

**Hermit Crabs of the Family Parapaguridae
(Crustacea: Decapoda: Anomura) from Australia:
Species of *Strobopagurus* Lemaître, 1989,
Sympagurus Smith, 1883 and Two New Genera**

RAFAEL LEMAITRE

Department of Invertebrate Zoology, National Museum of Natural History, Smithsonian Institution,
Washington, DC 20560, USA
Internet: mnhiv053@sivm.si.edu

ABSTRACT. The deep-water parapagurid hermit crab fauna from Australia is much more diverse than previously believed. The most recent information on parapagurids (De Saint Laurent, 1972) indicated the presence of three species and one subspecies in this region. The study of numerous unidentified or unreported parapagurid materials deposited in various Australian museums revealed the presence of at least 21 species. With the exception of three species of the genus *Parapagurus* Smith, 1879, all other parapagurids known from Australia are discussed. The heterogeneous genus *Sympagurus* Smith, 1883, is revised and restricted. Two new genera, *Oncopagurus* and *Paragiopagurus*, are proposed for a number of species previously assigned to *Sympagurus*. Four new species were discovered and are described, *Sympagurus papposus*, *S. soela*, *S. villosus*, and *Oncopagurus cidaris*. Of the previously recognised species, those found to be poorly described in the literature are diagnosed and illustrated. The Australian material is compared with types and/or supplemental material from other regions of the Pacific deposited in major museums or institutions. The affinities and important morphological variations of the species are discussed, and the overall distributions of the species updated. The subspecies of *Sympagurus acutus* (De Saint Laurent, 1972) are elevated to specific rank, and assigned to *Paragiopagurus* n.gen. The juvenile stages of *S. brevipes* (De Saint Laurent, 1972), an abundant species that reaches a large size, is described, and compared with the adults. Keys for the identification of all parapagurid genera and Australian species (except those of *Parapagurus*), are presented. The distribution of the species is summarised.

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Introduction

The Australian Museum zoologist, Thomas Whitelegge (1900: 135), in his account of the HMCS *Thetis* Expedition off the coast of New South Wales, remarked on the limited knowledge of the deep-water fauna from that coast, and accurately predicted that once it "has been thoroughly explored, there can be no doubt that its waters will be found as richly endowed with life as in any part of the world". In that same publication he described a new hermit crab in the family Paguridae, *Sympagurus diogenes* Whitelegge, 1900, a species that eventually would prove to be the first Parapaguridae known from Australian waters. Since then, few additions have been made to the parapagurid fauna of Australia. The use of the family Parapaguridae Smith, 1882, was abandoned by A. Milne Edwards & Bouvier (1893) and most subsequent carcinologists; however, some continued to use it. Hale (1941), for example, described in the

Parapaguridae three subspecific taxa, *Sympagurus arcuatus diogenes*, *S. a. johnstoni*, and *S. a. mawsoni*, from Tasmania and Macquarie Island. When De Saint Laurent (1972) reinstated the family Parapaguridae and presented a preliminary worldwide review of all known species, she synonymised Hale's *S. a. diogenes* with *Parapagurus diogenes*, and the other two subspecies with *P. dimorphus* (Studer, 1883). In De Saint Laurent's study, only three species and one subspecies were reported from the Australian region, all of which she placed in the genus *Parapagurus* Smith, 1879, i.e. *P. dimorphus* (Studer, 1883), *P. diogenes* (Whitelegge, 1900), *P. minutus* Henderson, 1896, and *P. pilosimanus latimanus* Henderson, 1888. Although in his revisionary studies, Lemaitre (1989, 1993) did not add any parapagurids to the Australian fauna, he did elevate *P. pilosimanus latimanus* to its original specific status, retaining it in *Parapagurus* (sensu Lemaitre, 1989), and assigned the remaining three species known from Australia at the time to the genus *Sympagurus* Smith, 1883.

Until recently, the only parapagurid material available from the Australian region was restricted to that collected during earlier major, worldwide deep-sea expeditions, such as those conducted on the British *Challenger* (1872–1876), U.S. *Albatross* (late 1800's to early 1900's), Dutch Siboga Expedition (1899–1900), and Danish *Galathea* (1950–1952). During the decade of the 1980's, however, several intense, deep-water expeditions sponsored by the Australian government obtained a large number of parapagurid specimens that accumulated, unidentified, in various museums in the country. The examination of all these specimens revealed the existence of a rich parapagurid fauna on the Australian continental shelf and slope regions. Twenty-one species are represented in the materials examined. Of these, one is of *Strobopagurus* Lemaitre, 1989; 17 are assignable to *Sympagurus* Smith, 1883 (sensu Lemaitre, 1989), four of them new; and three of *Parapagurus* Smith, 1879 (sensu Lemaitre, 1989). The study of the materials clearly showed the need to reevaluate the heterogeneous assemblage of species currently assigned to *Sympagurus*, a genus previously reinstated, broadly defined, and divided into three informal groups of species (Lemaitre, 1989, 1994). As result, *Sympagurus* is herein redefined and restricted to a group of species (Group 2 of Lemaitre, 1994) typified by *Sympagurus pictus* Smith, 1883, and characterised by the presence of a vestigial pleurobranch on each side of the last thoracic somite. A new genus, *Oncopagurus*, is proposed for a group of species (Group 1 of Lemaitre, 1994) whose representatives exhibit a curved epistomial spine. The remaining species previously assigned to *Sympagurus* (Group 3 of Lemaitre, 1994), are placed in another new genus, *Paragiopagurus*; these have not been found to share any unique character.

In this study, the Australian species of *Strobopagurus*, *Sympagurus* sensu stricto, and the new genera *Oncopagurus* and *Paragiopagurus*, all of which typically live in continental shelf and slope depths (ranging from 50 to 1000 m), are discussed. Additionally, keys to all currently recognised parapagurid genera and their Australian species are presented. Excluded from this study are species of *Parapagurus* (sensu Lemaitre, 1989), which commonly occur in depths greater than 1000 m, which will be discussed separately (Lemaitre, in prep.).

Some of the species that occur in Australian waters exhibit a broad range of morphological variations. Particularly broad are the variations seen in *Sympagurus dimorphus* (Studer, 1883) and *Oncopagurus indicus* (Alcock, 1905), which can make their identification difficult. Further complicating identification is the very dissimilar morphology seen in juveniles and adults in species such as *S. dimorphus*, or *S. brevipes* (De Saint Laurent, 1972), both of which have young that reach a size as large or larger than many adults of other congeneric species. A description of the juveniles of *S. brevipes* is included here. Juveniles of *S. dimorphus* are described in Lemaitre (1989) and Lemaitre & McLaughlin (1992).

Materials and Methods

The majority of the Australian material used for this study has come from cruises sponsored in the 1980's by government agencies such as Commonwealth Scientific Industrial Research Organization (CSIRO), Northern Territory Fisheries, Queensland Fisheries Service, and New South Wales State Fisheries. Particularly significant for its abundance and species diversity is the material obtained during the CIDARIS I expedition, and from exploratory expeditions conducted on board the ORV *Franklin*, FRV *Kapala*, and FRV *Soela*. Abundant, supplemental material of *Sympagurus dimorphus* from New Zealand was obtained primarily from expeditions by the New Zealand Oceanographic Institute vessel RV *Tangaroa*. Additional specimens used have come from cruises conducted by at least 18 other vessels that have operated in the Australian or New Zealand regions.

During the early stages of this investigation it became apparent that the examination of types and as much supplemental material as possible would be indispensable in defining several previously described but poorly understood taxa, understanding the range of morphological variations, and confirming the existence of undescribed species. Moreover, the study of the often abundant material from outside the study area has been required in order to obtain the best estimate of the distribution of the species. This material is listed under the heading "Other Material". Types, as well as supplemental material examined, were borrowed from major museums in Australia, Europe, and the USA.

Specimens have been returned to the following museums or institutions: Australian Museum, Sydney (AM); Queensland Museum, Brisbane (QM); B.P. Bishop Museum, Honolulu, Hawaii (BPBM); Natural History Museum of Los Angeles County (LACM); Musée Océanographique, Monaco (MO); Muséum national d'Histoire naturelle, Paris (MNHN); Museum of Victoria, Melbourne (NMV); National Museum of Natural History, Smithsonian Institution, Washington, D.C. (USNM); National Museum of New Zealand, Wellington (NMNZ); Northern Territories Museum, Darwin (NTM); South Australian Museum, Adelaide (SAMA); The Natural History Museum, London (formerly British Museum [Natural History]) (NHM); Western Australian Museum, Perth (WAM); Zoölogisch Museum, Amsterdam (ZMA); and Zoologisk Museum, Copenhagen (ZMK). The holotypes and paratypes of all new species described herein have been deposited in specified Australian museums. When possible, paratypes of these new species, and/or duplicate specimens of previously known species, have been deposited in the National Museum of Natural History, Smithsonian Institution.

The general terminology used in the descriptions is that of McLaughlin (1974, 1980) and Lemaitre (1989), with exception of the 4th pereopods where the terms "subchelate" and "scmichelate" are used following the definitions provided by McLaughlin (1996). In the material examined, that from Australia is listed separately by State or Territory in a clockwise direction around the

country. All materials are cited from north to south. A single measurement, shield length (SL), indicative of size, is indicated in parenthesis, as measured (to the nearest 0.1 mm) from the tip of the rostrum to the midpoint of the posterior margin of the shield. Months are abbreviated by the first three letters. Other abbreviations used are: coll., collector; sta, station; Is., island; JCU, James Cook University, Townsville; NZOI, New Zealand Oceanographic Institute.

The term juvenile, used for *Sympagurus brevipes*, is applied to those specimens with incompletely developed pleopods (all with $SL \leq 5.5$ mm). In these specimens, the 2nd to 5th pleopods are paired, asymmetrical; in males, the 1st gonopods are rudimentary. Although some presumed juveniles were found to have clearly open gonopores, it is unclear

whether they were sexually mature.

In order to observe the armature of the chelipeds in some species, the dense setae were removed by immersing the appendage for 5–10 minutes in full-strength sodium hypochlorite (commercial "Clorox"), and subsequently cleaning the surfaces with a fine brush.

De Saint Laurent (1972) listed only holotypes in her descriptions of various new taxa. Evidently, however, she used numerous other specimens as well, most of which were labelled and catalogued as paratypes in the collections of some museums (e.g., ZMA, USNM). It is unclear whether De Saint Laurent intended to designate all, or part of those specimens as paratypes. These are included under "Other material", and marked with an asterisk following the museum number or abbreviation.

Systematic Account

Parapaguridae Smith, 1882

Key to genera of the family

1. Corneae present 2
- Corneae absent *Typhlopagurus* De Saint Laurent, 1972
2. Rostrum short, not exceeding eye-stalks 3
- Rostrum long, exceeding eye-stalks *Probeebei* Boone, 1926
3. Ocular acicles present 4
- Ocular acicles absent *Tylaspis* Henderson, 1885
4. Posterior carapace mostly membranous; unpaired 3rd to 5th left pleopods 5
- Posterior carapace calcified; paired (asymmetrical) 3rd to 5th pleopods *Bivalvopagurus* Lemaitre, 1993
5. Shield about as broad as long, or slightly broader than long; rostrum bluntly triangular or broadly rounded; abdomen twisted 6
- Shield distinctly longer than broad; rostrum acutely triangular; abdomen straight *Tsunogaipagurus* Osawa, 1995
6. Shield distinctly broader than long; dactyls of ambulatory legs straight or nearly so; corneae strongly dilated; males with 2nd pleopod having short exopod and strongly twisted distal segment *Strobopagurus* Lemaitre, 1989
- Shield about as broad as long; dactyls of ambulatory legs curved; corneae moderately or weakly dilated; males with 2nd pleopods lacking exopod and distal segment not twisted (2nd pleopods rarely absent) 7

7. Vestigial pleurobranch absent on last thoracic somite 8
 — Vestigial pleurobranch present on each side of last thoracic somite *Sympagurus* Smith, 1883, s.s.
8. Epistomial spine straight, or absent 9
 — Epistomial spine strongly curved upward *Oncopagurus* n.gen.
9. Phyllobranchiate or intermediate gills; 4th segment of antennal peduncle armed with dorsodistal spine; length of ocular peduncles, including corneae, at least half length of shield *Paragiopagurus* n.gen.
 — Trichobranchiate gills; 4th segment of antennal peduncle unarmed; length of ocular peduncles, including corneae, less than half length of shield (except *Parapagurus bouvieri* Stebbing, 1910) *Parapagurus* Smith, 1879

Strobopagurus Lemaitre, 1989

Parapagurus.—De Saint Laurent, 1972: 101 (in part).

Strobopagurus Lemaitre, 1989: 35. Type species by original designation: *Sympagurus gracilipes* A. Milne Edwards, 1891: 132. Gender: masculine.

Diagnosis. Eleven pairs of phyllobranchiate or intermediate gills. Shield distinctly broader than long, weakly and evenly calcified. Eye-stalks stout. Corneae strongly dilated. Fourth segment of antennal peduncle unarmed. Epistomial spine absent. Right cheliped elongate, often slender; palm rounded mesially, with weakly to well delimited dorsolateral margin. Left cheliped usually weakly calcified on merus, carpus, and often proximal portion of palm. Ambulatory legs with dactyls straight or nearly so. Fourth pereopod with propodal rasp consisting of 1 row of corneous scales. Second abdominal somite with left pleuron terminating ventrally in small subtriangular lobe. Males with well developed paired 1st and 2nd gonopods; 1st gonopods each with short, broad subtriangular distal lobe; 2nd gonopods each with rudimentary exopod and strongly twisted distal segment.

Species. *Strobopagurus gracilipes* (A. Milne Edwards, 1891), *S. kilburni* (Kensley, 1973), and *S. sibogae* (De Saint Laurent, 1972).

Strobopagurus sibogae (De Saint Laurent, 1972)

Fig. 1

Parapagurus sibogae De Saint Laurent, 1972: 116, figs 10, 23 (type locality: Indonesia, Siboga Exp. sta. 12).

Strobopagurus sibogae.—Lemaitre, 1989: 36.

Holotype. Female ovig. (SL 7.4 mm), Indonesia, Siboga Exp. sta. 12, 07°15'S, 115°15.6'E, 289 m, 14 Mar 1899, coll. M. Weber, ZMA De103.109.

Australian material. WESTERN AUSTRALIA: 1 female ovig. (SL 7.5 mm), NW of Augustus Is., 13°33.3'S, 122°54.5'E, FRV *Soela*, 396–390 m, 14 Feb 1984, WAM 1320–86. 4 males (SL 4.6–6.0 mm), 3 females (SL 4.0–4.9 mm), NW of Collier Bay, 14°16'S, 122°38.3'E, FRV *Soela*, 302 m, 14 Feb 1984, coll. S. Slack-Smith, WAM 1314–86. 2 males (SL 4.7, 6.9 mm), NW of Collier Bay, FRV *Soela*, sta. S01/84/074, 14°16.5'S, 122°34.4'E, 302 m, 14 Feb 1984, coll. S. Slack-Smith, WAM 1316–86. 1 male (SL 5.2 mm), 1 female (SL 5.8 mm), NW of Leveque, FRV *Soela*, 14°49.0'S, 121°36.1'E, 302–300 m, coll. S. Slack-Smith, 12 Feb 1986, WAM. 1 male (SL 8.6 mm), NW of Beagle Bay, FRV *Soela*, 15°13.5'S, 121°08.9'E, 352 m, 11 Feb 1984, WAM 1107–86. 2 males (SL 7.8, 8.1 mm), 1 female (SL 5.2 mm), NW of Beagle Bay, 15°20'S, 121°09.6'E, FRV *Soela*, 300–302 m, 11 Nov 1984, coll. S. Slack-Smith, WAM 1133–86. 1 female (SL 7.9 mm), WNW of Lacepede Arch, 15°40.2'S, 120°37.3'E, FRV *Soela*, 10 Feb 1984, WAM. 1 male (SL 5.6 mm), W of Lacepede Arch, 16°55.8'S, 119°53.9'E, FRV *Soela*, 426 m, 19 Feb 1984, WAM 1307–86. 1 male (SL 4.5 mm), 1 female (SL 6.2 mm), W of Lacepede Arch, FRV *Soela*, sta. S001/84/105, 16°56.9'S, 119°52.0'E., 432 m, 21 Feb 1984 WAM 1297–86. 1 female (SL 4.8 mm), W of Lacepede Arch, 16°57'S, 119°51'E, FRV *Soela*, 436 m, 22 Feb 1984, WAM 1099–86. 1 female (SL 6.7 mm), W of Broome, FRV *Soela*, sta. 01/84/122, 17°59–54'S, 118°23–29'E, 390 m, 24 Feb 1984, WAM 863–86. 1 male (SL 6.0 mm), North West Shelf, FRV *Soela*, sta. 0184/29, 18°10.15'S, 118°14.4'E, 302 m, 2 Feb 1984, coll. T. Ward, NTM Cr 007014. 1 female (SL 4.6 mm), *Courageous*, sta. 5, 18°08'S, 118°13'E, 350–354 m, 17 Aug 1985, WAM 1011–85. 1 male (SL 5.2 mm), NNE Cape Lambert, 18°32'S, 117°21'E, FRV *Soela*, 496–504 m, 8 Apr 1982, WAM 1237–86. 4 males (SL 5.0–6.5 mm), 1 female (SL 5.3 mm), FRV *Soela*, sta. NWS-7, 18°32.2'S, 117°30.9'E, 392–400 m, 25 Apr 1982, NTM Cr 010916. 2 males (SL 5.8, 6.0 mm), 1 female (SL 5.3 mm), North West Shelf, FRV *Soela*, CSIRO cruise 0184, sta. 22, 18°34.3'S, 117°30'E, 202 m, 1 Feb 1984, NTM Cr 000669. 1 male (SL 6.5 mm), Scampi, FRV *Soela*, sta. NWS-6, 18°41.6'S, 117°18.6'E, 320–360 m, 25 Apr 1983, NTM Cr 010915. 3 males (SL 5.3–6.3 mm), North West Shelf, FRV *Soela*, sta. 0184/13, 18°55.3'S, 116°09'E, 403 m, 30 Jan 1984, NTM Cr 006858. 1 male (SL 6.0 mm), FRV *Soela*, CSIRO cruise 0184, 19°15'S, 115°38'E, sta. NNS-36 T10, 404 m, 29 Jan 1984, coll. T. Ward, NTM Cr 010914. 1 male (SL 5.5 mm), North West Shelf, FRV *Soela*, cruise 0184, sta. T/8, 19°20.2'S, 115°44.1'E, 307 m, 29 Jan 1984, NTM Cr 000670.

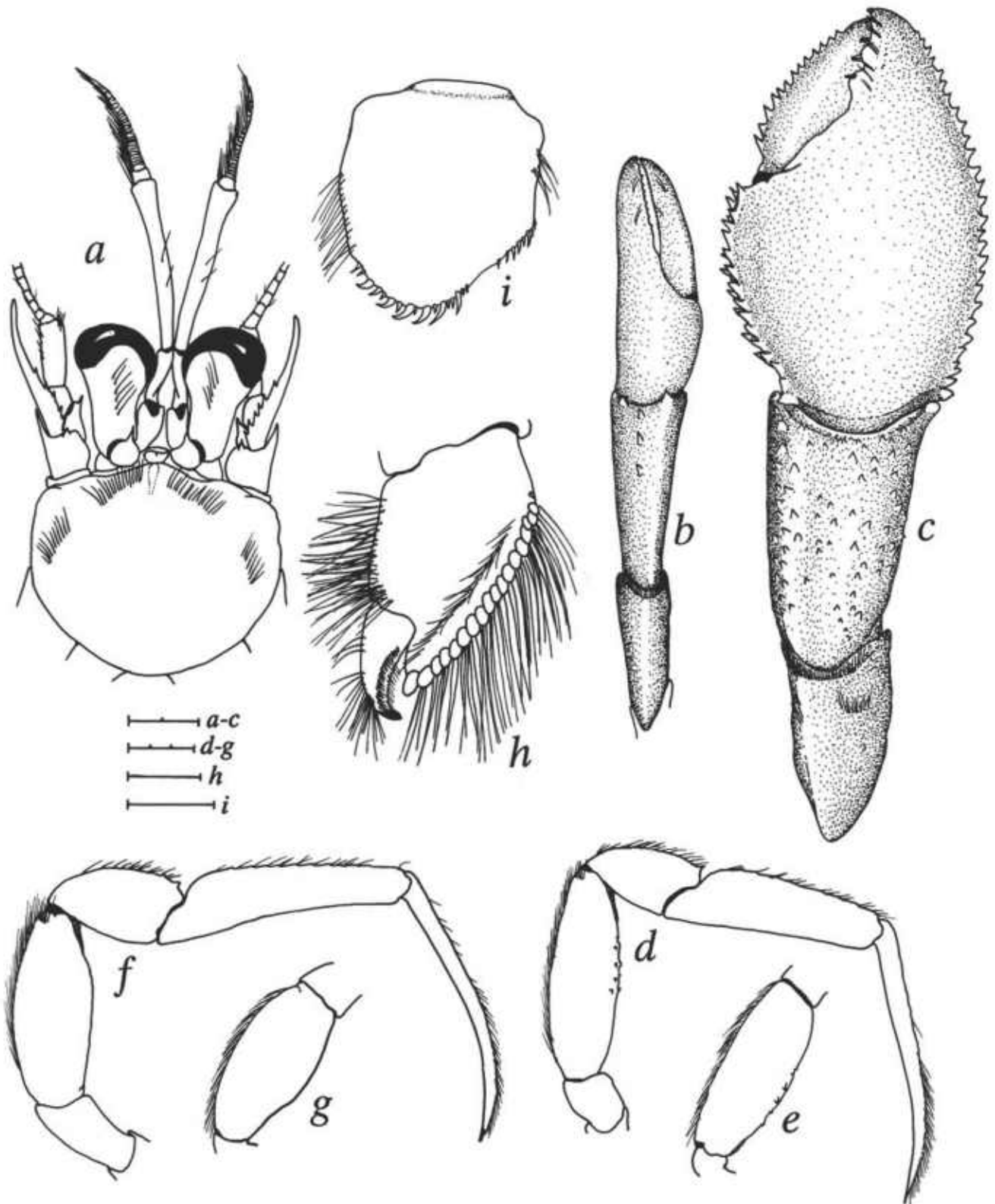


Fig. 1. *Strobopagurus sibogae* (De Saint Laurent, 1972). a, shield and cephalic appendages; b, left cheliped; c, right cheliped; d, right 2nd pereopod, lateral; e, merus of same, lateral; f, right 3rd pereopod, lateral; g, merus of same, lateral; h, propodus and dactyl of left 4th pereopod, lateral; i, telson. Scales = 2 mm (a-c), 3 mm (d-g), 0.5 mm (h), and 1 mm (i). (Male [SL 6.0 mm], Western Australia, WAM 1314-86).

QUEENSLAND: 1 male (SL 5.0 mm), Marian Plateau, FRV *Soela*, sta.0685-03, 22°34.8'S, 158°38.7'E, 314–319 m, 16 Nov 1985, NTM Cr 010917. 1 female ovig. (SL 5.8 mm), E of Gold coast, FRV *Kapala*, sta. K78-09-05, 550 m, 2 Jun 1978, AM P40419.

NEW SOUTH WALES: 1 female (SL 4.5 mm), E of Long Reef Point, Sydney, FRV *Kapala*, sta. K78-26-02, 33°43'S, 151°40'E, 143 m, 5 Dec 1978, AM P40418. 10 males (SL 2.5–6.1 mm), 6 females (SL 3.3–4.6 mm), 6 females ovig. (SL 4.5–5.5 mm), off Newcastle, NZOI *Tangaroa*, cruise U207, 34°11.1'S, 151°26'E, 198 m, 5 Oct 1982, AM P40416. 3 males (SL 5.8–7.5 mm), 1 female ovig. (SL 6.9 mm), 20 mi (37 km) off Wollongong, 238–274 m, 30 Jul 1968, AM P17613.

Diagnosis. Shield (Fig. 1a) convex in lateral view. Rostrum broadly rounded, with short longitudinal dorsal ridge. Ocular peduncles more than half length of shield, widening distally. Ocular acicles terminating in strong spine. Antennular peduncles exceeding distal margin of corneae by slightly more than length of ultimate segment. Antennal peduncles exceeding distal margin of corneae by about 0.3 or less length of 5th segment; 2nd segment with dorsolateral distal angle produced, terminating in strong spine (occasionally bifid), mesial margin with small spine at dorsodistal angle. Antennal acicles exceeding distal margin of corneae by as much as 0.3 length of acicle; mesial margin armed with 5 to 7 spines on proximal half. Sternite of 3rd maxilliped with small spine on each side of midline. Right chela (Fig. 1c) with dorsal surface unarmed, dactyl with row of spines on mesial margin; palm with mesial and lateral margins well delimited by row of often strong spines (usually double row on mesial margin). Ambulatory legs (Fig. 1d–g) with meri shorter on left side than on right; merus of 2nd pereopod 2.5 times as long as dorsoventral height; merus of 3rd twice as long as dorsoventral height. Fourth pereopod (Fig. 1h) with propodus clongate, length of dorsal margin subequal to greatest height; propodal rasp with 1 row of rounded scales. Anterior lobe of sternite of 3rd pereopods unarmed, setose. Uropods and telson (Fig. 1i) strongly asymmetrical; terminal margin of posterior lobes armed with strong, often curved corneous spines.

Distribution. Western Pacific: Indonesia, China Sea, Japan, and Australia. Depth: 40 to 550 m.

Affinities. This species most closely resembles *Strobopagurus gracilipes* (A. Milne Edwards, 1891); however, the two can be separated using several characters. The spines on the mesial margin of the antennal acicles and the lateral and mesial margins of the right chela are much stronger in *S. sibogae* than in *S. gracilipes*. The dorsoventral height of the meri of the 2nd and 3rd pereopods are greater in *S. sibogae* than in *S. gracilipes* (the merus length/height ratio of the 2nd and 3rd pereopods is 2.0 and 2.5 respectively in the former, and 3.0 and 3.5 respectively in the latter).

The propodus of the 4th pereopod is about as high as long in *S. sibogae*, whereas in *S. gracilipes* the propodus is distinctly higher than long (1.5 times as high as long, length measured dorsally).

Sympagurus Smith, 1883, s.s.

Sympagurus Smith, 1883:37.—Lemaitre, 1989:36. Type species by monotypy: *Sympagurus pictus* Smith, 1883. Gender: Masculine.

Parapagurus.—De Saint Laurent, 1972: 101 (in part).

Diagnosis. Twelve pairs of gills: 11 trichobranchiate or intermediate and 1 pair of vestigial pleurobranchiae on last thoracic somite. Shield about as broad as long, or slightly broader than long; dorsal surface usually with irregularly-shaped, weakly calcified areas. Corneae weakly to moderately dilated. Fourth segment of antennal peduncle unarmed, or with small dorsodistal spine. Epistomial spine straight or absent. Right chela with rounded dorsomesial and dorsolateral margins, or sometimes operculate with well delimited dorsomesial and dorsolateral margins. Left cheliped usually well calcified. Ambulatory legs with dactyls curved. Fourth pereopod with propodal rasp consisting of 1 or more rows of corneous scales or spines. Second abdominal somite with left pleuron terminating ventrally in small subtriangular lobe. Males with moderately to well developed paired 1st and 2nd pleopods.

Species. In addition to the new species described herein as *S. papposus*, *S. soela*, and *S. villosus*, the following are retained in *Sympagurus* s.s.: *S. acinops* Lemaitre, 1989, *S. affinis* (Henderson, 1888), *S. andersoni* (Henderson, 1896), *S. brevipes* (De Saint Laurent, 1972), *S. dimorphus* (Studer, 1883), *S. dofleini* (Balss, 1912), *S. pictus* Smith, 1883, *S. planimanus* (De Saint Laurent, 1972), *S. poupini* Lemaitre, 1994, and *S. trispinosus* (Balss, 1911).

Key to Australian species of *Sympagurus* s.s.

(In the following key, juveniles (SL < 5.5 mm) of *S. brevipes* are not considered; *S. papposus* n.sp. is keyed twice to account for variation in the ocular acicles)

1. Propodal rasp of 4th pereopod with 1 row of scales 2
 — Propodal rasp of 4th pereopod with 2 or more rows of scales 3
2. Ocular acicles simple *S. planimanus*
 — Ocular acicles multifid *S. soela* n.sp.
3. Fourth antennal segment armed with dorsodistal spine *S. dimorphus*
 — Fourth antennal segment unarmed 4
4. Ocular acicles simple or bifid (one side only) 5
 — Ocular acicles multifid 6
5. Propodal rasp of 4th pereopod with 4–6 rows of scales *S. brevipes*
 — Propodal rasp of 4th pereopod with 2–3 rows scales 7
6. Posterior lobes of telson separated by broad, shallow median cleft; merus of 3rd pereopod short, length distinctly less than 3 times dorsoventral height *S. trispinosus*
 — Posterior lobes of telson separated by narrow, deep median cleft (Fig. 10); merus of 3rd pereopod long, length 3 or more times dorsoventral height (Fig. 8i) *S. papposus* n.sp.
7. Ambulatory legs with numerous long bristle-like setae dorsally on four distal segments (Fig. 15d–f); dorsal surfaces of chelae with numerous long bristle-like setae in addition to dense mat of short plumose setae (Fig. 14b,c) *S. villosus* n.sp.
 — Ambulatory legs with few scattered short setae dorsally on four distal segments (Fig. 8g–i); dorsal surfaces of chelae lacking bristle-like setae, with only dense mat of short plumose setae (Fig. 3d) *S. papposus* n.sp.

Sympagurus brevipes (De Saint Laurent, 1972)

Figs 2, 3a,b, 4, 5a, 6

Parapagurus arcuatus var. *monstrosus*.—Balss, 1912: 99, pl. 10, fig. 3.

Parapagurus brevipes De Saint Laurent, 1972: 105, figs 2, 14 (type locality: Indonesia, Siboga Exp., sta. 12).

Sympagurus brevipes.—Lemaitre, 1989: 37; 1994: 412.

Holotype. Male (SL 12.9 mm) Indonesia, Siboga Exp., sta. 12, 07°15'S, 115°15.6'E, 289 m, coll. M. Weber, ZMA De 103.103.

Australian material. WESTERN AUSTRALIA: 1 female (SL

10.7 mm), NNW of Cape Leveque, FRV *Soela*, sta. 01/84/082A, 13°07.2'S, 123°15.7'E, 400 m, 15 Feb 1984, WAM 1292–86. 1 juv. sex indet. (SL 5.5 mm), NW of Augustus Is., FRV *Soela*, 13°17'S, 122°37.4'E, 494–484 m, 15 Feb 1984, USNM. 1 male (SL 10.8 mm), 1 female (SL 9.8 mm), NW of Collier Bay, FRV *Soela*, sta. 01/84/070, 13°44'S, 122°13.3'E, 496–494 m, WAM 1313–86. 1 female ovig. (SL 14.4 mm), NW of Augustus Is., FRV *Soela*, sta. S01/84/076, 13°44.5'S, 122°56.5'E, 348–350 m, 14 Feb 1984, WAM 1094–86. 1 male (SL 12.3 mm), 1 female (SL 11.7 mm), NW of Bathurst Is., FRV *Soela*, sta. S01/84/067, 14°29.4'S, 122°01.4'E, 348–350 m, 12 Feb 1984, WAM 1109–86. 1 male (SL 11.9 mm), 5 females (SL 8.5–11.1 mm), NW of Leveque, FRV *Soela*, sta. S01/84/064, 14°50.2'S, 121°31.4'E, 356 m, 12 Feb 1984, WAM 1112–86, 1312–86. 1 juv. sex indet. (SL 4.5 mm), NW of Beagle Bay, FRV *Soela*, sta. S01/84/060, 15°08.6'S, 121°03.4'E, 500–504 m, 11 Feb 1984, WAM. 3 males (SL

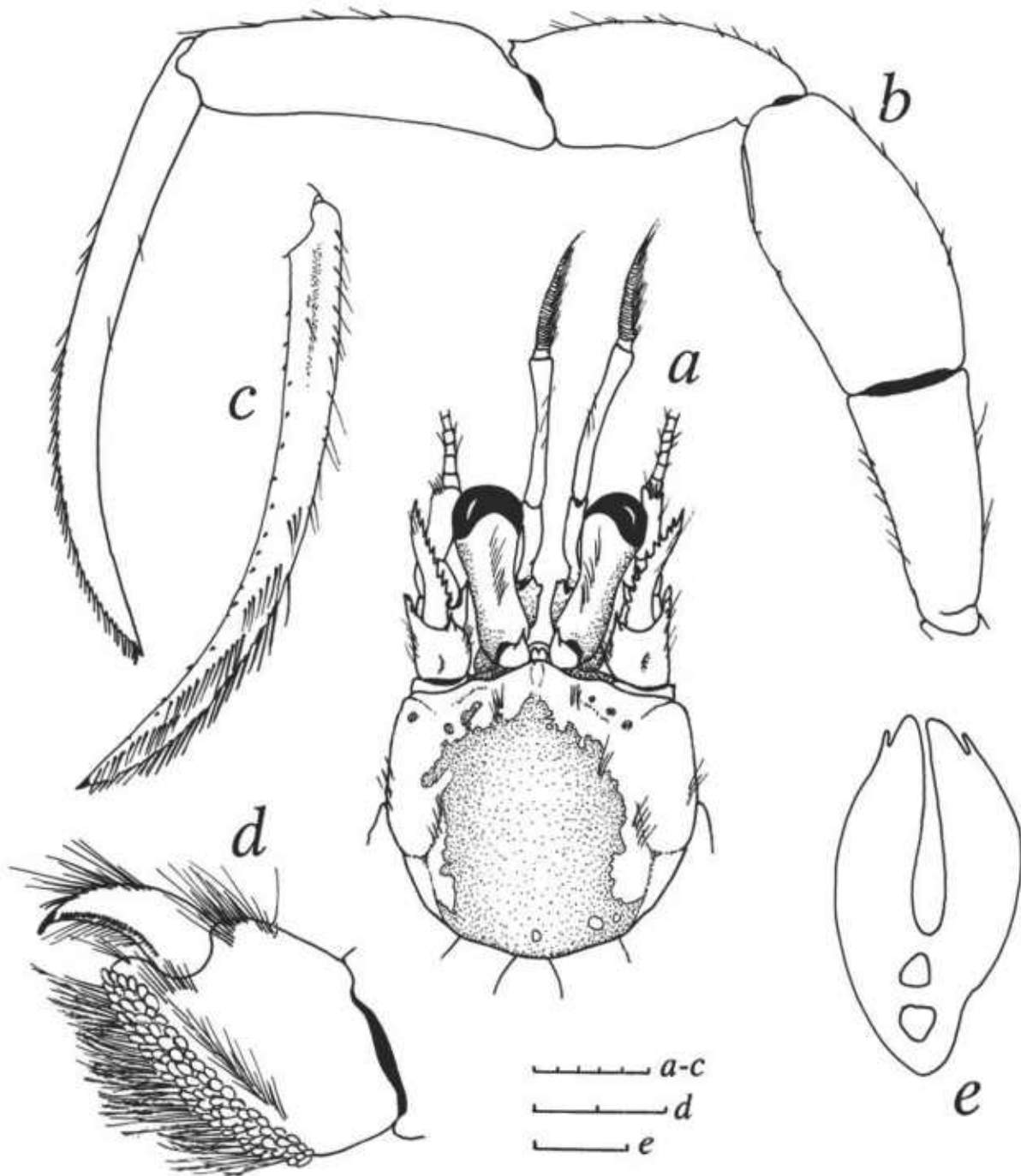


Fig. 2. *Sympagurus brevipes* (De Saint Laurent, 1972). a, shield and cephalic appendages; b, left 3rd pereopod, lateral; c, dactyl of same, mesial; d, propodus and dactyl of left 4th pereopod, lateral; e, branchia, transverse section. Scales = 5 mm (a-c), 2 mm (d), and 1 mm (e). (a, paratype female [SL 13.3 mm], Philippines, USNM 168914; b-d, holotype male [SL 12.9 mm], Indonesia, ZMA De103.103; e, paratype female [SL 14.0 mm], Philippines, USNM 168913).

8.9–12.8 mm), 1 female (SL 12.8 mm), NW of Beagle Bay, FRV *Soela*, sta. S01/84/059, 15°09.4'S, 121°05.5'E, 450–448 m, 11 Feb 1984, WAM 2022–86. 1 female (SL 7.5 mm), NW of Beagle Bay, FRV *Soela*, sta. S01/84/057, 15°13.5'S, 121°08.9'E, 352 m, 11 Feb 1984, WAM. 3 females (SL 8.1–8.3 mm), WNW of Lacepede Arch, FRV *Soela*, sta. 01/84/051, 15°40.2'S, 120°37.3'E, 500–504 m, 10 Feb 1984, USNM.

1 male (SL 9.8 mm), WNW of Lacepede Arch, FRV *Soela*, sta. 01/84/053, 15°48'S, 120°41'E, 400–396 m, 10 Feb 1984, coll. S. Slack-Smith, WAM 1306–86. 1 female ovig. (SL 14.9 mm), W of Lacepede Arch, FRV *Soela*, sta. S01/84/050, 16°41.8'S, 120°07.3'E, 434–430 m, 9 Feb 1984, WAM 1296–86. 2 females (SL 9.3, 11.8 mm), 1 female ovig. (SL 13.5 mm), W of Lacepede Arch, FRV *Soela*, sta. 01/84/90, 16°55'S,

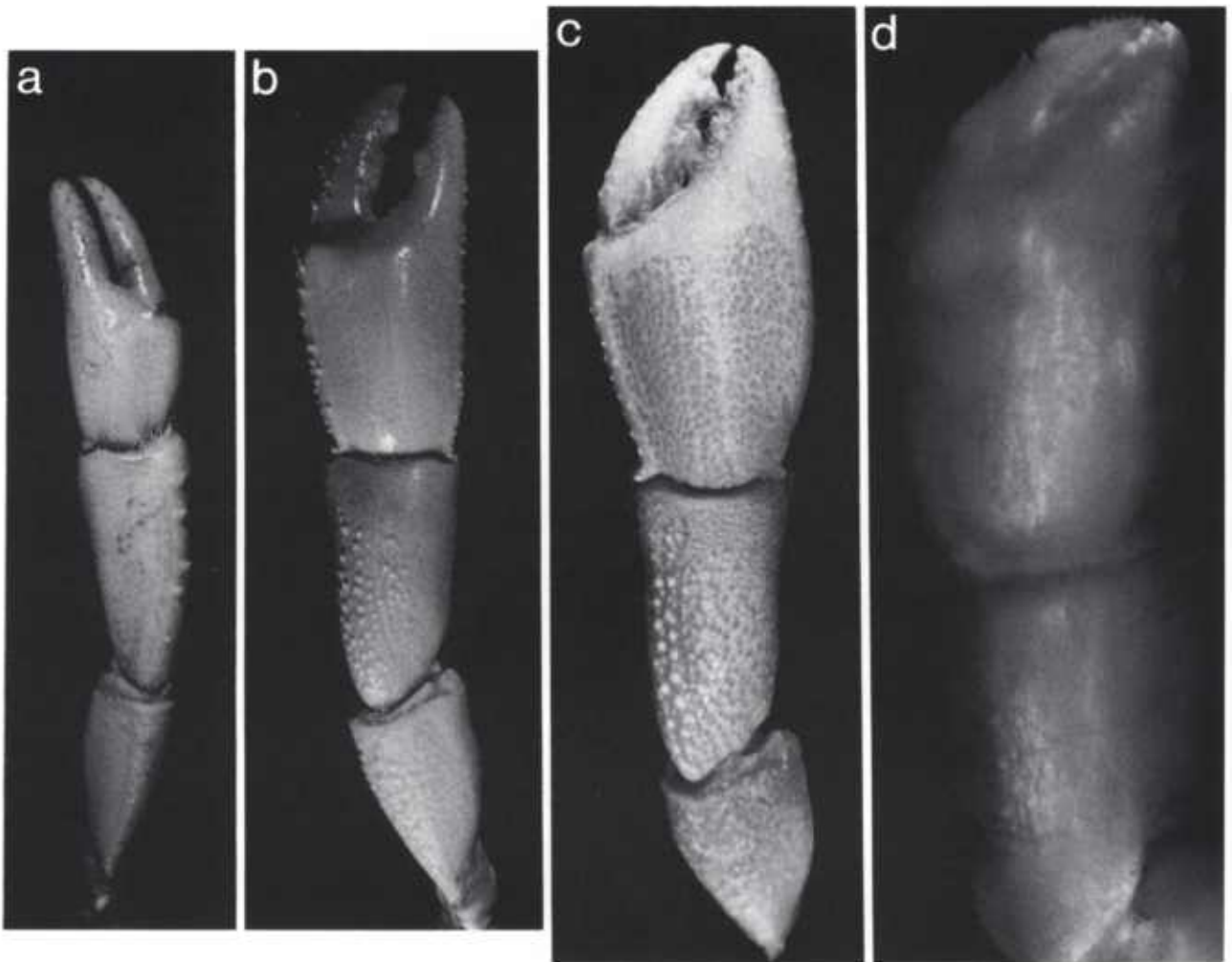


Fig. 3. *Sympagurus brevipes* (De Saint Laurent, 1972): a, left cheliped, denuded (1.1×); b, right cheliped, denuded (1.1×). *Sympagurus papposus* n.sp.: c, right cheliped, denuded (2.0×); d, right cheliped with setation (2.0×). (a,b, male [SL 18.3 mm], Western Australia, NTM; c, paratype male [SL 12.1 mm], Western Australia, NTM Cr 006863; d, paratype male [SL 13.0 mm], Western Australia, USNM 270108).

119°54'E, 435–434 m, 18 Feb 1984, coll. S. Slack-Smith, WAM 1437–86. 1 male (SL 12.3 mm), FRV *Courageous*, sta. 12, 16°55'S, 119°55'E, 429–430 m, 19 Aug 1983, colls. P. Berry and N. Sinclair, WAM 1012–85. 1 female (SL 14.1 mm), W of Lacepede Arch, FRV *Soela*, sta. S01/84/089, 16°55.1'S, 119°54.6'E, 432–434 m, 18 Feb 1984, WAM 1305–86. 1 male (SL 7.0 mm), W of Lacepede Arch, FRV *Soela*, sta. 01/84/096, 16°55.4'S, 119°52.5'E, 431–432 m, 19 Feb 1984, WAM 1308–86. 1 male (SL 11.6 mm), 2 females (SL 8.5, 10.8 mm), W of Lacepede Arch, FRV *Soela*, sta. S001/84/105, 16°56.9'S, 119°52'E, 432 m, 21 Feb 1984, coll. S. Slack-Smith, WAM 1297–86. 2 females (SL 6.4, 11.8 mm), W of Lacepede Arch, FRV *Soela*, sta. 01/84/105, 16°56.9'S, 119°53.8'E, 432 m, 21 Feb 1984, coll. S. Slack-Smith, WAM1293–86. 1 male (SL 18.3 mm), 1 female (SL 15.9 mm), Scampi trawl grounds, *Comoc Endeavour*, sta. WH 85–15, 17°22'S, 118°38'E, 430 m, 2 Nov 1985, NTM Cr 011527. 1 male (SL 8.9 mm), FV *Courageous*, sta. 10, 17°28'S, 118°52'E, 428–435 m, 18 Aug 1983, colls. P. Berry and N. Sinclair, WAM 1281–85. 1 female (SL 12.0 mm), Scampi trawl grounds, *Comoc Endeavour*, sta. WH 85–18, 17°35'S,

118°43'E, 445 m, 3 Nov 1985, NTM Cr 006850. 1 female (SL 8.9 mm), Northwest Shelf, FRV *Soela*, sta. 0184/30, 17°41.2'S, 118°42.5'E, 357 m, NTM Cr 006859. 2 males (SL 10.6, 14.0 mm), 1 female (SL 12.1 mm), W of Broome, FRV *Soela*, sta. 01/84/122, 17°59–54'S, 118°23–29'E, 390 m, 24 Feb 1984, WAM. 2 males (SL 24.7, 26.0 mm), North West Shelf, sta. T7, 17°59.4'S, 118°18.4'E, 406–416 m, coll. A.J. Bruce, NTM Cr 006251, 006249. 1 female ovig. (SL 14.8 mm), 44 mi (81.4 km) SW of Impericuse Reef, FRV *Soela*, sta. S02/82/17A, 18°01'S, 118°17'E, 410–420 m, 3 Apr 1982, WAM 1357–86. 1 male (SL 9.8 mm), FV *Courageous*, sta. 3, 18°01'S, 118°13'E, 450–452 m, 12 Aug 1983, colls. P. Berry and N. Sinclair, WAM 1283–85. 2 females (SL 6.9, 12.1 mm), FV *Courageous*, sta. 2, 18°05'S, 118°10'E, 401–400 m, 17 Aug 1983, WAM 1287–85. 1 female (SL 9.8 mm), SW of Impericuse Reef, FV *Courageous*, sta. 53, 18°03'S, 118°16'E, 400 m, 28 Aug 1983, colls. P. Berry and N. Sinclair, WAM 1324–86. 1 female (SL 10.1 mm), W of Roebuck Bay, FRV *Soela*, sta. 01/84/121, 18°04'S, 118°04'E, 400–396 m, 24 Feb 1984, coll. S. Slack-Smith, WAM 1322–86. 1 male (SL 11.0 mm), W of Roebuck Bay, FRV *Soela*, sta. S01/84/121,

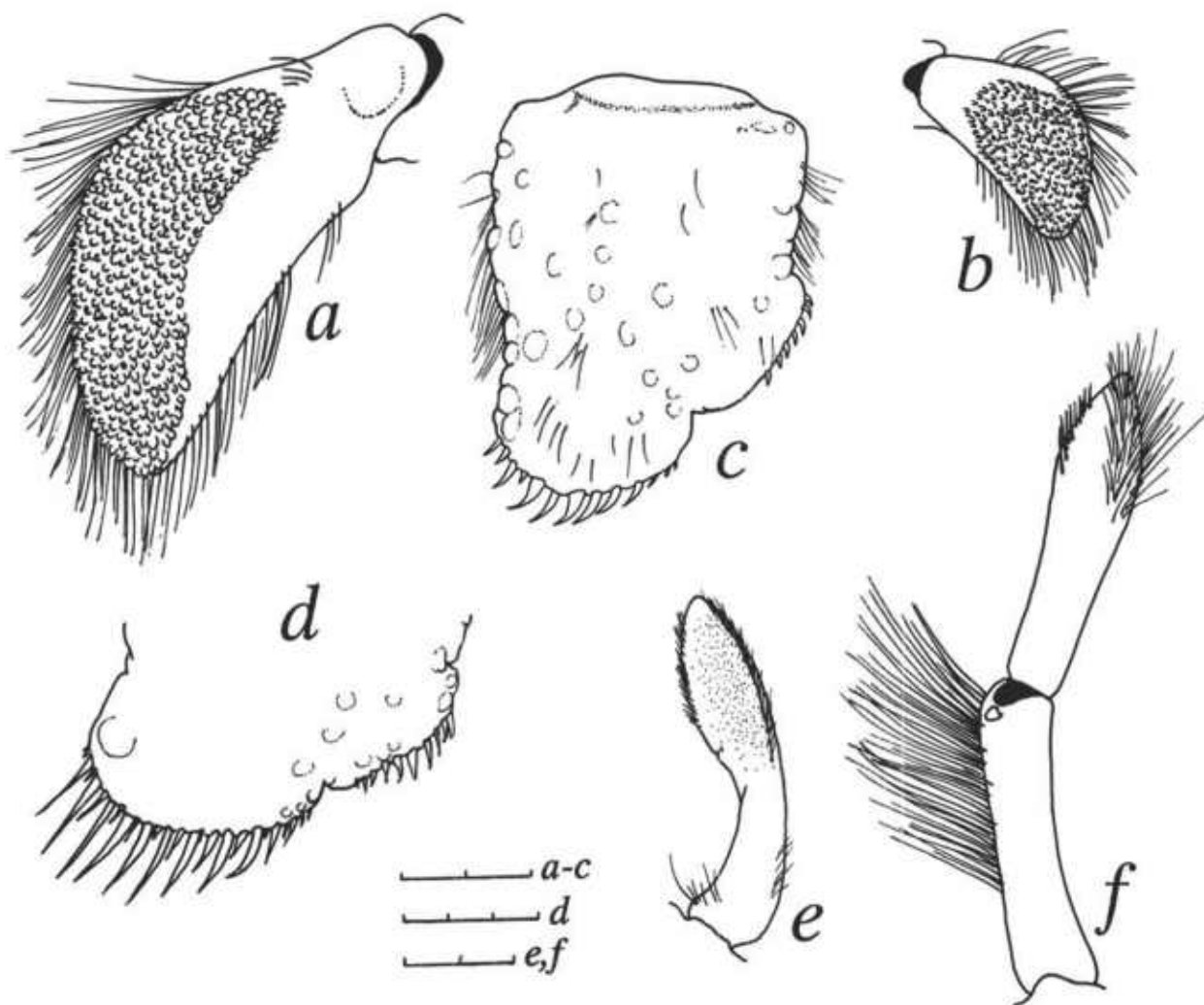


Fig. 4. *Sympagurus brevipes* (De Saint Laurent, 1972). a, b, exopod of uropods, dorsal: a, left; b, right; c, telson; d, posterior lobes of telson; e, male left 1st gonopod, mesial; f, male left 2nd gonopod, anterior. Scales = 2 mm (a-c), 3 mm (d), and 2 mm (e, f). (a-c, holotype male [SL 12.9 mm], Indonesia, ZMA De103.103; d, paratype female [SL 14.0 mm], Philippines, USNM 168913; male [SL 22.0 mm], Western Australia, AM P39443).

18°04'S, 118°14'E, 400–396 m, 24 Feb 1984, WAM 1137–86. 1 male (SL 12.0 mm), 1 female (SL 9.2 mm), FV *Courageous*, sta. 26, 18° 05'S, 118°08'E, 440–442 m, 22 Aug 1983, colls. P. Berry and N. Sinclair, WAM 1282-85. 1 female (SL 10.4 mm), 56 mi (103.6 km) SW of Imperieuse Reef, FRV *Soela*, sta. SO 18/02/82, 18°08'S, 118°06'E, 404 m, 3 Apr 1982, WAM 1097–86. 1 male (SL 22.0 mm), 190 km NW of Port Hedland, FRV *Soela*, sta. S02-02-36137/38, 18°16'S, 118°12'E, 298–320 m, 10 Apr 1982, coll. J. Paxton, AM P39443. 1 female (SL 5.2 mm), North West Shelf, FRV *Soela*, sta. 0184/16, 18°37.4'S, 117°02.4'E, 504–508 m, 31 Jan 1984, NTM Cr 006857. 2 males (SL 19.7, 24.2 mm), 22 km NW of Port Hedland, FRV *Soela*, sta. S02-82-46, 18°41'S, 116°46'E, 508 m, 13 Apr 1982, coll. J. Paxton, AM P39442. 2 females ovig. (SL 12.0, 18.0 mm), FRV *Soela*, sta. NWS-6, 18°41.6'S, 117°18.6'E, 320–360 m, 25 Apr 1983, NTM Cr 011528. 1 female (SL 8.1 mm), North West Shelf, FRV *Soela* 0283, sta. NWS-7, 392–400 m, 25 Apr 1983, coll. A.J. Bruce, NTM Cr 000765. 1 female (SL 8.8 mm), North West Shelf,

FRV *Soela*, CSIRO cruise 0184, sta. NWS-36 T/10, 19°15.5'S, 115°38'E, 404 m, 29 Jan 1984, coll. A.J. Bruce, NTM Cr 000668. 2 males (SL 21.5, 24.5 mm), 2 females (SL 12.8, 19.2 mm), North West Shelf, FRV *Soela*, sta. S01-84-61, 11 Feb 1984, coll. T. Ward, AM P39451.

NORTHERN TERRITORY: 1 female (SL 15.2 mm), Arafura Sea, 09°20'S, 131°04'E, 295 m, 9–16 Jul 1988, coll. Barry Clemens, NTM Cr 007007. 1 male (SL 24.1 mm), Timor Sea, 09°45'S, 129°59'E, 300 m, 23 Sep 1987, coll. NT Fisheries, USNM. 1 female ovig. (SL 17.7 mm), Timor Sea, *Endeavour Pearl*, Shot 1, 09°46'S, 130°15'E, 267 m, 16 Sep 1987, USNM. 1 female (SL 13.3 mm), 1 female ovig. (SL 14.0 mm), Scampi trawl grounds, *Comoc Endeavour*, sta. WH 85-17, 17°23'S, 118°57'E, 430 m, 3 Nov 1985, coll. W. Houston, NTM Cr 006849. 1 female (SL 9.6 mm), Scampi trawl grounds, *Comoc Endeavour*, sta. WH 85-28, 18°00'S, 118°16'E, 430 m, 6 Nov 1985, coll. W. Houston, NTM Cr 006851.

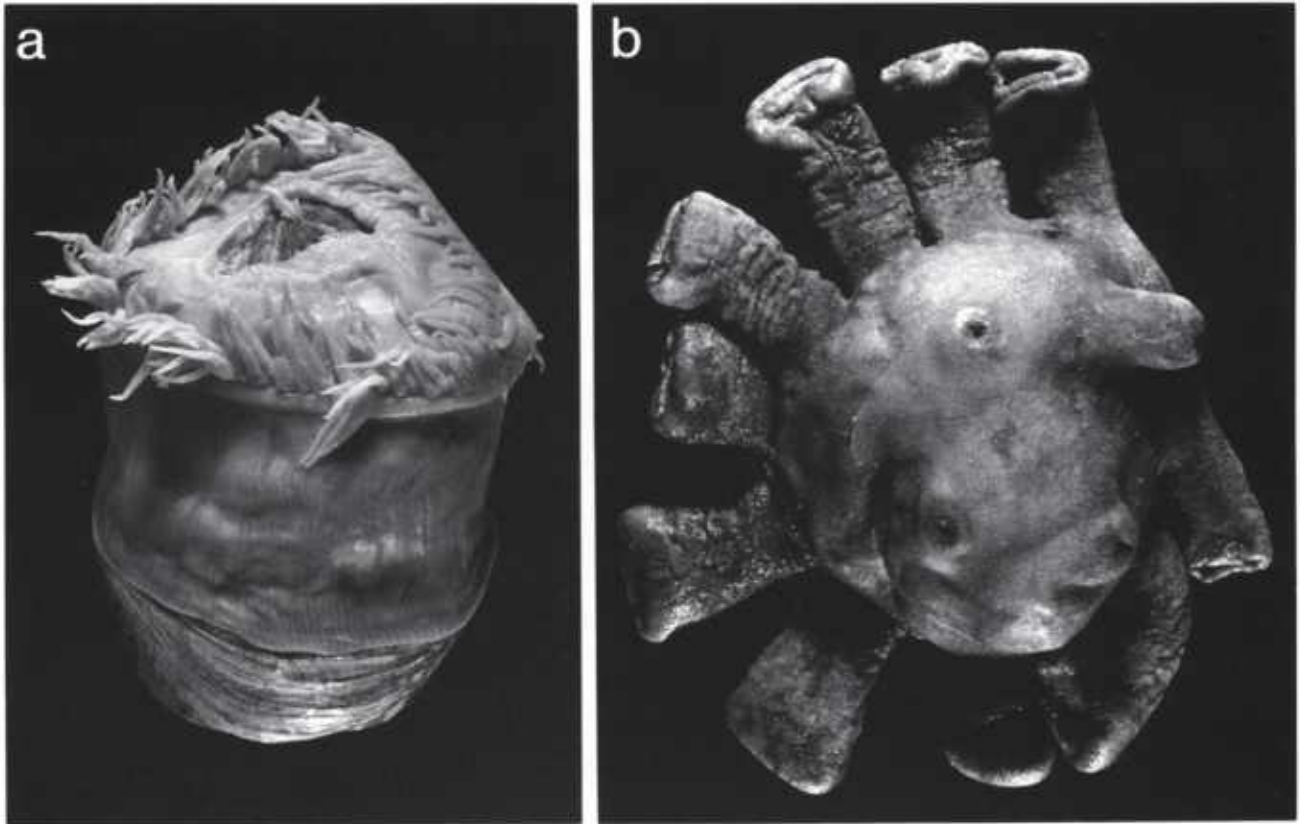


Fig. 5. Symbionts of *Sympagurus brevipes* (De Saint Laurent, 1972) (a), and *S. papposus* n.sp. (b). a, actinian, probably *Stylobates* sp. (0.8×); b, zoonthid *Epizoanthus* sp. (1.0×). (a, Western Australia, AM P39442; b, New South Wales, AM P21008).

QUEENSLAND: 1 male (SL 9.2 mm), off Innisfail, CIDARIS I, sta. 43–3, 17°35'S, 146°52.2'E, ORV *Franklin*, 480–504 m, 15 May 1986, coll. JCU, QM W16500. 2 juvs. sex indet. (SL 2.4, 3.5 mm), off Tully, 17°51.8'S, 147°07.9'E, epibenthic sledge, ORV *Franklin*, sta. 47–2, 503–497 m, 16 May 1986, coll. JCU, QM. 1 male (SL 9.0 mm), 1 female (SL 5.7 mm), off Tully, CIDARIS I, sta. 47–2, 17°52'S, 147°08'E, epibenthic sledge, ORV *Franklin*, 503–497 m, 16 May 1986, coll. JCU, QM W16501.

Other material. (For meaning of asterisks see Materials and Methods). SOUTH CHINA SEA: 1 female (SL 8.6 mm), SE of Hong Kong, *Albatross*, sta. 5301, 20°37'N, 115°43'E, 380 m, 8 Aug 1908, USNM 168916*.

PHILIPPINES: 1 female (SL 4.4 mm), W of Luzon, *Albatross*, sta. 5438, 15°54'42"N, 119°44'42"E, 543 m, 8 May 1909, USNM 168917*. 1 female (SL 14.0 mm), Luzon, off Sombrero Is., *Albatross*, sta. 5111, 13°45'15"N, 120°46'30"E, 432 m, USNM 168913*. 1 female (SL 13.3 mm), Luzon, Tayabas Bay, off San Andres Is., *Albatross*, sta. 5221, 13°38'15"N, 121°48'15"E, 353 m, 24 Apr 1908, USNM 168914*. 1 female (SL 13.7 mm), Mindoro Is., off Balanja Point, *Albatross*, sta. 5260, 12°25'35"N, 121°31'35"E, 428 m, 3 Jun 1908, USNM 168915*. 1 female (SL 8.8 mm), N Mindanao, *Albatross*, sta. 5506, 08°40'N, 124°31'45"E, 479 m, 5 Aug 1909, USNM 168918*.

INDONESIA: 1 male (SL 8.4 mm), Borneo (Kalimantan), Sibuko Bay, off Silungan Is., *Albatross*, sta. 5592, 04°12'44"N, 118°27'44"E, 558 m, 29 Sep 1909, USNM 168919*. 1 male (SL 11.6 mm), 4 females (SL 5.9–9.2 mm), same sta. data as holotype, ZMA De 103.104*. 1 male juv. (damaged), Siboga Exp., sta. 316, 07°19.4'S, 116°49.5'E, 538 m, coll. M. Weber, ZMA De 103.107*. 1 male juv. (SL 4.7 mm), 1 female juv. (4.2 mm), Siboga Exp., sta. 45, 07°24'S, 118°15.2'E, 794 m, coll. M. Weber, ZMA De 103.106*. 1 male (SL 21.2 mm), Siboga Exp., sta. 5, 07°46'S, 114°30.5'E, 330 m, coll. M. Weber, ZMA De 103.105*.

Diagnosis. First 11 pairs of gills intermediate (Fig. 2c); vestigial pleurobranchs on last thoracic somite occasionally obsolete or missing in small specimens SL < 5.5 mm. Shield (Fig. 2a) broader than long; dorsal surface weakly calcified medially; rostrum triangular, with low dorsal ridge; anterior margins straight; lateral projections broadly rounded, often nearly obsolete; ventrolateral margin unarmed; posterior margin broadly rounded. Ocular peduncles more than half length of shield; ocular acicles subtriangular, terminating in spine (rarely bifid on one side); corneae slightly dilated. Sternite of 3rd maxillipeds with spine on each side of midline. Epistomial spine straight, often absent. Antennular peduncle exceeding distal margin of corneae

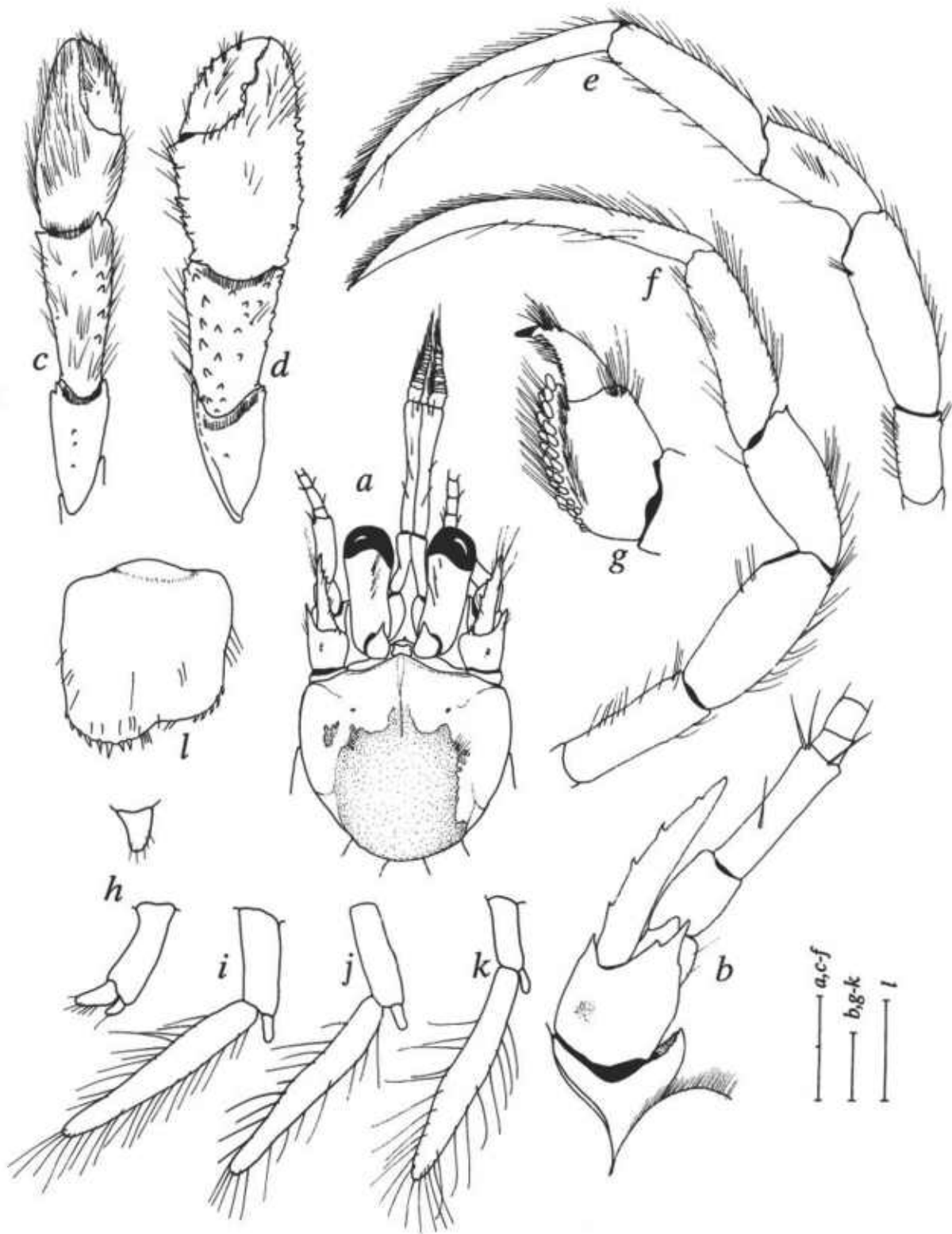


Fig. 6. *Sympagurus brevipes* (De Saint Laurent, 1972), juvenile sex indet. (SL 4.1 mm), Western Australia, USNM 270112. a, shield and cephalic appendages; b, right antennal peduncle, lateral; c, left cheliped; d, right cheliped; e, left 2nd pereopod, lateral; f, left 3rd pereopod; g, propodus and dactyl of left 4th pereopod; h-k, pleopods: h, 2nd (upper is right, lower is left); i, left 3rd; j, left 4th; k, left 5th; l, telson. Scales = 2 mm (a,c-f), 0.5 mm (b,g-k), 1 mm (l).

by full length of ultimate segment. Antennal peduncle at most slightly exceeding distal margin of cornea; 4th segment unarmed; 3rd segment with strong ventromesial distal spine; 2nd segment with dorsolateral distal angle produced, terminating in strong spine with 3 small spines dorsally; acicles reaching at most distal margin of cornea, mesial margin armed with 9 to 12 spines; flagellum with few setae < 1 flagellar article in length. Chelipeds markedly dissimilar, with numerous tufts of setae (not shown in Fig. 3a,b) obscuring surfaces. Right cheliped (Fig. 3b) with chela varying from 1.5 to more than twice as long as broad in larger individuals; fingers weakly curved ventromesially, dactyl with weakly concave ventromesial face; dorsal and ventral faces of palm unarmed, smooth except for tufts of setae; mesial and lateral faces of palm rounded, with lateral and dorsomesial rows of spines; carpus with numerous small tubercles or spines on dorsal surface. Left cheliped (Fig. 3a) with chela unarmed, well calcified; carpus with dorsodistal spine, and dorsal row of 2 to 4 well-spaced spines. Ambulatory legs (Fig. 2b,c) exceeding tip of extended right cheliped; dactyl about twice as long as propodus, with ventromesial irregular row of 20 to 25 minute corneous spines, dorsal row of long setae, and 3 dorsomesial oblique rows of long setae distally; carpus with small dorsodistal spine; ischium and merus of 2nd pereopod with row of few small tubercles or spines. Anterior lobe of sternite of 3rd pereopods unarmed or with 1 marginal spine, setose. Fourth pereopod with dactyl terminating in corneous claw; propodal rasp of adults consisting of 4 to 6 rows of ovate scales (Fig. 2d), and of juveniles (SL < 5.5 mm) of 1 or 2 rows of ovate scales (Fig. 6g). Uropods and telson (Fig. 4a-d) markedly asymmetrical; telson with weak transverse suture separating anterior and posterior lobes, dorsal surface with low blister-like tubercles; posterior lobes separated by V-shaped cleft, terminal margins armed with often long corneous spines, spines on left side strongly curved laterally, usually much longer in females than in males (Fig. 4c,d). Male 1st gonopods (Fig. 4e) each with concave distal lobe; 2nd gonopods (Fig. 4f) each with distal segment nearly flat, rounded distally, often with rudimentary exopod. Females with vestigial right 2nd pleopod.

Habitat and symbiotic associations. Lives associated with an actinian (Fig. 5a) that secretes a carcinoecium similar to that produced by species of *Stylobates* (see Fautin Dunn *et al.*, 1980; Fautin Dunn & Liberman, 1983; Fautin, 1987).

Distribution. Indo Pacific: Zanzibar; Indonesia; Philippines; and Australia. Depth: 267 to 794 m.

Remarks. As pointed out by the De Saint Laurent (1972: 106), specimens of this species can attain a large size. The largest specimen measured during the present study has a SL of 26.0 mm, exceeding all other specimens of *Sympagurus* species. This species is among the most common of *Sympagurus* found in Australia but apparently is confined to the north.

Comparison of juveniles and adults. Juvenile specimens of *S. brevipes* that are as large or larger than adult specimens of other *Sympagurus* species are frequently encountered. As in other species in the genus, such as *S. dimorphus* (see Lemaitre & McLaughlin, 1992), the morphology of juveniles of *S. brevipes* can be quite different from that of adults. The most important differences between juveniles and adults of this species are summarised below.

The ocular peduncles of juveniles are subequal in width throughout their length (Fig. 6a); the peduncles of adults are medially constricted (Fig. 2a). The antennal acicle of juveniles is armed mesially with usually four weak spines (Fig. 6b); the acicle of adults is armed with nine to 12 spines. Chelipeds of juveniles, when extended, have nearly the same length, the spines are weak, not numerous (Fig. 6c,d), and pilosity does not obscure the surfaces; chelipeds of adults are markedly different in distal extension, spination is strong, and pilosity is dense, obscuring the surfaces. The meri of the 2nd and 3rd pereopod in juveniles (Fig. 6e,f) are not as broad as those of adults (Fig. 2b). In juveniles, the propodal rasp of the 4th pereopod has two rows of scales (Fig. 6g), smaller specimens (SL < 3.5 mm) only one row; the rasp of adults has four or five rows (Fig. 2d). The 2nd to 5th pleopods of juveniles are paired, asymmetrical, the left biramous with a short endopod, the right uniramous (Fig. 6h-k). Juvenile males exhibit rudimentary paired 1st gonopods. Adults have gonopods or pleopods as indicated in the diagnosis. The terminal margin of the posterior lobes of the telson of juveniles are armed with few small spines (8, left lobe; 5, right lobe; Fig. 6l); the terminal margins of adults are armed with many spines (20+ on left lobe, 8 on right lobe). The vestigial pleurobranch on the last thoracic somite is occasionally absent in small juveniles (SL < 3.5 mm), whereas the pleurobranch is invariably present in adult specimens.

Sympagurus dimorphus (Studer, 1883)

Fig. 7

Eupagurus dimorphus Studer, 1883: 24, figs 11, 12 (type locality: off Cape of Good Hope, South Africa, S.M.S. Gazelle, 34°13.6'S, 15°00.7'W, 211 m).

Parapagurus dimorphus.—De Saint Laurent, 1972: 108.

Sympagurus dimorphus.—Lemaitre, 1989: 71, figs 36–38, 40E–H.—Lemaitre, 1990: 229.—Lemaitre, 1994: 412.—Lemaitre & McLaughlin, 1992: 747, figs 1–5, tables 1, 2.

Type material. Syntypes, Museum für Naturkunde der Humboldt-Universität zu Berlin (not examined).

Australian material. NEW SOUTH WALES: 1 female (SL 5.3 mm), off Newcastle, FRV *Kapala*, 549 m, Apr 1971, AM P18027. 2 males (SL 4.2, 5.4 mm), E of Broken Bay, FRV *Kapala*, sta. K80-07-02, 329 m, 5 Oct 1976, AM P40387. 2 males (SL 4.6, 5.5 mm), E of Seal Rocks, FRV *Kapala*, sta. K78-14-09, 32°23'S, 152°59'E, 503 m, 20 Jul 1978, AM P40402. 1 male (SL 3.2 mm), Ulladulla-Bateman's Bay area,

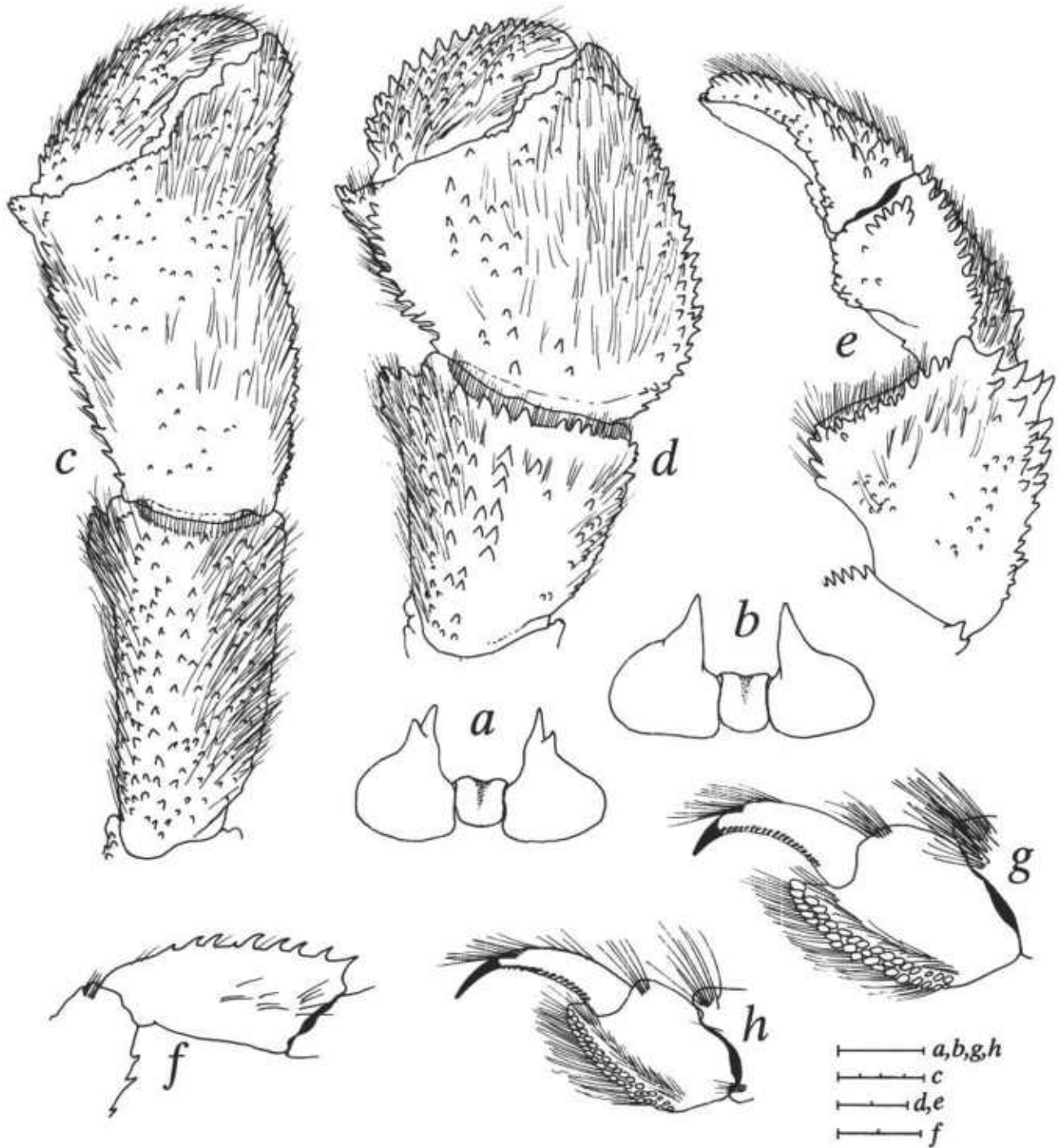


Fig. 7. *Sympagurus dimorphus* (Studer, 1883). a, b, ocular acicles, dorsal; c-e, carpus and chela of right cheliped: c, male; d, female; e, same, mesial; f, carpus of right 2nd pereopod, lateral; g, h, propodus and dactyl of left 4th pereopods, lateral: g, male; h, female. Scales = 1 mm (a, b, g, h), 4 mm (c), and 2 mm (d, e, f). (New Zealand: a, d-f, female [SL 8.1 mm], NMNZ Cr 3204; b, male [SL 8.4 mm], NMNZ Cr 3204; c, g, male [SL 9.2 mm], New Zealand, NMNZ Cr 8472; h, female [SL 6.9 mm], NMNZ Cr 3204).

FRV *Kapala*, sta. K77-03-07/08, 35°32'S, 15°47'E, 549 m, 28 Apr 1977, AM P40398. 1 female (SL 3.7 mm), SE of Gabo Is., FRV *Kapala*, sta. K75-03-02, 37°45–38'S, 150°12–16'E, 402–439 m, 10 Jul 1975, AM P20820.

VICTORIA: 1 male (SL 6.9 mm), 40 mi (74 km) S of Cape Everard, 400 m, Oct 1914, AM E.6153. 2 males (SL 5.2, 7.5 mm), off Gabo Is., 365 m, 11 Nov 1913, AM E.4771. 1 female (SL 5.5 mm), eastern slope, Bass Strait, 128–146 m, 29 Nov 1913, AM E.4827. 2 females (SL 4.6, 4.7 mm), off SE Victoria, 38°14.9'S, 149°26.1'E, CSIRO cruise FR5/86, SLOPE 34, 800 m, 23 Jul 1986, NMV J16208. 2 males (SL 5.2, 6.6 mm), 6 females ovig. (SL 5.2–6.3 mm), S of Point Hicks, Eastern Bass Strait, HMS *Kimbla*, sta. K7/73–8, 38°16'S, 149°26'E, 512 m, 21 Nov 1973, NMV J12126, J16190. 1 male (SL 5.8 mm), sta. MFG 15, Bass Strait, off Portland, 38°50'S, 141°46'E, 600 m, 6 Mar 1980, coll. M. Gomon *et al.*, NMV J40405. 3 males (SL 4.2–4.6 mm), 3 females (SL 3.7–4.4 mm), off eastern Victoria, CSIRO cruise FB5/86, SLOPE 46, 42°00.2'S, 148°37.7'E, 720 m, 27 Jul 1986, NMV J16191.

TASMANIA: 3 males (SL 4.2–7.0 mm), 2 females (SL 4.4, 5.3 mm), 1 female ovig. (SL 5.3 mm), off Babel Is., 124 m, 28 Oct 1912, AM E.3148, P.3545. 2 males (SL 3.9, 7.2 mm), FRV *Soela*, S05/84/51, 41°15'S, 144°03'E, 520–480 m, 20 Oct 1984, coll. R. Wilson, NMV J11396. 1 female (SL 5.3 mm), FRV *Soela*, S05/84, 41°15'S, 144°08'E, 520 m, 20 Oct 1984, NMV J16201. 3 males (SL 6.0–8.2 mm), 1 female (SL 6.7 mm), 39 km NE of Cape Tourville, Tasmania Marine Station no. SLOPE 84, 41°53.54'S, 148°39.07'E, 732 m, 30 Oct 1988, coll. G.C.B. Poore *et al.*, NMV J16188, J40406. 3 males (SL 2.6–4.2 mm), 3 females ovig. (SL 4.1–4.3 mm), Oyster Bay, 110 m, [no date], AM P4484. 1 female ovig. (SL 5.3 mm), FRV *Soela*, S04/84/3, 42°41.9'S, 148°25.1'E, 440 m, 15 Aug 1984, NMV J16207. 3 males (SL 6.9–7.5 mm), E of Maria Is., F/S *Endeavour*, 91–182 m, 1915, AM E6420. 7 males (SL 2.0–5.5 mm), 7 females (SL 2.0–4.0 mm), 3 females ovig. (SL 4.3–4.4 mm), 25 km E of Port Davey, FRV *Soela*, sta. S05/84/60, 43°25.3'S, 145°39.8'E, 160 m, 21 Oct 1984, coll. R.S. Wilson, NMV J12110. 1 male (SL 3.7 mm), 3 megalopae (SL 1.5–1.7 mm), S of Hobart, *Dmitry Mendeleev*, 43°43'S, 147°46'E, 160 m, 20 Feb 1976, coll. J. Paxton, AM P21968. 1 male (SL 5.8 mm), 2 females ovig. (SL 5.0, 6.3 mm), S of Hobart, *Dmitry Mendeleev*, 43°48.2'S, 147°50'E, 720–755 m, 20 Feb 1976, coll. J. Paxton, AM P21962. 7 males (SL 4.8–6.0 mm), 3 females (SL 2.2–4.0 mm), 1 female ovig. (SL 4.2 mm), 44 unsexed (left in zoanthid carcinoecia), off Tasman Head, Bruny Is., 146–183 m, AM E.5180. 5 males (SL 7.3–7.6 mm), off South Cape, FS *Endeavour*, 137 m, 1914, AM E5176. 7 males (SL 7.3–7.8 mm), off South Cape, 137 m, AM E.5177. 1 female ovig. (SL 5.4 mm), off Maatsuyter Is., Jul 1958, NMV J16197.

Other material. NEW ZEALAND: 1 male (SL 6.8 mm), BS 812, (0.592), W of Hokianga Harbour, RV *Tangaroa*, NZOI sta. O.556, 35°37.6'S, 172°36.5'E, 657 m, 11 Jan 1981, NMNZ Cr 8466. 1 male (SL 9.7 mm), BS 805, WSW of Cape Maria van Dieman, RV *Tangaroa*, NZOI sta. O.549, 37°33.1'S, 177°33.8'E, 776–836 m, 11 Jan 1981, NMNZ Cr 8464. 2 females ovig. (SL 6.5, 6.6 mm), BS 846, (0.592), SE of Aldermen Is., RV *Tangaroa*, 37°04.3'S, 176°26.6'E, 807–872 m, mud, 23 Jan 1981, NMNZ Cr 8460. 3 males (SL 6.9–7.6 mm), 2 females (SL 2.7, 5.3 mm), BS 844, W of White Is., RV *Tangaroa*, NZOI sta. O.590, 37°10.8'S, 176°38.0'E,

685–705 m, mud, 23 Jan 1981, NMNZ Cr 8467. 1 female (SL 4.3 mm), 1 female ovig. (SL 9.2 mm), BS 761, about 37 km E of Mayor Is., RV *Tangaroa*, NZOI sta. R 119, 37°22.0'S, 176°37.2'E, 616–666 m, mud, 24 Jan 1979, NMNZ Cr 8475. 1 male (SL 5.0 mm), about 31 km WNW of Orete Point, Cape Runaway, RV *Tangaroa*, NZOI sta. R 123, 37°33.1'S, 177°33.8'E, 482–353 m, 25 Jan 1979, NMNZ Cr 8461. 1 female (SL 8.5 mm), Bay of Plenty, FV *Trinity*, 380–420 m, Nov 1987, NMNZ Cr 8433. 1 juv. sex indet. (SL 2.5 mm), E coast, North Is., RV *James Cook*, J10/60/86, 38°32.4'S, 178°48.4'E, 630 m, NMNZ Cr 8426. 1 male (SL 9.0 mm), Mahia Peninsula, 38°47.5'S, 178°48.7'E, RV *James Cook*, J10/52/86, 769 m, 31 Aug 1986, coll. W.R. Webber, NMNZ Cr 8438. 1 male (SL 12.8 mm), Challenger Plateau, 38°53.6'S, 167°23.7'E, RV *James Cook*, J2/11/81, 841–847 m, 24 Jan 1981, NMNZ Cr 8441. 5 males (SL 3.3–9.3 mm), 1 female (SL 3.9 mm), BS 830, E of Cape Kidnappers, RV *Tangaroa*, NZOI sta. O.575, 39°52.8'S, 177°36.5'E, 785–882 m, mud, 21 Jan 1981, NMNZ Cr 8468. 1 female (SL 4.1 mm), Challenger Plateau, 40°06.3'S, 167°57.9'E, RV *James Cook*, J19/9/84, 919–922 m, 13 Nov 1984, NMNZ Cr 8454. 1 male (SL 9.2 mm), midway Castlepoint to Cape Tumagain, RV *James Cook*, J6/3/81, 40°49.8'S, 176°50.8'E, 752–688 m, 12 Apr 1981, coll. G.S. Hardy, NMNZ Cr 8456. 7 males (SL 6.2–10.5 mm), 1 female (SL 7.8 mm), 3 females ovig. (SL 6.1–8.0 mm), Hikurangi Trench, RV *James Cook*, J9/04/89, 41°21.6'S, 176°10.3'E, 710 m, 12 Sep 1989, NMNZ Cr 8451. 3 males (SL 6.8–9.2 mm), 5 females (SL 6.2–7.7 mm), 8 females ovig. (SL 5.6–7.3 mm), NW Westport, RV *James Cook*, J15/15/76, 41°25'S, 170°43'E, 212–332 m, 25 Sep 1976, USNM. 7 males (SL 6.9–10.6 mm), 6 females (SL 6.1–8.1 mm), 1 female ovig. (SL 8.1 mm), BS 672, off Turakirae Head, RV *Tangaroa*, NZOI sta. R 30, 41°31.4'S, 174°52.6'E, 533–225 m, mud and rocks, 15 Jan 1979, NMNZ Cr 8458, 8471, 8483. 10 males (SL 10.4–14.8 mm), 3 females (SL 7.5–10.5 mm), BS 643, 41°42.0'S, 175°15'E, RV *Tangaroa*, NZOI sta. R 1, Palliser slope, 461 m, mud, 9 Jan 1979, NMNZ Cr 8486, USNM. 1 male (SL 11.0 mm), 45 mi (83.2 km) NW of Perpendicular Point (Westland), RV *James Cook*, J15/17/76, 41°47'S, 170°29'E, 512–562 m, 26 Sep 1976, NMNZ Cr 8473. 1 male (SL 12.9 mm), 1 female ovig. (SL 10.9 mm), BS 668, about 43 km SE of Cape Campbell, RV *Tangaroa*, NZOI sta. R 26, 41°55.9'S, 174°43.2'E, 454–424 m, 14 Jan 1979, NMNZ Cr 8446. 4 males (SL 9.3–12.2 mm), 4 females (SL 3.4–6.4 mm), 2 females ovig. (SL 6.3–7.6 mm), BS 669, about 41 km SE of Cape Campbell, RV *Tangaroa*, NZOI sta. R 27, 41°55.8'S, 174°40.7'E, 434–446 m, 14 Jan 1979, NMNZ Cr 8479. 5 males (SL 7.8–14.8 mm), 5 females (SL 5.2–8.9 mm), 2 females ovig. (SL 8.5, 8.6 mm), off Westport, RV *James Cook*, J12/006/78, 42°33'S, 170°07'W, 400–473 m, 10 Dec 1978, NMNZ Cr 8448. 1 male (SL 6.3 mm), BS 560, 9.3 mi (17.2 km) S of Kaikoura Light, RV *Acheron*, 42°35'S, 173°41'E, 640 m, 28 Sep 1976, NMNZ Cr 8481. 3 males (SL 4.2–6.0 mm), 2 females (SL 4.8, 4.9 mm), BS 650, northern Mernoo slope, RV *Tangaroa*, NZOI sta. R 8, 42°38.2'S, 176°10.5'E, 999–984 m, 11 Jan 1979, NMNZ Cr 8465, 8482. 1 male (SL 4.8 mm), BS 664, Conway Trough, Kaikoura, RV *Tangaroa*, NZOI sta. R 22, 42°38.2'S, 173°36.0'E, 632 m, 13 Jan 1979, NMNZ Cr 8480. 1 female ovig. (SL 11.9 mm), NW of Chatham Is., COR/219/89, 42°49.8'S, 177°37.5'W, 815 m, 13 Aug 1989, NMNZ Cr 8455. 10 males (SL 3.6–10.2 mm), 2 females (SL 4.0, 5.2 mm), BS 546, about 24 mi (44.4 km) off Waiou River mouth, RV *Acheron*, 42°55'S, 173°43'E, 549–586 m, 18 Mar 1976, NMNZ Cr 8469. 5 males (SL 8.3–11.2 mm), 1 female (SL 7.1 mm), 22 females ovig. (SL 5.9–8.4 mm), BS 300, Turakirae Trench, 4.5 mi (8.3 km)

off Cape Turakirae, 640–658 m, 6 Sep 1972, NMNZ Cr 8439. 1 male (SL 7.8 mm), 3 females (SL 5.5–8.1 mm), 23 females ovig. (SL 6.1–8.5 mm), Turakirae trench, 2.5 mi (4.6 km) off Cape Turakirae, 640–658 m, 6 Sep 1972, NMNZ Cr 8445. 1 male (SL 12.2 mm), J09/15/77, 43°13.1'S, 173°51'E, 610 m, 18 Dec 1977, NMNZ Cr 3203. 7 males (SL 3.1–6.2 mm), 7 females (SL 3.9–6.4 mm), 29 females ovig. (SL 4.6–5.9 mm), 1 juv. sex indet. (SL 2.2 mm), BS 559, up steep wall of Pegasus Canyon, Pegasus Bay, RV *Acheron*, 43°14'S, 173°39'E, 1006–512 m, coral, 27 Sep 1976, NMNZ Cr 8450, 8463. 10 males (SL 4.2–6.4 mm), 2 females (SL 3.9, 4.8 mm), Taiaroa Trench off Otago Peninsula, RV *Acheron*, 768–722 m, 11 Aug 1974, coll. A.J. Black, NMNZ Cr 8474. 3 males (SL 10.3–12.2 mm), 5 females ovig. (SL 9.2–10.5 mm), Chatham Rise Carea, FV *Chiyo Maru*, 43°29'S, 176°34'W, 529–506 m, 15–19 Sep 1987, coll. R. Stewart, NMNZ Cr 8436. 2 males (SL 9.0, 12.5 mm), 1 female (SL 6.9 mm), 4 females ovig. (SL 7.2–8.1 mm), Canterbury Bight, RV *James Cook*, J9/6/77, 44°40.7', 172°35.5'E, 370–360 m, 13 Dec 1977, NMNZ Cr 8476. 3 males (SL 8.5–10.5 mm), 2 females ovig. (SL 8.5, 9.6 mm), Canterbury Bight, RV *James Cook*, 44°44'S, 172°41'E, 402 m, 13 Nov 1970, NMNZ Cr 8440. 2 males (SL 12.2, 12.9 mm), 1 female (SL 10.8 mm), Solander Through, FV *Chiyo Maru*, haul 149, 46°30'S, 166°14.4'E, 573–545 m, 10 Sep 1987, NMNZ Cr 8442. 2 males (SL 12.8, 14.4 mm), 1 female ovig. (SL 13.1 mm), Solander Through, FV *Chiyo Maru*, haul 147, 46°31.9'S, 165°44.4'E, 320–346 m, coll. R. Stewart, NMNZ Cr 8428, 8434, 8435. 1 male (SL 12.1 mm), Puysegur Bank, FV *Chiyo Maru*, Haul 146, 46°44.4'S, 165°43.8'E, 566–296 m, 10 Sep 1987, coll. R. Stewart, NMNZ Cr 8449. 1 female (SL 12.0 mm), S of South Otago, FV *Chiyo Maru*, H.156, 47°02.8'S, 169°34.7'E, 309–331 m, 13 Sep 1987, coll. R. Stewart, NMNZ Cr 8427. 7 males (SL 8.6–14.2 mm), 4 females (SL 5.9–12.4 mm), Northern Campbell Plateau, FV *Chiyo Maru*, H.155, 47°30.5'S, 169°14.7'E, 529–526 m, 13 Sep 1987, coll. R. Stewart, NMNZ Cr 8437, 8443, 8444. 9 males (SL 8.1–12.2 mm), 5 females (SL 8.7–11.8 mm), 1 female ovig. (SL 10.4 mm), Snares Is. Shelf, RV *James Cook*, J1/22/77, 48°12'S, 168°09'E, 700–706 m, 23 Jan 1977, NMNZ Cr 8457. 1 male (SL 9.7 mm), Snares Is. Shelf, RV *James Cook*, J1/24/77, 48°19'S, 167°55'E, 210–292 m, 23 Jan 1977, NMNZ Cr 8432. 1 male (SL 10.2 mm), Snares Is. Shelf, RV *James Cook*, J1/19/77, 48°50'S, 167°08'E, 514–535 m, 22 Jan 1977, NMNZ Cr 8478. 1 male (SL 12.1 mm), Auckland Is., RV *James Cook*, J2/16/80, 51°01.4'S, 166°19.2'E, 168–262 m, 30 Jan 1980, NMNZ Cr 8430.

Diagnosis. First 11 pairs of gills trichobranchiate. Shield usually as broad as long; dorsal surface often weakly calcified medially; rostrum rounded with broad low dorsal ridge; anterior margin concave; lateral projections subtriangular, with small terminal spine; ventrolateral margin unarmed; posterior margin broadly rounded. Ocular peduncles more than half length of shield; ocular acicles (Fig. 7a,b) subtriangular, terminating in strong simple or bifid spine; corneae slightly dilated. Sternite of 3rd maxilliped with spine on each side of midline. Epistomial spine short and straight, often absent. Antennular peduncle exceeding distal margin of corneae by nearly full length of ultimate segment. Antennal peduncle at most slightly exceeding distal margin of corneae; 4th segment with small dorsolateral distal spine; 3rd segment with strong ventromesial distal spine;

2nd segment with dorsolateral distal angle produced, terminating in strong multifid spine; acicles sinuous in dorsal view, usually not exceeding distal margin of corneae, mesial margin armed with 13 to 19 strong spines; flagellum distinctly overreaching right cheliped, with numerous setae 1 or 2 flagellar articles in length. Chelipeds markedly dissimilar, covered with moderately dense simple and plumose setae. Right cheliped massive (Fig. 7c–e), chela usually operculate; proportions and armature strongly affected by size and sexual dimorphism; fingers strongly curved ventromesially, dactyl with ventromesial face concave; dorsal surface of palm with numerous small tubercles or spines; dorsomesial and dorsolateral margins of palm well delimited by row of spines, dorsolateral margin often strongly curved. Left cheliped well calcified; palm with dorsomesial, dorsolateral, and often dorsomedial rows of small tubercles or spines; carpus with dorsal row of spines. Ambulatory legs usually overreaching extended right cheliped by about 0.25 length of dactyl, armature on meri, carpi and propodi frequently more developed on right than on left; dactyl shorter than propodus, with ventromesial row of 15 to 20 strong spinules, dorsal row of long setae, and 3 or 4 short dorsomesial oblique rows of setae on distally; carpus (Fig. 7f) with dorsal row of spines. Anterior lobe of sternite of 3rd pereopods with 1 to 3 small marginal spines, setose. Fourth pereopod (Fig. 7h,g) with dactyl terminating in sharp corneous claw; propodal rasp with 2 to 5 irregular rows of ovate scales. Uropods and telson markedly asymmetrical; telson with weak transverse suture, terminal margin separated by shallow, broad U-shaped sinus into unequal lobes armed with short corneous spines. Male 1st gonopods each with moderately concave distal lobe; 2nd gonopods each with distal segment spatulate, basal segment occasionally with short exopod. Females lacking 1st pleopods, or occasionally with rudimentary paired or unpaired 1st pleopods; with vestigial right 2nd pleopod.

Distribution. Southern hemisphere from 22°S to 57°S; in the Atlantic possibly as far north as Ascension Island. Depth: 91 to 1995 m.

Remarks. While examining the numerous material of this species from Australia and New Zealand, extreme variations were observed. The ocular acicles are frequently bifid (Fig. 7a). The armature of carpus and chela of the right cheliped, and carpi of walking legs, can be strong (Fig. 7c–f). On the 4th pereopod, the propodal rasp frequently exhibits two rows of ovate scales; the dactyl has a much longer, slenderer claw in females than in males (Fig. 7g,h). The type of housing used also varies, in some specimens consisting of a gastropod shell, in others of a zoanthid. Variations were particularly pronounced in the New Zealand material, but with such a considerable amount of morphological overlap with specimens from other regions that there is no character, or suite of characters, that can be used to justify separation at the species level.

Sympagurus papposus n.sp.

Figs 3c,d, 5b, 8–10

Sympagurus dofleini.—Lemaitre, 1994: 387 (in part) (Not *Sympagurus dofleini* [Balss, 1912]). (See remarks).

Holotype. Female ovig. (SL 14.3 mm), E of Broken Bay, FRV *Kapala*, sta. K75-01-02, 33°38'–34'S, 151°57'–152°01'E, 786–804 m, 2 Apr 1975, AM P44482.

Paratypes from Australia. WESTERN AUSTRALIA: 1 male (SL 7.8 mm), W of Cape Leveque, FRV *Soela*, sta. S01/84/092, 16°09.5'S, 120°08.8'E, 600–596 m, 18 Feb 1984, WAM 1241–86. 1 male (SL 12.1 mm), Scampi Trawl Grounds, *Comoc Endeavour*, sta. WH 85–15, 17°22'S, 118°38'E, 430 m, 2 Nov 1985, NTM Cr 006863. 1 male (SL 12.0 mm), North West Shelf, FRV *Soela*, sta. NWS-7, Scampi Shot 2, 18°32.2'S, 117°30.9'E, 392–400 m, 25 Jan 1983, coll. A.J. Bruce, NTM Cr 010911. 1 male (SL 13.0 mm), North West Shelf, FRV *Soela*, CSIRO, cruise 0184, sta. NWS-36 T/10, 19°15'S, 115°38'E, 404 m, 29 Jan 1984, coll. A.J. Bruce, USNM 270108. 2 females ovig. (SL 9.5, 10.8 mm), North West Shelf, FRV *Soela*, CSIRO, cruise 0184, sta. T8, 19°20.2'S, 115°44.1'E, 306–308 m, 29 Jan 1984, NTM Cr 000663, 000664. 3 males (SL 11.0–14.5 mm), West Shelf, FRV *Soela*, sta. S01-84-61, 11 Feb 1984, coll. T. Ward, AM P39452.

QUEENSLAND: 1 male (SL 14.2 mm), Marion Plateau, FRV *Soela*, sta. 0685-08, 22°55.1'S, 154°21.25'E, 590–606 m, 17 Nov 1985, NTM Cr 006852. 1 male (SL 14.0 mm), *Craigmin* Survey, sta. 26, 23°15.3'S, 154°21.7'E, 549 m, 4 Oct 1980, QM W10129. 1 female (SL 13.9 mm), FRV *Craig Mor*, shot 14, 23°18'S, 154°13'E, 530–585 m, 4 Oct 1980, NTM Cr 001157. 1 female ovig. (SL 11.0 mm), MV *Iron Summer*, shot 2, 27°19'91"S, 153°53'47"E, 600 m, 10 May 1983, trawled, QM W14338. 1 female ovig. (SL 13.3 mm), off N Stradbroke Is., MV *Iron Summer*, 27°35.5'S, 153°56.7'E, 520 m, 31 Mar 1983, trawled, coll. R. Noreton, QM W16520. 1 female ovig. (SL 14.0 mm), off N Stradbroke Is., MV *Iron Summer*, 27°36.5'S, 153°57'E, 550 m, 23 Nov 1982, trawled, G. Smith, QM W6518. 1 male (SL 16.6 mm), off N Stradbroke Is., MV *Iron Summer*, 27°40'S, 153°56.9'E, 530 m, 22 Nov 1982, trawled, G. Smith, USNM 270109. 1 male (SL 15.0 mm), off Southport, MV *Iron Summer*, 27°59.4'S, 154°00.1'E, 590 m, 31 Mar 1983, trawled, coll. R. Noreton, QM W16519.

NEW SOUTH WALES: 1 female (SL 8.0 mm), 30°31'–19'4"S, 161°54'2"–40'6"E, RV *Dmitry Mendeleev*, cruise 16, sta. 1245, 29 Dec 1975, NMV J11164. 1 female (SL 11.7 mm), E of Broken Bay, 33°30'–27'S, 152°05'–07'E, FRV *Kapala*, sta. K76-24-04, 819–823 m, 21 Dec 1976, AM. 3 males (SL 11.1–16.4 mm), 6 females ovig. (SL 11.8–14.5 mm), off Broken Bay, FRV *Kapala*, sta. K75-05-05, 33°32'–38'S, 152°00'–04'E, 823 m, 19 Aug 1975, AM P21008. 1 male (SL 16.3 mm), E of Broken Bay, FRV *Kapala*, sta. K77-23-12, 33°35'–33'S, 152°00'–02'E, 823 m, 8 Aug 1977, AM P26794. 3 males (SL 14.6–17.1 mm), E of Broken Bay, FRV *Kapala*, sta. K75-01-02, 33°38'–34'S, 151°57'–152°01'E, 786–804 m, 2 Apr 1975, AM P20495. 1 male (SL 17.0 mm), S of Sydney, FRV *Kapala*, sta. K07-01, 34°00'S, 151°43'E, 732 m, 6 Nov 1972, USNM 270110. 1 male (SL 10.4 mm), 40 km ESE of Ulladulla, FRV *Soela*, sta. S03/88/20, 35°31.29'S, 150°49.85'E, 910 m, Engels high-lift demersal, coll. M. Norman, NMV

J16189. 1 male (SL 7.9 mm), E of Eden, FRV *Kapala*, sta. K83-12-02, 37°36'S, 150°21'E, 860–960 m, 26 Sep 1983, AM P44031.

Other Paratypes. INDONESIA: 1 female ovig. (SL 9.7 mm), Indonesia, Java Sea, Siboga Exp., sta. 314, 07°36'S, 117°30.8'E, 694 m, 17 Jan 1900, ZMK.

WESTERN INDIAN OCEAN: 1 male (SL 11.0 mm), 1 female (SL 12.8 mm), Madagascar, *Vitiaz*, cruise 17, leg 3, sta. 2635, 25°05'S, 35°15'E, 228–205 m, 25 Nov 1989, LACM 95–17.1. 2 females ovig. (SL 11.2, 12.9 mm), Tulear [SW Madagascar], *Vitiaz*, cruise 17, sta. 2707, 33°01.8'S, 44°23.6'E, 910–925 m, 15 Dec 1988, USNM 270111.

Description. First 11 pairs of gills intermediate, weakly divided distally (Fig. 9f), or occasionally phyllobranchiate (Fig. 9e). Shield (Fig. 8a) as broad as long; dorsal surface frequently weakly calcified medially, with scattered short setae; rostrum broadly triangular, with short mid-dorsal ridge; anterior margins sinuose; lateral projections broadly rounded, often nearly obsolete; anterolateral margins slightly sloping; posterior margin broadly rounded. Anterodistal margin of branchiostegite rounded, unarmed, setose.

Ocular peduncles about half length of shield, with row of long setae dorsally. Cornea slightly dilated. Ocular acicles subtriangular, terminating in strong spine (occasionally bifid or trifid); separated basally by less than basal width of 1 acicle.

Antennular peduncle long, slender, exceeding distal margin of cornea by half length of penultimate segment. Ultimate segment twice or more as long as penultimate segment, naked or with scattered setae. Basal segment with strong ventromesial spine; lateral face with distal subrectangular lobe armed with 2 to 5 small spines, and strong spine proximally. Ventral flagellum with about 9 articles.

Antennal peduncle (Fig. 9d) exceeding distal margin of cornea by approximately half length of 5th segment. Fifth segment with scattered setae on lateral margin, and row of long setae dorsodistally. Fourth segment unarmed. 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 tubercle on lateral face; ventromesial angle produced, with 3 to 7 small spines laterally. Antennal acicles nearly straight (in dorsal view), exceeding distal margin of cornea by about 0.25 length of acicle, terminating in strong spine; mesial margin armed with 7 to 13 well-spaced spines, setose. Flagellum long, naked or with inconspicuous short setae less than half 1 flagellar article in length, exceeding extended right cheliped and ambulatory legs.

Mandible with 3-segmented palp. Maxillule (Fig. 9a,b) with external lobe of endopod weakly developed, internal lobe with 2 or 5 long setae. Maxilla with endopod slightly exceeding distal margin of scaphognathite. First maxilliped with endopod slightly exceeding exopod in distal extension. Second maxilliped without distinguishing characters. Third maxilliped (Fig. 9c) slender, distal 3

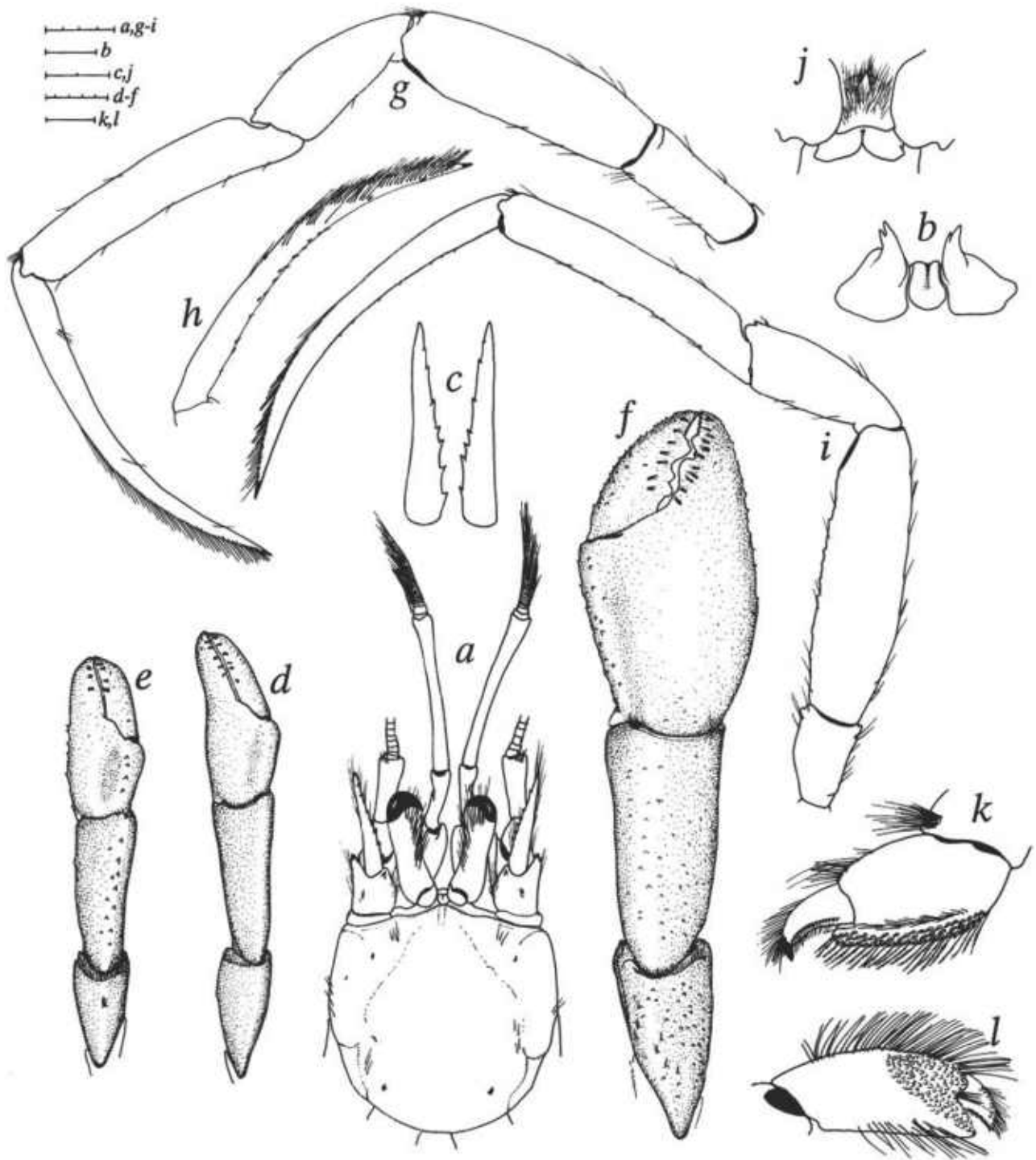


Fig. 8. *Sympagurus papposus* n.sp. a, shield and cephalic appendages; b, ocular acicles, dorsal; c, antennal acicles, dorsal; d, e, left cheliped, denuded; f, right cheliped, denuded; g, left 2nd pereopod, lateral; h, dactyl of same, mesial; i, left 3rd pereopod, lateral; j, sternite of 3rd pereopods, ventral; k, propodus and dactyl of left 4th pereopod, lateral; l, propodus and dactyl of left 5th pereopod, lateral. Scales = 4 mm (a, g-i), 1 mm (b, k, l), 2 mm (c, j), 5 mm (d-f). (a, c, d, f-l, paratype male [SL 12.1 mm], Western Australia, NTM Cr 006863; b, paratype female [SL 14.5 mm], New South Wales, AM P21008; e, paratype male [SL 11.0 mm], Madagascar, LACM).

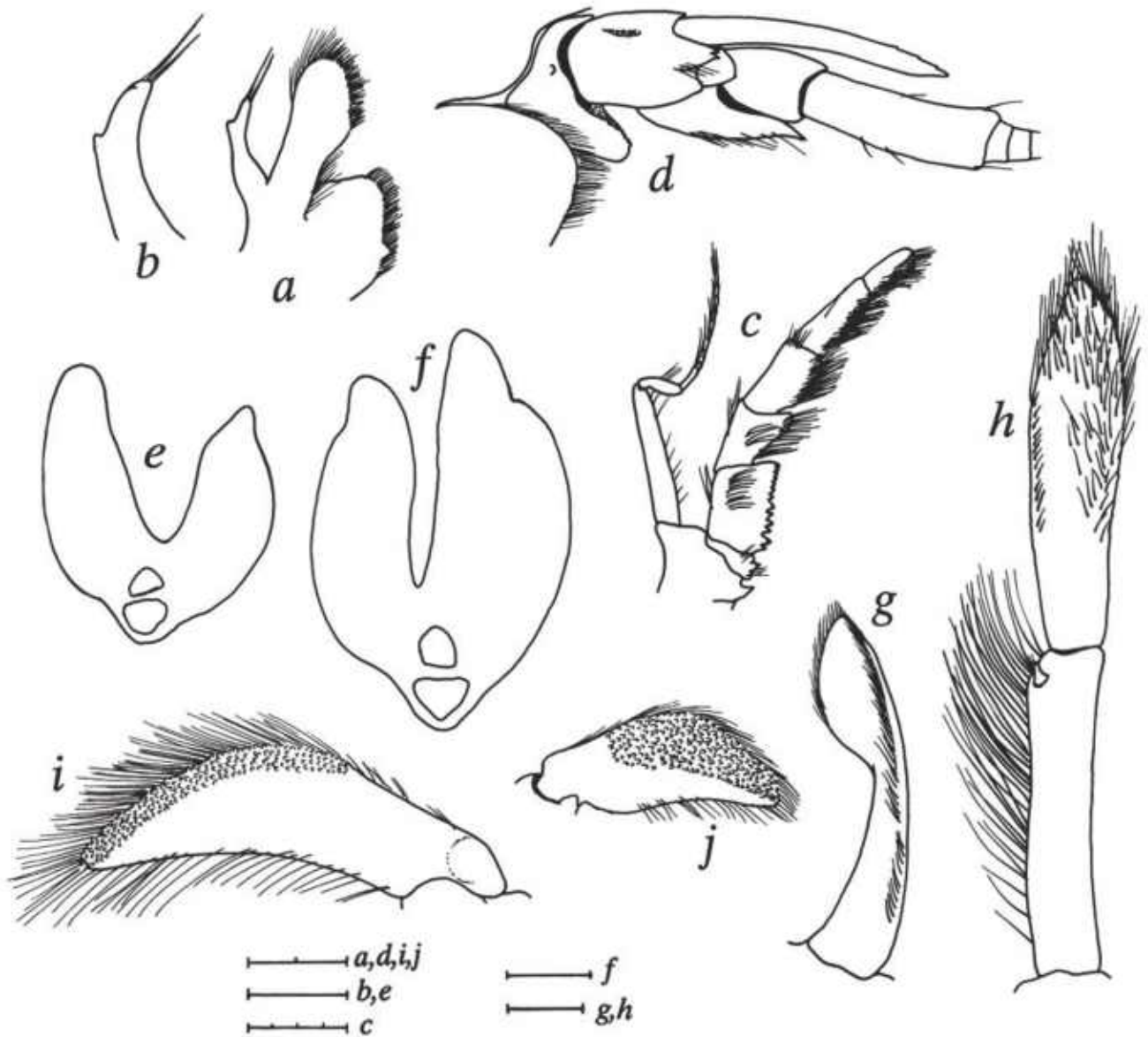


Fig. 9. *Sympagurus papposus* n.sp. a, left maxillule, internal, b, endopod of same; c, left 3rd maxilliped, internal; d, right antennal peduncle, lateral; e, f, branchia, transverse section; g, male left 1st gonopod, mesial; h, male left 2nd gonopod, anterior; i, j, exopod of uropods, dorsal: i, left, j, right. Scales = 2 mm (a, d, i, j), 1 mm (b, e, g, h), 4 mm (c), and 0.5 mm (f). (a–d, f–j, paratype male [SL 12.1 mm], Western Australia, NTM Cr 006863; e, paratype male [SL 14.0 mm], Queensland, QM W10129).

segments each 3 times as long as broad; crista dentata formed of 14 to 17 corneous-tipped teeth; coxa and basis each with small mesial tooth. Sternite of 3rd maxillipeds with small spine on each side of midline. Epistome with short, straight spine (often blunt), or unarmed. Labral spine present.

Chelipeds markedly dissimilar. Right cheliped (Fig. 8f) massive, with dense plumose setae. Fingers straight, terminating in small corneous claw; cutting edges each with irregularly-sized calcareous teeth; dorsal and ventral faces each with row of tufts of setae parallel to cutting edge. Dactyl subequal in length to palm, set at weakly

oblique angle to longitudinal axis of palm; mesial face rounded, with irregular rows of small spines; dorsal and ventral faces unarmed or at most with scattered small tubercles. Fixed finger with dorsal and ventral surfaces similar to dactyl. Palm about as long as broad; lateral and mesial faces rounded, with irregular rows of well-spaced small spines; dorsal and ventral surfaces smooth or at most with scattered tubercles. Carpus with small, well-spaced tubercles or spines on dorsal surface, dorsodistal margin unarmed; ventral surface with scattered small tubercles. Merus with dorsal surface similar to that of carpus; ventromesial margin with row of small spines.

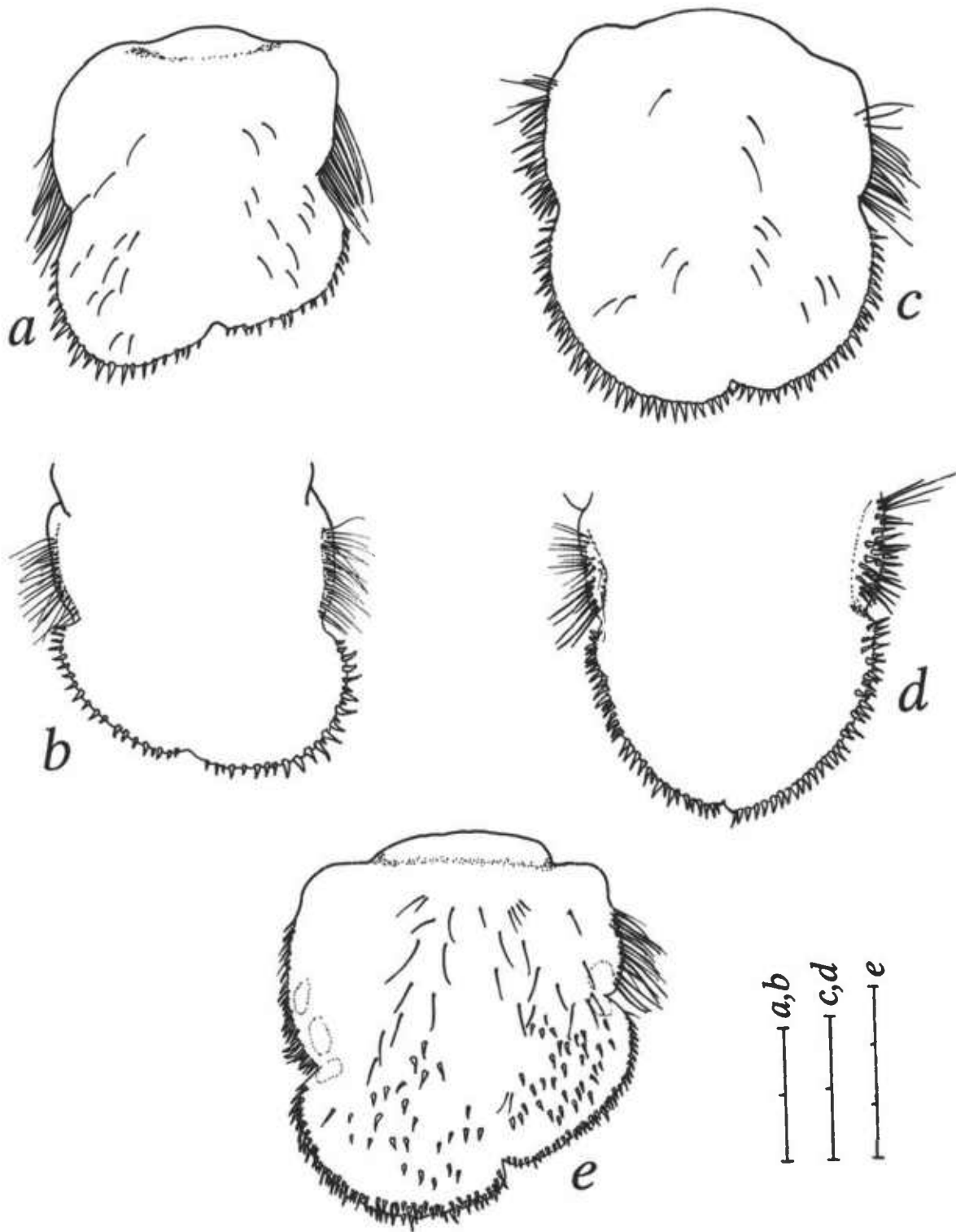


Fig. 10. Telson of *Sympagurus papposus* n.sp. a, male, dorsal; b, same, ventral; c, female, dorsal; d, same, ventral; e, female, dorsal. Scales = 2 mm (a–d), and 3 mm (e). (a,b, paratype male [SL 12.1 mm], Western Australia, NTM Cr 006863; c,d, paratype female [SL 11.0 mm], Queensland, QM 14338; e, paratype female [SL 14.5 mm], New South Wales, AM P21008).

Coxa and ischium with small spines on ventral face; coxa with ventromesial row of setae.

Left cheliped (Fig. 8e,d) well calcified, with dense plumose setae. Fingers terminating in small corneous claws; dorsal and ventral surfaces smooth except for tufts of setae; cutting edge of dactyl with row of minute, fused corneous teeth; cutting edge of fixed finger with row of regularly-spaced, small calcareous teeth interspersed with minute, fused corneous teeth. Dactyl about 1.3 times as long as palm. Palm unarmed or occasionally with dorsomesial row of small tubercles or spines; ventral surface smooth or with scattered small tubercles. Carpus with dorsal surface usually unarmed (Fig. 8d), or occasionally with row of small tubercles or spines on dorsal margin (Fig. 8e); ventral surface smooth. Merus with dorsal surface unarmed or at most with small, low tubercles on dorsal margin; ventral face often with scattered small spines. Ischium with row of spines on ventral margin. Coxa unarmed but with ventromesial row of setae.

Ambulatory legs (Fig. 8g-i) similar from right to left, long, reaching to extended right cheliped; ischium, merus, carpus and propodus with scattered short setae. Dactyl about 1.4 times as long as propodus, terminating in sharp corneous claw; with dorsomesial row of long setae, and ventromesial row of about 17 to 30 small corneous spines. Carpus with small dorsodistal spine (often blunt). Merus of 2nd pereopods usually with row of small spines on ventral margin. Ischium and coxa unarmed. Anterior lobe of sternite of 3rd pereopods (Fig. 8j) with strong marginal spine (sometimes bifid), setose.

Fourth pereopod (Fig. 8k) semichelate. Dactyl subtriangular, terminating in sharp corneous claw, and ventrolateral row of small corneous spinules. Propodus with dorsal margin longer than dorsoventral height, rasp consisting of 2 or 3 rows of conical scales. Carpus with long setae on dorsal margin. Merus with rows of long setae on dorsal and ventral margins.

Fifth pereopod (Fig. 8l) semichelate. Propodal rasp extending to mid-length of segment.

Uropods and telson (Fig. 9i,j, 10) markedly asymmetrical. Telson with transverse suture; dorsal surface with scattered short setae; female with ventrolateral margin of left anterior lobe (occasionally also of right lobe) with cluster of corneous spines mixed with long bristle-like setae (Fig. 10c-e); male with ventrolateral margins of anterior lobes with long setae (Fig. 10a,b); both sexes with posterior lobes separated by U- or V-shaped cleft, terminal margin of lobes armed with corneous spines.

Males with paired 1st and 2nd gonopods well developed. First gonopods (Fig. 9g) each with ovate, weakly concave distal lobe. Second gonopods (Fig. 9h) each occasionally with rudimentary exopod on one side; distal segment nearly flat, setose on distomesial face, with row of short setae on lateral margin; basal segment with long setae on posterior face. Females rarely with rudimentary paired 1st pleopods, and vestigial 2nd right pleopod.

Habitat and symbiotic associations. Found living in zoanthids (probably *Epizoanthus* sp.; Fig. 5b).

Distribution. Indo Pacific: Madagascar; Indonesia; and Australia. Depth: 205 to 960 m.

Etymology. The specific name is derived from the Latin *pappus*, bristles, and refers to the characteristic spines and bristle-like setae on the telson in females of this species.

Affinities. This new species closely resembles *Sympagurus dofleini* (Bals, 1912) (see Lemaitre, 1994: 384, figs 7, 8). Female specimens of *S. papposus* can immediately be separated from male or females of *S. dofleini* by the ventrolateral armature of the anterior lobes of the telson. Females of the new species have the left anterior lobe (and sometimes also the right anterior lobe) armed ventrolaterally with a fringe or cluster of corneous spines mixed with long bristle-like setae (Fig. 10c-e). In *S. dofleini* the anterior lobes in both sexes have at most a row of long setae ventrolaterally. In contrast to females, males of the two species can be separated using only a number of subtle but distinct differences. The anterolateral projections of the shield are broadly rounded, often obsolete (Fig. 8a), on *S. papposus*, whereas they are broadly triangular and often terminate acutely on *S. dofleini*. The armature of the antennal acicles in the two species differs in that the spines are stronger and more broadly spaced on *S. papposus* (Fig. 9c) than *S. dofleini* (Fig. 11a). The gills of *S. papposus* are phyllobranchs, or intermediate branchiae with lamellae weakly divided distally (Fig. 9e,f); the gills of *S. dofleini* are intermediate with lamellae deeply divided distally (Fig. 11b). The distal lobe of the male 1st gonopod (Fig. 9g) is broader in *S. papposus* than *S. dofleini*.

Although there is some interspecific overlap in the range of variation of the armature of the carpus of the left cheliped in *S. papposus* and *S. dofleini*, this character can also be of help in differentiating the two species. The carpus of the left cheliped of *S. papposus* is usually unarmed dorsally (Fig. 8d), whereas the carpus of *S. dofleini* has a row of spines or tubercles on the dorsal margin (in addition to one or more dorsodistal spines).

The two species also differ in their habitat and symbiotic associations. *Sympagurus papposus* has been found living exclusively in large zoanthids (*Epizoanthus* sp.; Fig. 5b), whereas *S. dofleini* is commonly found living in large actinians of the genus *Stylobates* which secrete a chitinous pseudo-shell (see Fautin Dunn *et al.*, 1980; Fautin, 1987).

Remarks. During a study of parapagurids from French Polynesia, Lemaitre (1994: 387) mentioned under the distribution of *S. dofleini* that he had examined specimens of that species from Australia. However, reexamination of those specimens showed that they actually represent the new species *S. papposus*. *Sympagurus dofleini* has not been found to date in Australian waters.

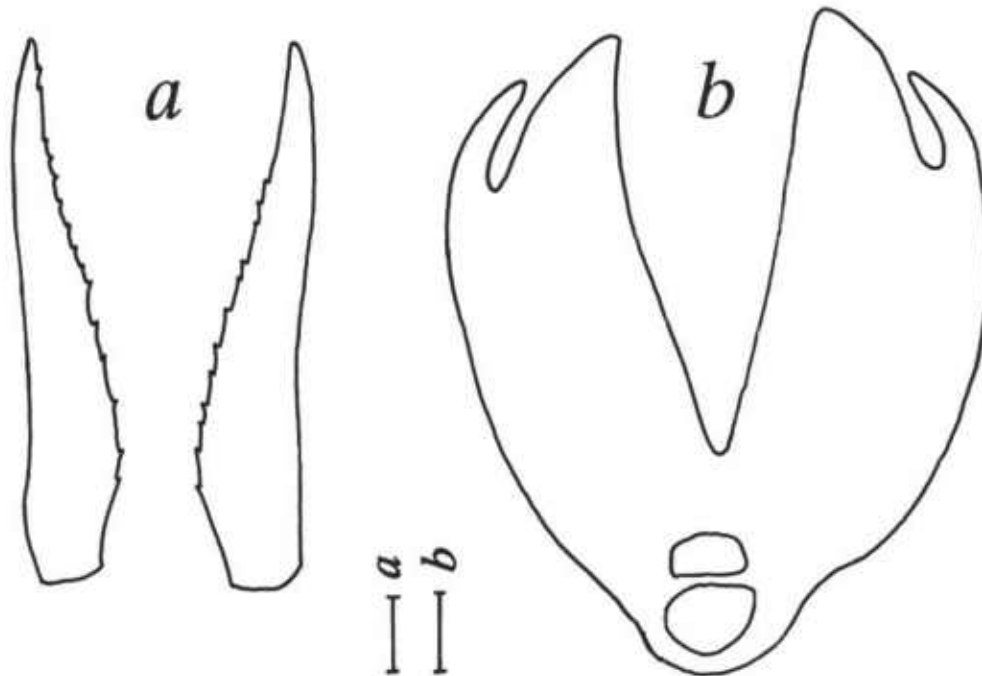


Fig. 11. *Sympagurus dofleini* (Balss, 1912). a, antennal acicles, dorsal; b, branchia, transverse section. Scales = 1 mm (a), and 0.5 mm (b). (Hawaiian Is.: a, male [SL 17.5 mm], USNM; b, female [SL 18.8 mm], BPBM).

Sympagurus planimanus (De Saint Laurent, 1972)

Parapagurus planimanus De Saint Laurent, 1972: 109, figs 4, 22 (type locality: Indonesia, Flores Sea, Siboga Exp., sta. 45).

Sympagurus planimanus.—Lemaitre, 1989: 37; 1994: 387, figs 9, 10.

Holotype. Male (SL 6.3 mm), Indonesia, Flores Sea, Siboga Exp., sta. 45, 07°24'S, 118°15.2'E, 794 m, 6 Apr 1899, ZMA Del03.111.

Australian material. WESTERN AUSTRALIA: 1 male (SL 5.7 mm), W of Cape Leveque, FRV *Soela*, 01/84/091, 16°08'S, 120°19.5'E, 550–544 m, 18 Feb 1984, coll. S. Slack-Smith, WAM 1096–86.

Other material. (For meaning of asterisks see Materials and Methods). INDONESIA: 1 male (SL 5.1 mm), 1 female (SL 4.4 mm), Borneo, Sibuko Bay, off Mabul Is., *Albatross*, sta. 5590, 04°10'50"N, 118°39'35"E, 567 m, 29 Sep 1909, USNM 168950*. 2 males (SL 5.0–5.6 mm), Borneo, Sibuko Bay, off Sipadan Is., *Albatross*, sta. 5586, 04°06'50"N, 118°47'20"E, 635 m, 28 Sep 1909, USNM 168949*. 3 males (SL 3.5–5.5 mm), 1 female (SL 3.6 mm), Molucca Passage, off Maren Is., *Albatross*, sta. 5618, 00°37'N, 127°15'E, 763 m, 27 Nov 1909, USNM 168951*. 26 males (SL 3.1–6.1 mm), 20 females (SL 3.7–5.1), 16 females ovig. (SL 3.6–5.1 mm), same station data as holotype, ZMA Del03.110*.

Diagnosis. First 11 pairs of gills trichobranchiate. Shield as long as broad; dorsal surface weakly calcified medially;

rostrum broadly rounded, with low dorsal ridge; anterior margin straight; lateral projections broadly subtriangular, terminating bluntly; ventrolateral margin usually with small spine; posterior margin broadly rounded. Ocular peduncles more than half length of shield; ocular acicles subtriangular, terminating in strong spine; corneae slightly dilated. Sternite of 3rd maxilliped with small spine on each side of midline. Epistomial spine absent. Antennular peduncle exceeding distal margin of corneae by length of penultimate segment. Antennal peduncle at most exceeding distal margin of cornea by 0.25 length of 5th segment; 4th segment with dorsolateral distal spine; 3rd segment with strong ventromesial distal spine; 2nd segment with dorsolateral distal angle produced, terminating in strong spine; acicles reaching distal margin of corneae, mesial margin armed with 7 to 10 spines; flagellum with numerous setae 1 to 3 flagellar articles in length. Chelipeds dissimilar, with moderately dense setation. Right cheliped with chela less than twice as long as wide, fingers strongly curved ventromesially, dactyl with concave ventromesial face; dorsal and ventral faces of palm smooth; palm with dorsomesial and dorsolateral margins well delimited by row of spines, and rounded mesial face; carpus with numerous small tubercles or spines on dorsal surface. Left cheliped with chela unarmed, usually well calcified; carpus with dorsodistal spine. Ambulatory legs reaching to tip of extended right cheliped; dactyl about twice as long as propodus, with ventromesial row of about 5 well spaced corneous spinules, and dorsal and dorsomesial rows of long bristle-like setae; carpus with small dorsodistal

spine. Anterior lobe of sternite of 3rd pereopods unarmed. Fourth pereopod with long, curved corneous claw in large females (shield length > 4.0 mm); propodal rasp consisting of 1 row of ovate scales. Uropods and telson markedly asymmetrical; telson with weak median cleft separating anterior and posterior lobes; posterior lobes separated by broad shallow sinus, terminal margins armed with corneous spines. Male 1st gonopods each with concave distal lobe; 2nd gonopods each with distal segment nearly flat. Females with vestigial right 2nd pleopod.

Distribution. Western Pacific: South China Sea; Indonesia; and Australia. Depth: 100 to 794 m.

Sympagurus soela n.sp.

Figs 12, 13, 14a

Sympagurus affinis.—Lemaitre, 1994: 381 (in part) (Not *Sympagurus affinis* [Henderson, 1888]). (See remarks)

Holotype. Male (SL 6.5 mm), Marion Plateau, Queensland, FRV *Soela*, sta. 0685–30, 19°32.85'S, 152°34.8'E, 477–470 m, 23 Nov 1985, NTM Cr 006854.

Paratypes. QUEENSLAND: 1 male (SL 4.3 mm), 1 female ovig. (SL 3.7 mm), off Tully, ORV *Franklin*, sta. 47–2, 16°51.8'S, 147°0.8'E, 500 m, 16 May 1986, QM W16512. 1 female ovig. (SL 4.8 mm), off Tully, ORV *Franklin*, sta. 51–2, 18°03.9'S, 147°19.5'E, 689–704 m, 18 May 1986, QM W16505. 2 males (SL 6.4–6.5 mm), 2 females (SL 5.1, 5.2 mm), same sta. data as holotype, NTM Cr 006854.

NEW SOUTH WALES: 1 female (SL 5.2 mm), E of Woolli, FRV *Kapala*, sta. K77-13-11, 29°55'S, 153°41'E, 502 m, 23 Aug 1977, AM P40391. 2 males (SL 5.2, 5.8 mm), off Newcastle, 549 m, FRV *Kapala*, Apr 1971, USNM 270113. 1 male (SL 5.4 mm), transect between Sydney and Port Stevens, FRV *Kapala*, 366 m, Jul 1972, AM P19633. 1 male (SL 7.3 mm), 6–8 mi (11.1–14.8 km) E of Sydney, 274 m, 10 Aug 1972, coll. D. Griffin and J. Paxton, AM P40400. 2 males (SL 5.8, 6.7 mm), 1 female (SL 4.2 mm), 1 female ovig. (SL 5.4 mm), 52 km ENE of Nowra, ORV *Franklin*, sta. SLOPE 57, 34°43.55'S, 151°13.16'E, 450–345 m, 22 Oct 1988, colls. G.C.B. Poore *et al.*, NMV J16200.

Description. First 11 pairs of gills trichobranchiate. Shield (Fig. 12a) as broad as long, weakly calcified medially; dorsal surface with short rows of setae on each side of midline; rostrum broadly triangular, with short mid-dorsal ridge; anterior margins weakly concave; lateral projections broadly rounded; anterolateral margins slightly sloping; posterior margin broadly rounded. Anterodistal margin of branchiostegite rounded, unarmed.

Ocular peduncles more than half length of shield, with dorsal row of setae. Cornea slightly dilated. Ocular acicles subtriangular, terminating in strong multifid spine (Fig. 12b,c); separated basally by less than basal width of 1 acicle.

Antennular peduncle long, slender, exceeding distal margin of corneae by length of ultimate segment. Ultimate segment 1.5 times or more as long as penultimate segment, with scattered setae. Basal segment with strong ventromesial spine on lateral face, distal subrectangular lobe with 2 small spines and strong spine proximally. Ventral flagellum with about 9 to 13 articles

Antennal peduncle (Fig. 12d) slightly exceeding distal margin of cornea. Fifth segment unarmed, with row of setae on distolateral angle. Fourth segment usually unarmed (occasionally with small spine on dorsolateral distal angle). Third segment with strong ventromesial distal spine. Second segment with dorsolateral distal angle produced, terminating in strong, simple to bifid spine (often with small additional spine dorsally); mesial margin with spine on dorsodistal angle. First segment with small spine on lateral face; ventromesial angle produced, with 5 small spines laterally. Acicles slightly curved laterally (dorsal view), at most exceeding slightly distal margin of cornea, terminating in strong spine; mesial margin armed with row of 9 to 12 spines, setose. Flagellum long, reaching to tip of fingers of extended right cheliped, with scattered short setae less than 1 article in length.

Mandible with 3-segmented palp. Maxillule (Fig. 13a,b) with external lobe of endopod moderately developed, internal lobe with long seta distally. Maxilla with endopod exceeding distal margin of scaphognathite. First maxilliped with endopod exceeding exopod in distal extension. Second maxilliped without distinguishing characters. Third maxilliped (Fig. 13c) with crista dentata of 14 corneous-tipped teeth; basis and coxa each with small spine mesially. Sternite of 3rd maxillipeds with spine on each side of midline. Epistome unarmed. Labral spine present.

Chelipeds markedly dissimilar. Right cheliped (Figs 12f, 14a) covered with moderately dense setae (setae not shown in Fig. 12f). Fingers weakly curved ventromesially, tips crossed when closed and terminating in small corneous claws; cutting edges each with irregularly-sized calcareous teeth; dorsal surfaces with numerous sharp and blunt spines. Dactyl subequal in length to palm, set at oblique angle to longitudinal axis of palm; mesial margin well defined by row of spines; ventromesial face weakly concave. Palm about as long as broad, mesial and lateral faces rounded, with small spines; dorsal and ventral faces densely covered with sharp and blunt spines (less dense on ventral face and often on dorsal face in small specimens SL < 5.0 mm). Carpus with all faces densely covered with sharp and blunt spines (less dense on ventral face). Merus with row of small tubercles on dorsal margin; dorsolateral face with scattered small tubercles; ventral face with numerous well-spaced small tubercles. Ischium ventral face armed with small spines. Coxa with setose ventromesial margin.

Left cheliped (Fig. 12e) evenly calcified, covered with dense (ventral surfaces) to moderately dense setae (dorsal surfaces). Fingers with tips crossed when closed, terminating in small corneous claws; dorsal surfaces with small spines on proximal half; dorsal and ventral

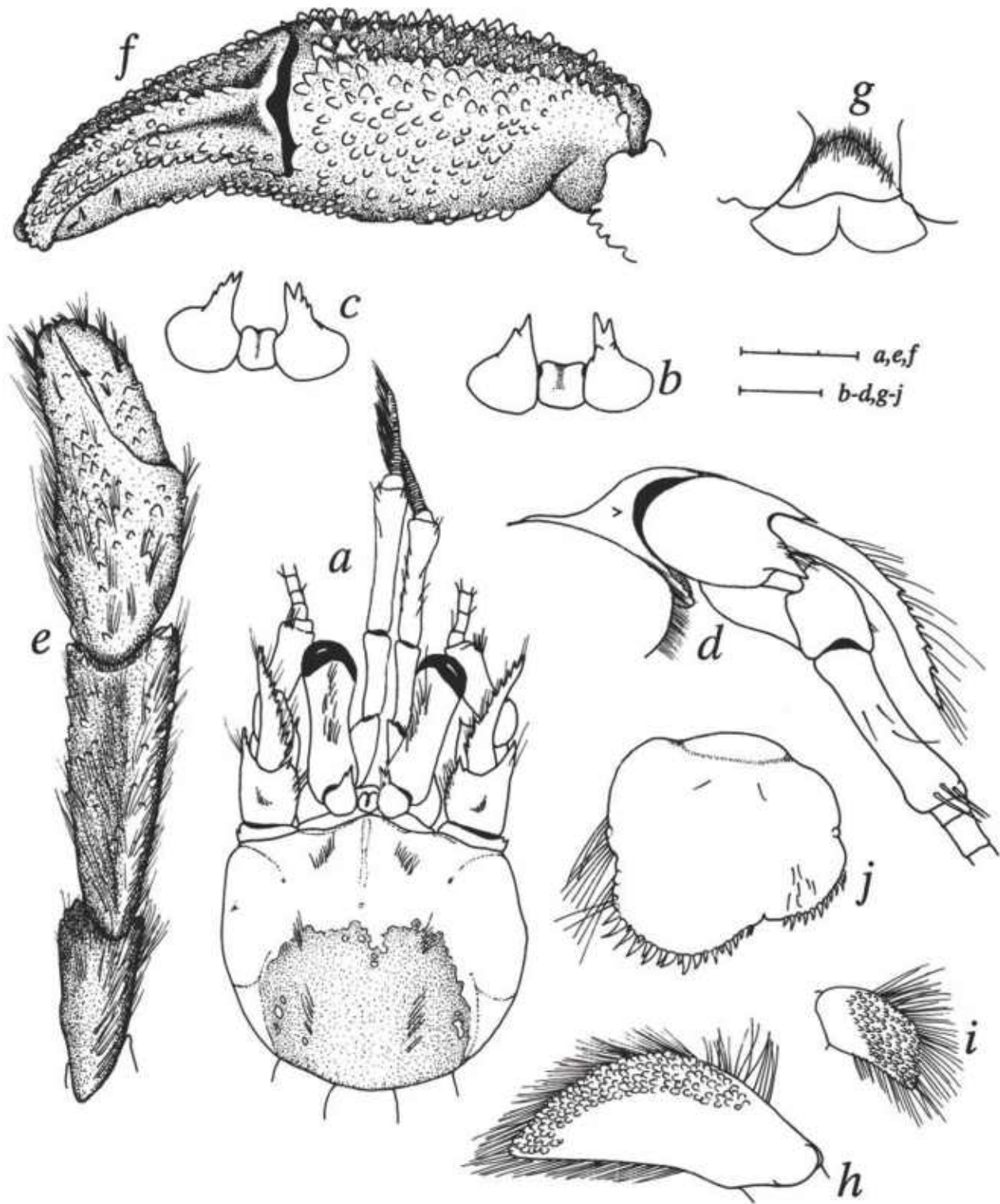


Fig. 12. *Sympagurus soela* n.sp. a, shield and cephalic appendages; b,c, ocular acicles, dorsal; d, right antennal peduncle, lateral; e, left cheliped; f, right chela, mesial (setae omitted); g, sternite of 3rd pereopods; h,i, exopod of uropods, dorsal: h, left; i, right; telson. Scales = 3 mm (a,e,f), and 1 mm (b-d,g-j). (Queensland, NTM Cr 006854: a,b,d-j, holotype male [SL 6.5 mm]; c, paratype male [SL 6.4 mm]).

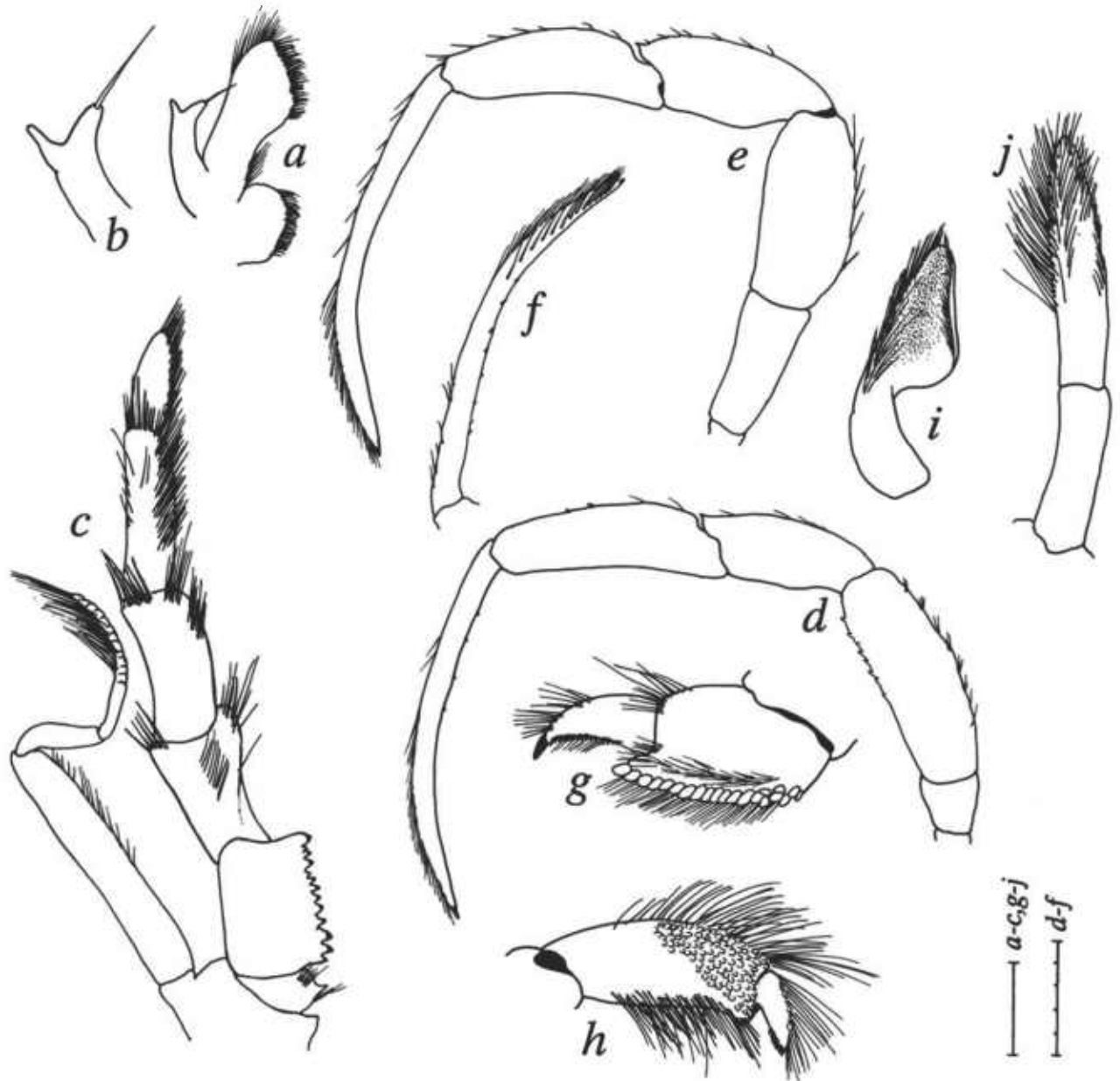


Fig. 13. *Sympagurus soela* n.sp. a, left maxillule, internal; b, endopod of same; c, left 3rd maxilliped, internal; d, left 2nd pereopod, lateral; e, left 3rd pereopod, lateral; f, dactyl of same, mesial; g, propodus and dactyl of left 4th pereopod, lateral; h, propodus and dactyl of right 5th pereopod, lateral; i, male left 1st gonopod, mesial; j, male left 2nd gonopod, anterior. Scales = 1 mm (a-c, g-j), and 5 mm (d-f). (Queensland, NTM Cr 006854: a-c, i, j, paratype male [SL 6.4 mm]; d-h, holotype male [SL 6.5 mm]).

surfaces with scattered tufts of setae. Dactyl subequal in length to palm; cutting edge with row of small, fused corneous spinules. Fixed finger with cutting edge with evenly-sized, small calcareous teeth and overlapping row of fused corneous spinules. Palm with numerous spines on dorsal surface. Carpus with small dorsodistal spine, and small spine at laterodistal angle; dorsolateral face with scattered small, blunt spines; dorsal margin with row of 3 or 4 small spines. Merus and ischium unarmed. Coxa with setose ventromesial margin.

Ambulatory legs (Fig. 13d-f) similar from right to left, long, reaching or exceeding tips of fingers of extended right cheliped. Dactyl long, about twice as long as propodus, terminating in sharp corneous claw; ventral margin armed with row of 7 to 11 small corneous spines; with dorsodistal and dorsomesial row of long setae. Propodi with short setae on dorsal margin. Carpus with small dorsodistal spine, and row of short setae dorsally. Merus with row of short setae dorsally and occasionally with row of small spines in specimens SL < 5.0 mm;

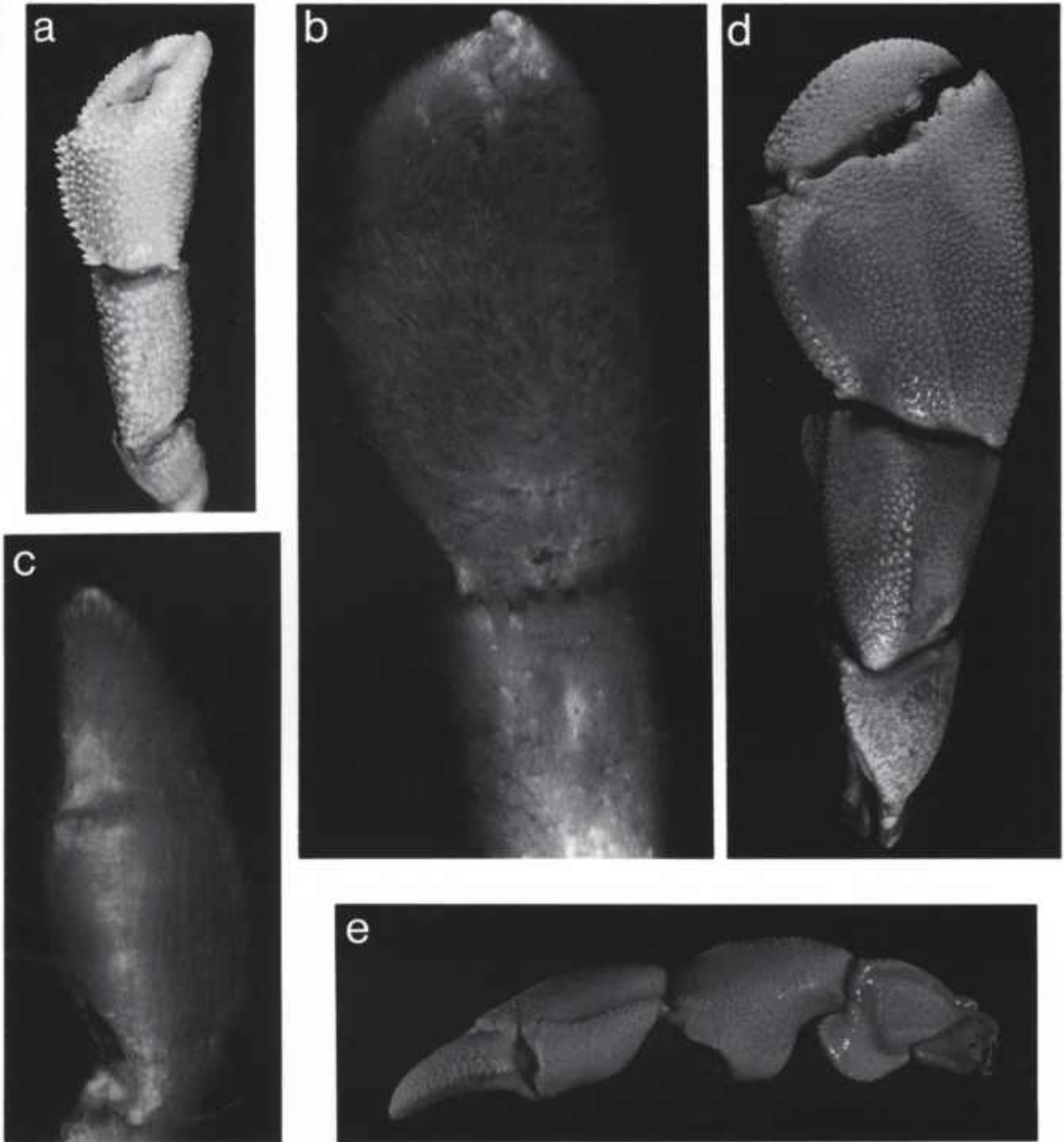


Fig. 14. Right chelipeds: a, *Sympagurus soela* n.sp. (2.5 \times). b,c, *S. villosus* n.sp.: b, carpus and chela, dorsal (2.8 \times); c, chela, mesial (2.5 \times). d,e, *Paragiopagurus diogenes* (Whitelegge, 1900): d, dorsal (2.7 \times); e, mesial (1.8 \times).

merus of 2nd pereopod with row of blunt to sharp tubercles on ventral margin distally, merus of 3rd pereopod unarmed. Ischium and coxa unarmed. Anterior lobe of sternite of 3rd pereopods (Fig. 12g) unarmed, setose.

Fourth pereopod (Fig. 13g) semichelate. Dactyl subtriangular, terminating in sharp corneous claw, and with ventrolateral row of small corneous spinules.

Propodus longer than broad, rasp formed of 1 row of rounded or ovate scales. Carpus and merus with dense setae on dorsal margins.

Fifth pereopod (Fig. 13h) semichelate. Propodal rasp extending to mid-length of segment.

Uropods and telson (Fig. 12h-j) asymmetrical. Telson with anterior and posterior lobes separated by weak transverse suture, dorsal surface with scattered setae;

posterior lobes separated by V-shaped cleft, terminal margins of lobes armed with strong corneous spines.

Males with paired 1st and 2nd gonopods well developed. First gonopods (Fig. 13i) each with concave distal lobe. Second gonopods (Fig. 13j) each with distal segment nearly flat, setose on lateral and mesial margins and on distal portion of anterior face. Female with vestigial 2nd right pleopod.

Habitat and symbiotic associations. Gastropod shells.

Distribution. So far known only from Australia. Depth: 274 to 704 m.

Etymology. The specific name is for the FRV *Soela*, in recognition of the collecting efforts conducted on this ship.

Affinities. This species is most similar to *Sympagurus affinis* (Henderson, 1888). The two can be separated by the armature of the dorsal surface of the right and left chelae. In *S. soela* both chelae have numerous spines on the dorsal surface (Fig. 12e,f, 14a), whereas in *S. affinis* the chelae are unarmed dorsally.

Remarks. In a study of parapagurids from French Polynesia, Lemaitre (1994: 381) mentioned that he had examined specimens of *S. affinis* from Australia. Further study of those specimens has shown that they actually represent the new species *S. soela*. Although *S. affinis* is broadly distributed in the central and western Pacific (Indonesia, Philippines, Hawaiian Islands, and French Polynesia), so far it has not been found in Australian waters.

Sympagurus trispinosus (Balss, 1911)

Parapagurus arcuatus var. *trispinosa* Balss, 1911: 3 (type locality: Tiefsee-Exped. "Valdivia", Pemba Canal [western Indian Ocean], sta. 246, 05°24'S, 39°19'E, 818 m).—Balss, 1912: 100, fig. 8, pl. 7, fig. 2, pl. 10, fig. 4.

Parapagurus trispinosus.—De Saint Laurent, 1972: 105.

Sympagurus trispinosus.—Lemaitre, 1989: 37; 1994: 390, figs 11, 12, 28e.

Type material. SYNTYPES: 3 females, Zoologische Staatssammlung, Munich (presumably lost, L. Tiefenbacher, pers. comm.).

Australian material. QUEENSLAND: 9 males (SL 8.5–19.0 mm), 1 female (SL 7.5 mm), 4 females ovig. (SL 10.5–19.0 mm), off Cairns, 16°55'S, 151°34'E, trawled, FRV *Soela*, cruise 6, sta. 78, 880 m, 6 Dec 1985, coll. P.J.F. Davie, QM W16514. 1 male (SL 16.1 mm), 1 female ovig. (SL 9.0 mm), off Cairns, 17°01'S, 151°20'E, P.J.F. Davie, FRV *Soela*, cruise 6, sta. 79, 800 m, 6 Dec 1985, QM W16513. 1 female ovig. (SL 14.0 mm), off Tully, CIDARIS 1, sta. 49–3, 17°52'S, 147°10'E, trawled, ORV *Franklin*, 881–920 m, 17 May 1986, coll. JCU, QM W16497. 1 male (SL 20.5 mm), off Tully, CIDARIS 1, sta. 48–3, 17°52'S, 147°08'E, trawled, ORV *Franklin*, 700 m, 17 May 1986, coll. JCU, QM W16502. 1 female (SL 9.4 mm), 1 female ovig. (SL 11.0 mm), off Tully, CIDARIS 1, sta. 50–3, 18°02'S, 147°20'E, trawled, ORV *Franklin*, 918–891 m, 17 May 1986, coll. JCU, QM W16499.

1 male (SL 11.4 mm), Marion Plateau, FRV *Soela*, sta. 0685–35, 19°00.65'S, 150°39.2'E, 752–751 m, 24 Nov 1985, NTM Cr 006840. 1 male (SL 15.8 mm), Marion Plateau, FRV *Soela*, sta. 0685–09, 22°57'S, 154°25.5'E, 678–695 m, 18 Nov 1985, NTM Cr 006853. 1 female (SL 14.7 mm), Southern Intruder Survey, shot 40, 23°17'S, 153°56'E, 460 m, 30 Nov 1983, coll. P.J.F. Davie, QM W11304.

Diagnosis. First 11 pairs of gills intermediate. Shield as long as broad; dorsal surface weakly calcified medially; rostrum broadly rounded, with low dorsal ridge; anterior margins straight; lateral projections broadly subtriangular, terminating acutely or bluntly; posterior margin broadly rounded. Ocular peduncles half or slightly more than length of shield; ocular acicles subtriangular, terminating in bifid or multifid spine; corneae slightly dilated. Sternite of third maxillipeds with small spine on each side of midline. Epistomial spine short, straight. Antennular peduncle exceeding distal margin of corneae by about 0.3 length of penultimate segment. Antennal peduncle exceeding distal margin of cornea by about 0.5 length of fifth segment; 4th segment unarmed; 3rd segment with strong ventromesial distal spine (occasionally bifid); acicles slightly exceeding distal margin of corneae, mesial margin armed with 9 to 13 small spines; flagellum long, naked. Chelipeds dissimilar, with dense setae obscuring surfaces. Right cheliped with chela less than twice as long as wide, dorsal and ventral faces smooth; palm with mesial and lateral faces rounded or with dorsolateral margin weakly delimited by irregular rows of small spines; carpus with numerous small tubercles or spines on proximal half of dorsal surface. Left cheliped evenly calcified, chela unarmed; carpus unarmed or with irregular row of tubercles or spines on dorsal margin. Ambulatory legs long, slender, reaching to tip of extended right cheliped; dactyl about 1.7 times as long as propodus, with row of about 18 corneous spines on ventromesial margin, and with several short, oblique rows of bristles on mesial face distally; carpus with small dorsodistal spine; ischium and merus of 2nd pereopod each with row of small often obsolete spines on ventral margin. Anterior lobe of sternite of third pereopods unarmed, or with 1 marginal spine. Fourth pereopod with propodal rasp consisting of 3 to 4 irregular rows of conical scales. Uropods and telson markedly asymmetrical; telson with anterior lobes each with fringe of long setae on ventrolateral margin; posterior lobes separated by broad, shallow median cleft, terminal margins armed with numerous corneous spines. Male 1st gonopods each with ovate, weakly concave distal lobe; second gonopods each with distal segment nearly flat. Females with 2nd left pleopod with rami about twice as broad as rami of 3rd and 4th pleopods; with right vestigial second pleopod.

Colour. Body mostly cream yellow; tips of dactyls of ambulatory legs pinkish (Lemaitre, 1994).

Distribution. Indo Pacific: Zanzibar; South Africa; Indonesia; Australia; and French Polynesia. Depth: 460 to 1412 m.

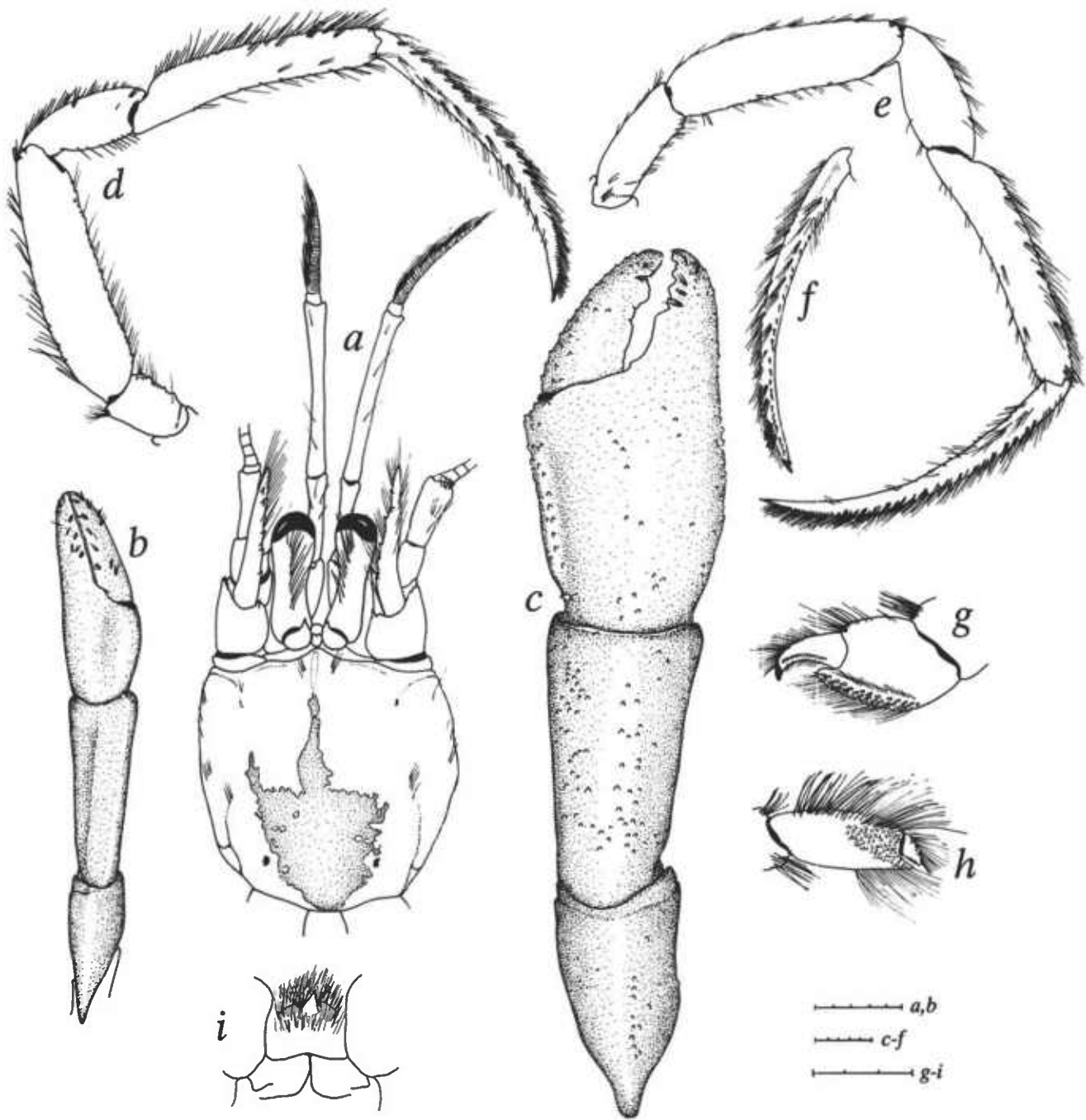


Fig. 15. *Sympagurus villosus* n.sp. a, shield and cephalic appendages; b, left cheliped, denuded; c, right cheliped, denuded; d, right 2nd pereopod, lateral; e, right 3rd pereopod, lateral; f, dactyl of same, mesial; g, propodus and dactyl of left 4th pereopod, lateral; h, propodus and dactyl of left 5th pereopod, lateral; i, sternite of 3rd pereopods; Scales = 5 mm (a,b,c-f), and 3 mm (g-i). (Queensland: a,d-i, holotype male [SL 13.8 mm], NTM Cr 010912; b,c, paratype male [SL 13.7 mm], QM W16516).

Sympagurus villosus n.sp.

Figs 14b,c, 15, 16

Holotype. 1 male (SL 13.8 mm), Marion Plateau, Queensland, FRV *Soela*, sta. 0685-09, 22°57'S, 154°25.5'E, 678-695 m, 18 Nov 1985, NTM Cr 010912.

Paratypes. QUEENSLAND: 1 female (SL 7.2 mm), same sta. data as holotype, NTM Cr 010912 1 male (SL 13.7 mm), off S Stradbroke Is., MV *Iron Summer*, 27°54'S, 153°58'E, trawled, 490 m, 30 Nov 1982, coll. S. Hyland, QM W16516.

Description. First 11 pairs of gills intermediate. Shield

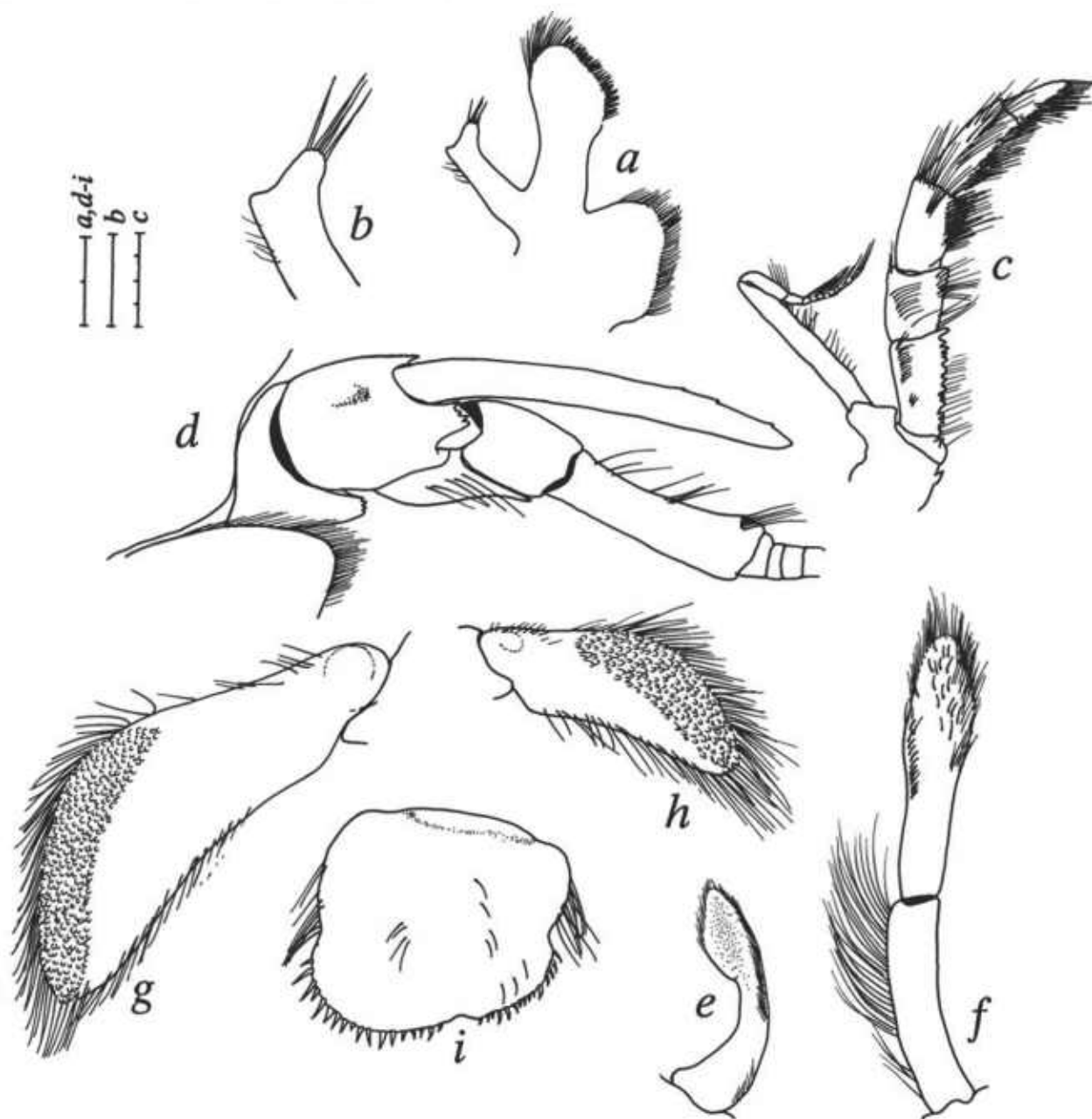


Fig. 16. *Sympagurus villosus* n.sp. a, maxillule, internal; b, endopod of same; c, left 3rd maxilliped, internal; d, right antennal peduncle, lateral; e, left male 1st gonopod, mesial; f, left male 2nd gonopod, anterior; g,h, exopod of uropods, dorsal: g, left; h, right; i, telson. Scales = 2 mm (a,d-i), 1 mm (b), and 4 mm (c). (Queensland: a-c, paratype male [SL 13.7 mm], QM W16516; d-i, holotype male [SL 13.8 mm], NTM Cr 010912).

(Fig. 15a) approximately as broad as long; dorsal surface weakly calcified, with scattered short setae; rostrum broadly triangular, with short mid-dorsal ridge; anterior margins sinuose; lateral projections broadly rounded; anterolateral margins slightly concave; posterior margin broadly rounded. Anterodistal margin of branchiostegite rounded, unarmed, setose.

Ocular peduncles about half length of shield, with row of setae dorsally. Cornea slightly dilated. Ocular acicles subtriangular, terminating in strong spine; separated

basally by less than basal width of 1 acicle.

Antennular peduncle long, slender, exceeding distal margin of cornea by half length of penultimate segment. Ultimate segment about twice as long as penultimate segment, with scattered setae. Basal segment with strong ventromesial spine; lateral face with distal subrectangular lobe armed or with 2 to 5 small spines, and strong spine proximally. Ventral flagellum with 7 to 9 articles.

Antennal peduncle (Fig. 16d) exceeding distal margin of cornea by about half length of 5th segment. Fifth

segment unarmed, with few setae on lateral and mesial margins. Fourth segment unarmed. Third segment with strong ventromesial distal spine. Second segment with dorsolateral distal angle produced, terminating in multifid spine; mesial margin with spine on dorsodistal angle. First segment unarmed or with 1 or 2 small spines on lateral face; ventromesial angle produced, with 5 or 6 small spines laterally. Antennal acicles slightly curved outward (in dorsal view), exceeding distal margin of corneae by 0.3 to 0.5 length of acicle, terminating in strong spine; mesial margin armed with row 6 to 10 spines, densely setose. Flagellum long, exceeding extended right cheliped and ambulatory legs, articles with scattered setae < 1 to 2 articles in length.

Mandible with 3-segmented palp. Maxillule (Fig. 16a,b) with external lobe of endopod weakly developed, internal lobe with 4 long setae. Maxilla with endopod slightly exceeding distal margin of scaphognathite. First maxilliped with endopod slightly exceeding exopod in distal extension. Second maxilliped without distinguishing characters. Third maxilliped (Fig. 16c) with crista dentata of 14 corneous-tipped teeth; coxa and basis each with small mesial tooth. Sternite of 3rd maxillipeds with spine on each side of midline. Epistomial spine straight. Labral spine present.

Chelipeds markedly dissimilar; mesial and ventral surfaces of meri, and all surfaces on carpi and chelae, covered with dense mat of short plumose setae mixed with long simple, bristle-like setae. Right cheliped (Fig. 14b,c, 15c) with fingers nearly straight, terminating in small corneous claw; cutting edges each with irregularly-sized calcareous teeth; dorsal and ventral faces each with distal row of 3 or 4 tufts of setae parallel to cutting edge. Dactyl subequal in length to palm, set at weakly oblique angle to longitudinal axis of palm; mesial face rounded, armed with small, blunt and sharp spines; dorsal and ventral faces unarmed or with scattered small spines. Fixed finger broad at base, dorsal and ventral surfaces similar to dactyl. Palm slightly longer than broad (males) or as long as broad (females), lateral and mesial faces rounded, with irregular rows of small blunt to sharp spines; dorsal surface covered with scattered small spines; ventral surface with scattered small tubercles. Carpus with moderately dense spines or tubercles on dorsal and ventral surfaces; dorsodistal margin unarmed or with 1 or 2 small spines. Merus with scattered small tubercles on lateral face; ventromesial margin with row of small spines. Coxa and ischium each with row of small spines on ventral face; coxa with ventromesial row of setae.

Left cheliped (Fig. 15b) well calcified. Fingers terminating in small corneous claws; dorsal and ventral surfaces unarmed but with several tufts of setae; cutting edge of dactyl with row of minute, fused corneous teeth; cutting edge of fixed finger with row of regularly-spaced, small, evenly-sized teeth. Dactyl longer than palm in length. Palm unarmed on all surfaces. Carpus unarmed except for small dorsodistal spine. Merus unarmed. Ischium with row of small spines on ventral margin. Coxa unarmed but with ventromesial row of setae.

Ambulatory legs (Fig. 15d-f) generally similar from right to left (or right with slightly longer segments than left), at most exceeding extended right cheliped by about 0.5 length of dactyl; meri, carpi, propodi, and dactyls with numerous stiff setae (more numerous on dactyl). Dactyl approximately 1.4 times as long as propodus, terminating in sharp corneous claw; with dorsal and dorsomesial row of long setae (setae arranged in tufts on proximal two-thirds), and ventromesial row of about 32 corneous spines (most clearly visible in mesial view). Propodus with setae on dorsal and ventral margins. Carpus usually with blunt dorsodistal angle, or at most with small blunt dorsodistal spine, and row of setae dorsally. Merus with setae on dorsal and ventral margins; merus of 2nd pereopods with row of small spines on ventral margin. Ischium of 2nd pereopod with small spines on ventral margin. Coxa of 2nd pereopod with few small spines on ventrodistal margin. Anterior lobe of sternite of 3rd pereopods armed with strong marginal spine, setose (Fig. 15i).

Fourth pereopod (Fig. 15g) semichelate. Dactyl subtriangular, terminating in sharp corneous claw, and ventrolateral row of small corneous spinules. Propodus longer than broad, rasp formed of 2 or 3 irregular rows of conical scales. Merus and carpus with long setae on dorsal margin.

Fifth pereopod (Fig. 15h) semichelate. Propodal rasp extending to mid-length of segment.

Uropods and telson (Fig. 16g-i) markedly asymmetrical. Telson with weak transverse suture; posterior lobes separated by shallow cleft, terminal margin of lobes armed with weakly curved corneous spines.

Males with paired 1st and 2nd gonopods; 1st gonopods (Fig. 16e) each with moderately concave distal lobe; 2nd gonopods (Fig. 16f) each with distal segment nearly flat, anterior face setose distally, and row of short setae on lateral margin medially; basal segment with long setae on posterior face. Females with vestigial 2nd right pleopod.

Habitat and symbiotic associations. Found living in zoanthids (*Epizoanthus* sp.).

Distribution. So far known only from Australia. Depth: 490 to 695 m.

Etymology. The specific name is from the Latin *villosus*, hairy, in reference to the dense setation on the chelipeds and ambulatory legs of this species.

Affinities. This new species superficially resembles *Sympagurus trispinosus* (Balss, 1911), but differs from it in pilosity of the chelipeds and ambulatory legs, and armature of ocular acicles. The pilosity of both right and left chelipeds of *S. villosus* is very dense, consisting of a mat of short plumose setae mixed with numerous long, simple bristle-like setae (Fig. 14b,c). Pilosity of the chelipeds of *S. trispinosus* is also dense but consists

of a mat of only short plumose setae. The ocular acicles are simple on *S. villosus*, whereas they are multifid on *S. trispinosus*. Other characters helpful in distinguishing the two species include armature of the ventromesial margin of the dactyls of the ambulatory legs; the dactyl has about 32 spines on *S. villosus*, and about 18 spines on *S. trispinosus*. Also helpful is the relative length of the propodi and dactyls of the ambulatory legs; the dactyl is about 1.4 times as long as the propodus on *S. villosus*, and about 1.7 times as long as the propodus on *S. trispinosus*. Additionally, the new species lives symbiotically with a zoanthid (*Epizoanthus* sp.), whereas *S. trispinosus* lives with the actinian *Stylobates cancrisocia* (Carlgren) (see Fautin Dunn *et al.*, 1980).

Oncopagurus n.gen.

Sympagurus.—Lemaitre, 1989: 36 (in part).

Diagnosis. Eleven pairs of phyllobranchiate gills. Shield about as broad as long; dorsal surface usually weakly calcified medially. Corneae weakly to moderately dilated. Fourth segment of antennal peduncle armed with dorsodistal spine. Epistomial spine strongly curved upward. Right chela operculate, with well delimited dorsomesial and dorsolateral margins. Left cheliped with

carpus and palm frequently with weakly calcified areas. Ambulatory legs with dactyls curved. Fourth pereopod with propodal rasp consisting of 1 row of corneous scales. Second abdominal somite with left pleuron terminating ventrally in small subtriangular lobe. Males with poorly to moderately developed paired 1st and 2nd gonopods; 1st sometimes absent, or if present each with weakly concave distal lobe; 2nd gonopods each with flat distal segment.

Species. In addition to *Oncopagurus cidaris* n.sp., the following are included in this new genus: *Sympagurus africanus* (De Saint Laurent, 1972), *S. bicristatus* (A. Milne Edwards, 1880), *S. gracilis* (Henderson, 1888), *S. haigae* (De Saint Laurent, 1972), *S. indicus* Alcock, 1905, *S. minutus* (Henderson, 1896), *S. monstrosus* (Alcock, 1894), *S. orientalis* (De Saint Laurent, 1972), and *S. tuamotu* Lemaitre, 1994.

Type species. *Eupagurus bicristatus* A. Milne Edwards, 1880.

Etymology. From the Greek *onkos* meaning hook, and *pagourus* meaning crab, and referring to the curved, hook-like epistomial spine in this genus. Gender: masculine.

Key to Australian species of *Oncopagurus* n.gen.

1. Corneae somewhat cone-shaped (Fig. 21a,b) *O. minutus*
 — Corneae not cone-shaped 2
2. Merus of right 3rd pereopod unarmed dorsally; corneal width distinctly greater than distal width of ocular peduncle *O. monstrosus*
 — Merus of right 3rd pereopod armed dorsally with small spines; corneal width subequal to distal width of ocular peduncle 3
3. Male with paired 1st gonopods; female with mesial face of right palm expanded distally and with ventromesial margin well delimited by row of spines (Fig. 18a,c) *O. indicus*
 — Male lacking paired 1st gonopods; female (and male) with mesial face of right palm not expanded distally and with ventromesial margin not delimited by row of spines (Fig. 22c,d) *O. cidaris* n.sp.

Oncopagurus indicus (Alcock, 1905)

Figs 17, 18

Sympagurus bicristatus var. *indicus* Alcock, 1905: 105, pl.10, fig. 4.—Gordan, 1956: 341 (type locality: Andaman Sea).
Parapagurus bicristatus.—Balss, 1912: 98, figs 6, 7. (Not *Parapagurus bicristatus* [A. Milne Edwards, 1880]).
 ?*Parapagurus minutus*.—Thompson, 1943: 417. (?Not *Parapagurus minutus* Henderson, 1896). (See remarks).
Sympagurus bicristatus.—Thompson, 1943: 418.
Parapagurus bicristatus indicus.—De Saint Laurent, 1972: 112.
Sympagurus indicus.—Lemaitre, 1989: 37.—Lemaitre, 1994: 412.

Type Material. Syntypes from Andaman Sea, Indian Ocean, probably in Indian Museum, Calcutta (not seen).

Material examined. WESTERN AUSTRALIA: 1 male (SL 2.7 mm), 1 female ovig. (SL 2.1 mm), WSW of Lancelin, WAM 1746–86.

QUEENSLAND: 1 male (SL 2.3 mm), off Tully, CIDARIS 1, sta. 43–2, 17°35'S, 146°53'E, epibenthic sledge, ORV *Franklin*, 458–500 m, 15 May 1986, coll. JCU, QM W16590. 2 females ovig. (SL 3.0, 3.3 mm), off Tully, CIDARIS 1, sta. 49–2, 17°51'S, 147°10'E, epibenthic sledge, ORV *Franklin*, 904–916 m, 17 May 1986, coll. JCU, QM W16599. 17 males (SL 2.7–4.2 mm), off Tully, CIDARIS 1, sta. 47–2, 17°51.8'S, 147°07.9'E, epibenthic sledge, ORV *Franklin*, 503–497 m, 16 May 1986, coll. JCU, QM W16600.

NEW SOUTH WALES: 1 male (SL 2.4 mm), 1 female ovig. (SL 2.7 mm), off Newcastle, NZOI *Tangaroa*, cruise U207, 34°11.1'S, 151°26'E, 1998 m, 5 Oct 1982, AM P44032. 1 female (SL 3.2 mm), NZOI *Tangaroa*, cruise U222, off Newcastle, 1075–1040 m, 9 Oct 1982, AM.

Other material (all from *Albatross*). PHILIPPINES: 1 female (SL 3.0 mm), sta. 5342, 10°56'55"N, 119°17'24"E, 26–46 m, 23 Dec 1908, USNM 168969.

INDONESIA: 1 male (SL 3.0 mm), sta. 5586, 04°06'50"N, 118°47'20"E, 635 m, 28 Sep 1909, USNM 168970. 3 males (SL 1.8–4.2 mm), sta. 5619, 00°35'N, 127°14'40"E, 796 m, 27 Nov 1909, USNM 168971. 2 males (SL 3.6, 4.2 mm), sta. 5631, 00°57'S, 127°56'E, 1480 m, 2 Feb 1909, USNM 168972.

HAWAIIAN ISLANDS: 1 male (SL 4.2 mm), sta. 3979, Oahu, SW of Bird Island, 406–708 m, 3 Jun 1902, USNM 168959. sta. 4134, Oahu, Kauai Channel, 22°03'35"N, 159°19'40"W, 593–412 m, 1 Aug 1902, USNM 168968. 2 males (SL 1.6, 2.2 mm), 1 female (SL 1.8 mm), sta. 4133, Oahu, Kauai Channel, 22°02'40"N, 159°19'55"W, 302 m, 1 Aug 1902, USNM 168967. 1 male (SL 2.7 mm), sta. 4132, Oahu, Kauai Channel, 22°01'30"N, 159°21'10"W, 470–571 m, 1 Aug 1902, USNM 168966. 2 females (SL 2.1, 2.2 mm), sta. 4131, 21°59'35"N, 159°20'40"W, 565–470 m, 1 Aug 1902, USNM 168965. 1 male (SL 3.0 mm), 1 female (SL 2.5 mm), sta. 4122, Oahu, SW of Barbers Point Light, 351–644 m, 26 Jul

1902, USNM 168964. 1 male (SL 2.8 mm), sta. 3917, Oahu, SW of Diamond Head, 604–538 m, 6 May 1902, USNM 168857. 1 female (SL 2.5 mm), sta. 3815, Oahu, SE of Diamond Head, 571–417 m, 28 Mar 1902, USNM 168952. 2 males (SL 2.7, 3.1 mm), sta. 3909, Oahu, SW of Diamond Head, 563–589 m, 5 May 1902, USNM 168956. 1 male (SL 1.6 mm), sta. 3918, Oahu, SW of Diamond Head, 538–470 m, 6 May 1902, USNM 168958. 1 male (SL 1.5 mm), 1 female (SL 1.6 mm), sta. 4095, Pailolo Channel, off Mokuhooniki Is., 21°14'30"N, 156°29'45"W, 530–523 m, 22 Jul 1902, USNM 168962. 3 males (SL 1.9–2.2 mm), sta. 3866, 21°10'40"N, 156°34'50"W, 518–519 m, 10 Apr 1902, USNM 168955. 2 males (SL 1.6, 2.8 mm), 4 females (SL 1.6–2.1 mm), sta. 4084, Maui, W of Puniawa Point, 21°06'40"N, 156°20'15"W, 463–488 m, 21 Jul 1902, USNM 168960. 1 female (SL 3.1 mm), sta. 4102, between Maui and Molokai Is., Pailolo Channel, 21°03'10"N, 156°45'20"W, 223–241 m, 23 Jul 1902, USNM 168963. 1 male (2.2 mm), 2 females (SL 1.8, 1.8 mm), sta. 4085, Maui, W of Puniawa Point, 488–518 m, 21 Jul 1902, USNM 168961. 12 males (SL 1.5–3.0 mm), 8 females (SL 1.5–2.8 mm), sta. 3839, south coast of Molokai Is., 21°02'N, 157°09'40"W, 474–487 m, 4 Apr 1902, USNM 168954. 3 males (SL 2.5–3.0 mm), 5 females (SL 1.9–2.4 mm), sta. 3836, 21°00'05"N, 157°08'20"W, 435–466 m, 3 Apr 1902, USNM 168953.

Diagnosis. Shield (Fig. 17a) as long as broad; rostrum broadly rounded, with low dorsal ridge; anterior margins weakly concave; lateral projections subtriangular, usually terminating in small spine; ventrolateral margin with small spine (not always visible in dorsal view); posterior margin broadly rounded. Ocular peduncles more than half length of shield; ocular acicles subtriangular, terminating in strong spine; corneae slightly dilated. Maxillule with internal lobe of endopod with long seta. Sternite of 3rd maxillipeds with small spine on each side of midline. Antennular peduncle exceeding distal margin of corneae by full length of ultimate segment. Antennal peduncle (Fig. 17b) at most reaching distal margin of cornea; 2nd segment with dorsolateral distal angle produced, terminating in strong simple or multifid spine; acicles reaching distal margin of corneae, mesial margin with 8 to 11 spines; flagellum with few setae about 1 flagellar article in length. Chelipeds markedly dissimilar, both with moderately dense setae. Right cheliped (Fig. 17d, 18a–d) exhibiting sexual dimorphism. Males with right palm varying from as long as broad to slightly longer than broad; dorsomesial margin always well delimited by row of spines, ventromesial margin varying from weakly to well delimited by row of tubercles or spines; mesial face occasionally weakly expanded distally. Females with right palm broader than long, mesial face concave and expanded distally (more so in large females SL > 3.0 mm). Left cheliped (Fig. 17c) usually weakly calcified on lateral face of carpus; dorsal margin of carpus with irregular row of small spines, or few small tubercles, or unarmed; carpus with dorsodistal spine. Ambulatory legs (Fig. 17f–h) with dactyl with row of about 4 corneous spines on ventromesial margin, and dorsal and dorsomesial rows of long setae; carpus with small dorsodistal spine; merus of 3rd pereopods (Fig. 18e,f) each with row of 2 to 8 small

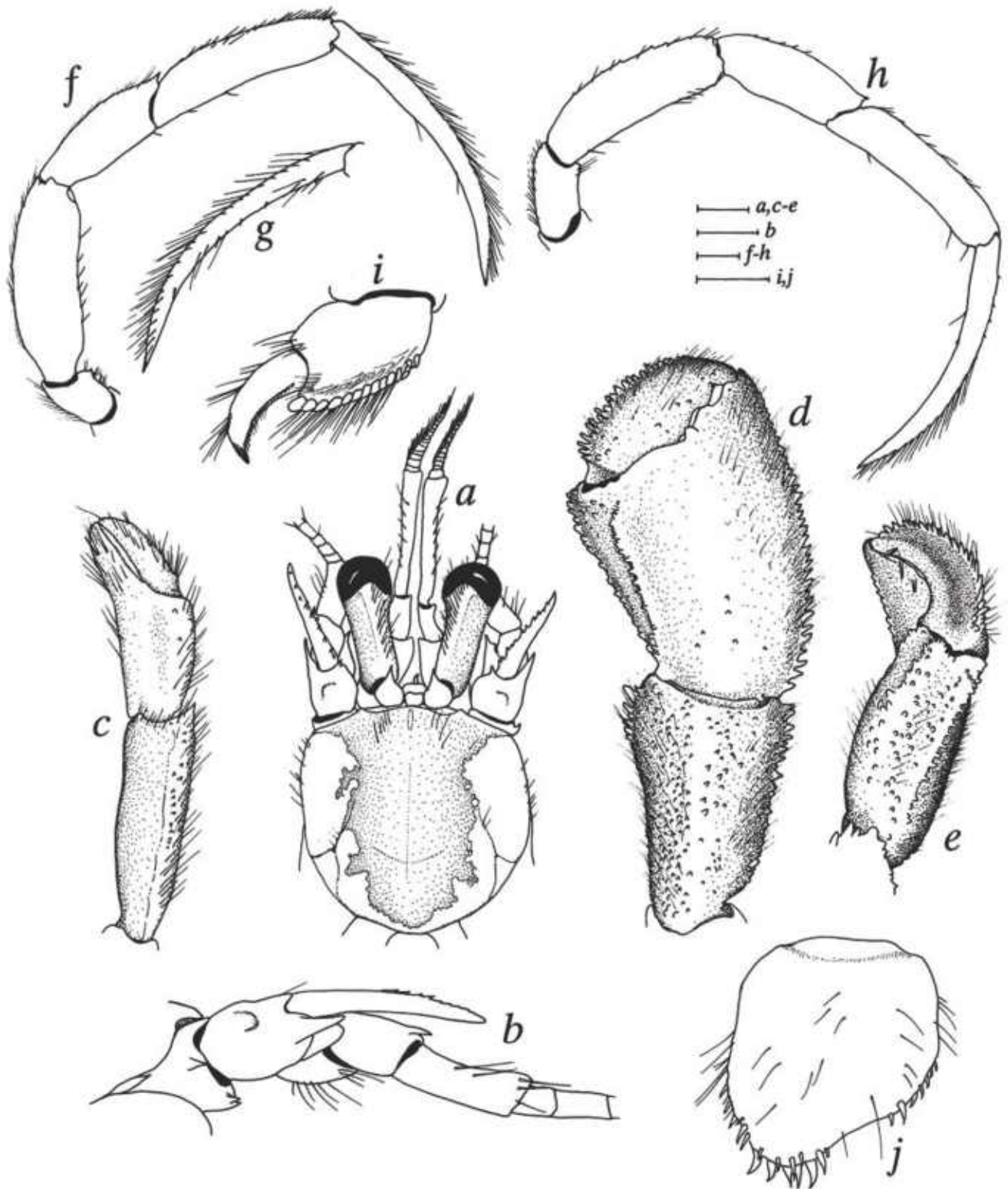


Fig. 17. *Oncopagurus indicus* (Alcock, 1905). a, shield and cephalic appendages; b, right antennal peduncle, lateral; c, carpus and chela of left cheliped; d, carpus and chela of right cheliped; e, chela of same, mesial; f, right 2nd pereopod, lateral; g, dactyl of same, mesial; h, right 3rd pereopod, lateral; i, propodus and dactyl of left 4th pereopod, lateral; j, telson. Scales = 1 mm (a,c-h), and 0.5 mm (b,i,j). (Male [SL 4.0 mm], Queensland, QM W16600).

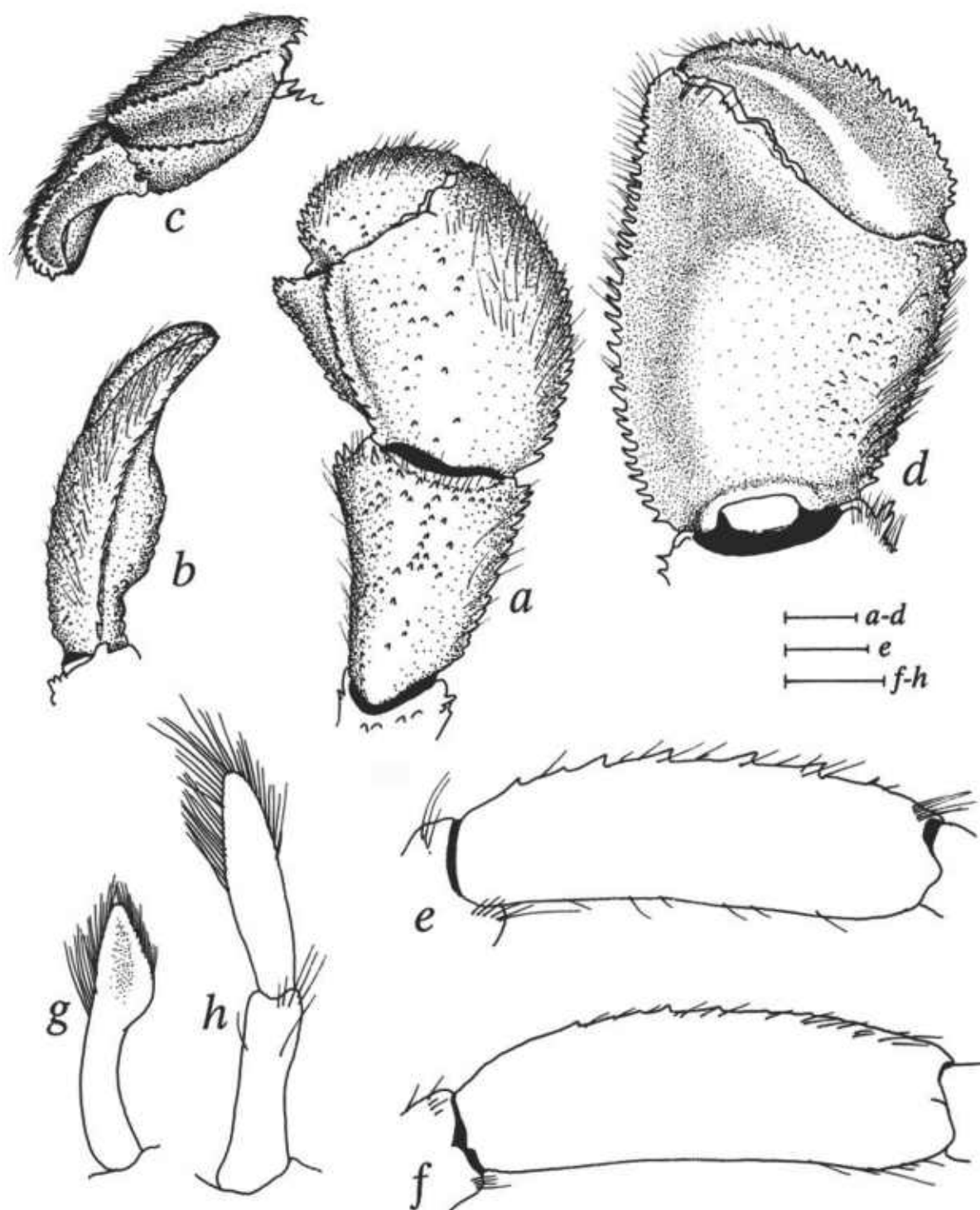


Fig. 18. *Oncopagurus indicus* (Alcock, 1905). a, carpus and chela of right cheliped of female; b, chela of same, lateral; c, same, mesial; d, right chela of male, ventral; e, f, merus of right 3rd pereopods, lateral; g, male right 1st gonopod, mesial; h, male right 2nd gonopod, posterior. Scales = 1 mm (a-d, f), 0.5 mm (e), and 1 mm (g, h). (Queensland: a-c, female [SL 3.3 mm], QM W16599; d, male [3.7 mm], QM W16600; e, male [SL 2.5 mm], QM W16600; f-h, male [SL 4.0 mm], QM W16600).

spines (occasionally with 1 spine). Anterior lobe of sternite of 3rd pereopods setose, armed with marginal spine. Fourth pereopod (Fig. 17i) with propodal rasp consisting of ovate scales. Uropods and telson (Fig. 17j) markedly asymmetrical, lacking transverse suture separating anterior and posterior lobes; posterior lobes separated by shallow U-shaped median cleft, terminal margins armed with often strongly curved corneous spines. Male 1st gonopods (Fig. 18g) each with weakly concave distal lobe; 2nd gonopods (Fig. 18h) each with distal segment nearly flat. Females with vestigial right 2nd pleopod.

Habitat and symbiotic associations. Inhabits gastropod shells; occasionally with one or more anthozoan polyps attached to the shell.

Distribution. Indo Pacific: Zanzibar; Maldives; Indonesia; Australia; Philippines; and Hawaiian Islands. Depth: 183 to 1480 m.

Affinities. Among the Indo Pacific species of *Oncopagurus* n.gen., *O. indicus* is most similar to *O. monstrosus* (Alcock, 1894), from which it is often difficult to separate, particularly if only male specimens are available. Females of the two species can immediately be separated by differences in the mesial face of the palm of the right cheliped. In *O. indicus*, the mesial face of the palm is expanded distally, and has a well delimited ventromesial margin that consists of a row of spines (Fig. 18a,c). The mesial face of the palm of *O. monstrosus* is not expanded distally; the ventromesial face is rounded and lacks spines (Fig. 19e,c).

In males, the mesial face of the right palm is only of limited help in separating the two species. The mesial face of *O. indicus* is at most weakly expanded distally (Fig. 17d,e); the mesial face of *O. monstrosus* is not expanded (Fig. 19c,e). The ventromesial margin of *O. indicus* exhibits a well developed row of spines, or occasionally a row of weak spines or small tubercles distally (Fig. 17e), whereas in *O. monstrosus* the ventromesial margin is unarmed (Fig. 19e). Males of both *O. indicus* and *O. monstrosus* have a dorsomesial row of spines.

Males of the two species can best be separated by using differences in the development of the ocular peduncles and corneae, and armature of the merus of the 3rd pereopod. In both males and females of *O. indicus*, the peduncles are nearly subequal in width throughout the peduncle, and the width of the corneae is subequal to the distal width of the peduncles (Fig. 17a); in *O. monstrosus*, the peduncles increase in width distally, are slightly constricted medially, and the width of the corneae is distinctly greater than that of the peduncles (Fig. 19a). Additionally, the merus of the right 3rd pereopod is armed with spines in *O. indicus* (Fig. 18e,f), whereas it is usually unarmed in *O. monstrosus* (Fig. 19f,h).

Supplemental characters that can help to differentiate the two species of either sex are the armature of the ventral surface of the right chela, and size of the

individuals. The ventral surface of the right chela in *O. indicus* is usually smooth or at most is armed with scattered small tubercles (Fig. 18d); the ventral surface in *O. monstrosus* frequently has strong spines or tubercles (Fig. 20c,d). Individuals of *O. indicus* do not grow as large as those of *O. monstrosus*, the former rarely exceeding a SL of 3 mm (largest specimen measured is 4.0 mm), whereas the latter can reach a SL of 6.0 mm.

Oncopagurus indicus also resembles two Atlantic species, *O. bicristatus* (A. Milne Edwards, 1880), and *O. gracilis* (Henderson, 1888). In the absence of distributional data, *O. indicus* can be separated from the two Atlantic species by differences in the shape and armature of the right chela, antennal acicles, and 1st gonopods in males (see Lemaitre, 1989). It is of interest to note the sexually dimorphic differences of the right chela between *O. indicus* and *O. bicristatus*. In *O. indicus*, the distal expansion of the mesial face of the chela is more distinctly developed in females than in males, whereas the reverse is true in *O. bicristatus*.

Remarks. The high degree of variability in proportions and armature of the right cheliped, and especially the marked differences frequently seen in this cheliped between males and females, has caused problems in defining this species. Particularly problematic has been the interpretation of the usefulness of the dorsomesial and ventromesial rows of spines (often described in the literature as "crests") on the palm of the right chela. Only after examining a large number of specimens of *O. indicus* and related forms during this study, has it been possible to elucidate the limits of morphological variations of the right cheliped, and to define useful diagnostic characters for this and other structures. To fully understand how this variation has hampered proper definition of this taxon, it is useful to summarise how carcinologists have used or interpreted characters derived from the right cheliped.

Alcock (1905) initially proposed the "variety" *indicus* for the Atlantic *Sympagurus bicristatus* (A. Milne Edwards, 1880), in order to accommodate specimens from the Indian Ocean that differed slightly from the Atlantic form. Alcock noted that in his "variety" the carpus and chela of the right cheliped were longer, the right chela less oval in shape, and the antennal acicle longer, than in the typical Atlantic form. Balss (1912), who considered *Sympagurus* Smith a synonym of *Parapagurus* Smith, subsequently reported specimens of *Parapagurus bicristatus* from the Indian Ocean, and indicated that his material contained specimens assignable to both the typical form and "variety" *indicus*; the former were characterised by a short right cheliped, the latter by a long one. Balss did observe substantial variability in the shape of the right cheliped, and in particular the development of the "upper crest" (=dorsomesial row) of spines on the chela. For example, he found both short and long types of chelipeds in males of the "variety" *indicus*, and observed that in contrast to the distinct "upper crest" of spines on the chela found in the typical form, some of his specimens had only a rudimentary "upper crest". Thompson (1943) again reported specimens of *Sympagurus bicristatus* from the Indian Ocean, and

made observations similar to those of Balss (1912). Thompson (1943) was unable to assign his specimens to either the typical form or the "variety" *indicus*, because of the great variability and overlap of characters he encountered. Although Thompson suggested the possibility that A. Milne Edwards's *S. bicristatus* could be divided into as many as three species, he did not formally take that action. It was De Saint Laurent (1972) who divided, although only provisionally, this taxon into three subspecies which she placed in *Parapagurus* Smith: *P. bicristatus bicristatus*, *P. b. gracilis* Henderson, 1888, and *P. b. indicus*. Lemaitre (1989) reevaluated the characters used to define these subspecies and returned them to their original specific status. In so doing, he placed all three species in *Sympagurus*, and showed that *S. bicristatus* and *S. gracilis* occurred only in the Atlantic, whereas *S. indicus* is broadly distributed in the Indo Pacific. These three species are herein placed in the new genus *Oncopagurus*.

De Saint Laurent (1972) synonymised, without comment, the taxon that Thompson (1943) reported as *Parapagurus minutus* Henderson, 1896, with *P. bicristatus indicus*. It has not been possible to examine Thompson's material, and he did not supply sufficient information in order to confirm the assignment of his specimens to *Oncopagurus indicus*.

Oncopagurus monstrosus (Alcock, 1894)

Figs 19, 20

"*Parapagurus monstrosus*" Alcock, 1894: 243 (type locality, by lectotype designation: Bay of Bengal).

Sympagurus monstrosus.—Henderson, 1896: 533.—Alcock & Anderson, 1897, pl. 32, fig. 4.—Alcock, 1901: 223.—Lemaitre, 1989: 37.—Lemaitre, 1994: 412.

Sympagurus arcuatus var. *monstrosus*.—Alcock, 1905: 104, pl. 10, fig. 5.—Gordan, 1956: 341.—Kemp & Sewell, 1912: 26.

?*Eupagurus brevimanus*.—Yokoya, 1933: 90, fig. 34. (See remarks)

Parapagurus monstrosus.—Miyake, 1978: 72 (key); 1982: 119, pl. 40, fig. 1.—Baba *et al.*, 1986: 302, fig. 146.—Imafuku, 1992: 234, unnumbered fig.

not *Parapagurus arcuatus* var. *monstrosus*.—Balss, 1912: 99, pl. 10, fig. 3. (= *Sympagurus brevipes* [De Saint Laurent, 1972]).

Type material. LECTOTYPE (herein selected): male (SL 4.2 mm), Indian Ocean, Bay of Bengal, [probably from HM Indian Marine Survey Steamer *Investigator*, sta. 120, 15°56'50"N, 81°30'30"E, 439 m, 24 Dec 1890], USNM 156566. PARALECTOTYPES: 2 males (SL 3.4, 3.7 mm), same sta. data as lectotype, USNM 156566.

Australian material. WESTERN AUSTRALIA: 15 males (SL 3.6–5.1 mm), 2 females (SL 3.9, 4.6 mm), 3 females ovig. (SL 4.2–4.8 mm), NW of Augustus Is., FRV *Soela*, sta. 01/84/079, 13°17'S, 122°37.4'E, 494–484 m, 15 Feb 1984, WAM 1321–86. 1 male (SL 5.0 mm), NW of Augustus Is., FRV *Soela*, sta. 01/84/078, 13°27.6'S, 122°44.4'E, 444–440 m, coll.

S. Slack-Smith, WAM 1238–86. 4 males (SL 4.9–5.2 mm), NW of Collier Bay, FRV *Soela*, sta. 01/84/070, 13°44'S, 122°13.3'E, 496–494 m, 13 Feb 1984, coll. S. Slack-Smith, WAM. 1 male (SL 5.2 mm), NW of Cape Leveque, FRV *Soela*, sta. S01/84/063, 14°43.1'S, 121°33.1'E, 410–408 m, 12 Feb 1984, WAM 1090–86. 20 males (SL 3.7–5.3 mm), NW of Beagle Bay, FRV *Soela*, sta. 01/84/060, 15°08.6'S, 121°03.4'E, 500–504 m, 11 Feb 1984, coll. S. Slack-Smith, WAM 1079–86, 1084–86. 2 males (SL 5.5, 6.0 mm), NW of Beagle Bay, FRV *Soela*, sta. 01/84/058, 15°12.8'S, 121°05.9'E, 410–404 m, 11 Feb 1984, coll. S. Slack-Smith, WAM 1078–86, 1134–86. 2 males (SL 5.7, 6.0 mm), North West Shelf, FRV *Soela*, sta. NWS-7, 18°33.2'S, 117°30.9'E, 392–400 m, 25 Apr 1983, NTM Cr 010913. 1 male (SL 6.6 mm), 1 female (SL 5.8 mm), North West Shelf, FRV *Soela*, CSIRO cruise 0184, sta. 22, 18°34.4'S, 117°30'E, 202 m, 1 Feb 1984, NTM Cr 000665, 000667. 2 males (SL 4.5, 5.2 mm), North West Shelf, FRV *Soela*, sta. 0184/16, 18°37.4'S, 117°02.4'E, 504–508 m, 31 Jan 1984, NTM Cr 011546.

Other material (all from *Albatross*). PHILIPPINES: 2 males (SL 4.2, 4.5 mm), sta. 5268, Verde Is., 13°42'N, 120°57'15"E, 311 m, 8 Jun 1908, USNM 168923. 1 female ovig. (SL 3.7 mm), sta. 5123, Mindoro Is., 13°12'45"N, 121°38'45"E, 518 m, 2 Feb 1908, USNM 168920. 1 female ovig. (SL 3.4 mm), sta. 5124, Mindoro Is., 12°52'N, 121°48'20"E, 514 m, 2 Feb 1908, USNM 168921. 2 males (SL 3.7, 4.5 mm), sta. 5214, Masbate Is., 12°25'18"N, 123°37'15"E, 399 m, 21 Apr 1908, USNM 168922. 2 males (3.3, 4.3 mm), 3 females (SL 2.5–2.8 mm), 1 female ovig. (SL 2.8 mm), sta. 5402, between Leyte and Cebu, 11°11'45"N, 124°15'45"E, 344 m, 16 Mar 1909, USNM 168924, 168925. 2 males (SL 3.1–3.2 mm), sta. 5404, Leyte, Dupon Bay, 10°50'N, 124°26'18"E, 347 m, 17 Mar 1909, USNM 168927. 1 male (SL 5.2 mm), sta. 5405, Leyte, Dupon Bay, 10°49'20"N, 124°24'23"E, 479 m, 17 Mar 1909, USNM 168928. 1 male (SL 2.4 mm), sta. 5535, between Cebu and Siquijor Is., 09°20'30"N, 123°23'45"E, 567 m, 19 Aug 1909, USNM 168935. 1 male (SL 4.8 mm), sta. 5541, N of Mindanao, 08°49'38"N, 123°34'30"E, 401 m, 20 Aug 1909, USNM 168936. 1 male (SL 5.1 mm), sta. 5517, N of Mindanao, 08°45'30"N, 123°33'45"E, 309 m, 9 Aug 1909, USNM 168934. 6 males (SL 3.1–4.8 mm), sta. 5506, N of Mindanao, 08°40'N, 124°31'45"E, 479 m, 5 Aug 1909, USNM 168932. 3 males (SL 3.9–5.1 mm), 1 female (SL 5.2 mm), sta. 5501, N of Mindanao, 08°37'37"N, 124°35'E, 391 m, 4 Aug 1909, USNM 168929. 1 male (SL 4.5 mm), 2 sex indet. (SL 3.6, 5.1 mm), sta. 5502, N of Mindanao, 08°37'37"N, 124°35'E, 391 m, 4 Aug 1909, USNM 168930. 4 females (SL 3.7–5.2 mm), sta. 5504, N of Mindanao, 08°35'30"N, 124°36'E, 366 m, 5 Aug 1909, USNM 168931. 1 male (SL 4.3 mm), 3 females (SL 3.7–4.9 mm), sta. 5508, N of Mindanao, Iligan Bay, 08°17'24"N, 124°11'42"E, 494 m, 5 Aug 1909, USNM 168933. 1 male (SL 3.4 mm), sta. 5550, Sulu Sea, Jolo Is., 06°02'N, 120°44'40"E, 472 m, 17 Sep 1909, USNM 168937. 1 female (SL 4.3 mm), sta. 5551, Sulu Sea, Jolo Is., 05°54'48"N, 120°44'24"E, 353 m, 17 Sep 1909, USNM 168938.

INDONESIA: 4 males (SL 3.6–4.0 mm), 1 female (SL 3.3 mm), 1 female ovig. (SL 3.4 mm), sta. 5590, Borneo, Sibuko Bay, off Mabul Is., 04°10'50"N, 118°39'35"E, 567 m, 29 Sep 1909, USNM 168939. 1 male (SL 4.2 mm), 1 female (SL 2.7 mm), sta. 5622, Moluccas, off Makyan Is., 00°19'20"N, 127°28'30"E, 503 m, 29 Nov 1909, USNM 168940. 1 male (SL 4.8 mm), 1 female (SL 2.8 mm), 00°12'15"N, 127°29'30"E, 527 m, 29 Nov 1909, USNM 168941.

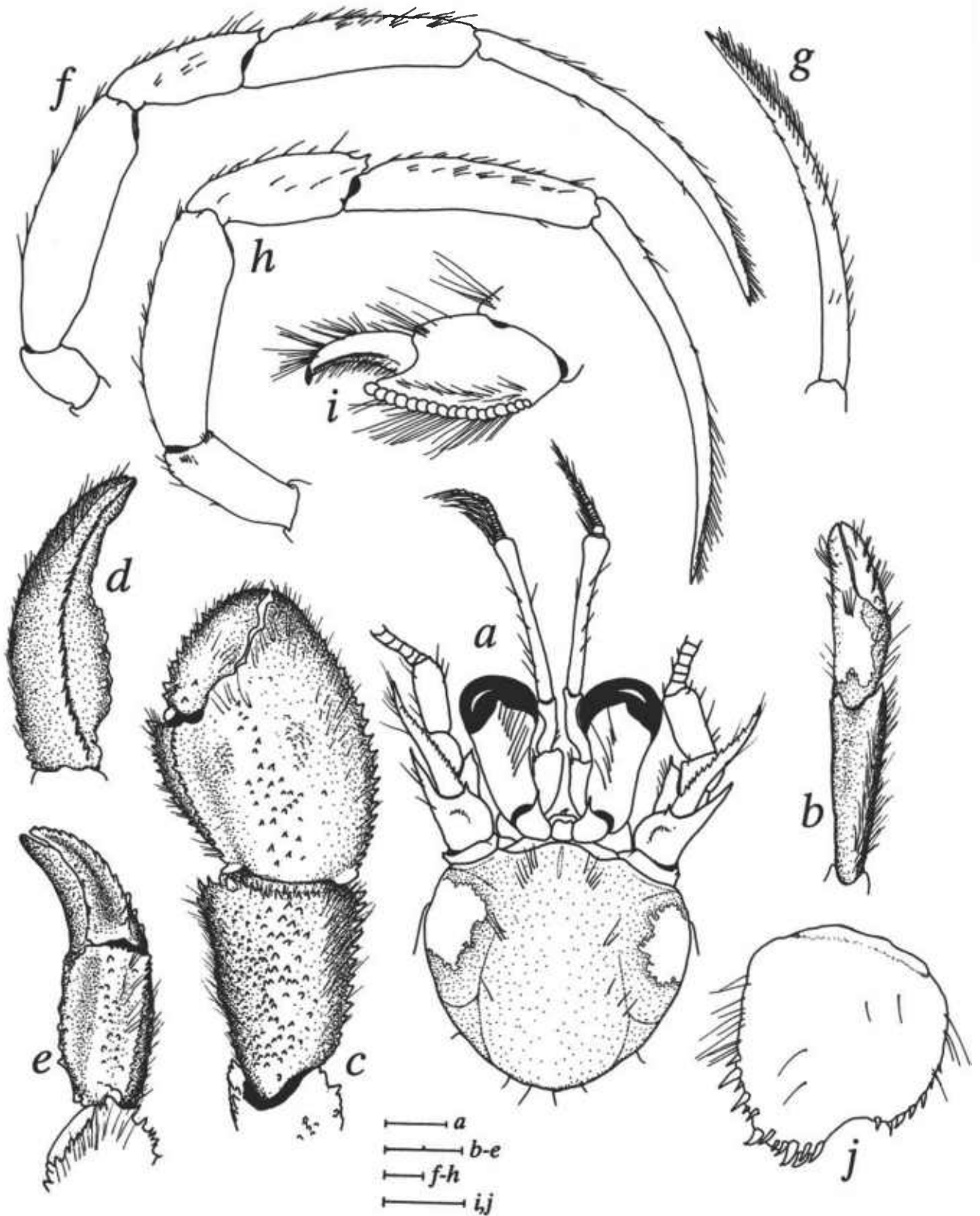


Fig. 19. *Oncopagurus monstrosus* (Alcock, 1894). a, shield and cephalic appendages; b, carpus and chela of left cheliped; c, carpus and chela of right cheliped; d, chela of same, lateral; e, same, mesial; f, right 2nd pereopod, lateral, g, dactyl of same, mesial; h, right 3rd pereopod, lateral; i, propodus and dactyl of left 4th pereopod; j, telson. Scales = 1 mm (a), 2 mm (b-e), 1 mm (f-h), 0.5 mm (i,j). (lectotype male [SL 4.2 mm], Bay of Bengal, USNM 156566).

Diagnosis. Shield (Fig. 19a) as long as broad; dorsal surface weakly calcified medially; rostrum broadly rounded, with low dorsal ridge; anterior margins weakly concave; lateral projections broadly subtriangular, usually terminating in small spine; ventrolateral margin unarmed or occasionally with small spine; posterior margin broadly rounded. Ocular peduncles more than half length of shield; ocular acicles subtriangular, terminating in strong spine; corneae dilated. Sternite of 3rd maxillipeds with small spine on each side of midline. Antennular peduncle exceeding distal margin of corneae by full length of ultimate segment. Antennal peduncle (Fig. 20a) exceeding distal margin of cornea by at most 0.25 length of 5th segment; 3rd segment with strong ventromesial distal spine; 2nd segment with dorsolateral distal angle produced, terminating in strong spine; acicles at most slightly exceeding distal margin of corneae, mesial margin armed with 8 to 15 spines; flagellum with series of short setae (< 1 article in length) and long setae (> 3 articles in length) every 8 to 20 articles. Chelipeds markedly dissimilar, with some iridescence and moderately dense setae. Right cheliped (Figs 19c–e, 20b–d) with chela less than twice as long as broad (males), or about as long as broad (females); fingers curved ventromesially; dactyl with concave ventromesial face; palm with irregular rows of small spines medially on dorsal face, and dorsolateral and dorsomesial margins well delimited by row of spines; mesial face of palm rounded, with small spines or tubercles. Left cheliped (Fig. 19b) with palm and carpus often weakly calcified; carpus with dorsodistal spine. Ambulatory legs (Fig. 19f–h) with ventromesial row of about 5 (occasionally up to 15) small corneous spines on dactyl, and dorsal and dorsomesial rows of long setae; carpus with small dorsodistal spine; merus of right 3rd pereopod unarmed, (rarely 1 or 2 small dorsal spines). Anterior lobe of sternite of 3rd pereopods with small marginal spine, setose. Fourth pereopod (Fig. 19i) with dactyl terminating in short, corneous claw; propodal rasp consisting of ovate scales. Uropods and telson (Fig. 19j) markedly asymmetrical. Telson lacking transverse suture separating anterior and posterior lobes; posterior lobes separated by U-shaped median cleft, terminal margins armed with often strongly curved corneous spines. Male 1st gonopods (Fig. 20e) each with weakly concave distal lobe; 2nd gonopods (Fig. 20f) each with distal segment nearly flat. Females with vestigial right 2nd pleopod.

Colour. [Based on Miyake (1982: 118, pl. 40, fig. 1), Baba *et al.* (1986: 146, pl. 302), and Imafuku (1992: 234)]. Carapace light orange. Left cheliped, and 2nd and 3rd pereopods, light pink with two orange-red spots on mesial and lateral faces of meri, carpi, and propodi (spots on meri often partially fused). Right cheliped with chela, distal two-thirds of carpus, and distal third of merus, cream white; merus and carpus with orange-red portion proximally

Habitat and symbiotic associations. Found in gastropod shells usually with actinian attached to shell.

Distribution. Indo Pacific: Gulf of Aden; Bay of Bengal; Japan; Philippines; Indonesia; and Australia. Depth: 202 to 1000 m.

Affinities. As previously mentioned, *Oncopagurus monstrosus* is similar to *O. indicus*, and often the two are difficult to separate. Individuals of *O. monstrosus* grow to a larger size than *O. indicus*. The most reliable characters in distinguishing between the two include size, development of ocular peduncles and corneae, and armature of the merus of the right 3rd pereopod (see "Affinities" under *O. indicus*).

Remarks. Because of the potential for confusion of this species with *O. indicus*, a lectotype is herein selected for *O. monstrosus*.

De Saint Laurent (1972) questionably synonymised *Eupagurus brevimanus* Yokoya, 1933, with *Parapagurus monstrosus* Alcock, 1894. From Yokoya's brief description it is not possible to confirm whether his taxon is indeed a synonym of *Oncopagurus monstrosus*, and his specimens are probably no longer extant.

Oncopagurus minutus (Henderson, 1896)

Fig. 21

Parapagurus minutus Henderson, 1896: 531 (type locality: off the north Maldive Atoll, *Investigator*, sta. 150, 719 fms (1308.6 m).—Alcock & Anderson, 1897, pl. 32, fig. 3, 3a.—Alcock, 1901: 222.—Alcock, 1905: 101, pl. 10, fig. 3.—De Saint Laurent, 1972: 108.

Sympagurus minutus.—Lemaitre, 1989: 37.—Lemaitre, 1994: 412.

?not *Parapagurus minutus*.—Thompson, 1943: 417 (See remarks under *Oncopagurus indicus* Alcock, 1905).

Type material. SYNTYPE, female (SL 2.3 mm), Indian Ocean, off north Maldive Atoll, *Investigator*, sta. 150, 719 fms (1308.6 m), NHM 1896:9.8.24.

Australian material. NEW SOUTH WALES: 1 male (SL 2.5 mm), NZOI *Tangaroa*, U222, off Newcastle, 1075–1040 m, 9 Oct 1982, AM P40409.

Other material. INDONESIA: 1 male (SL 4.0 mm), Sulawesi (Celebes), Gulf of Tomini, off Limbe Is., *Albatross* sta. 5601, 01°13'10"N, 125°17'05"E, 1399 m, 13 Nov 1909, USNM 168943. 1 female (SL 2.2 mm), Siboga Exp. sta. 88, 00°34.6'S, 119°08.5'E, 1301 m, 20 Jun 1899, coll. M. Weber, ZMA De103.112. 1 male (SL 2.0 mm), Moluccas, S of Patiente Strait, off Doworra Is., *Albatross* sta. 5631, 00°57'S, 127°56'E, 1480 m, 2 Dec 1909, USNM 168944. 1 male (SL 3.5 mm), 1 female (SL 3.4 mm), Moluccas, Pitt Passage, off Gomomo Is., *Albatross* sta. 5636, 01°55'S, 127°42'30"E, 2308 m, 3 Dec 1909, USNM 168945. 2 males (SL 2.0, 2.6 mm), Celebes, Gulf of Boni, off Olang Point, *Albatross* sta. 5656, 03°17'40"S, 120°36'45"E, 885 m, 19 Dec 1909, USNM 168946.

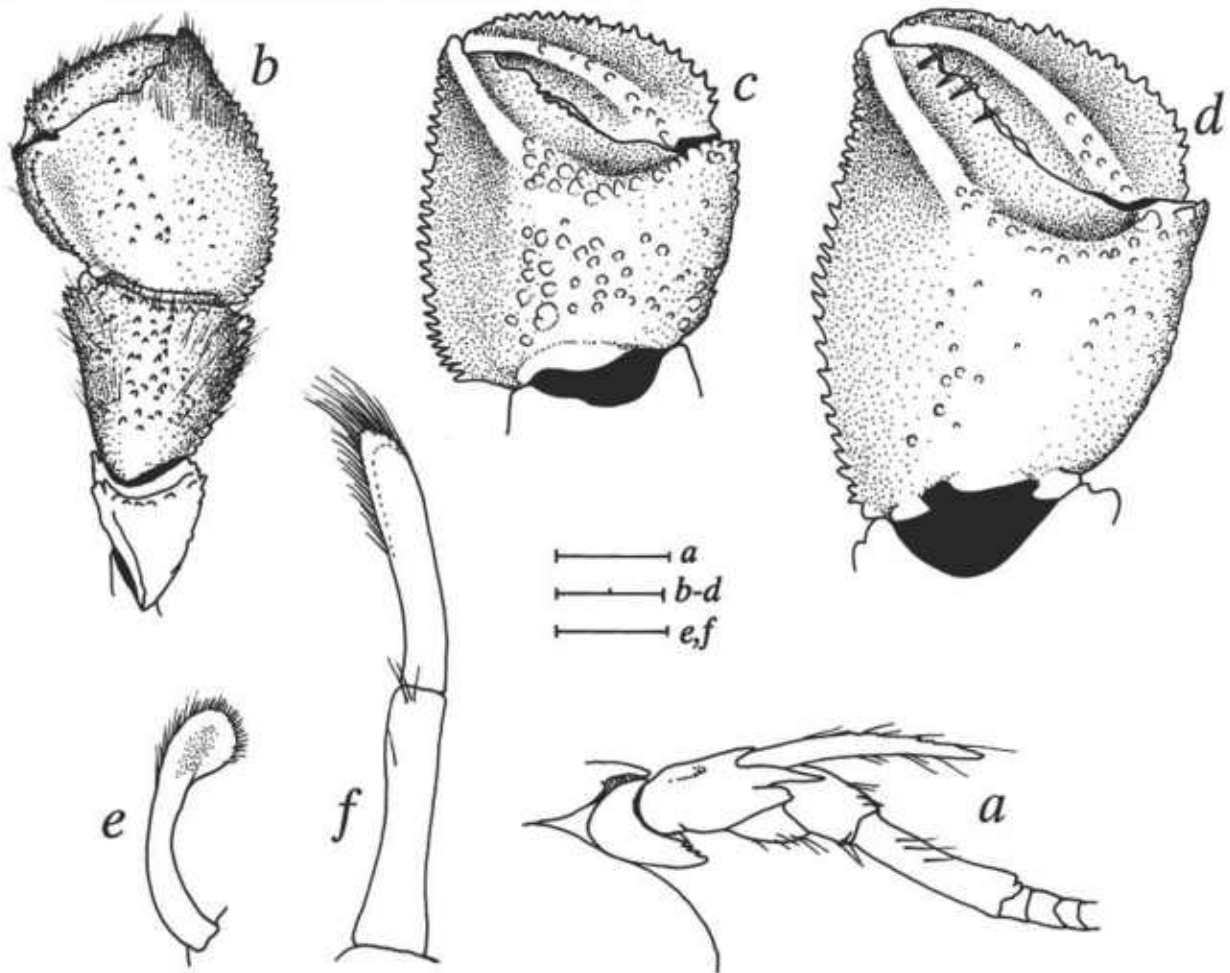


Fig. 20. *Oncopagurus monstrosus* (Alcock, 1894). a, right antennal peduncle, lateral; b, right cheliped of female; c, right chela of male, ventral; d, right chela of male, ventral; e, male right 1st gonopod, mesial; f, male right 2nd gonopod, posterior. Scales = 1 mm (a), 2 mm (b-d), 0.5 mm (e,f). (a,e,f, lectotype male [SL 4.2 mm], Bay of Bengal, USNM 156566; b, female [SL 3.4 mm], Indonesia, USNM 168939; c, male [SL 4.2 mm], Indonesia, USNM 168940; d, male [SL 5.1 mm], Philippines, USNM 168931).

Diagnosis. Shield (Fig. 21a) as long as broad; dorsal surface weakly calcified medially; rostrum broadly rounded, with short, low dorsal ridge; anterior margins weakly concave; lateral projections subtriangular, terminating in small spine; ventrolateral margin with small spine (not always visible in dorsal view); posterior margin broadly rounded. Ocular peduncles more than half length of shield, diminishing in width distally, and with long setae dorsally; ocular acicles subtriangular, terminating in strong spine; corneae cone-shaped (Fig. 21a,b), maximum width subequal to distal width of peduncle. Sternite of 3rd maxillipeds with small spine on each side of midline. Antennular peduncle exceeding distal margin of corneae by half or more length of penultimate segment. Antennal peduncle (Fig. 21c) slightly exceeding distal margin of cornea; 3rd segment with strong ventromesial distal spine; 2nd segment with dorsolateral distal angle produced, terminating in strong spine, mesial margin with small spine on dorsodistal angle; acicles at most slightly exceeding distal margin

of corneae, mesial margin armed with 5 to 7 spines; flagellum with setae 1 to 2 flagellar articles in length. Chelipeds markedly dissimilar, with moderately dense setae. Right cheliped (Fig. 21e,f) with fingers weakly curved ventromesially, dactyl with row of spines on mesial margin; palm with dorsal surface unarmed or at most with scattered small tubercles, dorsolateral and dorsomesial margins with row of spines, mesial face rounded and with few tubercles; carpus with numerous small tubercles or spines on dorsal surface. Left cheliped (Fig. 21d) with chela unarmed, well calcified; carpus with dorsolateral face weakly calcified, 1 dorsodistal and 1 laterodistal spine. Ambulatory legs (Fig. 21g-i) usually exceeding tip of extended right cheliped; dactyls evenly curved, about 1.9 as long as propodi, each with ventromesial row of about 5 (2nd) or 2 (3rd) small corneous spines, and dorsal and dorsomesial rows of long setae; carpus with small dorsodistal spine; ischium and merus of 2nd pereopod unarmed. Anterior lobe of sternite of 3rd pereopods unarmed or with small marginal

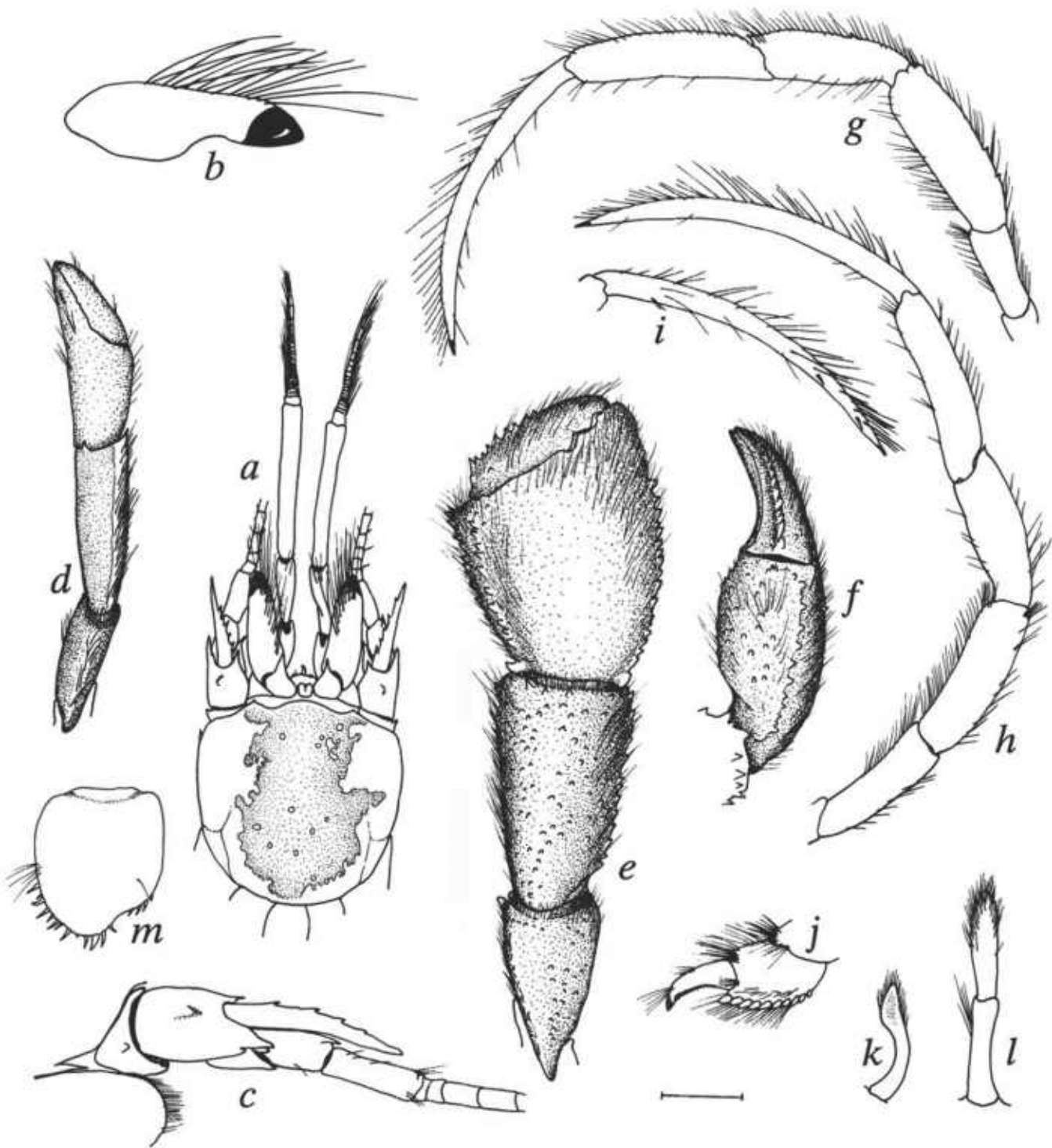


Fig. 21. *Oncopagurus minutus* (Henderson, 1896). a, shield and cephalic appendages; b, right ocular peduncle and cornea, lateral; c, right antennal peduncle, lateral; d, left cheliped; e, right cheliped; f, chela of same, mesial; g, left 2nd pereopod, lateral; h, left 3rd pereopod, lateral; i, dactyl of same, mesial; j, propodus and dactyl of left 4th pereopod, lateral; k, male left 1st gonopod, mesial; l, male left 2nd gonopod, anterior; m, telson. Scale = 1 mm (a,d-i), and 0.5 mm (b,c,j-m). (Male [SL 2.5 mm], New South Wales, AM P40409).

spine, setose. Fourth pereopod (Fig. 21j) with dactyl terminating in short, corneous claw; propodal rasp consisting of ovate scales. Uropods and telson markedly asymmetrical (Fig. 21m); telson lacking transverse suture; posterior lobes separated by shallow, U-shaped median cleft, terminal margins armed with often curved corneous spines. Male 1st gonopods (Fig. 21k) each with weakly concave distal lobe; 2nd gonopods (Fig. 21l) each with distal segment nearly flat. Females with vestigial right 2nd pleopod.

Habitat and symbiotic associations. Unknown, probably gastropod shells.

Distribution. Indo Pacific: Maldives; Indonesia; and Australia. Depth: 800 to 2308 m.

Affinities. This species, and *Sympagurus acinops* Lemaitre, 1989, from the eastern and western Atlantic Ocean, are the only parapagurids with subconical corneae. Other than in generic characters, the two species differ markedly in the length and armature of the antennal acicles, armature of chelipeds, and degree of development of male gonopods (see Lemaitre, 1989: 52, figs 24–27).

Remarks. De Saint Laurent (1972: 108) mentioned (without name) a form from the eastern Pacific (Galápagos Islands; Gulf of Panamá) which she considered close to, or conspecific with *O. minutus*. She did not, however, discuss such taxon any further.

Oncopagurus cidaris n.sp.

Figs 22, 23

Holotype. Male (SL 2.6 mm), off Tully, Queensland, CIDARIS I sta. 1–3, 18°07.9'S, 147°35.7'E, epibenthic sledge, ORV *Franklin*, 956–969 m, 6 May 1986, coll. JCU, QM W16596.

Paratypes. QUEENSLAND: 2 males (SL 2.2, 2.7 mm), off Tully, CIDARIS, sta. 16–3, ORV *Franklin*, 17°47'S, 148°13'E, epibenthic sledge, 1141–1102 m, 10 May 1986, coll. JCU, QM W16506, 16508. 3 males (SL 2.4–2.7 mm), 1 female (SL 2.3 mm), 2 females ovig. (SL 2.7, 2.8 mm) off Tully, CIDARIS I, sta. 49–2, ORV *Franklin*, 17°51'S, 147°10'E, epibenthic sledge, 904–916 m, 17 May 1986, coll. JCU, QM W16496, USNM 270107. 3 males (SL 2.6–2.9 mm), 2 females ovig. (SL 2.5, 2.6 mm), same station data as holotype, QM W16596.

NEW SOUTH WALES: 1 male (SL 3.8 mm), E of Bass Point, FRV *Kapala*, sta. K75-02-16, 34°29–35'S, 151°19–17'E, 439–457 m, 30 Jun 1975, AM P20754. 1 female ovig. (SL 3.2 mm), off Newcastle, NZOI *Tangaroa*, cruise U223, 1150–951 m, 10 Oct 1982, AM P40390.

Description. Shield (Fig. 22a) as broad as long; dorsal surface weakly calcified on usually more than half of surface, and scattered short setae; rostrum broadly rounded, weakly produced, with short mid-

dorsal ridge; anterior margins weakly concave; lateral projections subtriangular, terminating bluntly; anterolateral margins sloping; posterior margin broadly rounded; ventrolateral margins of shield each with small spine. Anterodistal margin of branchiostegite rounded, unarmed, setose.

Ocular peduncles more than half length of shield, with dorsal row of long setae. Cornea width subequal to distal width of ocular peduncle. Ocular acicles subtriangular, terminating in strong spine; separated basally by less than basal width of 1 acicle.

Antennular peduncle long, slender, exceeding distal margin of cornea by entire length of ultimate segment. Ultimate segment twice as long as penultimate segment, with scattered setae. Basal segment with strong ventromesial spine; lateral face with distal subrectangular lobe armed or with 1 small spine, and strong spine proximally. Ventral flagellum with 5 to 6 articles.

Antennal peduncle (Fig. 23a) reaching distal margin of cornea. Fifth segment unarmed, but with scattered setae. Fourth segment with strong dorsodistal spine. Third segment with strong ventromesial distal spine. Second segment with dorsolateral distal angle produced, terminating in strong, simple spine; mesial margin with spine on dorsodistal angle. First segment with 1 small spine on lateral face; ventromesial angle produced, with 3 to 4 small spines laterally. Antennal acicles slightly curved outward (in dorsal view), at most slightly exceeding distal margins of corneae, terminating in strong spine; mesial margin armed with row of 5 to 9 spines, setose. Flagellum long, exceeding extended right cheliped and ambulatory legs, articles with numerous setae < 1 to 3 flagellar articles in length (Fig. 23b).

Mandible with 3-segmented palp. Maxillule (Fig. 23c) with external lobe of endopod weakly developed, internal lobe with 1 long seta. Maxilla with endopod exceeding distal margin of scaphognathite. First maxilliped with endopod exceeding exopod in distal extension. Second maxilliped without distinguishing characters. Third maxilliped (Fig. 23d) with crista dentata of about 8 corneous-tipped teeth; coxa and basis each with 1 tooth mesially. Sternite of 3rd maxillipeds with small spine on each side of midline.

Chelipeds markedly dissimilar. Right cheliped (Fig. 22c,d) massive, with moderately dense, plumose setae on distal half of chela. Fingers curved ventromesially, terminating in small, usually blunt corneous claw; cutting edges with irregularly-sized calcareous teeth. Dactyl slightly shorter than length of mesial margin of palm, set at strongly oblique angle to longitudinal axis of palm; mesial margin broadly curved, well defined by row of blunt or sharp spines diminishing in size distally; dorsal face with scattered small tubercles, ventral face smooth, ventromesial face concave. Fixed finger broad at base, dorsal and ventral faces smooth. Palm longer than broad, lateral margin well delimited by row of blunt to sharp spines; mesial face rounded, with scattered small tubercles; dorsomesial margin delimited by row

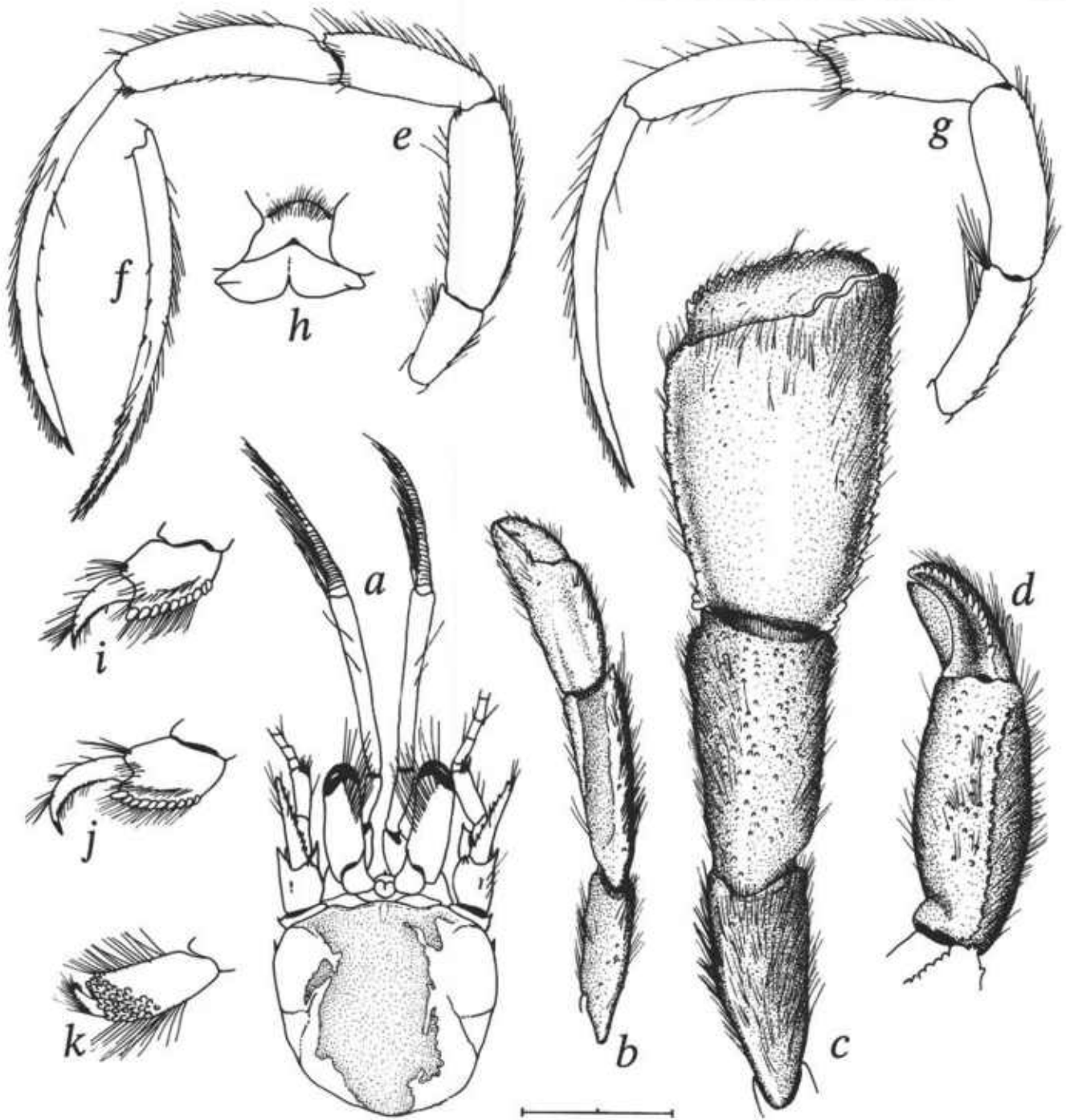


Fig. 22. *Oncopagurus cidaris* n.sp. a, shield and cephalic appendages; b, left cheliped; c, right cheliped; d, chela of same, mesial; e, left 2nd pereopod, lateral; f, dactyl of same, mesial; g, left 3rd pereopod, lateral; h, sternite of 3rd pereopods, ventral; i, propodus and dactyl of left 4th pereopod of male, lateral; j, propodus and dactyl of left 4th pereopod of female, lateral; k, propodus and dactyl of left 5th pereopod, lateral. Scale = 2 mm. (Same station data as holotype, Queensland, QM W16596: a, paratype male [SL 2.9 mm]; j, paratype female [SL 2.6 mm]).

of blunt or sharp spines; dorsal surface smooth except for scattered small tubercles; ventral surface smooth. Carpus with dorsolateral margin rounded or sometimes well delimited distally by row of spines; dorsal face with numerous small spines or tubercles; ventromesial margin

with row of spines; ventral face with scattered small tubercles. Merus with row of long bristles and scattered tubercles on dorsal surface; ventromesial margin with row of spines. Ischium and coxa unarmed, but with ventromesial row of setae.

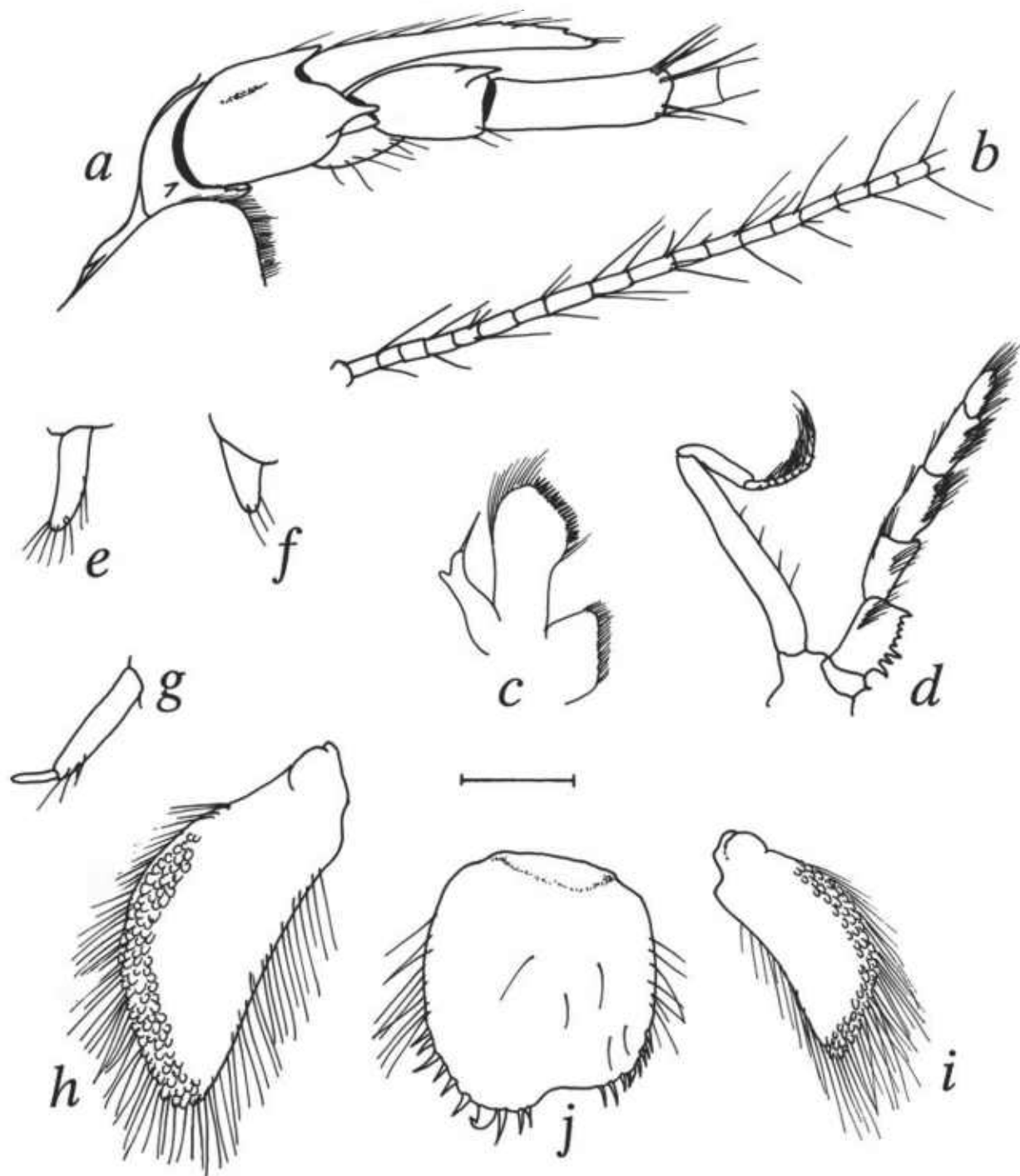


Fig. 23. *Oncopagurus cidaris* n.sp. a, right antennal peduncle, lateral; b, proximal one-third of antennal flagellum; c, left maxillule, internal; d, left 3rd maxilliped, internal; e, male left 2nd pleopod; f, male right 2nd pleopod; g, male left 2nd pleopod; h, i, exopod of uropods, dorsal: h, left; i, right; j, telson. Scale = 0.5 mm (a,c,e-j), and 1 mm (b,d). (Same station data as holotype, Queensland, QM W16596: a-f, h-j, paratype male [SL 2.9 mm]; g, male [SL 2.7 mm]).

Left cheliped (Fig. 22b) usually weakly well calcified on merus and carpus. Fingers terminating in small corneous claw; dorsal and ventral surfaces unarmed except for scattered tufts of setae; cutting edge of dactyl with row of minute, fused corneous teeth; cutting edge of fixed finger with row of regularly

spaced, small, evenly-sized teeth. Dactyl shorter than palm in length. Palm unarmed except for scattered setae on dorsal face and long setae on dorsomesial margin; ventral face smooth. Carpus with strong dorsodistal spine; dorsal margin with long setae; ventral face smooth. Merus with long setae on dorsal

margin; ventral face smooth. Ischium and coxa unarmed, but with ventromesial row of setae.

Ambulatory legs (Fig. 22e–g) similar right from left, exceeding extended right cheliped by approximately 0.25 length of dactyl. Dactyl broadly curved, twice as long as propodus, and terminating in sharp corneous claw; with dorsal and dorsomesial rows of long setae, and ventromesial row of about 7 to 9 slender corneous spines. Propodus with row of setae on dorsal margin. Carpus with small, blunt or sharp dorsodistal spine, and long setae dorsally. Merus with setae on dorsal margin. Ischium and coxa unarmed. Anterior lobe of sternite of 3rd pereopods (Fig. 22h) rounded, setose, unarmed.

Fourth pereopod (Fig. 22i,j) semichelate. Dactyl terminating in sharp corneous claw, and longer and more strongly curved in females than in males; with ventrolateral row of small corneous spinules. Propodus longer than broad, rasp formed of 1 row of rounded scales. Carpus with long setae on dorsal margin. Merus with rows of long setae on dorsal and ventral margins.

Fifth pereopod (Fig. 22k) semichelate. Propodal rasp extending to mid-length of segment.

Uropods and telson (Fig. 23h–j) markedly asymmetrical. Telson lacking transverse suture; dorsal surface with scattered setae; posterior lobes separated by shallow cleft, terminal margin of lobes armed with long, often strongly curved corneous spines.

Males lacking 1st gonopods; 2nd pair of gonopods (Fig. 23e–f) weakly developed, asymmetrical, left usually 1-segmented or occasionally 2-segmented with short distal segment (Fig. 23e,g), right 1-segmented, rudimentary or absent (Fig. 23f). Females with vestigial 2nd right pleopod.

Habitat. Found inhabiting gastropod shells.

Distribution. Known so far only from Australia. Depth: 439 to 1150 m.

Etymology. The specific name is given in recognition of the fruitful CIDARIS expeditions.

Affinities. This new species superficially resembles *O. tuamotu* (Lemaitre, 1994). The two species differ in several important characters (see Lemaitre, 1994: 407, figs 24–26, 28i). In *O. cidaris*, the right palm is distinctly longer than broad, and the ventromesial margin is rounded, unarmed, and the mesial face is not expanded distally (Fig. 22e,d); in *O. tuamotu* the palm is broader than long, the ventromesial margin is well delimited by a row of spines, and the mesial face is expanded distally. In the new species the dactyls of the ambulatory legs are more slender (Fig. 22c–g) than in *O. tuamotu*; the dactyl of the 4th pereopod is longer and more strongly curved in females than in males (Fig. 22i,j), whereas in *O. tuamotu* the dactyl is similar in both sexes. Although males of both species have asymmetrical 2nd gonopods, those of *O. cidaris* are less developed. In males of *O. cidaris*, the right 2nd gonopod can consist of a short bud (Fig. 23f), or sometimes is absent; the left 2nd gonopod is two to three times as

long as the right, and can consist of one, or occasionally two segments (Fig. 23e,g). In *O. tuamotu*, the 2nd gonopods are two-segmented on both sides.

Remarks. In addition to this new species, three other *Oncopagurus* species also lack 1st gonopods in males, *O. haigae* (De Saint Laurent, 1972) *O. orientalis* (De Saint Laurent, 1972) and *O. tuamotu* (Lemaitre, 1994). This condition in males has evolved in other parapagurid genera as well. Males of five species of *Paragiopagurus* n.gen. also lack 1st gonopods, *P. acutus*, *P. bicarinatus*, *P. hirsutus*, *P. hobbiti* (Macpherson, 1983), and *P. ruticheles* A. Milne Edwards, 1891, of which only the first three have been found so far in Australian waters.

Paragiopagurus n.gen.

Sympagurus.—Lemaitre, 1989: 36 (in part).

Diagnosis. Eleven pairs of phyllobranchiate or intermediate gills. Shield about as broad as long; dorsal surface often with irregularly-shaped, weakly calcified areas medially. Cornea weakly to moderately dilated. Fourth segment of antennal peduncle armed with dorsodistal spine. Epistomial spine straight, or absent. Right chela usually with well delimited dorsomesial and dorsolateral margins; often operculate. Left cheliped well calcified, or sometimes weakly calcified on merus and carpus. Ambulatory legs with dactyls curved. Fourth pereopod with propodal rasp consisting of 1 or more rows of ovate corneous scales. Second abdominal somite with left pleuron terminating in small subtriangular lobe. Males usually with weakly to moderately developed paired 1st and 2nd gonopods; 1st gonopods sometimes absent; rarely with 2nd unpaired left pleopod.

Species. Included in this new genus are three taxa previously considered subspecies by De Saint Laurent (1972) that are herein elevated to specific rank, *Sympagurus acutus acutus* (De Saint Laurent, 1972), *S. a. bicarinatus* (De Saint Laurent, 1972), and *S. a. hirsutus* (De Saint Laurent, 1972); and also *S. boletifer* (De Saint Laurent, 1972), *S. bougainvillei* Lemaitre, 1994, *S. curvispina* (De Saint Laurent, 1974), *S. diogenes* Whitelegge, 1900, *S. hobbiti* (Macpherson, 1983), *S. macrocerus* (Forest, 1955), *S. pacificus* Edmondson, 1925, *S. pilimanus* (A. Milne Edwards, 1880), *S. rugosus* (De Saint Laurent, 1972), *S. ruticheles* (A. Milne Edwards, 1891), *S. spinimanus* (Balss, 1911), *S. tuberculatus* (De Saint Laurent, 1972), and *S. wallisi* Lemaitre, 1994.

Type species. *Sympagurus diogenes* Whitelegge, 1900. Gender: masculine.

Etymology. From the Greek *parageios*, pertaining to shallow water, and *pagourus*, crab. The name is in reference to the depth distribution of the type species of the genus, the shallowest so far known of all parapagurids.

Key to Australian species of *Paragiopagurus* n.gen.

1. Ventral face of right chela covered with prominent mushroom-like tubercles *P. boletifer*
- Ventral face of right chela smooth, with small spines or tubercles 2
2. Right cheliped with transverse furrows on ventral face of chela and ventrolateral face of carpus *P. ruticheles*
- Right cheliped without transverse furrows on faces of chela or carpus 3
3. Ocular acicles simple; males with paired 1st gonopods *P. diogenes*
- Ocular acicles multifid; males lacking paired 1st gonopods 4
4. Palm of right chela with ventromesial margin well delimited by row of spines, mesial face expanded distally (Fig. 27d,e) *P. bicarinatus*
- Palm of right chela with ventromesial face not delimited by row of spines, mesial face not expanded distally 5
5. Dorsal face of right chela armed with strong spines (Fig. 28d) *P. hirsutus*
- Dorsal face of right chela smooth or with weak scattered spines or tubercles (Fig. 25d) *P. acutus*

Paragiopagurus diogenes (Whitelegge, 1900)

Fig. 14d,e, 24

Sympagurus diogenes Whitelegge, 1900: 172, pl. 34, fig 3 (type locality, by lectotype designation: 3km E of Port Hacking, New South Wales, sta. 35, 34°03.5'S, 151°12.5'E, 40–69 m).—Alcock, 1905: 173.—Lemaitre, 1989: 37.—Lemaitre, 1994: 412, fig. 27g.—Springthorpe & Lowry, 1994: 89.

Parapagurus diogenes.—Terao, 1913: 382.—Gordan, 1956: 338.—De Saint Laurent, 1972: 108.—Miyake, 1960: 90, pl. 45, fig. 2.—Miyake, 1975: 326, pl. 117, figs 3, 6.—Miyake, 1978: 72, figs 26, 27b, pl. 4, fig. 5.—Miyake, 1982: 119, pl. 40, fig. 2.—Baba *et al.*, 1986: 301, fig. 145.—Yu & Foo, 1991: 70, unnumbered pl.

Not *Sympagurus arcuatus diogenes* Hale, 1941: 279. (See remarks)

Type material. *Thetis* Exp., New South Wales: LECTOTYPE (herein selected): 1 female (SL 7.9 mm), 3 km E of Port Hacking, sta. 35, 34°03.5'S, 151°12.5'E, 22–38 fms (40–69 m), 10 Mar 1898, coll. E. R. Waite, AM G2379. PARALECTOTYPES: 2 males (SL 3.9(dry), 4.4 mm), 12 km E of Wollongong, sta. 48, 34°27'S, 151°04'E, 55–56 fms (101–102 m), 18 Mar 1898, coll. E.R. Waite, AM G2380.

Australian material. WESTERN AUSTRALIA: 1 female ovig. (SL 4.7 mm), between Shark Bay and Onslow, 1966, coll. W.W. Poole Bros, WAM 1167–86. 1 male (SL 2.7 mm), 1 female ovig. (SL 3.2 mm), NW Bluff Pt., CSIRO sta. 204, 27°18'S, 113°16'E, 99 m, 9 Oct 1963, WAM 1199–85. 2 males (SL 4.3, 5.1 mm), about 97 km W of Dongara, MV *Sprightly*, sta. 34M, 29°07.2'S, 113°56.4'E, 141 m, 19 Feb 1976, WAM 1092–86. 8 males (SL 3.0–6.3 mm), 7 females (SL 3.2–5.1 mm), 2 females ovig. (SL 4.3, 4.7 mm), 1 juv. sex indet. (SL 2.5 mm), about 92 km W of Dongara, MV *Sprightly*, sta. 18M, 29°11'S, 113°52.2'E, 137 m, 17 Feb 1976, WAM 1144–86, 1299–86, 1301–86. 6 males (SL 5.7–9.2 mm), W of Dongara, HMAS *Diamantina*, sta. 55, 29°15'S, 114°01'E, 146 m, 20 Mar 1972, WAM 1838–86. 2 males (SL 3.7, 5.4 mm), 1 female ovig. (SL 5.4 mm), about 73 km W of Cliff Head, MV *Sprightly*, sta. 22M, 29°31.7'S, 114°15.5'E, 145 m, 18 Feb 1976, WAM 1113–86. 1 male (SL 6.7 mm), about 69 km W of Cliff Head, MV *Sprightly*, sta. 24M, 29°34.1'S, 114°17.4'E, 126 m, 18 Feb 1976, WAM 1098–86. 1 female (SL 7.9 mm), NW of Beagle Is., HMAS *Diamantina*, sta. 53, 29°48'S, 114°20'E, 216–256 m, 20 Mar 1972, WAM 1759–86. 1 male (SL 5.5 mm), about 40 km W of Jurien Bay, MV *Sprightly*, sta. 1M, 30°21'S, 114°38'E, 15 Feb 1976, WAM 1326–86. 2 males (SL 5.7, 7.3 mm), 1 female (SL 4.3 mm), 1 female ovig. (SL 5.2 mm), SW of Jurien Bay, HMAS *Diamantina*, sta. 107, 30°29'S, 114° 40'E, 146 m, 9 Dec 1970, WAM 2207–86. 1 juv. sex indet. (SL 2.5 mm), NW of Green Is., HMAS *Diamantina*, sta. 68(3), approx. 30°34'S, 114°44'E, 128 m, 22 Mar 1972, WAM 1755–86. 7 males (SL 3.2–8.7

mm), 4 females (SL 4.0–6.1 mm), NW of Green Is., HMAS *Diamantina*, sta. 68(1), 30°37'S, 114°44'E, 146–139 m, 22 Mar 1972, WAM 1696–86, 1923. 1 male (SL 8.2 mm), NW Green Is., HMAS *Diamantina*, sta. 68/2, 30°37'S, 114°44'E, 137–144 m, 22 Mar 1972, WAM 1697–86. 7 males (SL 3.9–6.0 mm), 1 female (SL 5.2 mm), SW of Jurien Bay, HMAS *Diamantina*, sta. 108, 30°38'S, 114°47'E, 110 m, 9 Dec 1970, WAM 1716–86. 1 male (SL 7.6 mm), W. of Lancelin, HMAS *Diamantina*, sta. 37, 30° 55'S, 114° 48'E, 146 m, 27 Nov 1970, WAM 903–89. 1 male (SL 6.9 mm), 1 female (SL 7.5 mm), NW of Rottneest Is., *Bluefin*, 146 m, 15 Sep 1965, WAM 1998–86. 2 males (SL 4.2, 4.6 mm), W of Lancelin, HMAS *Diamantina*, sta. 70, 31°00'S, 114°52.5'E, 146–150 m, 23 Mar 1972, WAM 1744–86. 1 male (SL 6.9 mm), 1 female ovig. (SL 4.3 mm), W of Guilderton, HMAS *Diamantina*, sta. 77, 31°34'S, 115°06'E, 106–110 m, 23 Mar 1972, WAM 1695–86, 1747–86. 1 male (SL 8.1 mm), W of Rottneest Is., HMAS *Diamantina*, sta. 1, 32°00'S, 115°12'E, 150 m, 5 Mar 1976, coll. B. Hutchins *et al.*, WAM 393–86. 1 male (SL 4.9 mm), 2 females ovig. (SL 5.7, 8.2 mm), W of Rottneest Is., HMAS *Diamantina*, sta. 78, 32°00'S, 115°15'E, 146–150 m, 23 Mar 1972, WAM 1699–86, 1701–86. 2 males (SL 6.4, 6.4 mm), 1 female (SL 4.6 mm), SW of Rottneest Is., *Bluefin*, 146–152 m, 17 Sep 1965, coll. C. Disley, WAM 395–86, 832–86, 2011–86. 1 female (SL 5.2 mm), W of Garden Is., HMAS *Diamantina*, sta. 32, 32°15'S, 115°07'E, 210–212 m, 17 Mar 1972, WAM. 2 females (SL 3.7, 6.7 mm), W of Garden Is., HMAS *Diamantina*, sta. 34, 32°19'S, 115°07'E, 148–154 m, 18 Mar 1972, WAM 1712–86. 1 male (SL 7.2 mm), W of Manduram, HMAS *Diamantina*, sta. 4, 32°33'S, 115°04'E, 110 m, 23 Nov 1970, WAM 1702–86. 1 female (SL 3.6 mm), 2 females ovig. (SL 4.5, 6.0 mm), NW of Bunbury, HMAS *Diamantina*, sta. 8, 32°57'S, 114°48'E, 139–122 m, 15 Mar 1972, WAM 1703–86. 2 males (SL 6.4, 5.1 mm), 1 female (SL 5.8 mm), 1 female ovig. (SL 6.0 mm), NW of Bunbury, HMAS *Diamantina*, sta. 611, 33°00'S, 114°37'E, 219–221 m, 17 Mar 1972, WAM 2025–86. 5 males (SL 3.6–5.5 mm), 4 females (SL 2.7–4.5 mm), southwest coast of Western Australia, HMAS *Diamantina*, [no other data], WAM 1711–86.

QUEENSLAND: 1 male (SL 7.1 mm), 1 female (SL 5.3 mm), 2 females ovig. (SL 6.2, 7.0 mm), Marion Plateau, FRV *Soela*, sta. 0685-03, 22°34.8'S, 153°30.7'E, 678–695 m, 16 Nov 1985, NTM Cr 006856. 1 male (SL 5.5 mm), 18 mi (33.3 km) N of Cape Moreton, FRV *Gemini*, trawled, 113–119 m, sand and dead shell, 19–20 Mar 1970, coll. F. Wallace, QM W4423. 3 males (SL 6.5–8.0 mm), off Cape Moreton, 119 m, trawled, [no date], coll. D. Harris, QM W3336. 2 males (SL 6.3, 6.5 mm), 1 female ovig. (SL 6.9 mm), sta. 29, Nimbus Creek, Moreton Bay, [no depth], Jan 1968, coll. A.J. Bruce, WAM 203-94. 2 males (SL 6.6, 7.0 mm), off Coundra, coll. R. Elks, QM W3333. 1 male (SL 5.8 mm), Mooloolaba (ca 130 km N of Brisbane), 126–128 m, 12–14 Aug 1967, coll. R. Elks, QM W2848.

NEW SOUTH WALES: 4 males (SL 4.3–7.5 mm), 2 females (SL 4.3–5.1 mm), 1 female ovig. (SL 5.7 mm), E of Tweed Heads, FRV *Kapala*, sta. 78-09-09/10, 28°14'S, 153°50'E, 140 m, 2 Jun 1978, AM P40404. 1 male (SL 7.0 mm), E of Brunswick Heads, FRV *Kapala*, sta. K78-09-16, 28°24'S, 153°31'E, 174 m, 3 Jun 1978, AM P40401. 2 males (SL 5.4, 6.7 mm), 1 female ovig. (SL 5.7 mm), N of North Solitary Is., FRV *Kapala*, sta. K78-16-08, 29°54'S, 153°36'E, 109 m, 2 Aug 1978, AM P40399. 23 males (SL 3.0–6.7 mm), 20 females (SL 3.2–5.8 mm), E of Tweed Heads, FRV *Kapala*,

sta. K78-17-15, 146 m, (no date), AM P40389. 2 males (SL 10.0, 10.3 mm), transect between Sydney and Port Stephens, FRV *Kapala*, 366 m. July 1972, AM P19610. 1 male (SL 8.2 mm), off Newcastle, coll. A. d'Ombrain, AM P12327. 2 males (SL 7.9, 9.2 mm), N of Sydney, FRV *Kapala*, sta. K71-12-01, 33°40'S, 151°35'E, 137–146 m, 14 Jul 1972, AM P19631. 5 males (SL 4.0–7.8 mm), 2 females (SL 4.5, 5.4 mm), 1 female ovig. (SL 4.2 mm), E of Dangar Pt., Broken Bay, FRV *Kapala*, sta. K78-17-14, 201 m, 17 Aug 1978, AM P40393. 3 males (SL 6.3–9.4 mm), 1 female (SL 5.1 mm), 19 Jan 1973, coll. Shelf Benthic Survey, AM P40403, P40392. 1 male (SL 6.3 mm), E of Sydney, sta. 029, 33°49'S, 151°16'E, 19 Jan 1973, [no depth], coll. Shelf Benthic Survey, AM P40388. 1 male (SL 5.4 mm), 5.6 km E of North Head, sta. 901(1), 33°49'30"S, 150°21'48"E, 66 m, Apr 1973, coll. AM Shelf Benthic Survey, AM P20708. 2 males (SL 8.1, 8.9 mm), E of Malabar, Sydney, 33°50.6'S, 151°21'E, 66 m, 23 Jan 1973, coll. AM Shelf Benthic Survey, AM P39441. 2 males (SL 3.8, 7.8 mm), 3 females (SL 3.0–4.4 mm), 1 female ovig. (SL 4.4 mm), off Malabar, Sydney, sta. 25, 26 Jan 1973, coll. AM Shelf Benthic Survey, AM P20741. 5 males (SL 3.1–5.7 mm), 2.3 km E of Malabar, Sydney, AM Shelf Benthic Survey, sta. V, 33°59'27"S, 151°16'48"E, AM P40397. 1 male (SL 11.5 m), off Botany, 81 m, Aug 1921, AM P5594. 1 male (SL 10.9 mm), Burrwarra Hea, Bateman's Bay, 91 m, AM P9329. 1 male (SL 12.4 mm), 38 km NNE of Montague Is., 164 m, Sep 1926, AM P9312. 1 female (SL 8.7 mm), 16 km E of Montague Is., 137 m, 11 Jul 1925, AM P8218. 2 males (SL 8.3, 9.1 mm), off southern part of New South Wales coast, 73 m, AM P11435.

VICTORIA: 1 male (SL 10.8 mm), off Cape Everard, 119 m, Aug 1948, coll. W. French, NMV J10990.

Diagnosis. Intermediate gills. Shield (Fig. 24a) as broad as long; dorsal surface weakly calcified medially, and with low blister-like tubercles; rostrum broadly rounded, with short mid-dorsal ridge; anterior margins weakly concave; lateral projections subtriangular, with terminal spine; posterior margin broadly rounded. Ocular peduncles more than half length of shield, with dorsal longitudinal row of setae. Cornea slightly dilated. Ocular acicles subtriangular, terminating in strong spine usually directed anteromesially. Sternite of 3rd maxillipeds with small spine on each side of midline. Epistome with strong, straight spine. Antennular peduncle long, slender, exceeding distal margin of cornea by nearly entire length of ultimate segment. Antennal peduncle (Fig. 24b) exceeding distal margin of cornea by at most 0.20 length of 5th segment; 3rd segment with strong ventromesial distal spine; acicles curved outward (in dorsal view), not exceeding distal margin of cornea, and armed mesially with 4 to 7 strong spines; flagellum long, reaching to or slightly exceeding extended right cheliped, articles with very short setae interspersed with long setae every 5 to 15 articles. Chelipeds markedly dissimilar, glabrous or at most with scattered short setae, carpi and chelae usually iridescent dorsally. Right cheliped (Fig. 14d,e) with small tubercles or spines on dorsal surfaces of carpus and chela (tubercles or spines decreasing in size and number with increased size of individuals); fingers curved ventromesially; palm with

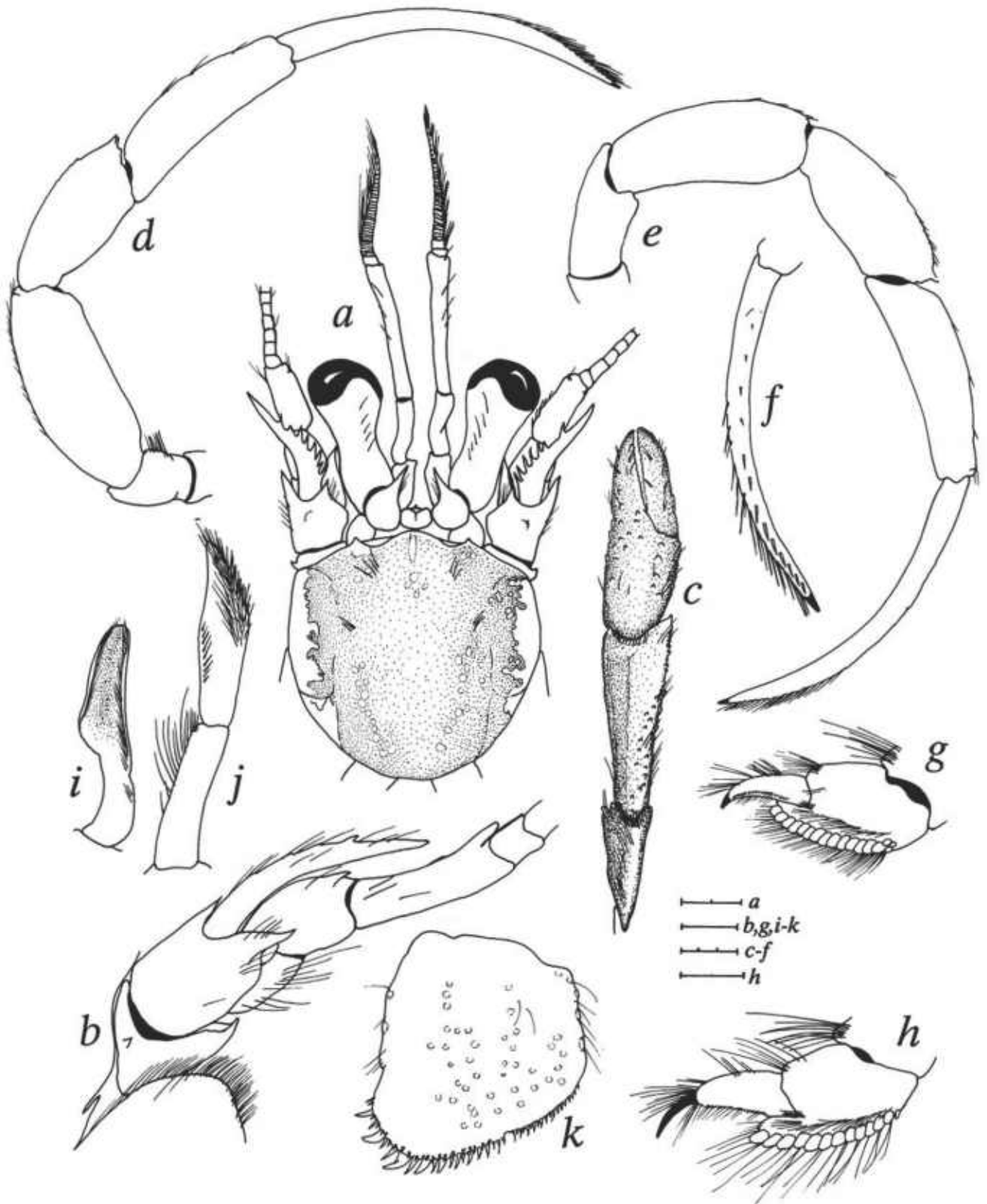


Fig. 24. *Paragiopagurus diogenes* (Whitelegge, 1900). a, shield and cephalic appendages; b, right antennal peduncle, lateral; c, left cheliped; d, right 2nd pereopod, lateral; e, right 3rd pereopod, lateral; f, dactyl of same, mesial; g, propodus and dactyl of male left 4th pereopod, lateral; h, propodus and dactyl of female left 4th pereopod, lateral; i, left male 1st gonopod, mesial; j, left male 2nd gonopod, anterior; k, telson. Scales = 2 mm (a), 1 mm (b,g,i-k), 3 mm (c-f), and 0.5 mm (h). (New South Wales: a-g,i-k, male [SL 8.1 mm], AM P39441; h, female [SL 4.0 mm], AM P40389).

dorsolateral margin well delimited by row of blunt to sharp spines, mesial face rounded. Left cheliped (Fig. 24c) with dorsolateral face of carpus frequently weakly calcified; chela with dorsomesial row of few small spines; carpus with irregular row of small spines dorsally. Ambulatory legs (Fig. 24d–f) reaching to tip of right cheliped, unarmed except for dorsodistal spine on carpus; dactyls approximately 1.8 times as long as propodus, each with ventromesial row of about 8 to 14 corneous spines. Anterior lobe of sternite of 3rd pereopods unarmed, or rarely with small blunt marginal spine. Fourth pereopod (Fig. 24g,h) with dactyl terminating in sharp corneous claw (longer and more slender in females than in males); propodal rasp consisting of 1 row of rounded scales. Uropods and telson markedly asymmetrical; telson (Fig. 24k) with weak transverse suture; dorsal surface usually with low, blister-like tubercles; posterior lobes separated by narrow cleft, terminal margin of lobes armed with numerous corneous spines (often strongly curved on left lobe). Male 1st gonopods (Fig. 24l) each with concave distal lobe; 2nd gonopods (Fig. 24j) each with distal segment setose on distomesial face, and row of short bristle-like setae on lateral margin. Females occasionally with paired 1st pleopods; with vestigial 2nd right pleopod.

Distribution. Western Pacific: Japan; China Sea; and Australia. Depth: 40 to 695 m.

Colour. In fresh specimens, general colour orange or reddish (in preservative, colour fades to cream white except on chelipeds where patterns remain for considerable time). Chelipeds with fingers cream white; dorsal surface of carpus and chela orange or reddish, iridescent, fading to white laterally. Walking legs orange or reddish, fading to cream white towards the dactyls. Carpi of chelipeds and walking legs each with dark red band proximally. Merus of right cheliped with dark red stripe dorsomesially. Carapace and chelae with small, scattered red spots.

Affinities. *Paragiopagurus diogenes* most closely resembles two species recently described from French Polynesia (as *Sympagurus*), *P. bougainvillei* (Lemaitre, 1994), and *P. wallisi* (Lemaitre, 1994). *Paragiopagurus diogenes* can be separated readily from those two species by differences in coloration, or in the absence of colour, by the weaker armature of the carpus and chela of the right cheliped in *P. diogenes* than in the two from French Polynesia.

Remarks. Whitelegge (1900: 177), in his description of *Sympagurus diogenes*, listed an "adult female" and a "young male" (AM G2379, G2380). He included measurements for one specimen without indicating sex; obviously they correspond to the female which is larger in size. While examining type material deposited in the Australian Museum, however, an additional male specimen was found labelled "co-type" (dry, and

catalogued under the same number as the other male, AM G2380). This dry male specimen was collected at the same date and locality as the male listed by Whitelegge (see Springthorpe & Lowry, 1994). In order to avoid any potential confusion, and considering that Whitelegge's species is the type of *Paragiopagurus* n.gen., a lectotype is herein selected for Whitelegge's taxon.

The female used by Whitelegge (1900) has paired 1st pleopods. It is not uncommon for this condition to occur in some female individuals of other parapagurid species, such as *Sympagurus pictus* Smith, 1883, and *S. dimorphus* (see Lemaitre, 1989). Whitelegge's (1900: pl. 34, fig. 3) photograph was evidently reversed during the printing process as it shows the larger cheliped on the left side rather than on the right.

Hale (1941) considered Whitelegge's (1900) *Sympagurus diogenes* (= *Paragiopagurus diogenes* [Whitelegge, 1900]) a subspecies of *S. arcuatus*, based on the dense pilosity of the right cheliped that he (Hale) observed in specimens from Tasmania and Macquarie Island. The surface of the chelipeds in *Paragiopagurus diogenes* is glabrous, at most with only scattered setae. Although Hale did not give any other information on his specimens, and they have not been available for examination, it is clear that they are not of *P. diogenes*, and instead represent some other undetermined species.

This species is among the most common parapagurids in Australian waters, and is frequently found in depths less than 100 m.

Paragiopagurus acutus (De Saint Laurent, 1972)

Figs 25, 26

Parapagurus acutus acutus De Saint Laurent, 1972: 113, figs 7, 18 (type locality: Philippines, *Albatross* sta. 5222).
Sympagurus acutus acutus.—Lemaitre, 1989: 37.—Lemaitre, 1994: 412.

Holotype. Male (SL 5.6 mm), Philippines, 9.2 mi (17 km) NW of W San Andreas Is., between Marinduque and Luzon, *Albatross* sta. 5222, 13°38'30"N, 121°42'45"E, 357 m, 24 Apr 1908, USNM 168309.

Australian Material. WESTERN AUSTRALIA: 1 male (SL 4.6 mm), NW of Leveque, FRV *Soela*, sta. 01/84/065, 14°49.0'S, 121°36.1'E, 302–300 m, 12 Feb 1984, coll. S. Slack-Smith, WAM 1239–86.

Other material. (For meaning of asterisks see Materials and Methods). JAPAN: 1 male (SL 6.1 mm), Honshu, Uruga Strait, *Albatross* sta. 5094, 35°04'42"N, 139°38'20"E, 161 m, 26 Oct 1906, USNM 168973*.

PHILIPPINES: 14 males (SL 3.4–6.0 mm), 9 females (SL 2.8–4.8 mm), Verde Is. Passage, off Matocot Point, *Albatross* sta. 5268, 13°42'N, 120°57'15"E, 311 m, 8 Jun 1908, USNM 168980*. 7 males (SL 2.1–3.5 mm), between Cebu and Bohol, off Lauis

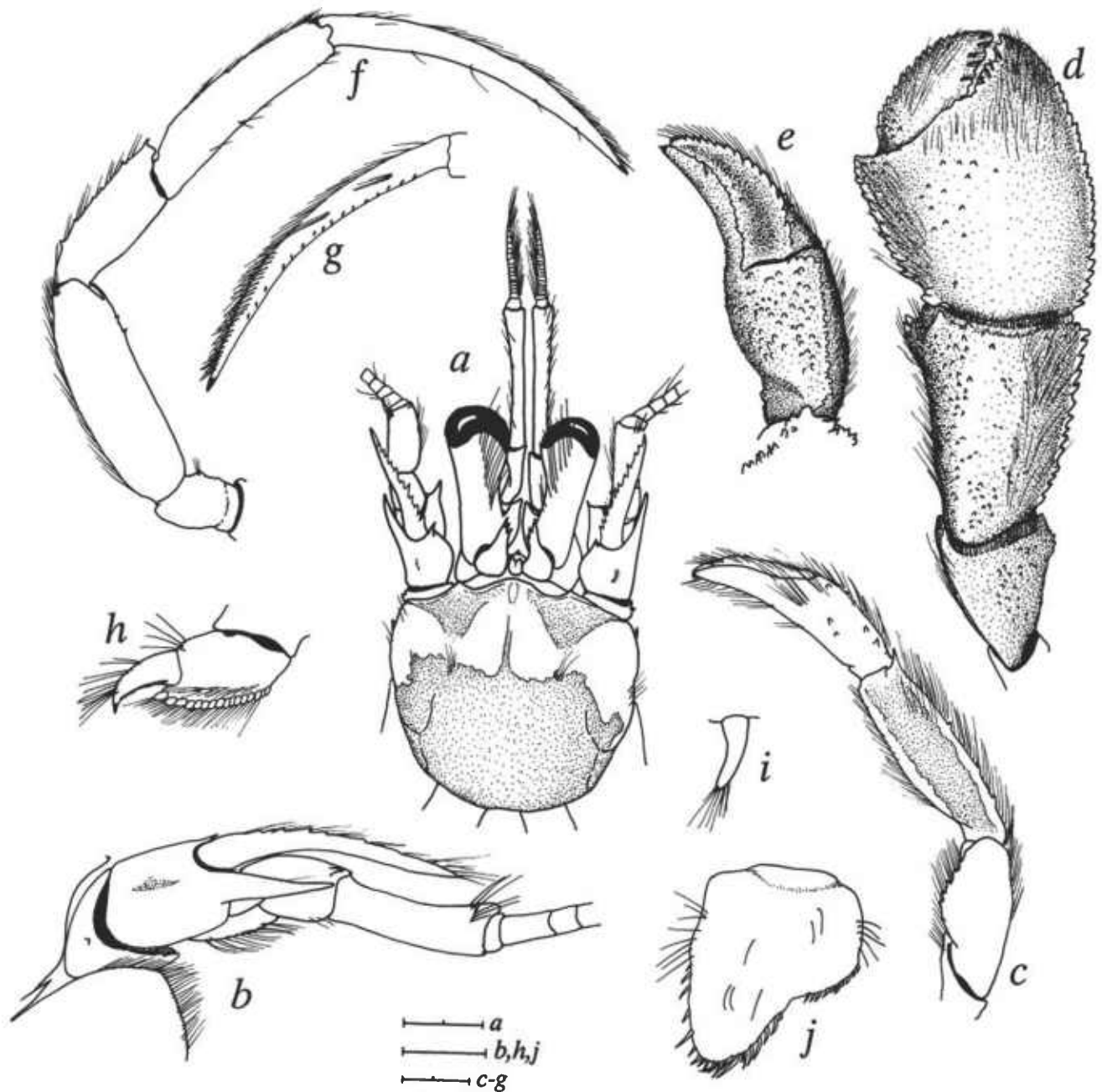


Fig. 25. *Paragiopagurus acutus* (De Saint Laurent, 1972), holotype male (SL 5.6 mm), Philippines, USNM 168309: a, shield and cephalic appendages; b, right antennal peduncle, lateral; c, left cheliped, dorsolateral; d, right cheliped; e, chela of same, mesial; f, right 2nd pereopod, lateral; g, dactyl of same, mesial; h, propodus and dactyl of left 4th pereopod, lateral; i, left 2nd pleopod, lateral; j, telson. Scales = 2 mm (a,c-g), and 1 mm (b,h,j).

Point, *Albatross* sta. 5412, 10°09'15"N, 123°52'E, 296 m, 23 Mar 1909, USNM 168977*. 2 males (SL 2.7, 3.2 mm), between Cebu and Bohol, off Luis Point, *Albatross* sta. 5411, 10°10'30"N, 123°51'15"E, 265 m, 23 Mar 1909, USNM 168976*. 2 males (SL 4.2, 4.8 mm), Verde Is. Passage, off Matocot Point, *Albatross* sta. 5297, 13°41'20"N, 120°58'E, 362 m, 24 Jul 1908, USNM 168975*. 1 female (SL 4.1 mm), Verde Is. Passage, off Matocot Point, *Albatross* sta. 5269, 13°39'50"N, 120°59'30"E, 402 m, 8 Jun 1908, USNM 168974*.

INDONESIA: 1 male (SL 5.2 mm), Borneo, Darvel Bay, off Sibutu Is., *Albatross* sta. 5579, 04°54'15"N, 119°09'52"E, 320 m, 25 Sep 1909, USNM 168978*. 1 female (SL 6.4 mm), Borneo, Sibuko Bay, off Silungan Is., *Albatross* sta. 5592, 04°12'44"N, 118°27'44"E, 558 m, 29 Sep 1909, USNM 168979*. 1 female (SL 5.8 mm), Den danske Kei Ekspd. 1922, sta. 59, 05°28'S, 132°36'E, 385 m, 12 May 1922, ZMK. 4 males (SL 3.3–7.4 mm), Den danske Kei Ekspd. 1922, sta. 44, 05°39'S, 132°23'E, 268 m, 30 Apr 1922, ZMK. 1 male

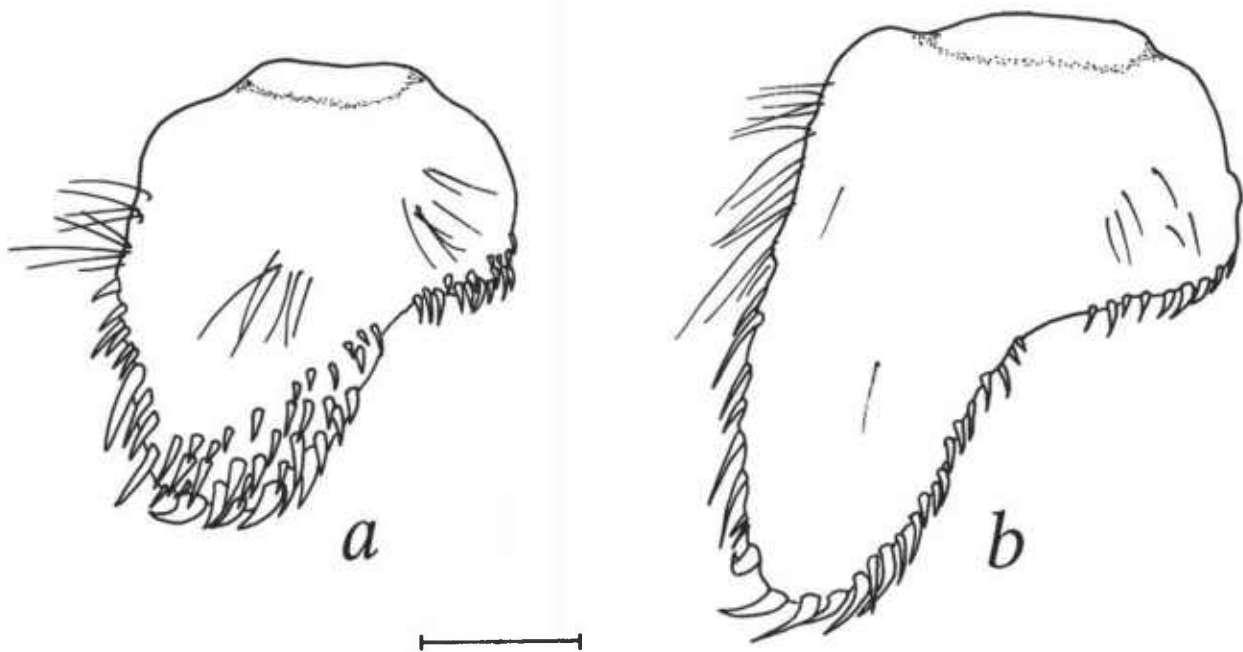


Fig. 26. Telsons of *Paragiopagurus acutus* (De Saint Laurent, 1972). Paratypes, Indonesia, ZMK: a, female (SL 6.8 mm); b, male (SL 8.0 mm). Scale = 1 mm.

(SL 6.7 mm), Den danske Kei Eksp. 1922, sta. 51, 05°40'10"S, 132°21'E, 263 m, 3 May 1922, ZMK. 3 males (SL 2.1–8.0 mm), 2 females (SL 2.0, 3.3 mm), 4 females ovig. (SL 2.6–6.8 mm), Th. Mortensen's Java-S. Afrika Exp. 1929–30, sta. 7, 08°29'S, 114°40'E, 200 m, 5 Apr 1929, ZMK*.

Diagnosis. Phyllobranchiate gills. Shield (Fig. 25a) as long as broad; dorsal surface weakly calcified medially; rostrum broadly rounded, with low dorsal ridge; anterior margins weakly concave; lateral projections subtriangular, terminating in small spine; ventrolateral margin with spine (not always visible in dorsal view); posterior margin broadly rounded. Ocular peduncles more than half length of shield; ocular acicles subtriangular, terminating in strong multifid spine; corneae slightly dilated. Maxillule with internal lobe of endopod bearing 4 long setae. Sternite of 3rd maxillipeds with small spine on each side of midline. Epistomial spine straight. Antennular peduncle exceeding distal margin of corneae by 0.75 length of ultimate segment. Antennal peduncle (Fig. 25b) reaching distal margin of cornea; 2nd segment with dorsolateral distal angle produced, terminating in strong simple spine reaching to midpoint of antennal acicle; acicles reaching distal margin of corneae, mesial margin with 9 to 14 spines; flagellum with short and long setae < 1 to 4 flagellar articles in length respectively. Chelipeds markedly dissimilar, with moderately dense setae. Right cheliped (Fig. 25d,e) with palm broader than long or about as broad as long in large specimens (SL ca 6.0 mm); fingers curved ventromesially, dactyl

with strongly concave and smooth ventromesial face; dorsal face of palm with scattered small spines or tubercles, ventral face smooth or with small tubercles; palm with dorsolateral and dorsomesial margins each well delimited by row of spines, ventromesial margin rounded, occasionally with row of 2 or 3 blunt spines proximally; carpus with numerous small spines or tubercles on dorsal surface, and well delimited dorsolateral margin with row of spines. Left cheliped (Fig. 25c) usually weakly calcified on lateral face of carpus; carpus with dorsal row of 4 to 6 small, well-spaced spines, and strong dorsodistal spine. Ambulatory legs (Fig. 25f,g) with dactyls having ventromesial row of 7 (3rd pereopod) to 15 (2nd pereopod) small, often minute corneous spines, and dorsal and dorsomesial rows of long setae; carpi each with dorsodistal spine; carpus of 2nd pereopod with dorsal row of 7 small spines. Anterior lobe of sternite of 3rd pereopods setose, armed with 1 spine. Fourth pereopod (Fig. 25h) with propodal rasp consisting of 1 row of ovate scales. Uropods and telson (Figs 25j, 26) markedly asymmetrical; telson lacking transverse suture separating anterior and posterior lobes; posterior lobes separated by shallow U-shaped median cleft, terminal margins armed with often long, curved corneous spines; in large females (SL > 6.0 mm) posterior lobes armed with several rows of corneous spines on distal margin, rows of spines often extending to dorsodistal surface (Fig. 26a). Males lacking 1st gonopods, with unpaired, uniramous 2nd left pleopod (Fig. 25i). Females with vestigial right 2nd pleopod.

Habitat and symbiotic associations. Found in gastropod shells.

Distribution. Western pacific: Philippines, China Sea, Indonesia, Japan, and now Australia. Depth: 161 to 558 m.

Affinities. *Paragiopagurus acutus* is most similar to *P. bicarinatus* and *P. hirsutus*. The former can be separated from *P. bicarinatus* by the shape and armature of the mesial face of the right palm. The mesial face of *P. acutus* is not expanded distally, and the ventromesial margin is rounded; the mesial face of *P. bicarinatus* is expanded distally, and the ventromesial margin is well delimited by a row of spines. *Paragiopagurus acutus* differs from *P. hirsutus* by the armature and setation of the right chela (see Affinities under *P. hirsutus*). Additionally, *P. acutus* reaches a much larger size than *P. bicarinatus* or *P. hirsutus*, and exhibits a stronger degree of sexual dimorphism in the telson (Fig. 26).

Remarks. De Saint Laurent (1972) provisionally proposed three subspecies, *Parapagurus acutus acutus*, *P. a. bicarinatus*, and *P. a. hirsutus*, for specimens that apparently could be differentiated only by the characteristics of the right cheliped. De Saint Laurent did observe that when all specimens of her subspecies were considered, a great range of variability occurred in the relative length of the ocular peduncles, ocular acicles, and the right cheliped. She proposed a subspecific division for the specimens rather than a specific one because of the impossibility she encountered in assigning specimens that were missing the right cheliped. Subsequently, Lemaitre (1989) transferred the subspecies of *P. acutus* to *Sympagurus* (sensu Lemaitre, 1989).

The study of numerous specimens deposited in various museums previously assigned to De Saint Laurent's (1972) three subspecies, and comparisons with recently collected Australian specimens, clearly show that they are sufficiently distinct morphologically to warrant elevation to specific status. Furthermore, their relatively broad sympatric distributions provides additional support for considering them as full species. The three species are quite similar in a number of characters such as the shape of the ocular acicles, left cheliped, telson, and absence of 1st pair of gonopods in males. However, as previously mentioned, they clearly differ by the shape and armature of the right cheliped.

Paragiopagurus bicarinatus (De Saint Laurent, 1972)

Fig. 27

Parapagurus acutus bicarinatus De Saint Laurent, 1972: 113 (type locality: Philippines, *Albatross* sta. 5289).
Sympagurus acutus bicarinatus.—Lemaitre, 1989: 37.—Lemaitre, 1994: 412.

Holotype. Male (SL 5.6 mm), Philippines, southern Luzon, 5 mi (9.2 km) NW Matocot Point, *Albatross* sta. 5289, 13°41'50"N, 120°58'03"E, 315 m, 22 Jul 1908, USNM 168310.

Australian material. NORTHERN TERRITORY: 3 males (SL 4.8–5.8 mm), NW of Collier Bay, FRV *Soela*, 14°16.5'S, 122°36.6'E, 302 m, 14 Feb 1984, coll. S. Slack-Smith, WAM.

QUEENSLAND: 1 male (SL 4.1 mm), off Tully, 16°51.8'S, 147°08'E, epibenthic sledge, ORV *Franklin*, 500 m, 16 May 1986, coll. JCU, QM.

Other material. (For meaning of asterisks see Materials and Methods). SOUTH CHINA SEA: 2 males (SL 4.6, 5.2 mm), near Hong Kong, *Albatross* sta. 5313, 21°30'N, 116°43'E, 274 m, 4 Nov 1908, USNM 168982*.

PHILIPPINES: 7 males (SL 3.1–4.9 mm), 1 female (SL 2.9 mm), Verde Is. Passage, off Matocot Point, *Albatross* sta. 5268, 13°42'N, 120°57'15"E, 311 m, 8 Jun 1908, USNM 168981*. 1 male (SL 3.9 mm), between Leyte and Mindanao, off Botoselo Point, *Albatross* sta. 5486, 10°02'N, 125°19'20"E, 314 m, 22 Jul 1908, 1070 m, USNM 168983*.

Diagnosis. Phyllobranchiate gills. Shield (Fig. 27a) as long as broad; dorsal surface weakly calcified medially; rostrum broadly rounded, with low dorsal ridge; anterior margins weakly concave; lateral projections subtriangular, terminating in small spine; ventrolateral margin with spine (not always visible in dorsal view); posterior margin broadly rounded. Ocular peduncles more than half length of shield; ocular acicles subtriangular, terminating in strong multifid spine; corneae slightly dilated. Maxillule with internal lobe of endopod bearing 4 long setae. Sternite of 3rd maxillipeds with small spine on each side of midline. Epistomial spine straight. Antennular peduncle exceeding distal margin of corneae by 0.75 length of ultimate segment. Antennal peduncle (Fig. 27b) reaching distal margin of cornea; 2nd segment with dorsolateral distal angle produced, terminating in strong simple spine reaching to midpoint of antennal acicle; acicles reaching distal margin of corneae, mesial margin with 10 to 13 spines; flagellum with short and long setae < 1 to 4 flagellar articles in length respectively. Chelipeds markedly dissimilar, with moderately dense setae. Right cheliped (Fig. 27d,e) with palm broader than long, fingers curved ventromesially, dactyl with concave ventromesial face; dorsal face of palm with numerous small spines or tubercles, ventral face smooth or with scattered small tubercles; palm with dorsolateral, dorsomesial, and ventromesial margins each well delimited by row of strong spines, and ventromesial face expanded distally; carpus with numerous small tubercles or spines on dorsal surface, and well delimited dorsolateral margin with row of spines. Left cheliped (Fig. 27d) with lateral face of carpus usually weakly calcified; carpus with dorsal row of 6 to 15 small spines, and strong dorsodistal spine. Ambulatory legs (Fig. 27f–h) with dactyls having ventromesial row of 3 or 4 small corneous

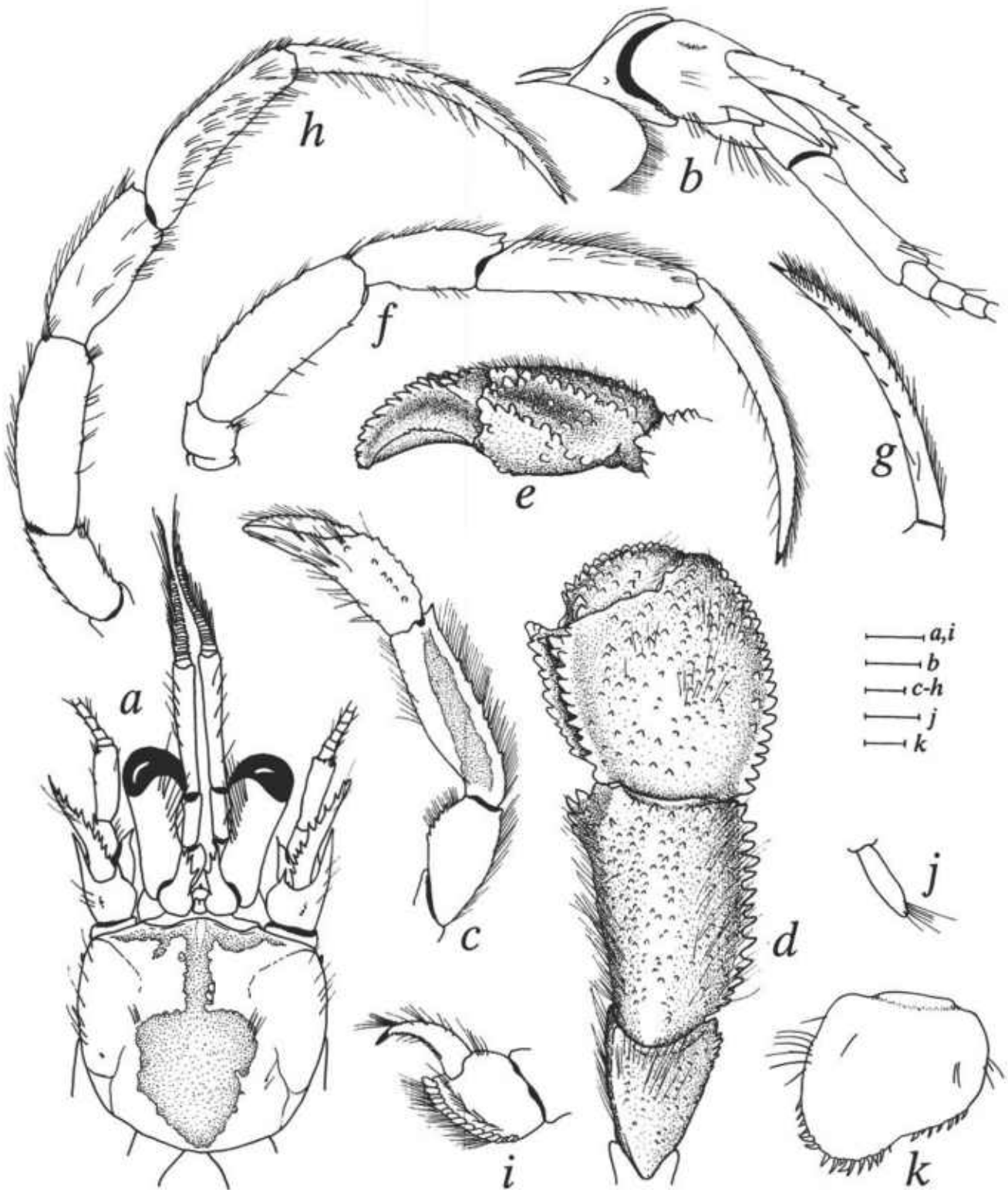


Fig. 27. *Paragiopagurus bicarinatus* (De Saint Laurent, 1972), male (SL 4.1 mm), Queensland, QM. a, shield and cephalic appendages; b, right antennal peduncle, lateral; c, left cheliped, dorsolateral; d, right cheliped; e, chela of same, mesial; f, right 2nd pereopod, lateral; g, dactyl of same, mesial; h, right 3rd pereopod, lateral; i, propodus and dactyl of left 4th pereopod, lateral; j, left 2nd pleopod, lateral; k, telson. Scales = 1 mm (a,c-h), and 0.5 mm (b,i-k).

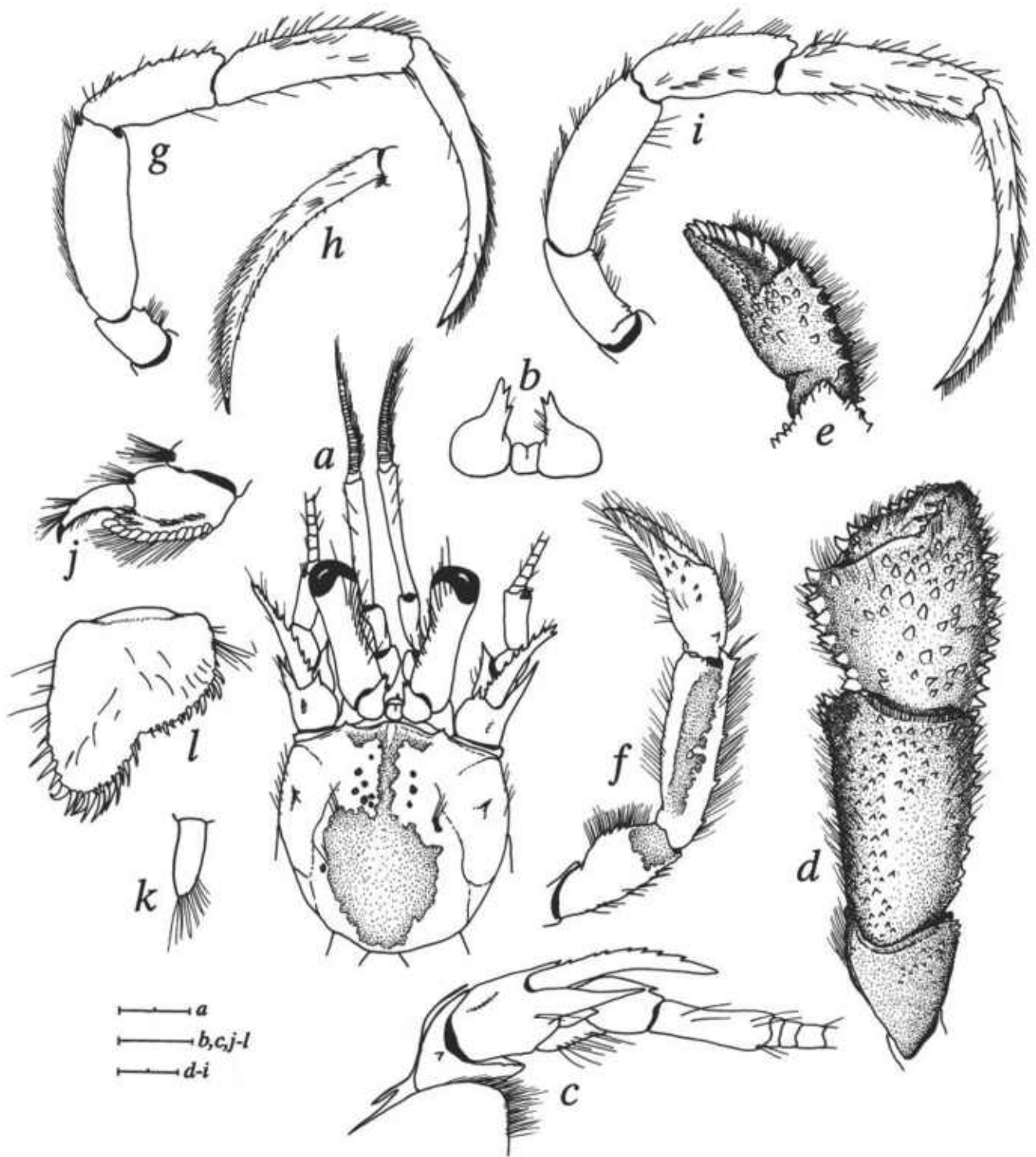


Fig. 28. *Paragiopagurus hirsutus* (De Saint Laurent, 1972), male (SL 6.1 mm), Queensland, QM. a, shield and cephalic appendages; b, ocular acicles, dorsal; c, right antennal peduncle, lateral; d, right cheliped (setae partially omitted); e, chela of same, mesial; f, left cheliped, dorsolateral (setae partially omitted); g, right 2nd pereopod, lateral; h, dactyl of same, mesial; i, right 3rd pereopod, lateral; j, propodus and dactyl of left 4th pereopod, lateral; k, left 2nd pleopod, lateral; l, telson. Scales = 2 mm (a), 1 mm (b,c,j-l), and 2 mm (d-i).

spines, and dorsal and dorsomesial rows of long setae; carpi each with small dorsodistal spine; carpus of 2nd pereopod with 2 small dorsal spines (spines sometimes obsolete). Anterior lobe of sternite of 3rd pereopods setose, armed with 1 marginal spine. Fourth pereopod (Fig. 27i) with propodal rasp consisting of 1 row of ovate scales. Uropods and telson (Fig. 27k) markedly asymmetrical; telson lacking transverse suture separating anterior and posterior lobes; posterior lobes separated by shallow U-shaped median cleft, terminal margins armed with often long, curved corneous spines. Males lacking 1st gonopods, with unpaired, uniramous 2nd left pleopod (Fig. 27j). Female with vestigial right 2nd pleopod.

Habitat and symbiotic associations. Found in gastropod shells.

Distribution. Western Pacific: Philippines, and Australia. Depth: 274 to 1070 m.

Affinities. *Paragiopagurus bicarinatus* closely resembles *P. acutus* and *P. hirsutus*. In the former, the mesial face of the right palm is expanded distally, and has a dorsomesial and a ventromesial row of spines. In both *P. acutus* and *P. hirsutus* the mesial face is not expanded distally, and the ventromesial face is rounded and lacks a row of spines.

Remarks. As previously mentioned, *Sympagurus acutus bicarinatus* (De Saint Laurent, 1972), is herein elevated to specific rank (see remarks under *Paragiopagurus acutus*).

Paragiopagurus hirsutus (De Saint Laurent, 1972)

Fig. 28

Paragiopagurus acutus hirsutus De Saint Laurent, 1972: 113, fig. 19 (type locality: Japan, Tosa Bay).

Sympagurus acutus hirsutus.—Lemaitre, 1989: 37.—Lemaitre, 1994: 412.

Holotype. Male, Japan, Tosa Bay, Nov 1963, coll. K. Sakai (not seen).

Australian material. WESTERN AUSTRALIA: 1 male (SL 5.0 mm), NW of Collier Bay, FRV *Soela*, 14°16.5'S, 122°36.6'E, 302 m, 14 Feb 1984, coll. S. Slack-Smith, WAM.

QUEENSLAND: 2 males (SL 4.0, 6.1 mm), 1 female ovig. (SL 3.6 mm), off Tully, 16°51.8'S, 147°08'E, epibenthic sledge, ORV *Franklin*, 500 m, 16 May 1986, coll. JCU, QM. 1 female (SL 4.1 mm), 1 female ovig. (SL 4.0 mm), off Tully, 17°51.3'S, 147°07.8'E, trawled, ORV *Franklin*, 505 m, 17 May 1986, coll. JCU, QM.

Other material. (For meaning of asterisks see Materials and Methods). SOUTHWESTERN INDIAN OCEAN?: 1 female (SL 5.6 mm), off Durban, 73 m, NMV J16205 (see remarks).

SOUTH CHINA SEA: 2 (dismembered, sex indet.), near Hong Kong, *Albatross*, sta. 5314, 21°41'N, 116°46'E, 223 m, 5 Nov 1908, USNM 168988*. 7 males (SL 4.4–6.3 mm), near Hong Kong, *Albatross*, sta. 5313, 21°30'N, 116°43'E, 274 m, 4 Nov 1908, USNM 168987*.

PHILIPPINES: 4 males (SL 6.8–7.2 mm), 1 female (SL 5.7 mm), N Luzon, off Hermanas Is., *Albatross*, sta. 5325, 18°34'15"N, 121°51'15"E, 410 m, 12 Nov 1908, USNM 168989*. 2 males (SL 4.0, 5.8 mm), Verde Is. Passage, off Matocot Point, *Albatross*, sta. 5268, 13°42'N, 120°57'E, 311 m, 8 Jun 1908, USNM 168984*. 3 males (SL 4.7–5.3 mm), 3 females (SL 4.8–5.8 mm), 2 (dismembered, sex indet.), Verde Is. Passage, off Matocot Point, *Albatross*, sta. 5289, 13°41'50"N, 120°58'30"E, 315 m, 22 Jul 1908, USNM 168985*. 1 male (SL 5.4 mm), Verde Is. Passage, off Matocot Point, *Albatross*, sta. 5297, 13°41'20"N, 120°58'E, 362 m, 24 Jul 1908, USNM 168986*.

NEW ZEALAND: 1 female ovig. (SL 8.8 mm), Wanganella Bank, Norfolk Ridge, E slope, RV *Tangaroa*, NZOI sta. 0.634, BS 888, 32°40.2'S, 167°39.0'E, 487–357 m, 29 Jan 1981, NMNZ Cr 8459.

Diagnosis. Phyllobranchiate gills. Shield (Fig. 28a) as long as broad; dorsal surface weakly calcified medially; rostrum broadly rounded, with low dorsal ridge; anterior margins weakly concave; lateral projections subtriangular, terminating in small spine; ventrolateral margin with spine (not always visible in dorsal view); posterior margin broadly rounded. Ocular peduncles more than half length of shield; ocular acicles (Fig. 28b) subtriangular, terminating in strong multifid spine (rarely simple on one side); corneae slightly dilated. Maxillule with internal lobe of endopod bearing 3 or 4 long setae. Sternite of 3rd maxillipeds with small spine on each side of midline. Epistomial spine straight, frequently bifid. Antennular peduncle exceeding distal margin of corneae by 0.75 length of ultimate segment. Antennal peduncle (Fig. 28c) reaching distal margin of cornea; 2nd segment with dorsolateral distal angle produced, terminating in strong simple spine reaching to midpoint of antennal acicle; acicles reaching distal margin of corneae, mesial margin with 8 to 13 spines; flagellum with long setae 3 or 4 flagellar articles in length. Chelipeds markedly dissimilar, surfaces with moderately dense setae interspersed with numerous long, stiff setae (shown partially in Fig. 28f,d). Right cheliped (Fig. 28d) with palm broader than long, fingers curved ventromesially, dactyl with longitudinal row of blunt spines on ventral face; dorsal face of palm with strong spines (at least proximomedially), ventral face with numerous tubercles; palm with dorsolateral and dorsomesial margins each well delimited by row of strong spines, and ventromesial face rounded; carpus with numerous small tubercles or spines on dorsal surface. Left cheliped (Fig. 28f) with lateral face of carpus usually weakly calcified; with dorsal row of 2 to 6 small, well-spaced spines, and strong dorsodistal spine on carpus. Ambulatory legs (Fig. 28g–i) with dactyls having ventromesial row of 8 to 13 corneous

spines, and dorsal and dorsomesial rows of long setae; carpi each with small dorsodistal spine; carpus of 2nd pereopod with dorsal margin armed with 1 to 4 small spines. Anterior lobe of sternite of 3rd pereopods setose, armed with 1 or 2 marginal spines. Fourth pereopod (Fig. 28j) with propodal rasp consisting of 1 row of ovate scales. Uropods and telson (Fig. 28l) markedly asymmetrical; telson lacking transverse suture separating anterior and posterior lobes; posterior lobes separated by U-shaped median cleft, terminal margins armed with often long, curved corneous spines. Males lacking 1st gonopods, with unpaired, uniramous 2nd left pleopod (Fig. 28k). Females with vestigial right 2nd pleopod.

Habitat and symbiotic associations. Inhabits gastropod shells.

Distribution. Indo Pacific: China Sea; Philippines; Australia; New Zealand; questionably from off Durban, South Africa (see remarks). Depth: 223 to 505 m.

Affinities. *Paragiopagurus hirsutus* resembles *P. acutus* and *P. bicarinatus*, but can easily be differentiated from those two species by armature and setation of the right chela. In *P. hirsutus* the spines on the dorsal surface of the chela are distinctly stronger and sharper than in *P. acutus* and *P. bicarinatus*; the surface of the right chela has numerous long, stiff setae, whereas those of *P. acutus* and *P. bicarinatus* do not.

Remarks. As previously mentioned, *Sympagurus acutus hirsutus* (De Saint Laurent, 1972) is herein elevated to specific rank (see remarks under *Paragiopagurus acutus*).

A single specimen (NMV J16205) of *Paragiopagurus hirsutus* presumably from off Durban, South Africa, in the western Indian Ocean, was examined. No data is available on when or how this specimen was obtained and deposited in NMV (G.C.B. Poore, pers. comm.). Although this species has not been previously collected outside the western Pacific, it is conceivable that its distribution may include the Indian Ocean. However, until more specimens are found that would confirm such a distribution, the presence of this species in the western Indian Ocean is considered questionable.

***Paragiopagurus boletifer* (De Saint Laurent, 1972)**

Paragiopagurus boletifer De Saint Laurent, 1972: 110, figs 5, 20 (type locality: Japan, Tosa Bay).—Miyake, 1978: 72.—Miyake, 1982: 120, pl. 40, fig. 4.—Baba *et al.*, 1986: 196, fig. 144.

Sympagurus boletifer.—Lemaitre, 1989: 37.—Lemaitre, 1994: 382, figs 5,6, 27a,b, 28b,c.—Poupin, 1994: 51.

Holotype. Male (SL 8.0 mm), Japan, Tosa Bay, 250–300 m, 1963, coll. K. Sakai, MNHN Pg2230.

Australian material. 1 male (SL 5.2 mm), Britannia Sea Mount, Western Tasman Sea, ORV *Franklin*, sta. 0589–47, 28°17.47'S, 158°37.89'E, 419 m, 10 May 1989, colls. J.K. Lowry *et al.*, AM P39447.

Diagnosis. Phyllobranchiate or intermediate gills. Shield as long as broad; dorsal surface usually weakly calcified on half or more of surface; rostrum broadly rounded, with low dorsal ridge; anterior margins straight; lateral projections broadly subtriangular, terminating in spine; posterior margin broadly rounded. Ocular peduncles more than half length of shield; ocular acicles subtriangular, terminating in strong spine; corneae slightly dilated. Sternite of third maxillipeds with small spine on each side of midline. Epistomial spine short, straight. Antennular peduncle exceeding distal margin of corneae by length of penultimate segment. Antennal peduncle at most reaching distal margin of cornea; 3rd segment with strong ventromesial distal spine; 2nd segment with dorsolateral distal angle produced, terminating in multifid spine (occasionally with additional small spine dorsally); acicles reaching distal margin of corneae, mesial margin armed with 11 to 14 spines; flagellum with setae arranged in series of long (4–8 articles in length) and short (about 1 article in length) setae about every 15–20 articles. Chelipeds strongly dissimilar. Right cheliped massive, operculate; chela about as broad as long, dorsal surface covered with numerous spines and dense plumose setae (especially on distal half and fingers); fingers curved ventromesially; ventral face of palm and fingers covered with numerous mushroom-like tubercles; palm with dorsolateral margin well delimited by row of spines; carpus with numerous small tubercles or spines on dorsal surface. Left cheliped usually well calcified; palm with dorsomesial row of small tubercles; carpus with dorsodistal spine. Ambulatory legs reaching to tip of extended right cheliped; dactyl about twice as long as propodus, with ventromesial row of about 12 corneous spines, and dorsal and dorsomesial rows of long bristle-like setae; carpus with small dorsodistal spine. Anterior lobe of sternite of 3rd pereopods armed with marginal spine. Fourth pereopod with dactyl terminating in corneous claw (more slender and longer in females than in males); propodal rasp consisting of 1 row of ovate scales. Telson and uropods strongly asymmetrical; telson with weak transverse suture separating anterior and posterior lobes; posterior lobes separated by V-shaped median cleft, terminal margins armed with corneous spines (often strongly curved on left lobe). Male 1st gonopods with concave distal lobe; 2nd gonopods each with distal segment nearly flat. Female with vestigial right second pleopod.

Colour. Shield cream yellow tinged with orange. Ocular peduncles, antennular and antennal peduncles pale yellow; antennular flagella pale purple. Left cheliped and second to fifth pereopods uniformly pale purple. Chela and carpus of right cheliped with dorsal and ventral surface orange-reddish, with white mushroom-

like tubercles or spines; merus whitish with tinge of pale orange distally (Lemaitre, 1994: 384).

Distribution. Indo Pacific: Comoro Islands; Japan; Australia; Hawaii; and French Polynesia. Depth: 85 to 419 m.

Paragiopagurus ruticheles (A. Milne Edwards, 1891)

Eupagurus ruticheles A. Milne Edwards, 1891: 133 (type locality: near Graciosa, Azores, *L'Hirondelle*, sta. 234, 39°01'40"N, 30°15'40"W, 454 m).

Parapagurus ruticheles.—De Saint Laurent, 1972: 112.

Sympagurus ruticheles.—Lemaitre, 1989: 37.—Lemaitre, 1990: 235, figs 11, 12.—Lemaitre, 1994: 412.

Type material. SYNTYPES: 2 males (SL 3.6–5.9 mm), 1 female ovig. (SL 3.2 mm), near Graciosa, Azores [Atlantic Ocean], *L'Hirondelle*, sta. 234, 39°01'40"N, 30°15'40"W, 454 m, 19 Aug 1888, MO.

Australian material. 1 male (SL 3.8 mm), Britannia Sea Mount, Western Tasman Sea, ORV *Franklin*, sta. 0589–47, 28°17.47'S, 158°37.89'E, 419 m, 10 May 1989, colls. J.K. Lowry *et al.*, AM P44473

Diagnosis. Phyllobranchiate gills. Shield about as broad as long, dorsal surface usually weakly calcified medially; rostrum broadly rounded, with short dorsal ridge; lateral projections subtriangular, with small terminal spine; ventrolateral margin with small spine (often lacking on one side). Ocular peduncles more than half length of shield; acicles terminating in strong spine; corneae dilated. Antennular peduncles exceeding distal margin of corneae by slightly less than length of ultimate segment. Antennal peduncles not exceeding distal margin of corneae; acicles not exceeding distal margin of corneae, mesial margin armed with 7 to 14 spines. Sternite of 3rd maxilliped with spine on each side of midline. Epistomial spine straight, occasionally bifid. Right cheliped elongate, with transverse furrows on ventral surfaces of chela and ventrolateral face of carpus; palm with well delimited dorsomesial, ventromesial and dorsolateral margins each armed with spines (usually having corneous tips), and concave mesial face often expanded distally; carpus with well delimited dorsolateral margin armed with corneous-tipped spines. Left cheliped weakly calcified on merus and carpus; unarmed except for scattered small spines on dorsal surface of palm and dorsal margin of carpus. Ambulatory legs with dactyls each having dorsal and distal dorsomesial row of setae, and ventromesial row of about 13 spinules; merus of right 3rd pereopod usually with dorsal row of small spines. Anterior lobe of sternite of 3rd pereopods unarmed. Fourth pereopod with strongly curved dactyl;

propodal rasp consisting of 1 row of ovate scales. Uropods and telson strongly asymmetrical; telson with transverse suture separating anterior and posterior lobes; posterior lobes separated by shallow median cleft, terminal margins armed with strong often curved corneous spines. Males lacking 1st pleopods; with unpaired, uniramous 2nd left pleopod. Females with unpaired left 2nd pleopod (lacking right vestigial 2nd pleopod).

Distribution. Central and western Pacific: Hawaiian Islands; and Australia. Eastern Atlantic: Portugal to Senegal. Depth: 200 to 1440 m.

Distribution

With our still limited knowledge of the parapagurid fauna from many areas of the Pacific and Indian Oceans, it is difficult to generalise as to the distributional patterns of species or groups of species. In Australia, parapagurids from the western, northern and southeastern shelf, and continental slope areas, now seem reasonably well sampled. However, those from the southern region, in particular the Great Australian Bight, still remain to be studied.

Of the 18 species treated in this study, eight are broadly distributed in the Indo Pacific region, and are found from the western Indian Ocean to at least as far east as Australia, *Sympagurus brevipes*, *S. papposus* n.sp., *S. trispinosus*, *Oncopagurus indicus*, *O. monstrosus*, *O. minutus*, *Paragiopagurus hirsutus*, and *P. boletifer*. Three of these eight are known to occur further to the east, *Paragiopagurus hirsutus*, in New Zealand, and *P. boletifer* and *S. trispinosus*, in French Polynesia. Of the species that occur in Australia, five are distributed exclusively in the western Pacific, *Strobopagurus sibogae*, *Sympagurus planimanus*, *P. acutus*, *P. bicarinatus*, and *P. diogenes*; five occur also in Japan, *Strobopagurus sibogae*, *O. monstrosus*, *P. acutus*, *P. diogenes*, and *P. boletifer*; and one in Hawaii, *P. boletifer*. One species, *Sympagurus dimorphus*, is distributed only in the cold-temperate regions of the southern hemisphere (south of 22°S, but in the Atlantic possibly as far north as 9°S). Of the new species discovered during this study, three have so far been found only in Australia, *S. soela* n.sp. and *O. cidaris* n.sp., from Queensland and New South Wales; and *S. villosus* n.sp., from Queensland. One species, *P. ruticheles*, has a broad, disjunct distribution, known from elsewhere in the Pacific only from Hawaii, but also occurs in the eastern Atlantic. Only two species, *S. dimorphus* and *P. hirsutus*, are so far known from New Zealand.

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