

A new genus of Parapaguridae (Decapoda: Anomura)

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Abstract. — A new monotypic genus, *Bivalvopagurus*, is described for *Sympagurus sinensis* (de Saint Laurent), a species of Parapaguridae known so far only from the China Sea. The new genus is distinguished from other genera in the family by the presence of paired pleopods in both sexes, calcification of the shield, posterior carapace, and tergites of the first two abdominal somites, and symmetry of the uropods and telson. The only species in the new genus commonly uses a bivalve shell with an actinian as means of partially protecting its abdomen. This species is redescribed and illustrated, and some evolutionary comments are made.

Introduction

Among the species assigned by Lemaitre (1989: 37) to the heterogeneous genus *Sympagurus* Smith, 1883, was *Parapagurus sinensis*, a species briefly described by de Saint Laurent (1972) based on two specimens from the China Sea. The assignment was made based exclusively on the information contained in de Saint Laurent's description of this species. A recent examination of the types as well as additional material of this species has brought to light two significant characters not mentioned in de Saint Laurent's original description: the presence of paired pleopods in both sexes, and the symmetry of the uropods and telson. These characters, together with the degree of calcification of the shield, posterior carapace and tergites of the first and second abdominal somites, clearly exclude this species from *Sympagurus* or any other genus of Parapaguridae. Therefore, *S. sinensis* is herein

removed from *Sympagurus* and placed in *Bivalvopagurus*, new genus. The new genus is diagnosed and its only species redescribed and illustrated.

The material used for this study remains deposited in the Muséum national d'Histoire naturelle, Paris (MNHN), and at the National Museum of Natural History, Smithsonian Institution, Washington, D. C. (USNM). The following abbreviations are used: SL, length of shield (to the nearest 0.1 mm), measured from the tip of the rostrum to the midpoint of the posterior margin of the shield; and MUSORSTOM, expedition of the MNHN and the office de la Recherche Scientifique et Technique Outre-Mer.

Systematic Account

Family Parapaguridae Smith, 1882

Bivalvopagurus new genus

Diagnosis. — Shield distinctly broader than long, well calcified. Eystalks stout. Posterior carapace short (less than length of shield), broad, densely setose, calcified. Antennal peduncles and acicles overreaching eystalks; flagellum dorsoventrally flattened; fourth segment armed with dorsodistal spine. Epistomial spine absent. Eleven pairs of phyllobranchiae or intermediate branchiae. Right cheliped elongate; palm rounded mesially, with weakly delimited dorsolateral margin. Left cheliped evenly calcified. Ambulatory legs (second and third pereopods) long, well exceeding extended right cheliped; dactyls nearly straight. Abdomen very short in relation to cephalothorax; tergites of first and second somites well calcified; second

somite with left pleuron terminating ventrally in small subtriangular lobe. Telson and uropods symmetrical. Males with paired symmetrical first and second pleopods, and paired asymmetrical third to fifth pleopods; first and second modified as gonopods, first with subtriangular distal lobe, second with short exopod and strongly twisted distal segment; third to fifth pleopods biramous on left side, uniramous and reduced on right side. Females with paired asymmetrical second to fifth pleopods, biramous on left side (rami crossed on second to fourth), uniramous and reduced on right side.

Type species. — *Parapagurus sinensis* de Saint Laurent, 1972.

Etymology. — A compound name using the mollusk class Bivalvia, in reference to the common usage of a bivalve shell to shield its abdomen by the only species in the genus. Gender: masculine.

Remarks. — This new genus is most closely allied to *Strobopagurus* Lemaitre, 1989. The two genera share a number of characters: a broad shield, flattened antennular flagella, slender chelipeds, straight dactyls of the ambulatory legs, and shape of the first and second pleopods in the males. The pattern of lines and sulci on the posterior carapace is also similar in both genera, although in *Bivalvopagurus* they are more marked. However, in several important characters, *Bivalvopagurus* is clearly distinct from *Strobopagurus*. In *Bivalvopagurus*, the shield, posterior carapace, and tergites of the first and second abdominal somites, are well calcified. In contrast, in *Strobopagurus* the shield is weakly calcified, and the posterior carapace and abdominal tergites are soft, uncalcified. In the new genus, the rostrum and lateral projections of the shield are considerably more developed than in *Strobopagurus*. In *Bivalvopagurus* the pleopods are paired in both sexes, and the telson and uropods are symmetrical, whereas in *Strobopagurus* only the first and sec-

ond pleopods in the males and the second in the females, are paired, and the telson and uropods are asymmetrical. Additionally, the only species in *Bivalvopagurus*, *B. sinensis*, most commonly uses a bivalve shell with an actinian to protect its very short abdomen, whereas species of *Strobopagurus* use gastropod shells.

Bivalvopagurus sinensis

(de Saint Laurent, 1972)

Figs. 1-4

Parapagurus sinensis de Saint Laurent, 1972: 116, figs. 12, 24.

Sympagurus sinensis: Lemaitre, 1989: 37.

Type material. — ♂ holotype (SL 9.0 mm), MNHN Pg. 1238; ♂ paratype (SL 7.3 mm), MNHN Pg. 2239; Fisheries Research Station Hong Kong, Cruise 7, Station 55, Transect 172, 16°19.3'N, 114°29'E, 220 m, [no date].

Additional material. — Philippines, MUSORSTOM, Station 50, 25 March 1976, 13°49.2'N, 120°01.8'E, 415-510 m: 2 ♂ (SL 9.7, 10.3 mm), 1 ♀ (SL 9.7 mm), 1 ovig. ♀ (SL 10.5 mm), USNM 265139; 61 ♂ (SL 7.0-12.0 mm), 17 ♀ (SL 5.5-9.0 mm), 56 ovig. ♀ (SL 6.5-9.5 mm), MNHN.

Redescription. — Shield (Fig. 1a, b) approximately 1.3 times as broad as long, evenly calcified. Dorsal surface strongly convex, densely covered with fine setae. Rostrum bluntly subtriangular, with low dorsal ridge. Anterior margins straight. Lateral projections broadly subtriangular, with small terminal spine and 1 or 2 small spines lateral to terminal spine. Anterolateral margins slightly sloping, often with small spine medially on one side. Lateral margins subparallel at least on anterior 1/2, with setose lobe posteriorly. Posterior margin broadly rounded. Posterior carapace shorter than shield, densely covered with fine setae (setae longer on branchiostegite); cardiac sulcus extending to poste-

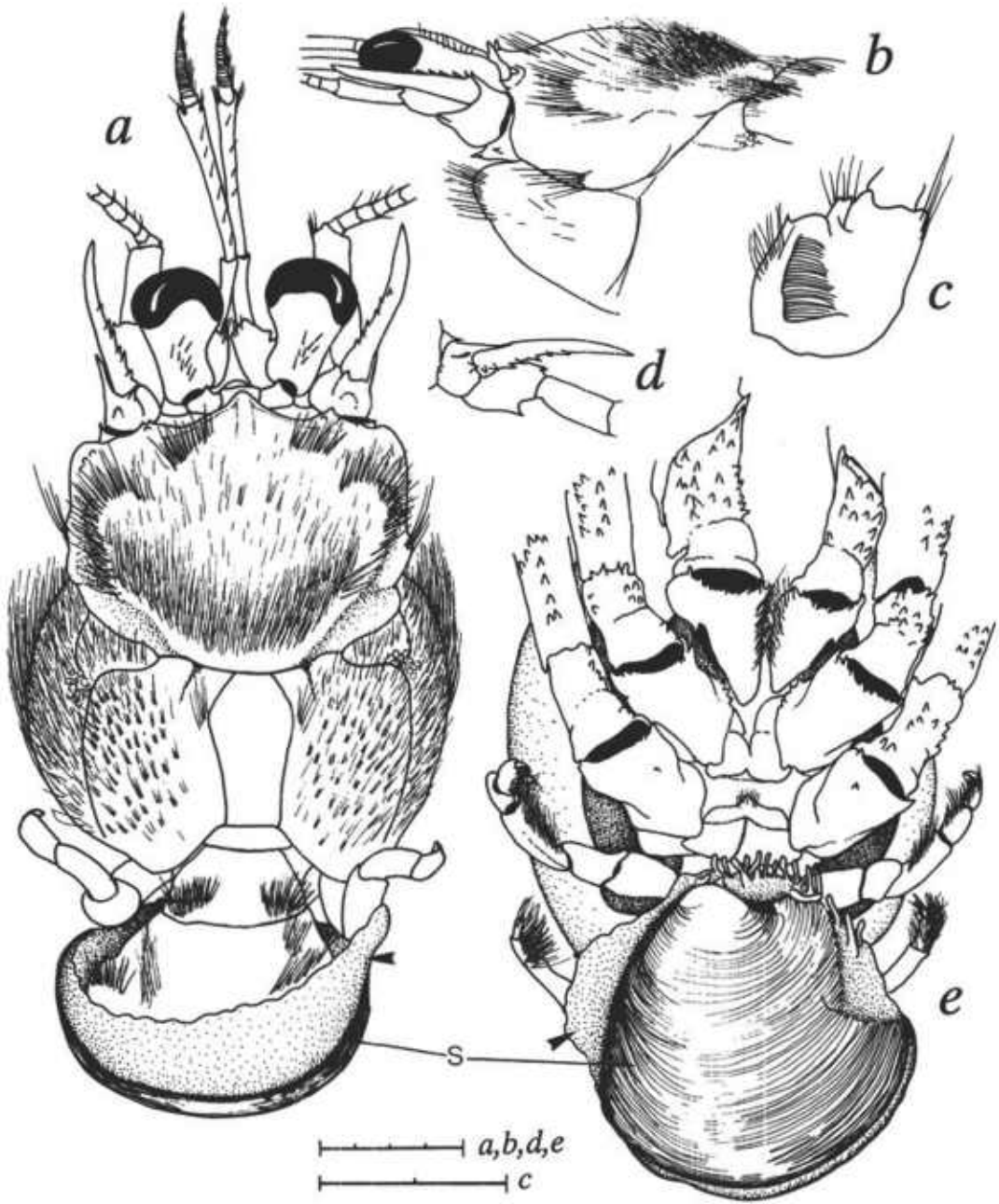


Fig. 1. *Bivalvopagurus sinensis* (de Saint Laurent, 1972), paratype, male, MNHN Pg. 2239: a, dorsal view of cephalothorax (including cephalic appendages and fifth pereopods), and abdomen showing portion of bivalve shell (s) and actinian wall (arrow); b, shield with cephalic appendages and anterior portion of branchiostegite, left lateral view; c, left basal antennular segment, dorsal view; d, right antennal peduncle, lateral view; e, ventral view of sternum of thoracic somites (including part of first to third pereopods, and fourth and fifth pereopods), showing bivalve shell (s) with actinian (arrow). Scales equal 4 mm (a, b, d, e), and 2 mm (c).

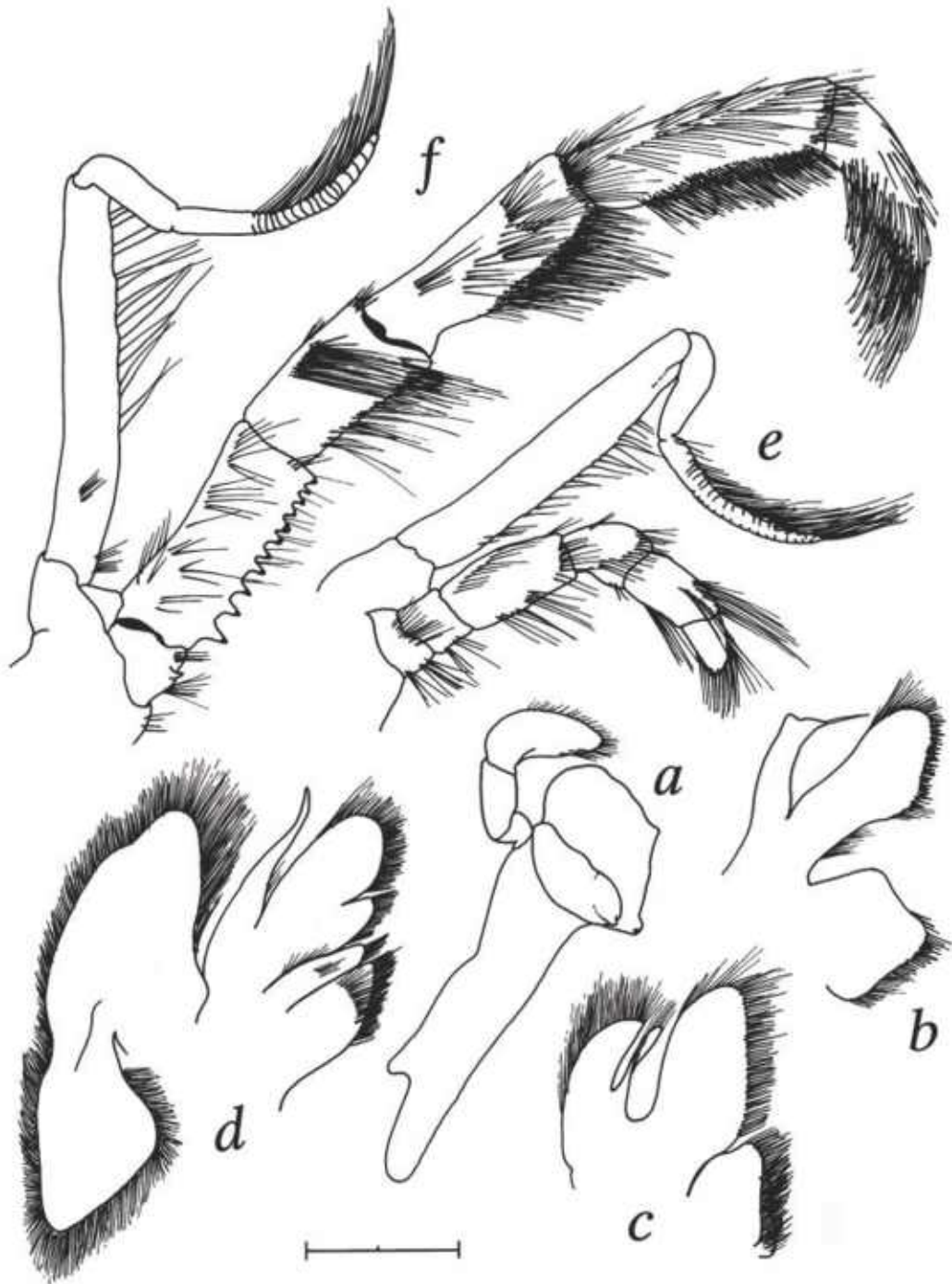


Fig. 2. *Bivalvopagurus sinensis* (de Saint Laurent, 1972), male (SL 10.3 mm), USNM 265139. Left mouthparts, internal view: a, mandible; b, maxillule; c, maxilla; d, first maxilliped; e, second maxilliped; f, third maxilliped. Scale equals 2 mm.

rior margin of carapace; sulcus cardiobranchialis short, weakly marked; *linea anomurica* extending posteriorly nearly to margin of carapace, bifurcated anteriorly near shield (lateral branch of *linea* weakly marked).

Ocular peduncles stout, half length of shield, with short setae dorsally; corneae strongly dilated. Ocular acicles subtriangular, directed upward, terminating in strong spine (occasionally bifid on one side); separated basally by slightly more than basal width of 1 acicle.

Mandible (Fig. 2a) with 3-segmented palp. Maxillule (Fig. 2b) with external lobe of endopod weakly developed, internal lobe with long terminal seta. Maxilla (Fig. 2c) with endopod slightly exceeding distal margin of scaphognathite. First maxilliped (Fig. 2d) with endopod subequal to exopod in distal extension. Second maxilliped (Fig. 2e) without distinguishing characters. Third maxilliped (Fig. 2f) with crista dentata formed of 11 corneous-tipped teeth increasing in size proximally; basis with mesial tooth. Sternite of third maxillipeds with small spine on each side of midline. Epistomial spine absent. Labral spine present.

Antennular peduncle long, slender, exceeding distal margin of corneae by about 1/4 length of penultimate segment; ventral flagellum formed of 5-7 articles. Ultimate segment slightly more than twice length of penultimate, with scattered setae. Basal segment (Fig. 1c) short, about as broad as long; lateral face with strong ventromesial spine, distal subrectangular lobe armed with 1 or 2 spines, and 1 small spine proximally.

Antennal peduncle (Fig. 1 a, d) exceeding distal margin of cornea by about 1/3 length of fifth segment. Flagellum long, exceeding dactyls of second and third pereopods; articles with pair of very short setae (less than half length of 1 article). Fifth segment unarmed, with row of few setae on lateral and mesial margins. Fourth segment with dorsolateral distal spine. Third segment

with strong ventromesial distal spine. Second segment with dorsolateral distal angle produced, terminating in strong spine (occasionally bifid or with additional small spine ventrally); mesial margin with strong spine on dorsodistal angle. First segment armed with 1-2 small spines on lateral face; ventromesial angle produced, terminating in 3-4 small spines. Antennal acicles exceeding distal margin of corneae by about 1/3 length of acicle; mesial margin armed with 6-12 spines.

Chelipeds dissimilar, slender, finely setose. Right cheliped (Fig. 3a) with fingers crossing at tips when closed, terminating in inwardly curved calcareous claws; cutting edge of fingers with irregularly sized calcareous teeth. Dactyl about as long as palm, with row of small spines on mesial margin; dorsal and ventral faces unarmed except for row of tufts of setae parallel to cutting edge. Fixed finger with small spines on lateral margin (spines diminishing in size distally and eventually lacking). Palm distinctly longer than broad (about 1.3 times as long as broad); mesial and lateral faces with irregular rows of small spines; dorsal surface with 2 median longitudinal rows of small spines, and scattered small spines on lateral half; ventral surface covered with small tubercles or spines. Carpus with row of spines near dorsodistal margin; dorsal and dorsomesial margin with row of spines; mesial, lateral and ventral faces with numerous small spines or tubercles. Merus with row of small spines on dorsal margin; ventromesial and ventrolateral margins armed with small spines. Ischium with ventral face armed with spines. Coxa with long setae on ventromesial margin, and row of spines on ventrodistal margin.

Left cheliped (Fig. 3b) evenly calcified, finely setose (setae short on chela, long on merus and carpus). Fingers crossing at tips when closed, terminating in inwardly curved sharp corneous claws; with scattered tufts of setae on dorsal and ventral surfaces; cutting edge of fixed finger with evenly

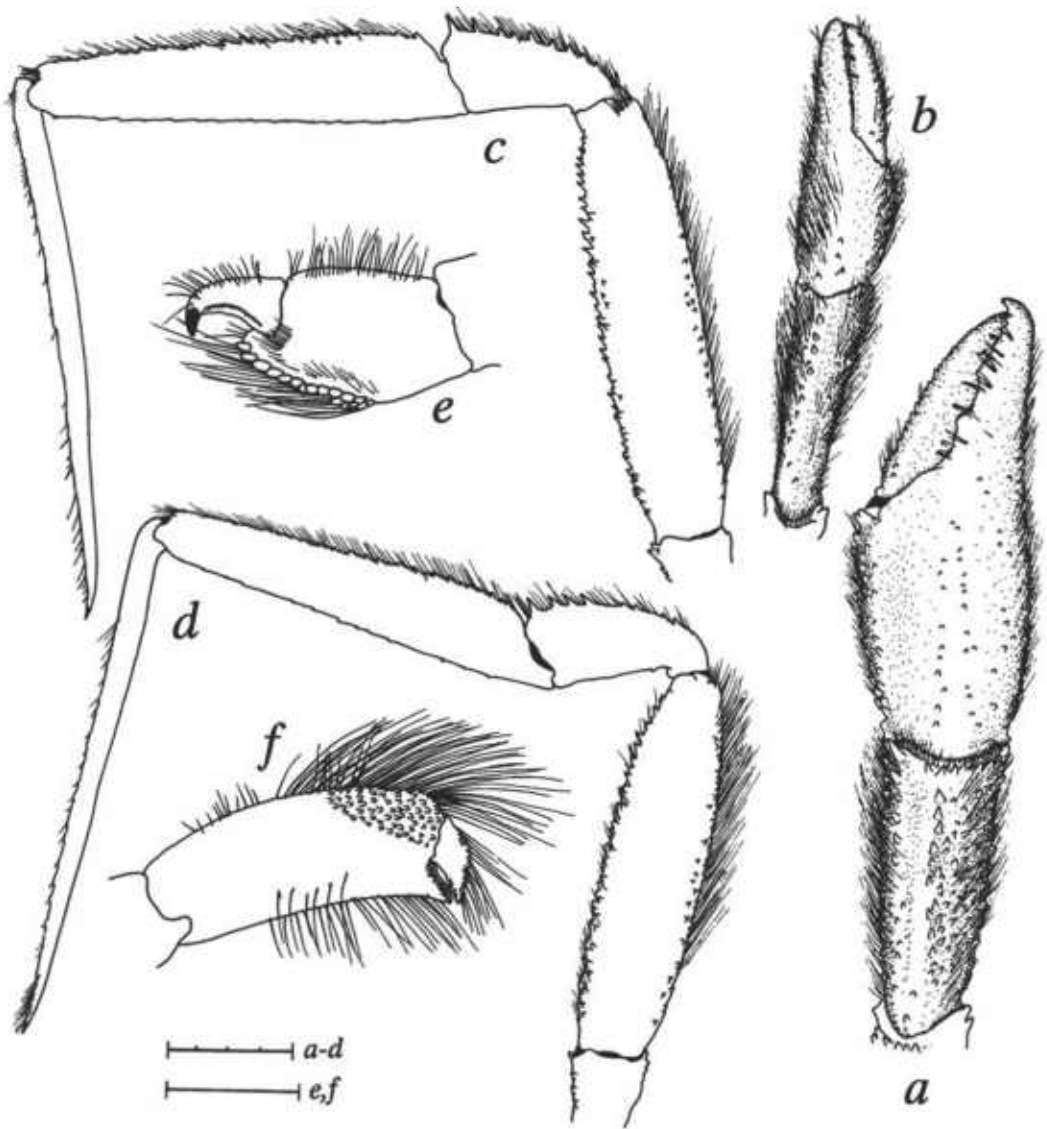


Fig. 3. *Bivalvopagurus sinensis* (de Saint Laurent, 1972), paratype, male, MNHN Pg. 2239: a, right cheliped, dorsal view; b, left cheliped, dorsal view; c, right second pereopod, lateral view; d, right third pereopod, lateral view; e, dactyl and propodus of left fourth pereopod, lateral view; f, dactyl and propodus of left fifth pereopod, lateral view. Scales equal 4 mm (a-d), and 1 mm (e, f).

sized, small calcareous teeth. Dactyl slightly longer than palm; cutting edge with row of closely set corneous spinules. Palm with lateral and mesial faces with small spines; dorsal surface with dorsomedian row of small spines proximally, and dorsomesial row of spines; ventral surface with scattered

small tubercles. Carpus with 3 strong spines near dorsodistal margin; dorsal face with 2 longitudinal rows of small spines (1 mesially, 1 laterally); mesial and lateral faces with small tubercles or spines. Merus with dorsodistal spine, and ventromesial and ventrolateral row of spines. Ischium with

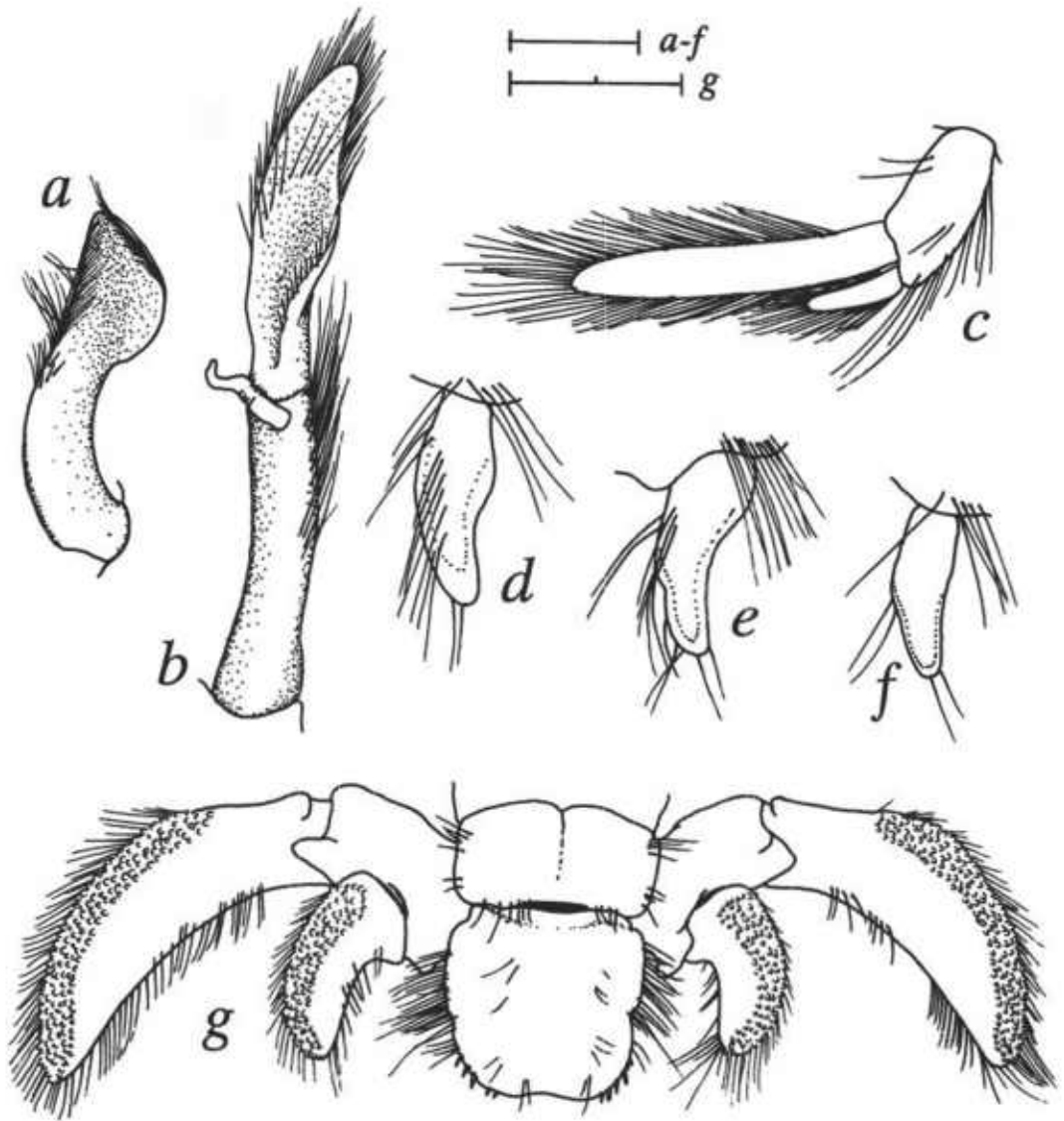


Fig. 4. *Bivalvopagurus sinensis* (de Saint Laurent, 1972), paratype, male, MNHN Pg. 2239. a, male right first pleopod, mesial view; b, male right second pleopod, lateromesial view; c, male left third pleopod, lateral view; d, e, f, male right third (d), fourth (e), and fifth (f) pleopods, lateral view; g, uropods and telson, dorsal view. Scales equal 1 mm (a-c), 0.5 mm (d-f), and 2 mm (g).

ventral face armed with spines. Coxa with long setae on ventromesial margin, and row of spines on ventrodistal margin.

Ambulatory legs (second and third pereopods; Fig. 3c, d) long, slender, exceeding right cheliped by nearly full length of dactyl of ambulatory leg. Dactyls long (about 1.4 times as long as propodus), terminating in

corneous claw; ventral margin unarmed, or at most with 2-3 minute spinules; with dorsal row and short dorsomesial distal row of setae. Propodi armed with small spines dorsally; ventral margin with row of small tubercles bearing spinules. Carpi with strong dorsodistal spine and row of spines on dorsal margin. Meri with small tubercles

or spines on dorsal and ventral faces (tubercles and spines larger on ventral than on dorsal face). Meri, carpi, and propodi with setae dorsally. Ischia with spines on ventral face. Coxae with 2-4 spines on ventral face near anteroproximal angle. Anterior lobe of sternite (Fig. 1e) of third pereopods broadly and narrowly subtriangular, unarmed, setose.

Fourth pereopod (Fig. 3e) subchelate. Dactyl subtriangular, terminating in strongly curved corneous claw, and ventrolateral row of small scales. Propodal rasp with 1 row of ovate scales (occasionally with 2 rows on proximal 1/5). Fifth pereopod (Fig. 3f) subchelate; propodal rasp forming subtriangular area less than half length of propodus. Coxae of fourth and fifth pereopods densely setose, more so in females.

Eleven pairs of phyllobranchiate or intermediate gills.

Uropods (Fig. 4g) with elongated exopods. Telson (Fig. 4g) divided into anterior and posterior lobes by weak median cleft; terminal margin of posterior lobes separated by shallow, unarmed broad sinus, each lobe with 5-13 small corneous spines.

Male left third (Fig. 4c) to fifth pleopods with short exopods; right third to fifth pleopods (Fig. 4d, e, f) reduced to short (often inconspicuous) setose buds masked by tuft of setae. Female second to fourth pleopods with crossed rami, fifth with short exopod (rami not crossed); right pleopods reduced to short setose buds (second the largest, remaining often inconspicuous).

Habitat and symbiotic associations. — Most of the specimens examined were found using a small shell of a bivalve mollusk with an unidentified actinian growing on it (Fig. 1a, e). The shell covers only part of the abdomen. The mouth and tentacles of the actinian face the sternum of the hermit, and the walls surround and extend the margins of the shell.

Distribution. — So far known only from

the South China Sea; 200-415 m.

Remarks. — In the original description of this species de Saint Laurent (1972: 116-118) indicated that only the male holotype and female paratype were known. I have examined the holotype and paratype, and have found that they are both males. De Saint Laurent also reported that the first pleopod of the male exhibits a short exopod, but this is evidently a typographical error as a short exopod is present only on the second pleopod of males.

Evolutionary Comments

The Parapaguridae, as currently interpreted, contains the following genera and number of species: *Parapagurus* Smith, 11 species; *Sympagurus* Smith, 28 species and 3 subspecies; *Strobopagurus*, three species; and four monotypic taxa, *Tylaspis anomala* Henderson, 1888, *Probeebei mirabilis* Boone, 1926, *Typhlopagurus foresti* de Saint Laurent, 1972, and *Bivalvopagurus sinensis*. As previously mentioned, *Bivalvopagurus* is most closely allied to *Strobopagurus*, as judged by the similarities of the shield, antennular flagella, dactyls of ambulatory legs, and distinctive first and second pleopods in the males. Several other characters exhibited by *Bivalvopagurus*, are shared with *Tylaspis* and *Probeebei*. These characters include calcification of the shield, posterior carapace and abdomen; tendency towards carcinization; and symmetry of the uropods and telson. The presence of these characters in *Bivalvopagurus*, *Tylaspis*, and *Probeebei*, however, is not necessarily indicative of a close phylogenetic relationship. The calcification of the cephalothorax and carcinization are believed to have evolved independently in various hermit crab groups (McLaughlin, 1983), and is found in various degrees in members of genera of other families (e.g. Paguridae: *Labidochirus* Benedict, *Ostraconotus* A. Milne Edwards; Diogenidae: *Tisea*

Morgan and Forest; Coenobitidae: *Birgus* Leach). Carcinization also has occurred in other hermit crab families, but most notably in the Lithodidae. The symmetry of the uropods and telson, in the past considered a primitive character (see Russell, 1962), has been shown to be a condition influenced by the type of habitat used (e.g. cochlean, tubiculous, spongicolous; see McLaughlin & Gunn, 1992, McLaughlin & Lemaitre, 1993).

The presence of paired pleopods in *Bivalvopagurus sinensis* is of interest to the study of the evolution of these appendages in hermit crabs. In other hermit crab families, paired pleopods occur in adults only in the family Pylochelidae (see Forest, 1987). In pylochelids, however, the pleopods differ from those of *B. sinensis* in being symmetrical (except in *Mixtopagurus paradoxus* A. Milne Edwards), and in that the second to fifth pleopods are biramous on both sides. According to McLaughlin (1983), pleopod evolution in hermit crabs has proceeded first through the practice of concealment and subsequent protection of the abdomen by some external means. In particular, the use of gastropod shells has led to the complete loss of pleopods on one side, and the development of asymmetry in the uropods and telson. *Bivalvopagurus sinensis* usually protects its abdomen with a bivalve shell and an actinian, and its pleopods are paired and asymmetrical, except for the first and second pair in males, which are symmetrical and modified as gonopods. If McLaughlin's view of pleopod evolution is invoked to explain the pleopod condition of *B. sinensis*, it would indicate that the ancestor (or ancestors) of this parapagurid used gastropod shells for shelter, but that a decrease in the use of gastropod shells led to a reduction of pleopods on the right side. Alternatively, it is also possible that the presence of rudimentary pleopods on the right side represents a neotenic condition unrelated to a cochlean habitat.

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