm, 8 ♀ 3.3-6.0 mm, 2 ov. ♀ 3.7, 5.8 mm (ZMK CRU-3406, 3407).

SW of Sri Lanka (Ceylon). *"Galathea"*: stn 280, 1°56'N, 77°05'E, 4465-4530 m, 9.04.1951: 1 ♀ 5.6 mm (ZMK CRU-3408).

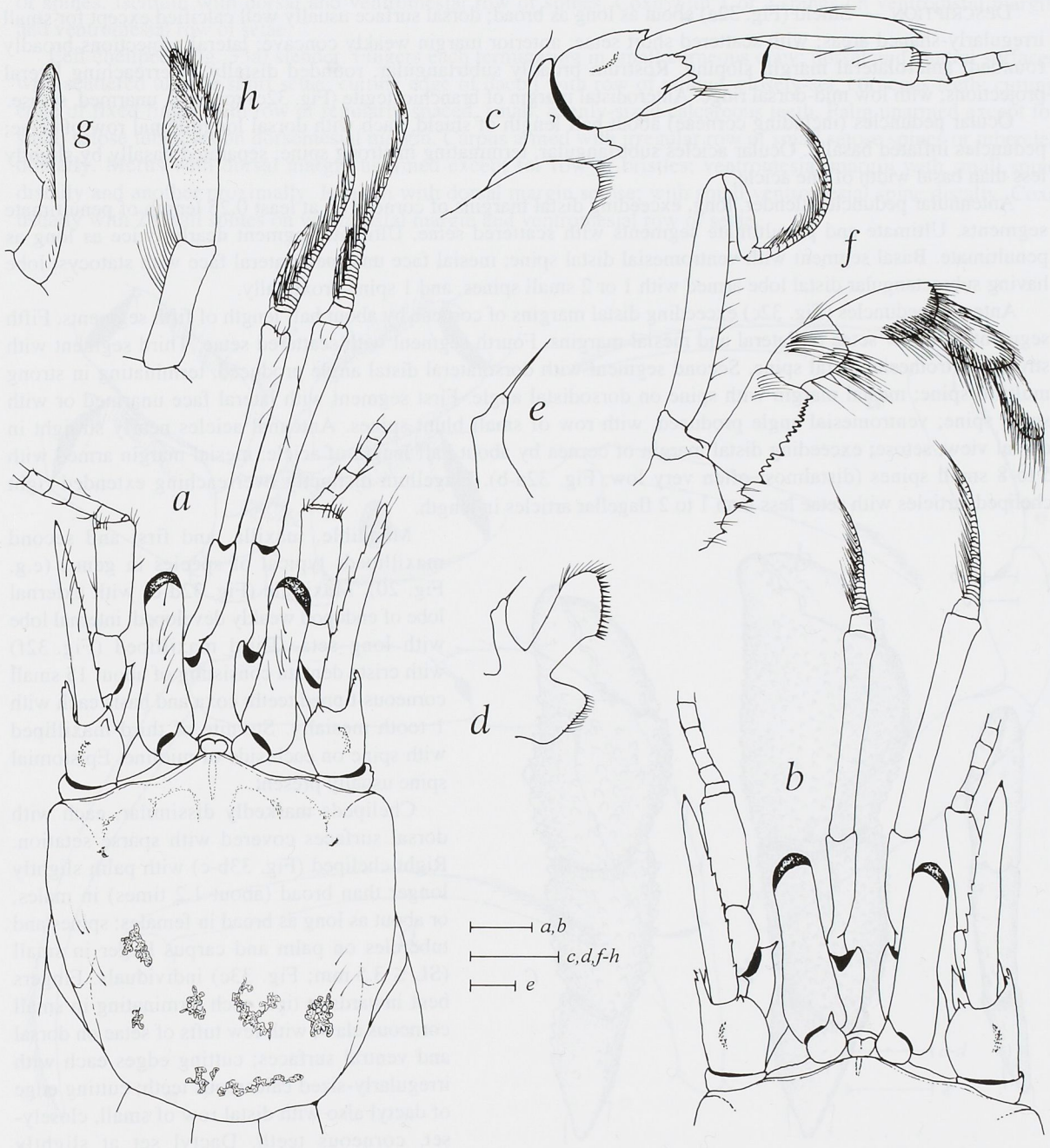

FIG. 32. — *Parapagurus stenorhinus* sp. nov., Indian Ocean, *"Galathea"*: a,c stn 232, holotype ov. ♀ 5.5 mm (ZMK CRU-3404); b, stn 192, paratype ♂ 6.4 mm (ZMK CRU-3405); d-h, stn 238, paratype ♂ 4.9 mm (ZMK CRU-3405). **a**, shield and cephalic appendages; **b**, anterior portion of shield and cephalic appendages (setae omitted); **c**, right antennal peduncle and anterolateral margin of branchiostegite, lateral view; **d**, maxillule, internal view; **e**, distal portion of endopod of same; **f**, left third maxilliped, internal view; **g**, male left first pleopod, mesial view; **h**, male left second pleopod, anterior view.

Scales equal 1 mm (a-d,f-h), and 0.25 mm (e).

TYPES. — *Holotype*: ov. ♀ 5.5 mm, *"Galathea"*, stn 232, N of Madagascar, 9°03'S, 49°22'E, 4930 m, 8.03.1951 (ZMK CRU-3404). *Paratypes*: All the others specimens mentioned above.

DESCRIPTION. — Shield (Fig. 32a) about as long as broad; dorsal surface usually well calcified except for small irregularly-shaped areas; with scattered short setae; anterior margin weakly concave; lateral projections broadly rounded; anterolateral margin sloping. Rostrum broadly subtriangular, rounded distally, overreaching lateral projections; with low mid-dorsal ridge. Anterodistal margin of branchiostegite (Fig. 32c) rounded, unarmed, setose.

Ocular peduncles (including corneae) about half length of shield, each with dorsal longitudinal row of setae; peduncles inflated basally. Ocular acicles subtriangular, terminating in strong spine; separated basally by slightly less than basal width of one acicle.

Antennular peduncles slender, long, exceeding distal margins of corneae by at least 0.25 length of penultimate segments. Ultimate and penultimate segments with scattered setae. Ultimate segment nearly twice as long as penultimate. Basal segment with ventromesial distal spine; mesial face unarmed; lateral face with statocyst lobe having subrectangular distal lobe armed with 1 or 2 small spines, and 1 spine proximally.

Antennal peduncles (Fig. 32c) exceeding distal margins of corneae by about half length of fifth segments. Fifth segment with few setae on lateral and mesial margins. Fourth segment with scattered setae. Third segment with strong ventromesial distal spine. Second segment with dorsolateral distal angle produced, terminating in strong multifid spine; mesial margin with spine on dorsodistal angle. First segment with lateral face unarmed or with small spine; ventromesial angle produced, with row of small blunt spines. Antennal acicles nearly straight in dorsal view, setose; exceeding distal margin of cornea by about half length of acicle; mesial margin armed with 5 to 8 small spines (distalmost often very low, Fig. 32a-b). Flagellum distinctly overreaching extended right cheliped; articles with setae less than 1 to 2 flagellar articles in length.

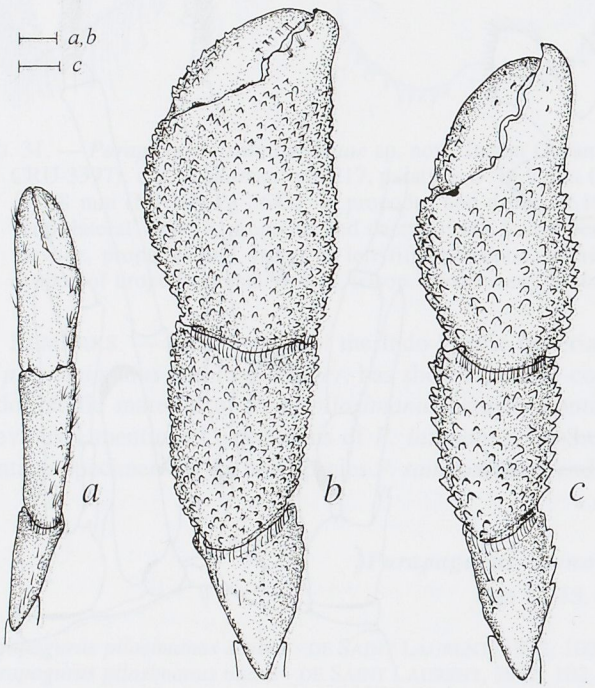

FIG. 33. — *Parapagurus stenorhinus* sp. nov., Indian Ocean, *"Galathea"*: a-b, stn 232, holotype ov. ♀ 5.5 mm (ZMKCRU-3404); c, stn 238, paratype ♀ 3.3 mm (ZMK CRU-3407). **a**, left cheliped; **b-c**, right chelipeds (setae omitted).
Scales equal 1 mm (a-b), and 0.5 mm (c).

Mandible, maxilla, and first and second maxillipeds typical of species in genus (e.g. Fig. 20). Maxillule (Fig. 32d-e) with external lobe of endopod weakly developed, internal lobe with long seta. Third maxilliped (Fig. 32f) with crista dentata consisting of about 15 small corneous-tipped teeth; coxa and basis each with 1 tooth mesially. Sternite of third maxilliped with spine on each side of midline. Epistomial spine usually present.

Chelipeds markedly dissimilar, each with dorsal surfaces covered with sparse setation. Right cheliped (Fig. 33b-c) with palm slightly longer than broad (about 1.2 times) in males, or about as long as broad in females; spines and tubercles on palm and carpus larger in small (SL ≤ 3.5 mm; Fig. 33c) individuals. Fingers bent inwards at tips, each terminating in small corneous claw; with few tufts of setae on dorsal and ventral surfaces; cutting edges each with irregularly-sized calcareous teeth; cutting edge of dactyl also with distal row of small, closely-set, corneous teeth. Dactyl set at slightly oblique angle to palm, with dorsomesial and mesial row of small spines proximally. Palm and carpus each with numerous small spines and tubercles on dorsal surface; ventral surfaces of palm and carpus also with spines and

tubercles but less numerous, tubercles on palm scattered (some often arranged in 2 median rows). Merus with scattered small tubercles on dorsal, dorsolateral and ventral surfaces; mesial surface smooth; with ventromesial row of spines. Ischium with dorsal and ventromesial row of spines. Coxa with 1 or 2 spines on ventrodistal margin and ventromesial row of setae.

Left cheliped (Fig. 33a) slender. Fingers each terminating in small corneous claw; dorsal and ventral surfaces with scattered tufts of short setae; cutting edge of dactyl with row of minute, closely-set, corneous teeth; cutting edge of fixed finger with row of regularly-spaced, small, evenly-sized calcareous teeth. Palm unarmed except for small setose tubercles on dorsomesial margin. Carpus armed with irregular row of small setose spines or tubercles dorsally. Merus with dorsal margin unarmed except for row of bristles; ventromesial margin with small spine distally and another proximally. Ischium with dorsal margin setose; with small ventromesial spine distally. Coxa usually with 2 small spines on ventrodistal margin and ventromesial row of setae.

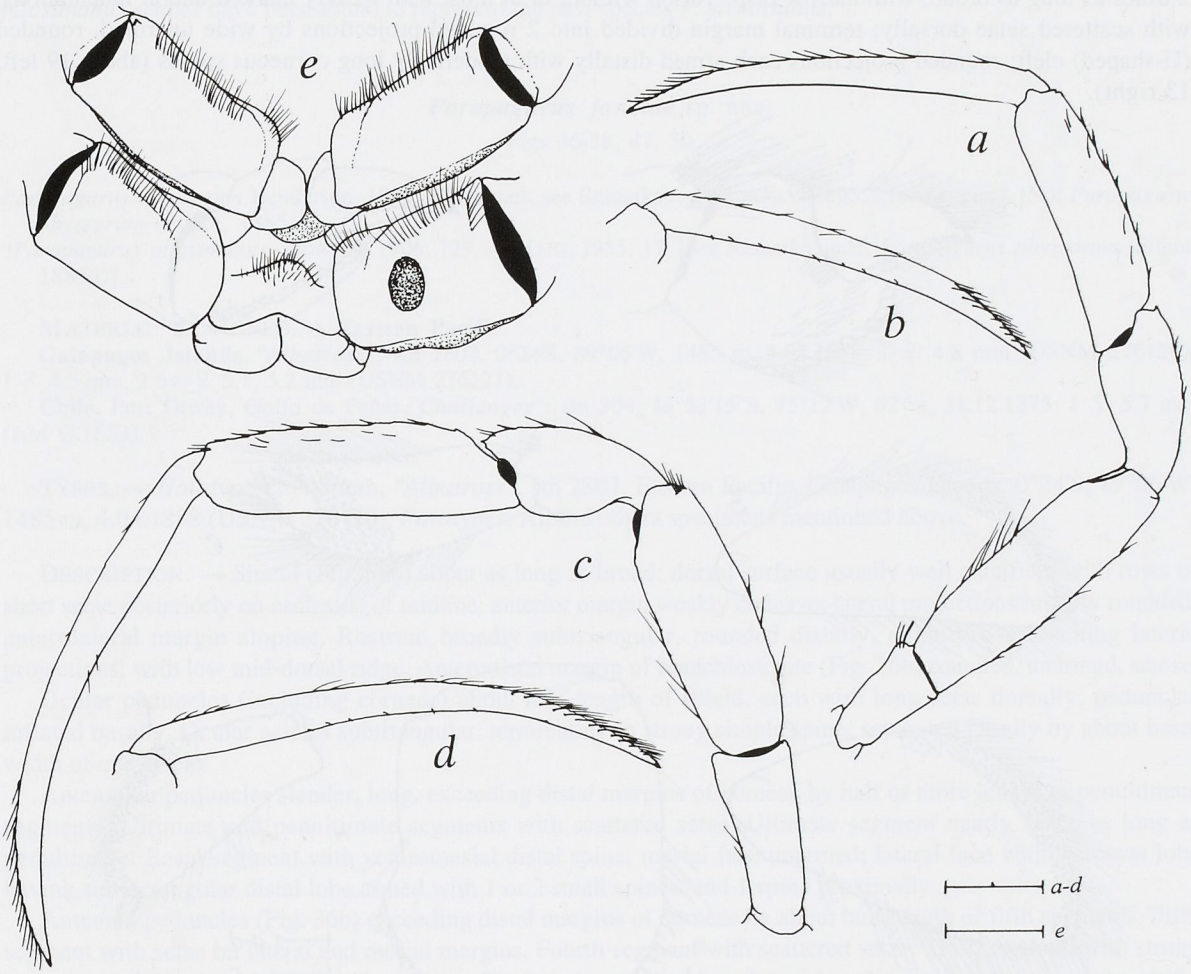

FIG. 34. — *Parapagurus stenorhinus* sp. nov., Indian Ocean, *"Galathea"*, stn 232, holotype ov. ♀ 5.5 mm (ZMK CRU-3404): **a**, left first ambulatory leg, lateral view; **b**, dactyl of same, mesial view; **c**, left second ambulatory leg, lateral view; **d**, dactyl of same, mesial view; **e**, coxae and sternites of ambulatory legs. Scales equal 2 mm (a-d), and 1 mm (e).

Ambulatory legs (Fig. 34a-d) similar from right to left (except for slightly longer segments on right), slender, long, distinctly overreaching right cheliped. Dactyl about 1.8 times as long as propodus; with dorsal and

ventromesial distal row of setae; ventromesial margin with row of about 8 to 10 minute corneous spinules. Merus, carpus, and propodus each with short bristles on dorsal margin; carpus with small dorsodistal spine; merus about 3.6 (first leg) or 2.9 (second leg) times as long as high. Ischium usually with small ventrodistal tubercle (first leg) or unarmed (second leg). Coxa (Fig. 34e) with ventrodistal margin usually armed with 1 or 2 small spines (first leg) or unarmed (second leg). Anterior lobe of sternite of second leg (Fig. 34e) setose, unarmed or with simple subterminal spine.

Fourth pereopod (Fig. 35a-b) semichelate. Dactyl subtriangular, shorter than length of propodal rasp, terminating in corneous claw; with ventrolateral row of small, closely-set, corneous spines. Propodal rasp with 1 row of ovate scales at least distally; rasp sometimes with 2 short irregular rows of rounded scales proximally. Carpus with row of long setae on dorsal margin. Merus with setae on dorsal and ventral margins.

Fifth pereopod (Fig. 35c) chelate; propodal rasp forming subtriangular area less than half length of propodus.

Telson and uropods (Fig. 35d-f) asymmetrical. Left exopod (Fig. 35e) usually broad, paddle-shaped, about 2 times as long as broad; with narrow rasp. Telson without or at most with weakly marked lateral indentations; with scattered setae dorsally; terminal margin divided into 2 rounded projections by wide unarmed, rounded (U-shaped) cleft; rounded projections each armed distally with moderately long corneous spines (about 19 left, 13 right).

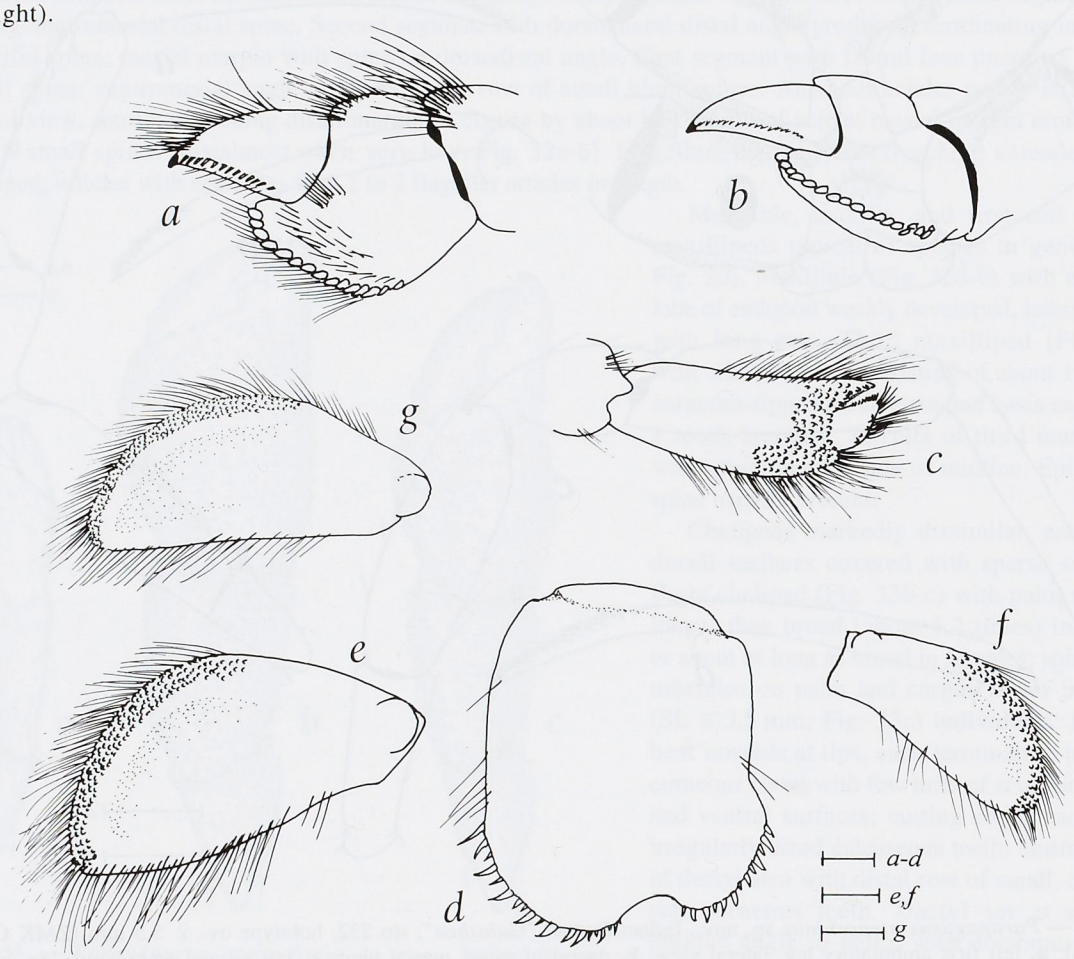

FIG. 35. — *Parapagurus stenorhinus* sp. nov., Indian Ocean, *"Galathea"*: a-f, stn 232, holotype ov. ♀ 5.5 mm (ZMK CRU-3404); g, stn 238, paratype ♂ 7.4 mm (ZMK CRU-3406). **a**, propodus and dactyl of left fourth pereopod, lateral view; **b**, same (setae omitted), ventrolateral view; **c**, propodus and dactyl of left fifth pereopod, lateral view; **d**, telson, dorsal view; **e-g**, left (e,g) and right (f) exopod of uropods, dorsal view.

Scales equal 0.25 mm (a-d,g), and 0.5 mm (e-f).

SIZE RANGE. — Males, SL 3.1 to 7.5 mm. Females 3.3 to 6.0 mm. Ovigerous females 3.7 to 5.8 mm.

HABITAT. — One of the specimens examined was lodged in gastropod shell, another in a scaphopod shell. The remaining specimens examined were without housing.

DISTRIBUTION (Figs 47, 49). — Indian Ocean, from off eastern Africa to southwest of Shri Lanka (Ceylon). Depth: 2400 to 4930 m.

ETYMOLOGY. — The specific name is a compound used as an adjective, derived from the Greek *stenos*, narrow, and *rhine*, rasp, and refers to the narrow rasp of the left uropodal exopod found in this species.

AFFINITIES. — See *P. richeri* sp. nov..

REMARKS. — Several Indo-Pacific specimens identified by DE SAINT LAURENT (1972) as *Parapagurus pilosimanus scaber* have been found to represent the new species *P. stenorhinus*.

Parapagurus janetae sp. nov.

Figs 36-38, 47, 50

Parapagurus abyssorum Henderson, 1888: 87 (in part, see Remarks). — MURRAY, 1895: 1140 (in part). [Not *Parapagurus abyssorum* (Filhol, 1885a)].

?*Parapagurus pilosimanus* - PORTER, 1906: 129. — HAIG, 1955: 17. [See Remarks under *Parapagurus abyssorum* (Filhol, 1885a)].

MATERIAL EXAMINED. — **Eastern Pacific**.

Galápagos Islands. *"Albatross"*: stn 2807, 0°24'S, 89°06'W, 1485 m, 4.04.1888: 1 ♀ 4.8 mm (USNM 276120); 1 ♂ 4.5 mm, 2 ov. ♀ 5.1, 5.2 mm (USNM 276121).

Chile. Port Otway, Golfo de Peñas,*"Challenger"*: stn 304, 46°53'15"S, 75°12'W, 82 m, 31.12.1875: 1 ♀ 5.7 mm (AM G.1653).

TYPES. — *Holotype*: ♀ 4.8 mm, *"Albatross"*, stn 2807, Eastern Pacific. Galápagos Islands, 0°24'S, 89°06'W, 1485 m, 4.04.1888 (USNM 276120). *Paratypes*: All the others specimens mentioned above.

DESCRIPTION. — Shield (Fig. 36a) about as long as broad; dorsal surface usually well calcified, with rows of short setae posteriorly on each side of midline; anterior margin weakly concave; lateral projections broadly rounded; anterolateral margin sloping. Rostrum broadly subtriangular, rounded distally, slightly overreaching lateral projections; with low mid-dorsal ridge. Anterodistal margin of branchiostegite (Fig. 36b) rounded, unarmed, setose.

Ocular peduncles (including corneae) about half length of shield, each with long setae dorsally; peduncles inflated basally. Ocular acicles subtriangular, terminating in strong simple spine; separated basally by about basal width of one acicle.

Antennular peduncles slender, long, exceeding distal margins of corneae by half or more length of penultimate segments. Ultimate and penultimate segments with scattered setae. Ultimate segment nearly twice as long as penultimate. Basal segment with ventromesial distal spine; mesial face unarmed; lateral face with statocyst lobe having subrectangular distal lobe armed with 1 or 2 small spines, and 1 spine proximally.

Antennal peduncles (Fig. 36b) exceeding distal margins of corneae by about half length of fifth segments. Fifth segment with setae on lateral and mesial margins. Fourth segment with scattered setae. Third segment with strong ventromesial distal spine. Second segment with dorsolateral distal angle produced, terminating in strong multifid spine; mesial margin with spine on dorsodistal angle. First segment with lateral face unarmed; ventromesial angle produced, with row of small spines. Antennal acicles weakly curved in dorsal view, setose; exceeding distal margin of cornea by 0.2 or more length of acicle; mesial margin armed on proximal half with 2-5 small spines. Flagellum distinctly overreaching extended right cheliped; articles with setae less than 1 to 2 flagellar articles in length.

Mandible, maxilla, and first and second maxillipeds typical of species in genus (e.g. Fig. 20). Maxillule (Fig. 36c) with external lobe of endopod weakly developed, internal lobe with long seta. Third maxilliped

(Fig. 36d) with crista dentata consisting of about 13 small distal corneous teeth and 2 large partially fused corneous teeth proximally; coxa and basis each with 1 tooth mesially. Sternite of third maxilliped with spine on each side of midline. Epistomial spine present.

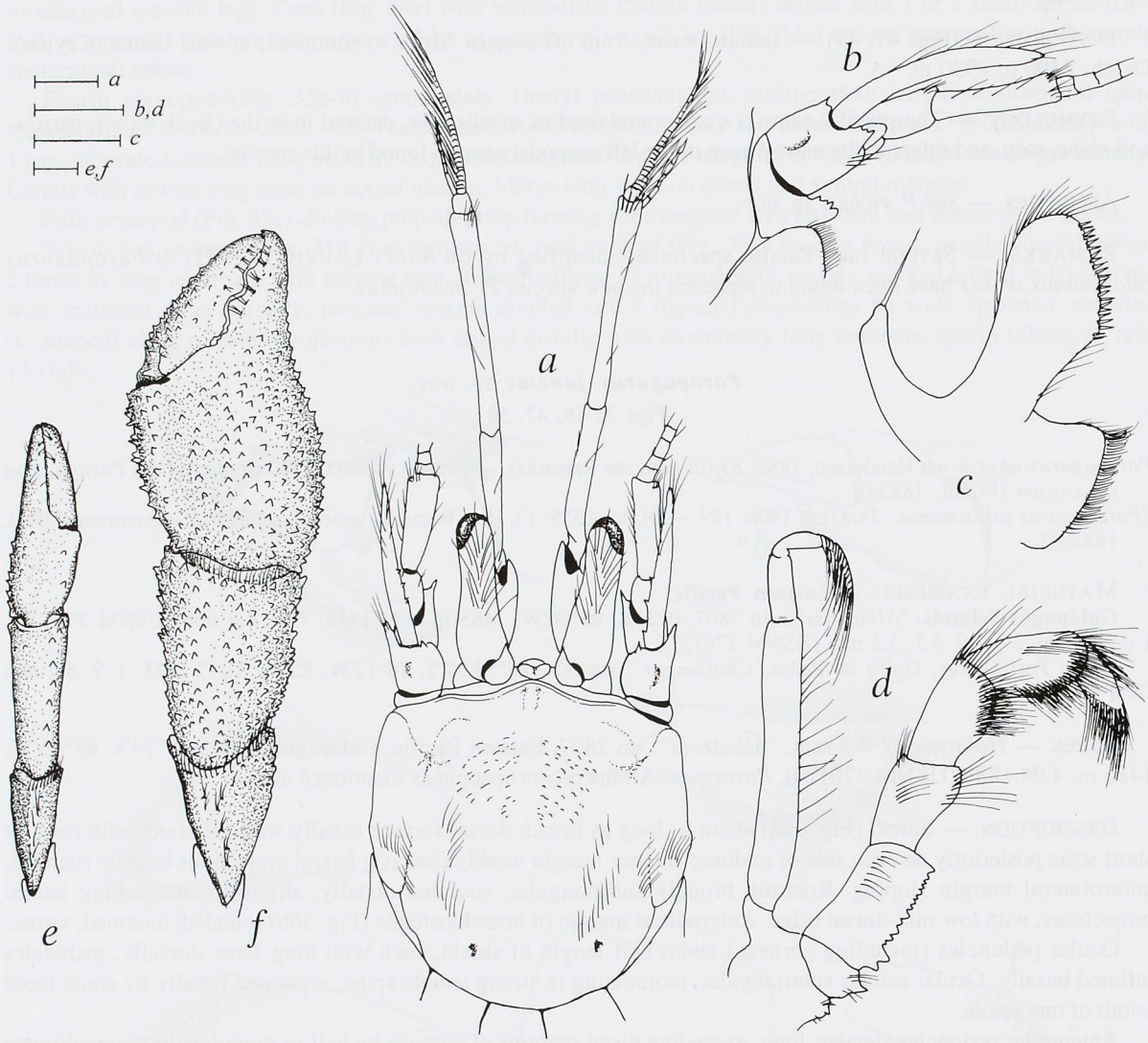

FIG. 36. — *Parapagurus janetae* sp. nov., eastern Pacific, *"Albatross"*, stn 2807: a-b,e-f, holotype ♀ 4.8 mm (USNM 276120); c-d, paratype ov. ♀ 5.2 mm (USNM 276121). **a**, shield and cephalic appendages; **b**, right antennal peduncle and anterolateral margin of branchiostegite, lateral view; **c**, left maxilliped, internal view; **d**, left third maxilliped, internal view; **e**, left cheliped (most setae omitted); **f**, right cheliped (most setae omitted).
Scales equal 1 mm (a-b,d-f), and 0.5 mm (c).

Chelipeds markedly dissimilar, each with dorsal surfaces of carpus and chela covered with moderately dense setation. Right cheliped (Fig. 36f) with proportions of carpus and chela not markedly different in male and female specimens examined. Fingers bent inwards at tips, each terminating in small corneous claw; with tufts of setae on dorsal and ventral surfaces; cutting edges each with irregularly-sized calcareous teeth; cutting edge of dactyl also with distal row of small, closely-set, corneous teeth. Dactyl set at slightly oblique angle to palm, with dorsomesial and mesial rows of small spines proximally. Palm and carpus each with numerous small spines and

tubercles on dorsal surface; ventral surfaces of palm and carpus also with spines and tubercles but less numerous than on dorsal surfaces. Merus with small setose tubercles dorsally, and scattered small spines or tubercles dorsolaterally and on ventral surface; mesial surface smooth; with ventromesial row of spines. Ischium with blunt spines dorsally, and ventromesial row of spines. Coxa usually with 1 or 2 small spines on ventrodistal margin and ventromesial row of setae.

Left cheliped (Fig. 36e) slender. Fingers each terminating in small corneous claw; dorsal and ventral surfaces with scattered tufts of short setae; cutting edge of dactyl with row of minute corneous teeth fused distally; cutting edge of fixed finger with row of regularly-spaced, small, evenly-sized calcareous teeth. Palm with 1-3 small spines or tubercles dorsomesially, and small spines dorsolaterally and laterally. Carpus armed with row of small spines

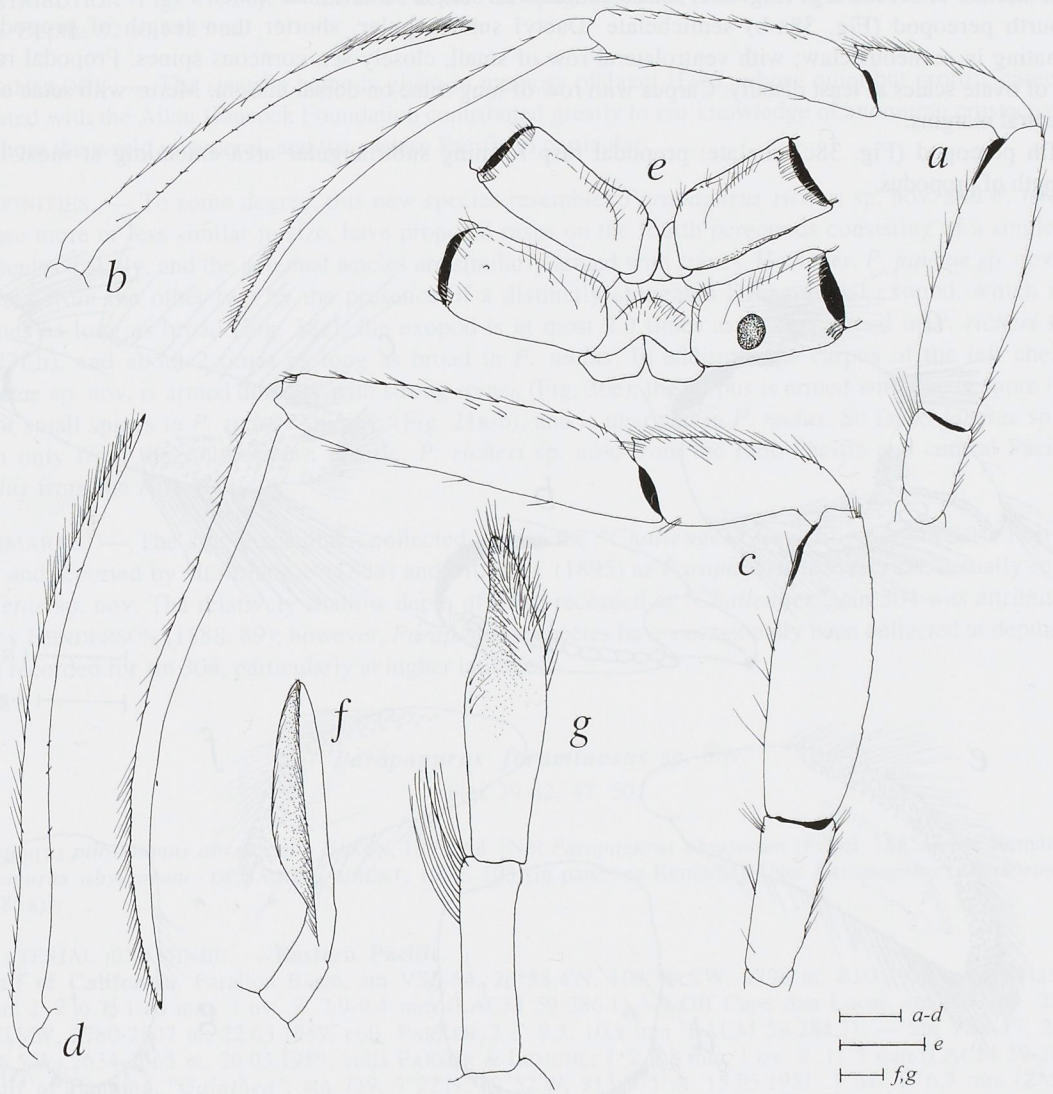

FIG. 37. — *Parapagurus janetae* sp. nov., eastern Pacific, *"Albatross"*, stn 2807: a-e, holotype ♀ 4.8 mm (USNM 276120); f-g, paratype ♂ 4.5 mm (USNM 276121). **a**, left first ambulatory leg, lateral view; **b**, dactyl of same, mesial view; **c**, left second ambulatory leg, lateral view; **d**, dactyl of same, mesial view; **e**, coxae and sternites of ambulatory legs, ventral view; **f**, male left first pleopod, mesial view; **g**, male left second pleopod, anterior view.
Scales equal 1 mm (a-e), and 0.5 mm (f,g).

dorsally. Merus unarmed except for row of bristles on dorsal margin; with ventromesial row of spines. Ischium with small, low setose tubercles on dorsal margin; with 2 small spines on ventromesial margin (one distally, one proximally). Coxa usually with 2 small spines on ventrodistal margin and ventromesial row of setae.

Ambulatory legs (Fig. 37a-d) similar from right to left (except for slightly longer segments on right), slender, long, distinctly overreaching right cheliped. Dactyl about 1.7 times as long as propodus; with dorsal and ventromesial distal row of setae; ventromesial margin with row of about 5 to 9 minute corneous spinules. Meri, carpi, and propodi each with short setae on dorsal margin, and smooth lateral and mesial faces; propodi about 3.8 to 4.0 (first leg) or 3.8 to 4.3 (second leg) times as long as high; carpi each with small dorsodistal spine; meri about 3.3 to 3.5 (first leg) or 2.4 to 3.0 (second leg) times as long as high. Ischia unarmed except for setae distally. Coxae (Fig. 37e) with ventromesial margin unarmed or at most with minute spine proximally. Anterior lobe of sternite of second legs (Fig. 37e) setose, armed with simple subterminal spine.

Fourth pereopod (Fig. 38a-b) semichelate. Dactyl subtriangular, shorter than length of propodal rasp, terminating in corneous claw; with ventrolateral row of small, closely-set, corneous spines. Propodal rasp with 1 row of ovate scales at least distally. Carpus with row of long setae on dorsal margin. Merus with setae on dorsal and ventral margins.

Fifth pereopod (Fig. 38c) chelate; propodal rasp forming subtriangular area extending at most to about midlength of propodus.

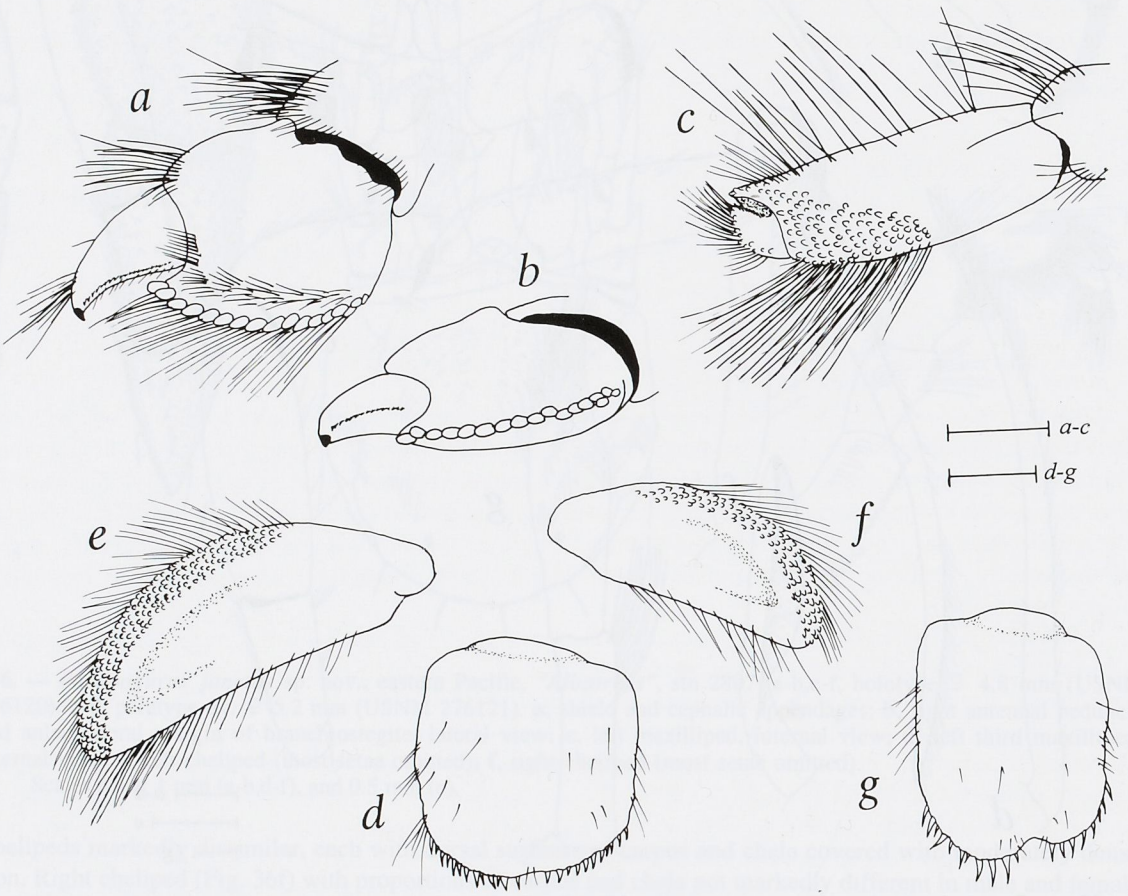

FIG. 38. — *Parapagurus janetae* sp. nov., eastern Pacific, *"Albatross"*, stn 2807: a-f, holotype ♀ 4.8 mm (USNM 276120); g, paratype ♂ 4.5 mm (USNM 276121). **a**, propodus and dactyl of left fourth pereopod, lateral view; **b**, same (setae omitted), ventrolateral view; **c**, propodus and dactyl of left fifth pereopod, lateral view; **d**, telson, dorsal view; **e-f**, left (e) and right (f) exopod of uropods, dorsal view; **g**, telson, dorsal view. Scales equal 0.5 mm.

Telson and uropods (Fig. 38d-g) weakly asymmetrical. Left exopod (Fig. 38e) elongate, about 2.9 times as long as broad; with moderately broad rasp. Telson without or at most with weakly marked lateral indentations; with scattered setae dorsally, and few long setae laterally; terminal margin divided into 2 rounded projections by unarmed, rounded (U-shaped) cleft (very shallow in females, deep in only known male; Fig. 38g); rounded projections each armed distally with 8 to 14 short to moderately long corneous spines.

SIZE RANGE. — Only known male, SL 4.5 mm. Females 4.8, 5.7 mm. Ovigerous females 5.1, 5.2 mm.

HABITAT. — According to HENDERSON (1888: 89), the specimen obtained during the *"Challenger"* expedition from Port Otway, was found living in a gastropod shell (*Trochus* sp.).

DISTRIBUTION (Figs 47, 50). — Eastern Pacific: Galápagos Islands, and coast of Chile (Port Otway, Golfo de Peñas). Depth: 82 to 1485 m.

ETYMOLOGY. — The specific name is given in memory of Janet HAIG, whose quiet but prolific career while associated with the Allan Hancock Foundation contributed greatly to our knowledge of anomuran crustaceans from throughout the world in general, and the eastern Pacific in particular.

AFFINITIES. — To some degree, this new species resembles *Parapagurus richeri* sp. nov. and *P. nudus*. All three are more or less similar in size, have propodal rasps on the fourth pereopods consisting of a single row of ovate scales distally, and the antennal acicles are similarly armed with spines. However, *P. janetae* sp. nov. can be separated from the other two by the presence of a distinctly elongated left uropodal exopod, which is about 2.9 times as long as broad (Fig. 38e); the exopod is at most 2.3 times as long as broad in *P. richeri* sp. nov. (Fig. 23f,h), and about 2 times as long as broad in *P. nudus*. In addition, the carpus of the left cheliped in *P. janetae* sp. nov. is armed dorsally with strong spines (Fig. 36e); the carpus is armed with one or more irregular rows of small spines in *P. richeri* sp. nov. (Fig. 21a-b), and is unarmed in *P. nudus*. So far *P. janetae* sp. nov. is known only from the southeastern Pacific, *P. richeri* sp. nov. from the Indo-Pacific and central Pacific, and *P. nudus* from the Atlantic.

REMARKS. — The single specimen collected during the *"Challenger"* Expedition at stn 304, Port Otway, Chile, and reported by HENDERSON (1888) and MURRAY (1895) as *Parapagurus abyssorum*, actually represents *P. janetae* sp. nov. The relatively shallow depth of 82 m recorded at *"Challenger"*, stn 304 was attributed to an error by HENDERSON (1888: 89); however, *Parapagurus* species have occasionally been collected at depths similar to that recorded for stn 304, particularly at higher latitudes.

Parapagurus foraminosus sp. nov.

Figs 39-42, 47, 50

Parapagurus pilosimanus abyssorum - FAXON, 1895: 68. [Not *Parapagurus abyssorum* (Filhol, 1885a); see Remarks].
Parapagurus abyssorum - DE SAINT LAURENT, 1972: 103 (in part; see Remarks). [Not *Parapagurus abyssorum* (Filhol, 1885a)].

MATERIAL EXAMINED. — **Eastern Pacific**.

Gulf of California. Farallon Basin, stn VSS-54, 23°58.4'N, 108°59.5'W, 2798 m, 8.03.1959, coll. WISNER: 1 ♂ 7.0 mm, 2 ♀ 6.7, 10.0 mm, 3 ov. ♀ 7.9-9.4 mm (LACM 59-286.1). — Off Cape San Lucas, stn P-41-59, 22°32.5'N, 109°40.8'W, 2780-2807 m, 22.03.1959, coll. PARKER: 2 ♂ 9.5, 10.3 mm (LACM 59-284.1). — Stn VSS-17, 22°35.6'N, 110°06.5'W, 2634-2663 m, 26.03.1959, colls PARKER & LEMCHE: 1 ♀ 7.8 mm, 1 ov. ♀ 11.5 mm (LACM 59-285.1).

Gulf of Panamá. *"Galathea"*: stn 739, 7°22'N, 79°32'W, 915-975 m, 15.05.1951: 1 ov. ♀ 6.3 mm (ZMK CRU-3409).

Baja California to Ecuador. *"Albatross"*: stn 2793, off Ecuador, Galera Point, 1°03'N, 80°15'W, 1306 m, 3.03.1888: 9 ♂ 4.0-8.9 mm, 3 ♀ 6.4-8.2 mm, 8 ov. ♀ 6.0-9.6 mm (USNM 18999). — Stn 2807, Galápagos Islands, San Cristobal Island, 0°24'S, 89°06'W, 1485 m, 4.04.1888: 1 ♂ 8.2 mm (USNM 276122); 6 ♂ 6.3-8.4 mm, 5 ♀ 5.8-8.8 mm (USNM 19000). — Stn 2986, Mexico, off Baja California, 28°57'N, 118°14'30"W, 1251 m, 28.02.1889: 1 ♂ 7.9 mm (USNM 276109). — Stn 3362, Cocos Island, 5°56'N, 85°10'30"W, 2149 m, 26.02.1891: 1 ♂ 6.2 mm (USNM

21667). — Stn 3363, Cocos Island, 5°43'N, 85°50'W, 1789 m, 26.02.1891: 7 ♂ 5.1-9.1 mm, 2 ♀ 5.6, 9.0 mm, 3 ov. ♀ 7.9-9.6 mm (USNM 21668). — Stn 3364, Cocos Island, 5°30'N, 86°08'30"W, 1650 m, 27.02.1891: 1 ♂ (damaged) (USNM 42623). — Stn 3366, Cocos Island, 5°30'N, 86°45'W, 1951 m, 27.02.1891: 2 ♂ 8.6, 9.5 mm, 2 ♂ 4.5, 7.8 mm (USNM 21669).— Stn 3371, off Colombia and Panamá, 5°26'20"N, 86°55'W, 1408 m, 1.03.1891: 6 ♂ 7.6-9.9 mm, 5 ♀ 6.7-9.0 mm, ov. ♀ 7.0-9.6 mm (MCZ 4524). — Stn 3375, off Colombia, Malpelo Island, 2°34'N, 82°29'W, 2197 m, 4.03.1891: 1 ♂ 8.8 mm (USNM 21670). — Stn 3376, off Colombia, Malpelo Island, 3°09'N, 82°08'W, 2070 m, 4.03.1891: 1 ♂ 5.2 mm, 1 ♀ 6.1 mm (USNM 42626); 1 ♂ 4.6 mm, 1 ♀ 3.0 mm (USNM 42627). — Stn 3380, off Colombia, Malpelo Island, 4°03'N, 81°31'W, 1644 m, 5.03.1891: 1 ♂ 6.4 mm (USNM 21671). — Stn 3392, Gulf of Panamá, SE of Azuero Peninsula, 7°05'30"N, 79°40'W, 2323 m, 10.03.1891: 1 ♂ 6.0 mm, 1 ♀ 3.7 mm (USNM 21672). — Stn 3393, Gulf of Panamá, SE of Azuero Peninsula, 7°15'00"S, 79°36'00"W, 1866 m, 10.03.1891: 2 ♂ 8.2, 10.0 mm, 2 ♀ 7.9, 8.9 mm (USNM 21673). — Stn 3400, E off Galápagos Islands, 0°36'S, 86°46'W, 2418 m, 27.03.1891: 1 ♂ 8.6 mm, 1 ov. ♀ 8.7 mm (USNM 21674); 3 ♂ 6.0-10.3 mm, 2 ♀ 7.3, 9.2 mm (MCZ 20,020). — Stn 3407, N of Galápagos Islands, San Salvador Island, 0°04'S, 90°24'30"W, 1619 m, 3.04.1891: fragments of specimen (USNM 21675). — Stn 3413, Galápagos Islands, Culpepper Island, 2°34', 92°06'W, 2487 m, 5.04.1891: 1 ♂ 10.4 mm (USNM 21676); 1 ♂ 9.2 mm, 2 ♀ 10.4, 12.5 mm, 1 ov. ♀ 11.5 mm (MCZ 4526). — Stn 3429, off Mexico, Mazatlán,

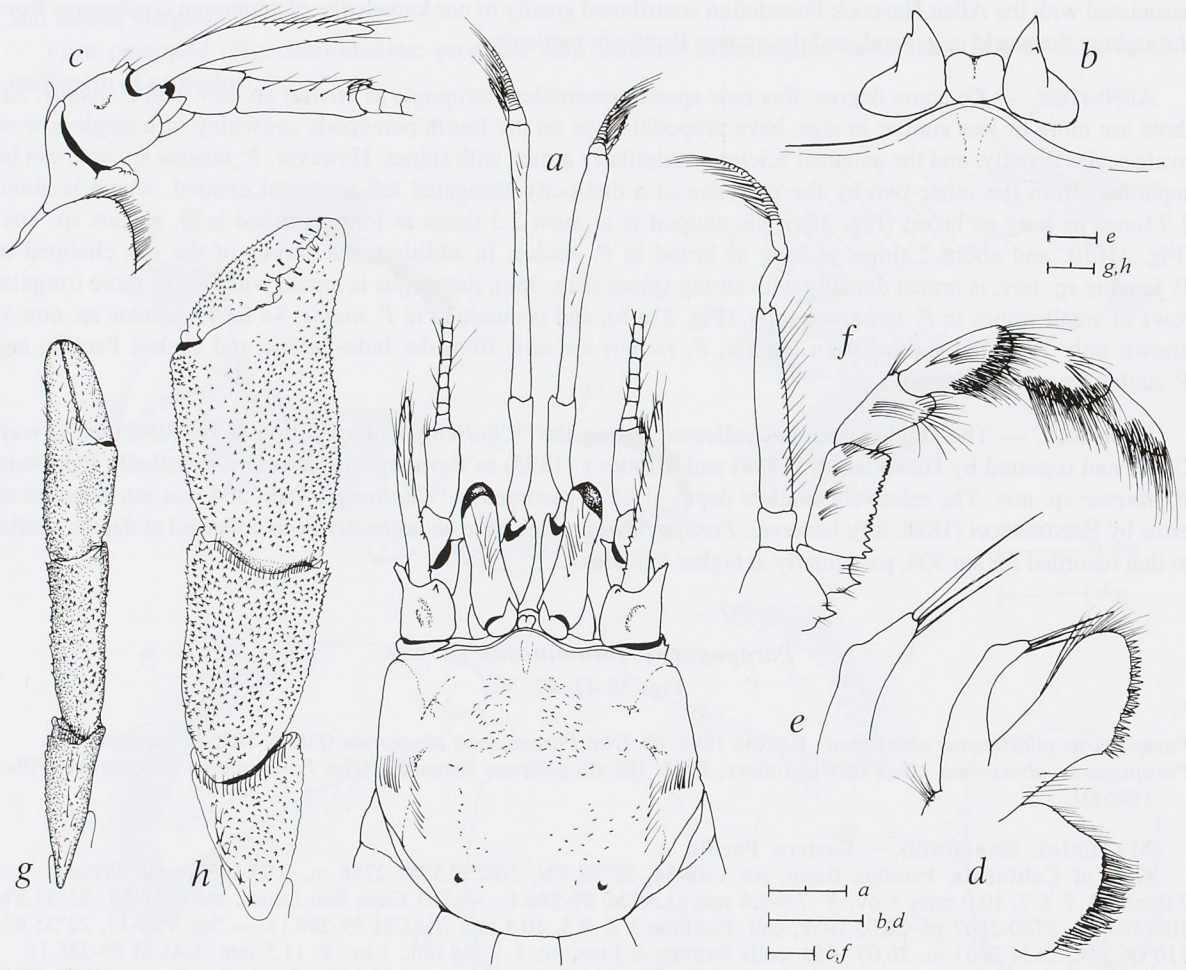

FIG. 39. — *Parapagurus foraminosus* sp. nov., eastern Pacific, *"Albatross"* : a,c,g,h, stn 2807, holotype ♂ 8.2 mm (USNM 276122); b, stn 2807, paratype ♂ 7.9 mm (USNM 19000); d-f, stn 5685, paratype ♂ 8.5 mm (USNM 276112). **a**, shield and cephalic appendages; **b**, ocular acicles and rostrum, dorsal view; **c**, right antennal peduncle and anterolateral margin of branchiostegite, lateral view; **d**, left maxillule, internal view; **e**, distal end of endopod of same; **f**, left third maxilliped, internal view; **g**, left cheliped (setae omitted); **h**, right cheliped (setae omitted).
Scales equal 2 mm (a), 1 mm (b-d,f), 0.25 mm (e), and 2 mm (g,h).

22°30'30"N, 107°01'W, 1681 m, 19.04.1891: 2 ♂ 6.4 mm (parasitized), 9.2 mm (USNM 21677). — Stn 3431, 23°59'N, 108°40'W, 1820 m, 20.04.1891: 1 ♂ 11.0 mm, 1 ♀ 10.4 mm (USNM 21678). — Stn 3432, E of Baja California, Cerralvo Island, 24°22'30"N, 109°03'20"W, 2599 m, 20.04.1891: 1 ov. ♀ 7.8 mm (USNM 21679). — Stn 5676, Baja California, 25°31'15"N, 113°29'30"W, 1180 m, 17.03.1911: 7 ♂ 6.7-9.4 mm, 4 ♀ 7.8-9.9 mm, 11 ov. ♀ 7.9-9.7 mm (USNM 276113). — Stn 5685, Baja California, S of Abreojos Point, 25°42'45"N, 113°38'30"W, 1180 m, 22.04.1911: 5 ♂ 7.0-8.7 mm, 5 ♀ 7.8-9.3 mm, 4 ov. ♀ 6.7-9.6 mm (USNM 276112); 3 ♂ 7.8-8.7 mm, 1 ♀ 8.7 mm, 2 ov. ♀ 8.0, 9.2 mm (MNHN-Pg 5647). — Stn 5686, Mexico, SW of Abreojos Point, 26°14'N, 114°00'W, 1701 m, 22.04.1911: 1 ♂ 8.9 mm (USNM 276111). — Stn 5690, Mexico, E of Guadalupe Island, 29°29'N, 116°18'W, 2014 m, 24.04.1911: 1 ♂ 8.1 mm (USNM 276110).

TYPES. — *Holotype*: ♂ 8.2 mm, *"Albatross"*, stn 2807, Eastern Pacific. Galápagos Islands, San Cristobal Island, 0°24'S, 89°06'W, 1485 m, 4.04.1888 (USNM 276122). *Paratypes*: All the others specimens mentioned above.

DESCRIPTION. — Shield (Fig. 39a) about as broad as long or at most slightly broader than long; dorsal surface usually well calcified, with rows of short setae posteriorly on each side; anterior margin weakly concave; lateral projections broadly rounded; anterolateral margins sloping. Rostrum broadly subtriangular, rounded distally, overreaching lateral projections; with low mid-dorsal ridge. Anterodistal margin of branchiostegite (Fig. 39c) rounded, unarmed, setose.

Ocular peduncles (including corneae) less than half length of shield, each with dorsal row of setae; peduncles inflated basally; width of cornea about same as distal width of ocular peduncle. Ocular acicles subtriangular, terminating in strong simple or bifid spine (Fig. 39a-b); separated basally by slightly less than basal width of one acicle.

Antennular peduncles slender, exceeding distal margins of corneae by half or more length of penultimate segments. Ultimate and penultimate segments with scattered setae; ultimate segment nearly twice as long as penultimate. Basal segment with ventromesial distal spine; mesial face unarmed; lateral face with statocyst lobe having subrectangular distal lobe armed with 1 or 2 small spines, and 1 spine proximally.

Antennal peduncles (Fig. 39c) exceeding distal margins of corneae by about 0.6 length of fifth antennal segments. Fifth segment with setae on lateral and mesial margins. Fourth segment with scattered setae. Third segment with strong ventromesial distal spine. Second segment with dorsolateral distal angle produced into strong, usually bifid spine; mesial margin with spine on dorsodistal angle. First segment with lateral face unarmed or with 1-3 small blunt spines; ventromesial angle produced, with row of small spines. Acicles weakly curved in dorsal view, exceeding distal margin of corneae by 0.3 to half length of acicle; mesial margin armed with 3 to 8 small spines on proximal half. Flagellum overreaching extended right cheliped; with setae about 1 to 2 flagellar articles in length.

Mandible, maxilla, and first and second maxillipeds typical of species in genus (e.g. Fig. 20). Maxillule (Fig. 39d-e) with external lobe weakly developed, internal lobe with 1 long terminal and 2 subterminal setae. Third maxilliped (Fig. 39f) with crista dentata consisting of about 17 small corneous teeth; coxa and basis each with strong sharp mesial tooth. Epistomial spine usually present. Sternite of third maxillipeds with strong spine on each side of midline.

Chelipeds markedly dissimilar. Right cheliped (Fig. 39h) with dorsal surfaces of carpus and chela covered with dense setation. Fingers bent inwards at tips, each terminating in small corneous claw; with tufts of setae dorsally and ventrally; cutting edges each with irregularly-sized calcareous teeth; cutting edge of dactyl with distal row of small, closely-set, corneous teeth. Dactyl about as long as mesial margin of palm; set at slightly oblique angle to palm; with numerous small spines on dorsomesial and mesial margins. Fixed finger with few small spines on dorsal face proximally, lacking spines distally. Palm and carpus each densely covered with small (often minute) spines on dorsal surfaces; with scattered small spines on ventral surfaces. Merus with dorsal row of short bristle-like setae; with small spines or tubercles on lateral and ventral surfaces, and ventromesial row of spines. Ischium with dorsal and ventromesial row of spines. Coxa with row of spines on ventrodistal margin and ventromesial row of setae.

Left cheliped (Fig. 39g) well calcified, with dense setation on carpus and chela. Fingers each terminating in short corneous claw; dorsal and ventral surfaces with scattered tufts of short setae; cutting edge of dactyl with row

of minute, closely-set, corneous teeth; cutting edge of fixed finger with row of small, evenly-spaced, calcareous teeth interspersed with small corneous teeth. Palm with irregular rows of small spines on dorsolateral and dorsomesial faces. Carpus with irregular rows of small spines dorsally; ventral face unarmed. Merus with row of short bristle-like setae on dorsal margin; with few small spines on lateral and ventral faces. Ischium with small setose tubercles dorsally; ventromesial margin with small spine proximally and another distally. Coxa with row of spines on ventrodistal margin and ventromesial row of setae.

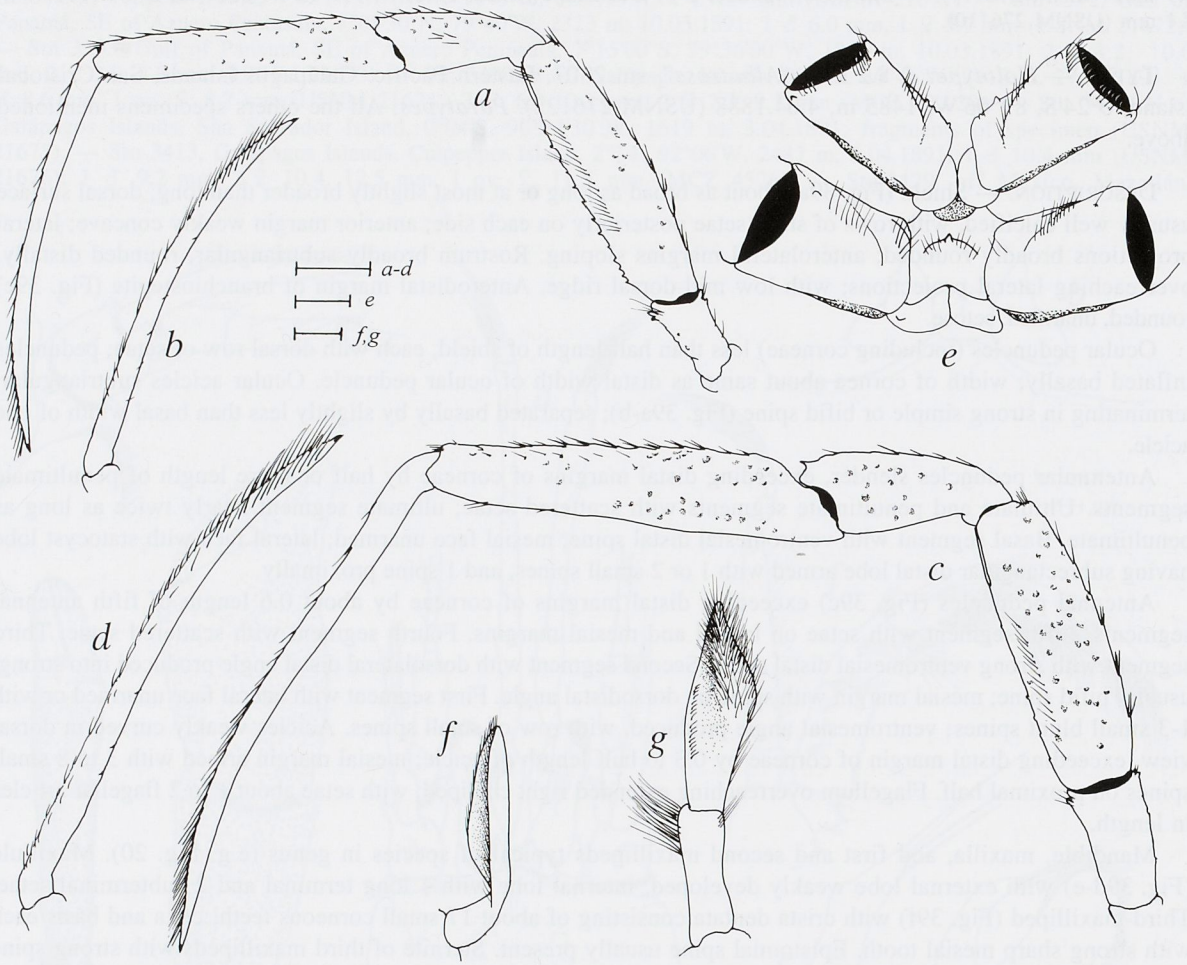

FIG. 40. — *Parapagurus foraminosus* sp. nov., eastern Pacific, *"Albatross"*, stn 2807, holotype ♂ 8.2 mm (USNM 276122): **a**, left first ambulatory leg, lateral view; **b**, dactyl of same, mesial view; **c**, left second ambulatory leg, lateral view; **d**, dactyl of same, mesial view; **e**, coxae and sternite of ambulatory legs, ventral view; **f**, male left first pleopod, mesial view; **g**, male left second pleopod, anterior view.
Scales equal 3 mm (a-d), and 1 mm (e-g).

Ambulatory legs (Fig. 40a-d) similar from right to left (except slightly longer segments on right). Dactyl about 1.6 times as long as propodus; with ventromesial row of 2 to 8 minute spinules, and dorsal and dorsomesial distal rows of setae. Meri, carpi, and propodi each with lateral faces with shallow pits more numerous on second leg (Figs 40a,c, 41). Propodi about 5 times (first leg) or 4.5 times (second leg) as long as high; with short transverse rows of bristle-like setae on dorsolateral and dorsomesial faces. Carpi each with small dorsodistal spine; dorsal margins with short, bristle-like setae often set at bases of small spines or tubercles. Meri each about 3.7 (first leg) or 3 (second leg) times as long as high; dorsal margins with short, bristle-like setae; with longitudinal

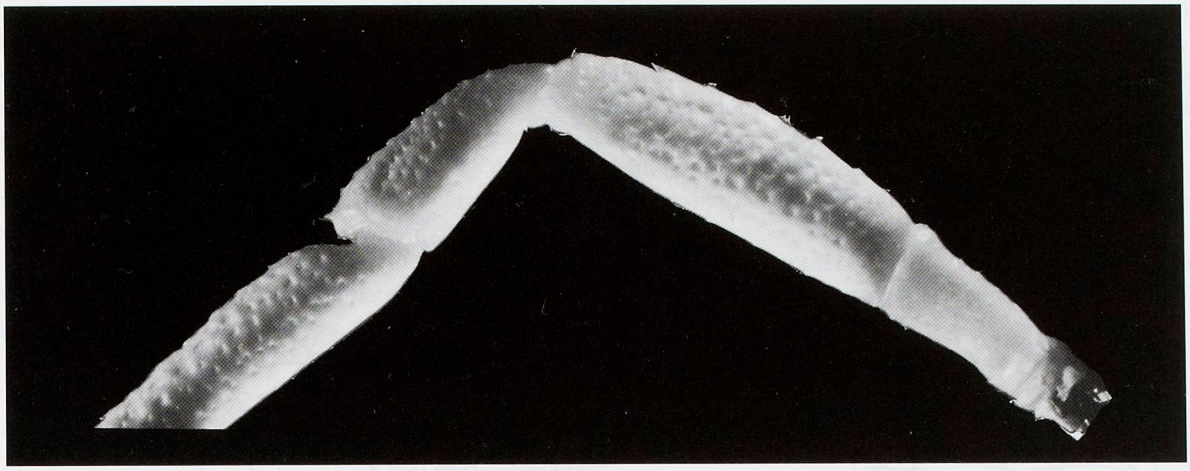

FIG. 41. — *Parapagurus foraminosus* sp. nov., eastern Pacific, Cocos Island, *"Albatross"*, stn 3363, paratype ♂ 9.4 mm (USNM 21668): ischium, merus, carpus, and portion of propodus, of left second ambulatory leg, showing pits, lateral view (x 4.2).

row of setae on ventral half of lateral face. Merus and ischium of first leg each with row of small spines on ventral margins; merus and ischium of second leg unarmed or with few small blunt spines. Coxa with ventrodistal margin unarmed or with small spines. Anterior lobe of sternite of second legs (Fig. 40e) subsemicircular, setose, with short subterminal spine.

Fourth pereopod (Fig. 42a-d) semichelate. Dactyl subtriangular, shorter than length of propodal rasp, terminating in corneous claw; with ventrolateral row of small corneous spines. Propodal rasp consisting of 1 or 2 rows of ovate scales. Carpus with long setae on dorsal margin. Merus with setae on dorsal and ventral margins.

Fifth pereopod (Fig. 42e) chelate; propodal rasp occupying subtriangular area less than half length of propodus.

Telson and uropods (Fig. 42f-h) asymmetrical. Left exopod (Fig. 42g) of uropod about 2.3 times as long as broad, with broad rasp. Telson lacking or at most with weakly marked lateral indentations; with scattered setae dorsally, and long setae laterally; terminal margin divided into 2 rounded projections by rounded (U-shaped) cleft; rounded projections each armed distally with long, often curved, corneous spines (usually about 10 to 15, occasionally up to 26 on left).

SIZE RANGE. — Males, SL 4.0 to 11.0 mm. Females 3.0 to 10.4 mm. Ovigerous females 5.8 to 11.5 mm.

VARIATIONS. — Small individuals (SL < 5.0 mm) usually exhibit less numerous pits on the lateral faces of meri, carpi and propodi of the ambulatory legs, pits which are often more clearly visible by tilting the appendage to a ventrolateral view.

HABITAT. — Found in gastropod shells often completely covered by an actinian.

DISTRIBUTION (Figs 47, 50). — Eastern Pacific: Baja California to Ecuador, including Cocos Island and Galápagos Islands. Depth: 915 to 2807 m.

AFFINITIES. — This new species shares only general similarities with other *Parapagurus* species having ovate scales on the propodal rasp of the fourth pereopod. The dense spination on the dorsal surfaces of the merus, carpus and chela of the right cheliped resembles that of *P. microps*. In both species the dorsal surfaces are covered with dense, small (often minute) spines. However, *P. foraminosus* sp. nov. differs from *P. microps* and all other congeners, in having many shallow pits on the lateral faces of the meri, carpi, and propodi of the ambulatory legs (Fig. 41).

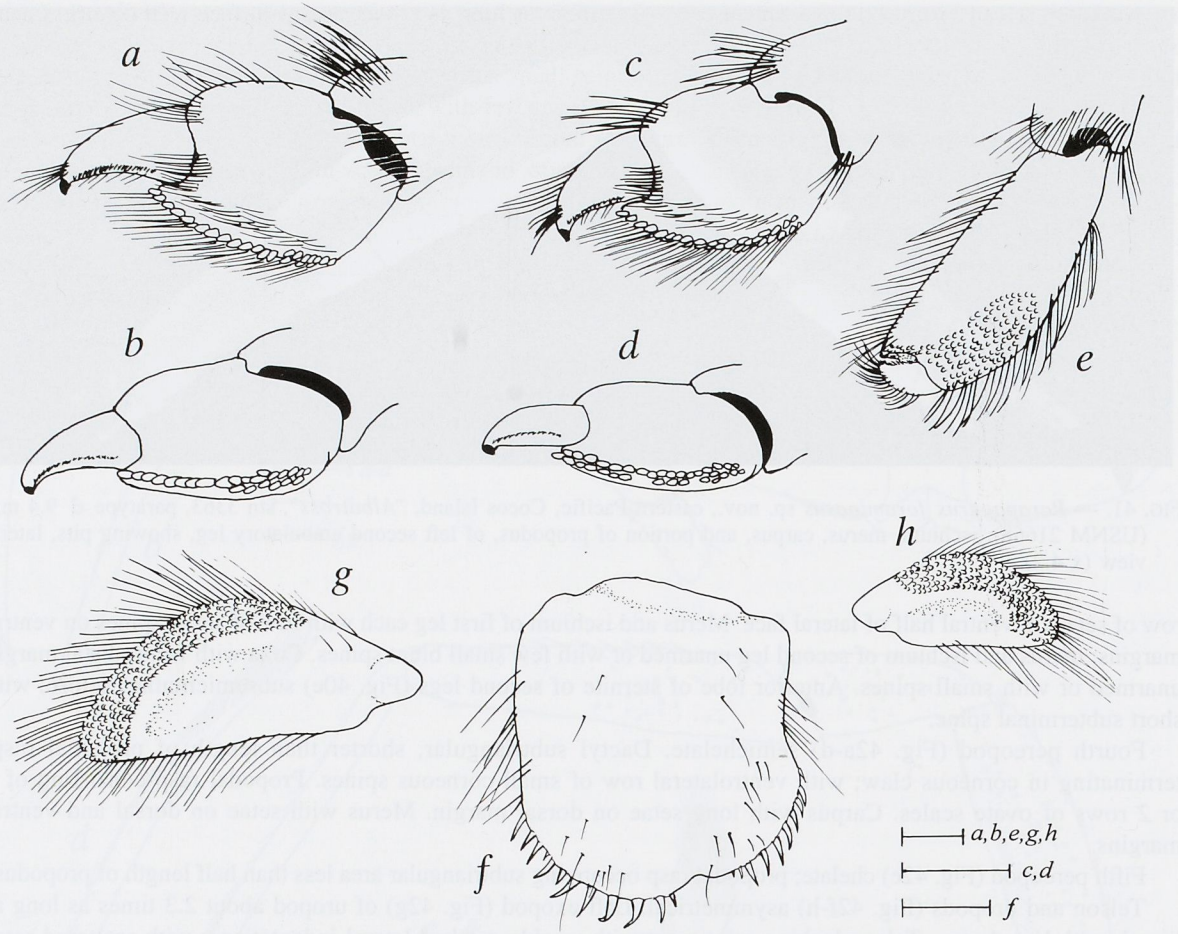

FIG. 42. — *Parapagurus foraminosus* sp. nov., eastern Pacific, *"Albatross"*: a-b,e-h, stn 2807, holotype ♂ 8.2 mm (USNM 276122); c,d, stn 2807, paratype ♂ 7.2 mm (USNM 19000). **a**, propodus and dactyl of left fourth pereopod, lateral view; **b**, same (setae omitted), ventrolateral view; **c**, propodus and dactyl of left fourth pereopod, lateral view; **d**, same (setae omitted), ventrolateral view; **e**, propodus and dactyl of left fifth pereopod, lateral view; **f**, telson, dorsal view; **g-h**, left (g) and right (h) exopod of uropods, dorsal view.
Scales equal 0.5 mm (a-b,e-h,), and 1 mm (c-d).

REMARKS. — The eastern Pacific material used by DE SAINT LAURENT (1972) in her report of *Parapagurus pilosimanus abyssorum* actually represents this new species.

Examination of the material reported by FAXON (1895) as *Parapagurus pilosimanus abyssorum* has shown that it represents *P. foraminosus* sp. nov.

Parapagurus wolffi sp. nov.

Figs 43-47, 50

Parapagurus abyssorum - GARTH & HAIG, 1971: 5. (See Remarks). [Not *Parapagurus abyssorum* (Filhol, 1885a)].

MATERIAL EXAMINED. — **Perú**. *"Anton Bruun"*, cruise 11, stn 169, 8°46'S, 80°44'W, 3909-3970 m, 2.11.1965: 1 ov. ♀ 4.6 mm (LACM 65-335.1).

TYPES. — The sole specimen known of this species is the one above which is the holotype.

DESCRIPTION OF HOLOTYPE. — Shield (Fig. 43a) about as long as broad; dorsal surface well calcified, with longitudinal rows of short setae on each side of midline, and small setose tubercle on each lateral margin medially; lateral projections broadly rounded; anterolateral margin sloping; anterior margin weakly concave. Rostrum broadly subtriangular, rounded distally, slightly overreaching lateral projections; with low mid-dorsal ridge. Anterodistal margin of branchiostegite (Fig. 43b) rounded, unarmed, setose.

Ocular peduncles (including corneae) less than half length of shield, each with long setae dorsally; peduncles inflated basally, constricted distally near corneae. Ocular acicles subtriangular, terminating in strong simple spine; separated basally by about basal width of one acicle.

Antennular peduncles slender, long, exceeding distal margins of corneae by full length of penultimate segments. Ultimate and penultimate segments with scattered setae. Ultimate segment about twice as long as penultimate.

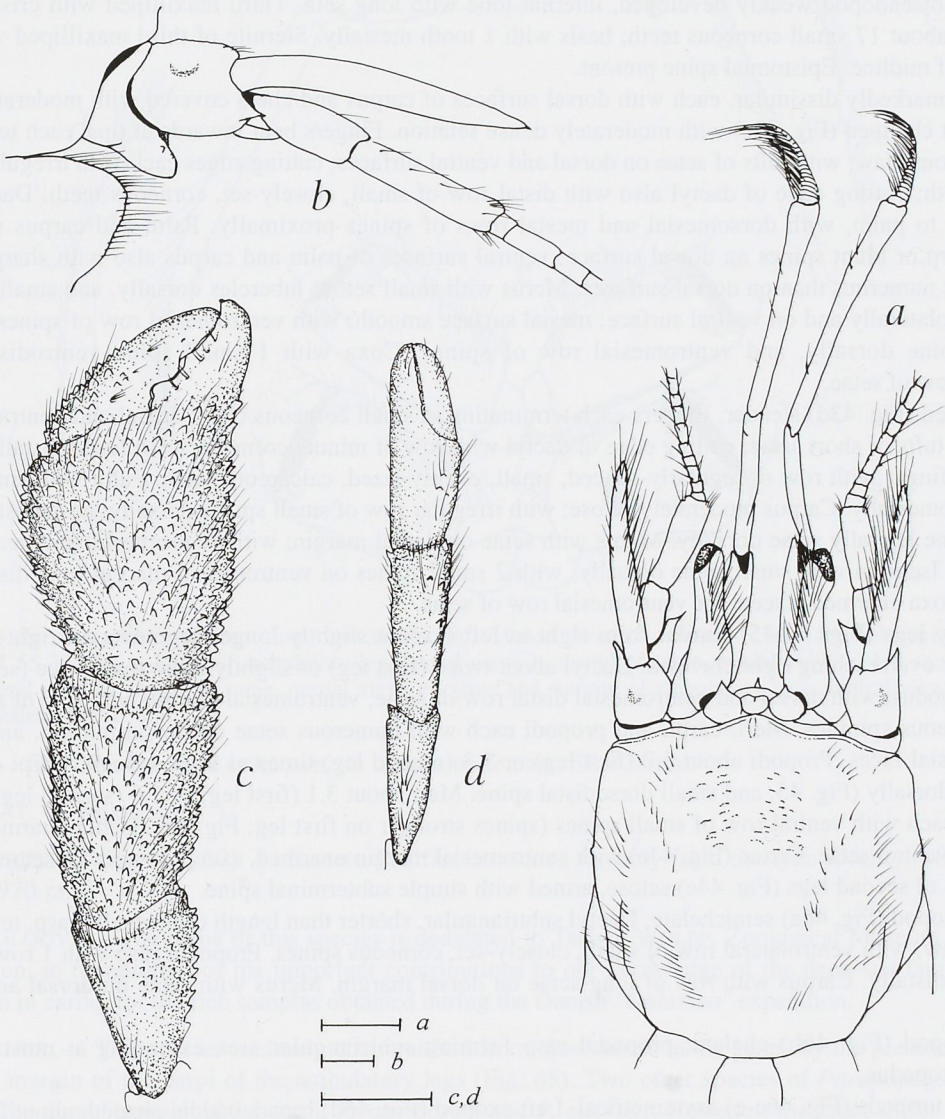

FIG. 43. — *Parapagurus wolffi* sp. nov., eastern Pacific, *"Anton Bruun"*, cruise 11, stn 169, holotype ov. ♀ 4.6 mm (LACM 65-335.1): **a**, shield and cephalic appendages; **b**, right antennal peduncle and anterolateral margin of branchiostegite, lateral view; **c**, right cheliped, dorsal view; **d**, left cheliped, dorsal view. Scales equal 1 mm.

Basal segment with ventromesial distal spine; mesial face unarmed; lateral face with statocyst lobe having subrectangular distal lobe armed with 1 small spines, and 1 spine proximally.

Antennal peduncles (Fig. 43b) exceeding distal margins of corneae by about half length of fifth segments. Fifth segment with scattered setae on lateral and mesial margins. Fourth segment with scattered setae. Third segment with strong ventromesial distal spine. Second segment with dorsolateral distal angle produced, terminating in strong spine; mesial margin unarmed (right) or with small blunt spine (left) on dorsodistal angle. First segment with lateral face unarmed; ventromesial angle produced, with row of small spines. Antennal acicles weakly curved in dorsal view, densely setose mesially; exceeding distal margin of cornea by about half length of acicle; mesial margin unarmed. Flagellum distinctly overreaching extended right cheliped, very setose; articles with setae 1 to 4 flagellar articles in length.

Mandible, maxilla, and first and second maxillipeds typical of species in genus (e.g. Fig. 20). Maxillule with external lobe of endopod weakly developed, internal lobe with long seta. Third maxilliped with crista dentata consisting of about 17 small corneous teeth; basis with 1 tooth mesially. Sternite of third maxilliped with spine on each side of midline. Epistomial spine present.

Chelipeds markedly dissimilar, each with dorsal surfaces of carpus and chela covered with moderately dense setation. Right cheliped (Fig. 43c) with moderately dense setation. Fingers bent inwards at tips, each terminating in small corneous claw; with tufts of setae on dorsal and ventral surfaces; cutting edges each with irregularly-sized calcareous teeth; cutting edge of dactyl also with distal row of small, closely-set, corneous teeth. Dactyl set at oblique angle to palm, with dorsomesial and mesial rows of spines proximally. Palm and carpus each with numerous sharp or blunt spines on dorsal surface; ventral surfaces of palm and carpus also with sharp or blunt spines but less numerous than on dorsal surfaces. Merus with small setose tubercles dorsally, and small spines or tubercles dorsolaterally and on ventral surface; mesial surface smooth; with ventromesial row of spines. Ischium with small spine dorsally, and ventromesial row of spines. Coxa with 1 small spine ventrodistally and ventromesial row of setae.

Left cheliped (Fig. 43d) slender. Fingers each terminating in small corneous claw; dorsal and ventral surfaces with scattered tufts of short setae; cutting edge of dactyl with row of minute corneous teeth fused distally; cutting edge of fixed finger with row of regularly-spaced, small, evenly-sized, calcareous teeth. Palm with small setose tubercles dorsomesially. Carpus moderately setose; with irregular row of small spines dorsally; dorsodistal margin with small spine laterally setae dorsally. Merus with setae on dorsal margin; with ventromesial and ventrolateral row of spines. Ischium with small spine dorsally; with 2 small spines on ventromesial margin (one distally, one proximally). Coxa unarmed, except for ventromesial row of setae.

Ambulatory legs (Figs 44-45) similar from right to left (except slightly longer segments on right), slender, long, distinctly overreaching right cheliped. Dactyl about twice (first leg) or slightly more than twice (second leg) as long as propodus; with dorsal and ventromesial distal row of setae; ventromesial margin with row of about 3 or 4 minute corneous spinules. Meri, carpi, and propodi each with numerous setae on dorsal margin, and smooth lateral and mesial faces. Propodi about 3.2 (first leg) or 3.3 (second leg) times as long as high. Carpi each with row of spines dorsally (Fig. 45, and small dorsodistal spine. Meri about 3.1 (first leg) or 2.6 (second leg) times as long as high; each with ventral row of small spines (spines stronger on first leg; Fig. 45). Ischia unarmed except for dorsal and ventral setae. Coxae (Fig. 44e) with ventromesial margin unarmed, except for row of setae. Anterior lobe of sternite of second legs (Fig. 44e) setose, armed with simple subterminal spine.

Fourth pereopod (Fig. 46a) semichelate. Dactyl subtriangular, shorter than length of propodal rasp, terminating in corneous claw; with ventrolateral row of small, closely-set, corneous spines. Propodal rasp with 1 row of ovate scales at least distally. Carpus with row of long setae on dorsal margin. Merus with setae on dorsal and ventral margins.

Fifth pereopod (Fig. 46b) chelate; propodal rasp forming subtriangular area extending at most to about midlength of propodus.

Telson and uropods (Fig. 46c-e) asymmetrical. Left exopod (Fig. 46d) broad, paddle-shaped, about 2 times as long as broad; with narrow rasp. Telson with weakly marked lateral indentations, and scattered setae dorsally; terminal margin divided into 2 rounded projections by unarmed, shallow, rounded (U-shaped) cleft; rounded projections each armed distally with 18 (left) and 10 (right) corneous spines.

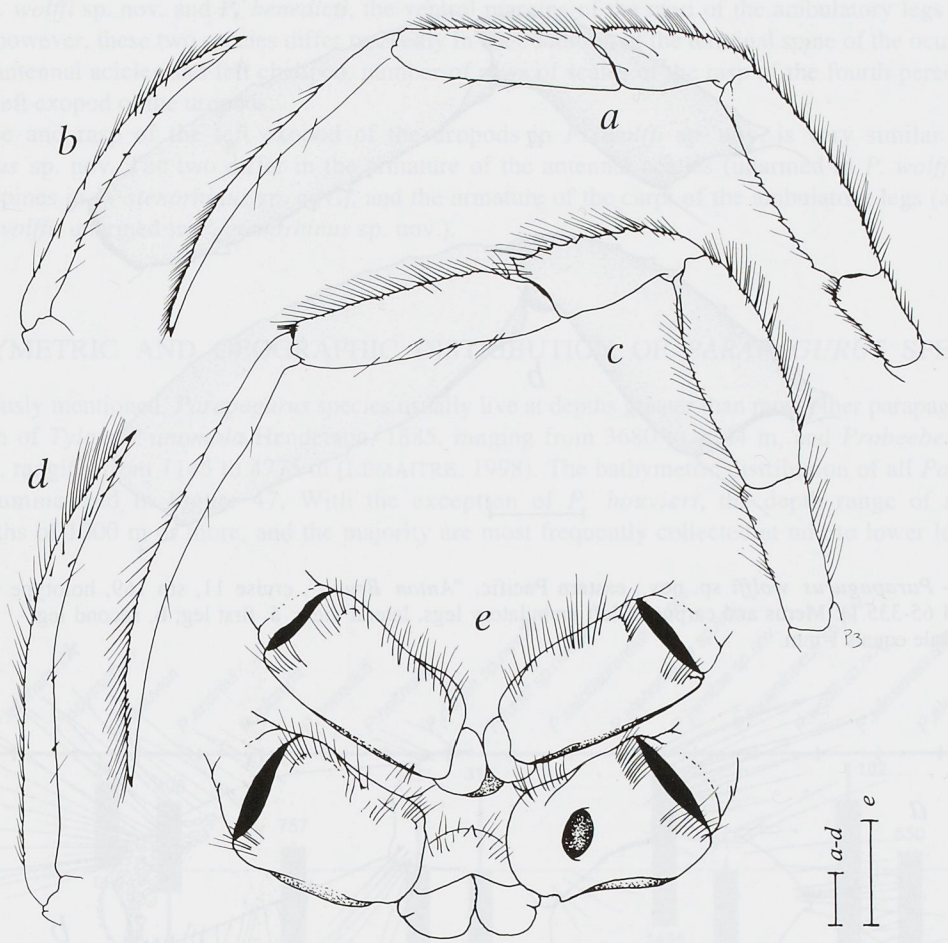

FIG. 44. — *Parapagurus wolffi* sp. nov., eastern Pacific, *"Anton Bruun"*, cruise 11, stn 169, holotype ov. ♀ 4.6 mm (LACM 65-335.1): **a**, left first ambulatory leg, lateral view; **b**, dactyl of same, mesial view; **c**, left second ambulatory leg, lateral view; **d**, dactyl of same, mesial view; **e**, coxae and sternite of ambulatory legs, ventral view.
Scales equal 1 mm.

SIZE. — Only the holotype is known, an ovigerous female, SL 4.6 mm.

HABITAT. — Unknown.

DISTRIBUTION (Figs 47, 50). — Eastern Pacific: known so far only from the type locality, off Perú. Depth: 3909 to 3970 m.

ETYMOLOGY. — The name of this species is dedicated to Torben WOLFF, Zoological Museum, University of Copenhagen, in recognition of his important contributions to our knowledge of the deep-sea fauna, and for his enthusiasm in caring for the rich samples obtained during the Danish *"Galathea"* expedition.

AFFINITIES. — This species is clearly distinguished from most others in the genus by the presence of spines on the dorsal margin of the carpi of the ambulatory legs (Fig. 45). Two other species of *Parapapagurus* also have spines on the dorsal margin of the carpi, *P. abyssorum* and *P. microps*. However, the latter differ from *P. wolffi* sp. nov. in several other characters, the most visible being the armature of the lateral faces of the meri, carpi, and propodi of the ambulatory legs; the lateral faces are unarmed in *P. wolffi* sp. nov., whereas they are armed with numerous spines in *P. abyssorum* and *P. microps*.

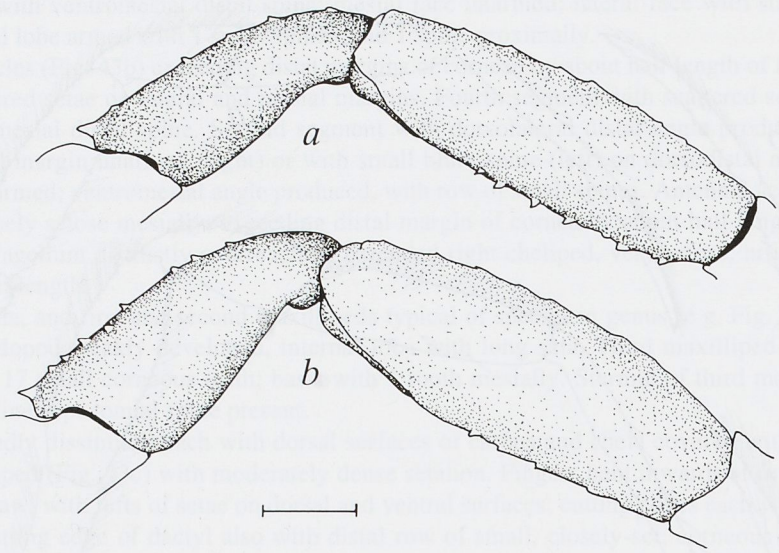

FIG. 45. — *Parapagurus wolffi* sp. nov., eastern Pacific, *"Anton Bruun"*, cruise 11, stn 169, holotype ov. ♀ 4.6 mm (LACM 65-335.1): Merus and carpus of left ambulatory legs, lateral view: **a**, first leg; **b**, second leg.
Scale equals 1 mm.

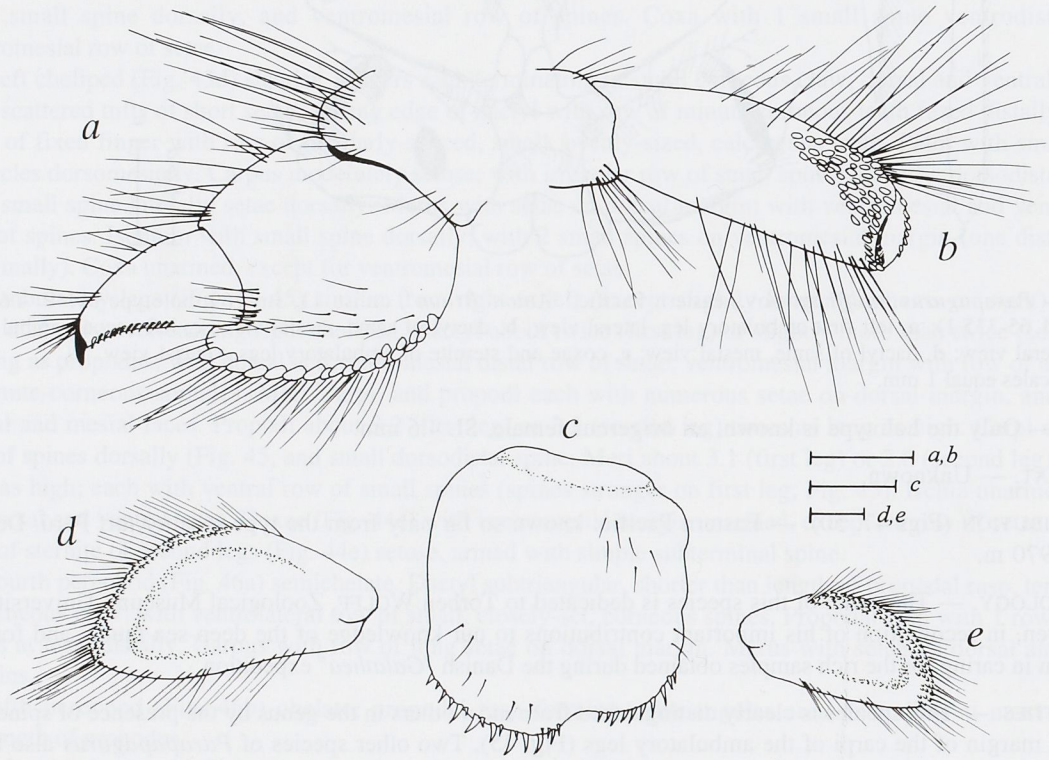

FIG. 46. — *Parapagurus wolffi* sp. nov., eastern Pacific, *"Anton Bruun"*, cruise 11, stn 169, holotype ov. ♀ 4.6 mm (LACM 65-335.1): **a**, propodus and dactyl of left fourth pereopod, lateral view; **b**, propodus and dactyl of left fifth pereopod, lateral view; **c**, telson, dorsal view; **d-e**, left (d) and right (e) exopods of uropods, dorsal view.
Scales equal 0.5 mm.

In both *P. wolffi* sp. nov. and *P. benedicti*, the ventral margins of the meri of the ambulatory legs are armed with spines; however, these two species differ markedly in the condition of the terminal spine of the ocular acicles, armature of antennal acicles and left cheliped, number of rows of scales of the rasp of the fourth pereopods, and shape of the left exopod of the uropods.

The shape and rasp of the left exopod of the uropods in *P. wolffi* sp. nov. is very similar to that of *P. stenorhinus* sp. nov. The two differ in the armature of the antennal acicles (unarmed in *P. wolffi* sp. nov., armed with spines in *P. stenorhinus* sp. nov.), and the armature of the carpi of the ambulatory legs (armed with spines in *P. wolffi*, unarmed in *P. stenorhinus* sp. nov.).

BATHYMETRIC AND GEOGRAPHIC DISTRIBUTION OF *PARAPAGURUS* SPECIES

As previously mentioned, *Parapagurus* species usually live at depths greater than most other parapagurids, with the exception of *Tylaspis anomala* Henderson, 1885, ranging from 3680 to 4344 m, and *Probeebei mirabilis* Boone, 1926, ranging from 1145 to 4775 m (LEMAITRE, 1998). The bathymetric distribution of all *Parapagurus* species is summarized in Figure 47. With the exception of *P. bouvieri*, the depth range of all species includes depths of 1000 m or more, and the majority are most frequently collected at mid to lower level depths

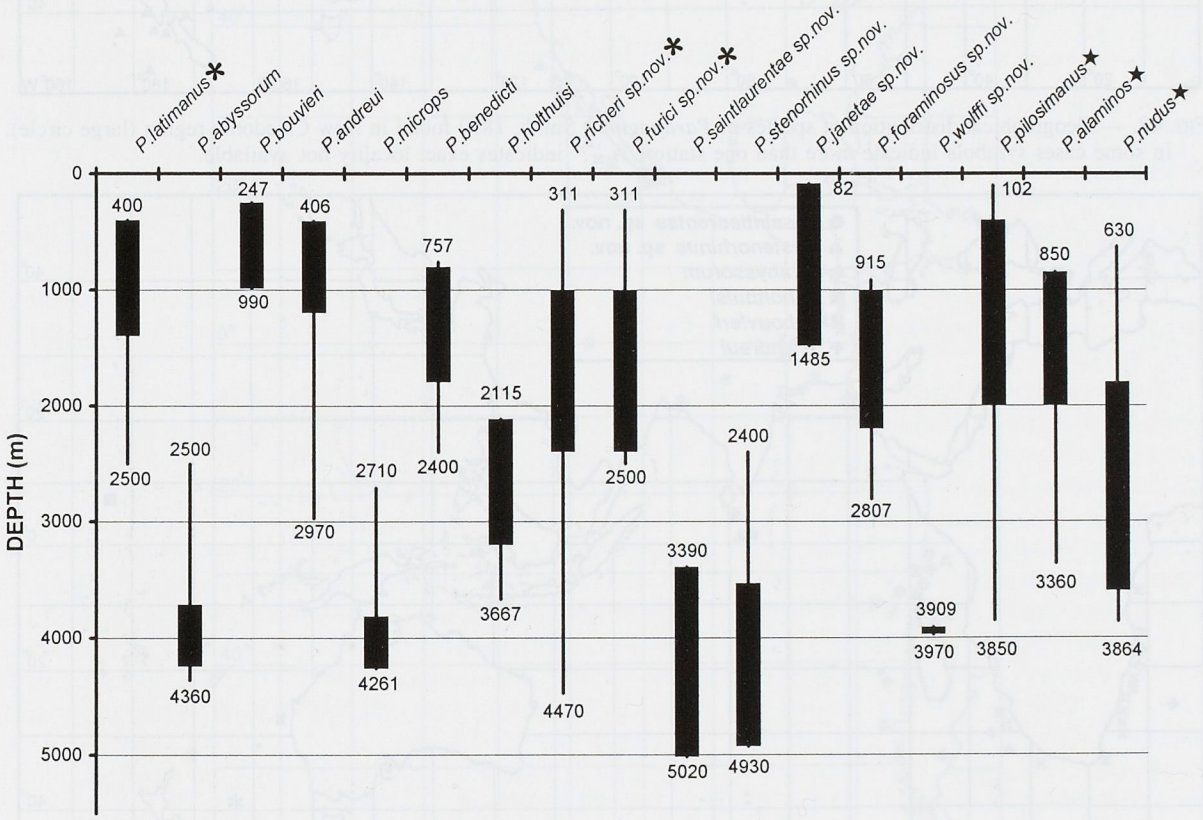

FIG. 47. — Bathymetric distribution of species of *Parapagurus* Smith, 1879 from the world, showing overall range (thin line) and most frequent range (black bar) for each species. The most frequent range was calculated from a station depth frequency histogram, and selecting a range that included 80% of station depths symmetrically around the mode. Depth data includes that used in this study as well as from published sources (e.g. DE SAINT LAURENT, 1972; MACPHERSON, 1983, 1984; LEMAITRE, 1986, 1989, 1990, 1997; LEMAITRE & MCLAUGHLIN, 1992). Asterisk: species found in New Caledonia; star: species known exclusively from the Atlantic Ocean.

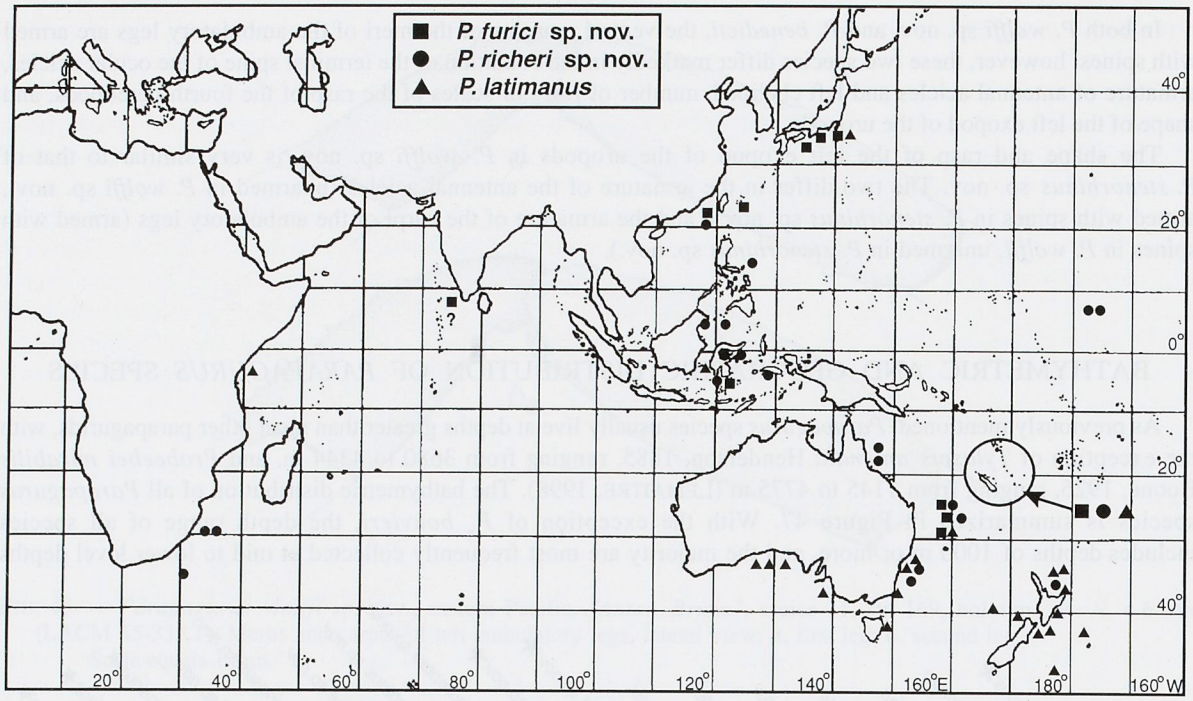

FIG. 48. — Geographical distribution of species of *Parapagurus* Smith, 1879 found in New Caledonia region (large circle). In some cases symbols indicate more than one station. A "?" indicates exact locality not available.

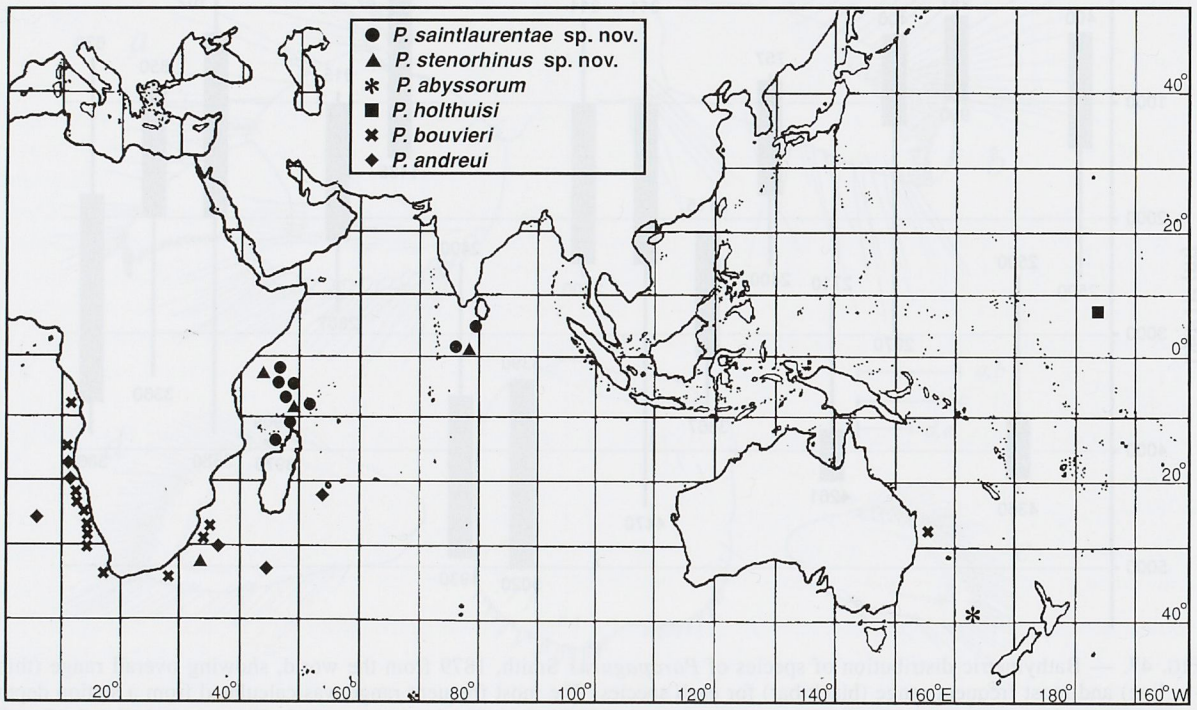

FIG. 49. — Geographical distribution of Indo-Pacific species of *Parapagurus* Smith, 1879 not found in New Caledonia region. For additional localities of *P. holthuisi* and *P. abyssorum* see FIG. 50, and LEMAITRE (1989: 29, fig. 12). In some cases symbols indicate more than one station.

(1000 to 3000 m) of the continental slope. Six species, *P. abyssorum*, *P. microps*, P. *holthuisi*, *P. saintlaurentae* sp. nov., *P. stenorhinus* sp. nov., and *P. wolffi* sp. nov., are so far known to occur exclusively below 2000 m; of these, *P. saintlaurentae* sp. nov., is found at 5020 m, which is the greatest depth recorded among all parapagurids. Only two species, *P. pilosimanus* and *P. janetae* sp. nov., have been collected in continental shelf depths (≤ 200 m), the former at 102 m off the northeastern coast of the United States (LEMAITRE, 1989), the latter at

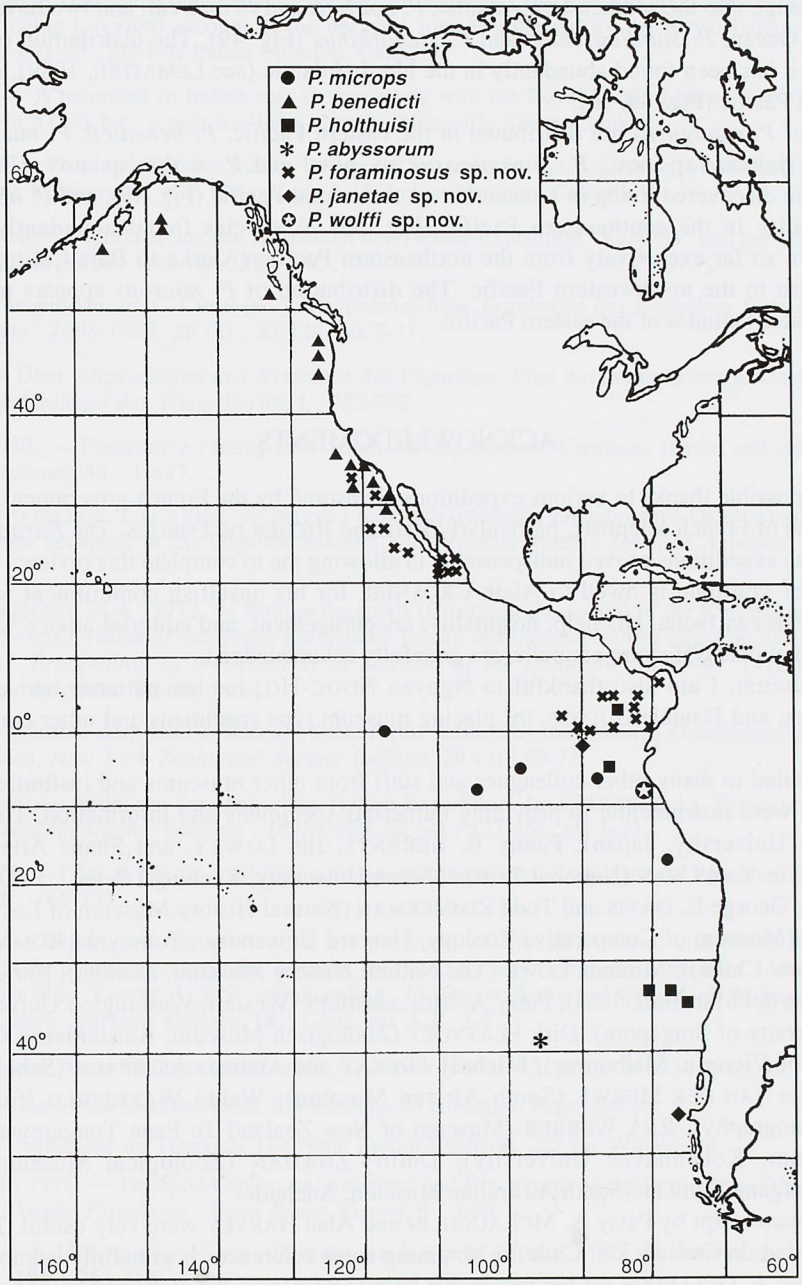

FIG. 50. — Geographical distribution of eastern Pacific species of *Parapagurus* Smith, 1879. For additional localities of *P. holthuisi* and *P. abyssorum* see FIG. 49, and LEMAITRE (1989: 29, fig. 12). In some cases symbols indicate more than one station.

82 m in the Gulf of Peñas, southern Chile. These exceptionally shallow collections (both at high latitudes) are rare, and may be attributable to the upward motion of deep cold water masses that would allow movement of individuals to much less deep water habitats.

In general, most species of *Parapagurus* are broadly distributed in one or two ocean basins (Figs 48-50). Of the 14 species that occur in the Pacific and Indian Oceans, three have been found in the New Caledonia region, *P. latimanus*, *P. richeri* sp. nov., and *P. furici* sp. nov. (Fig. 48); two are primarily distributed in the western Indian Ocean and range into the southeastern Atlantic, *P. bouvieri* and *P. andreui*, and two have so far been found only in the Indian Ocean, *P. saintlaurentae* and *P. stenorhinus* (Fig. 49). The distribution of *P. abyssorum* is particularly broad; it has been found abundantly in the North Atlantic (see LEMAITRE, 1989), and sparsely in the western and eastern Pacific (Figs 49, 50).

Seven species of *Parapagurus* are distributed in the eastern Pacific, *P. benedicti*, *P. microps*, *P. holthuisi*, *P. abyssorum*, *P. janetae* sp. nov., *P. foraminosus* sp. nov., and *P. wolffi* sp. nov. (Fig. 50). Of these, *P. holthuisi* has been discovered living in a seamount on the central Pacific (Fig. 49), and *P. abyssorum* is known from a single locality in the southeastern Pacific (Fig. 50). A species found abundantly in the region is *P. benedicti*, known so far exclusively from the northeastern Pacific (Alaska to Baja California, Mexico), but probably ranges also to the northwestern Pacific. The distribution of *P. microps* appears to include only the tropical and subtropical latitudes of the eastern Pacific.

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