

## A revision of the hermit crabs of the genera *Catapagurus* A. Milne-Edwards and *Hemipagurus* Smith from the Indo-West Pacific (Crustacea : Decapoda : Anomura : Paguridae)

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**Abstract.** A systematic review of the genus *Catapagurus* A. Milne-Edwards, 1880 from the Indo-West Pacific is presented. The genus *Catapagurus* is rediagnosed and its type species, *C. sharreri* A. Milne-Edwards, 1880 is redescribed. *Icelopagurus tuberculatus* Asakura, 1999 is transferred to *Catapagurus*. The genus *Hemipagurus* Smith, 1881a is reinstated and rediagnosed, and its type species *H. gracilis* Smith, 1881b is redescribed. Seven species previously assigned to *Catapagurus*, i.e. *C. alcocki* McLaughlin, 1998, *C. granulatus* Edmondson, 1951, *C. ensifer* Henderson 1893, *C. tanimbarensis* McLaughlin, 1997, *C. holthuisi* McLaughlin, 1997, *C. oculocrassus* McLaughlin, 1997 and *C. japonicus* Yokoya, 1933, are transferred to *Hemipagurus*. Eight new species of *Hemipagurus* are described from the Indo-West Pacific: *H. haigae*; *H. kosugei*; *H. lewinsohni*; *H. maclaughlinae*; *H. albatrossae*; *H. hirayamai*; *H. imperialis*; and *H. toyoshioae*. *Catapagurus doederleini* Doflein, 1902 is transferred to *Parapagurodes* McLaughlin & Haig, 1973.

### Introduction

The genus *Catapagurus* was established by A. Milne-Edwards (1880) for a new species, *C. sharreri*, from the Atlantic Ocean, which was characterised by a long male sexual tube arising from the right coxa of the fifth pereopod and directed externally and over the dorsal face of the abdomen. Smith (1881a, b) established the genus *Hemipagurus* for two new species, *H. socialis* and *H. gracilis*, from the Atlantic Ocean. His characterisation of *Hemipagurus* was simply his statement that it was allied to *Spiropagurus* Stimpson, 1858 but differed in having a single sexual appendage on the right coxa of the last thoracic somite in males. Subsequently, Smith (1882) placed *Hemipagurus* in synonymy with *Catapagurus* and transferred his two species to *Catapagurus*, although, shortly thereafter, he (Smith 1883) synonymised *C. socialis* with *C. sharreri*.

Considerable confusion and misidentification has occurred in species of *Catapagurus*. In her revisions of the genera *Catapaguroides* A. Milne-Edwards & Bouvier, 1892, *Cestopagurus* Bouvier, 1892 and, incidentally, *Catapagurus*, de Saint Laurent (1968a, b, c, 1969, 1970a, b) first clarified the systematic positions of these genera characterised by male sexual tubes. However, Haig and Ball (1988) pointed out that the lack of an up-to-date revision of the genus *Catapagurus* made identification of specimens difficult.

The genus *Icelopagurus* was established by McLaughlin (1997) for a new species, *I. crosnieri* McLaughlin, 1997 from Indonesia. This species is superficially similar to species of *Catapagurus* but differs in the shortness of the male sexual tube, which does not curve up and over the dorsal surface of the body. Recently another species assigned to that genus, *I. tuberculatus* Asakura, 1999 was described from Japan.

In this paper, a systematic review of *Catapagurus* from the Indo-West Pacific is presented, including a redescription of its type species. The genus *Hemipagurus* is reinstated, with redescriptions of its type species and other known species, as well as descriptions of eight new species from the Indo-West Pacific.

### Historical resumé of the Indo-West Pacific species

Although the first report of *Catapagurus* from the Indo-West Pacific waters was of *C. australis* Henderson, 1888 from the Arafura Sea and Fiji, it was transferred to *Nematopagurus* A. Milne-Edwards & Bouvier, 1892 by McLaughlin (1997) (Table 1). The first actual record of *Catapagurus* in the Indo-West Pacific was *C. ensifer* Henderson, 1893 from the Gulf of Martaban, Myanmar. His second taxon, *C. muricatus* Henderson, 1896 from Ceylon (now Sri Lanka) was transferred to *Nematopagurus* by Alcock (1905b) (Table 1). Numerous specimens have been reported under the name of

**Table 1. Summary of the history and the present revision of the species assigned to *Catapagurus* and *Hemipagurus* from the Indo-West Pacific**

Species	Current status	References
<i>Catapagurus australis</i> Henderson, 1888	<i>Nematopagurus australis</i>	McLaughlin (1997)
<i>Catapagurus ensifer</i> Henderson, 1893	<i>Hemipagurus ensifer</i> , comb. nov.	present study
<i>Catapagurus doederleini</i> Doflein, 1902	<i>Parapagurodes doederleini</i> , comb. nov.	present study
<i>Catapagurus misakiensis</i> Terao, 1914	Species <i>insertae sedis</i>	present study
<i>Catapagurus japonicus</i> Yokoya, 1933	<i>Hemipagurus japonicus</i> , comb. nov.	present study
<i>Catapagurus vallatus</i> (Melin, 1939)	<i>Nematopagurus vallatus</i>	de Saint Laurent (1968a,b,c, 1969, 1970)
<i>Catapagurus fragilis</i> (Melin, 1939)	<i>Catapaguroides fragilis</i>	de Saint Laurent (1968a,b,c, 1969, 1970)
<i>Catapagurus granulatus</i> Edmondson, 1951	<i>Hemipagurus granulatus</i> , comb. nov.	present study
<i>Catapagurus</i> sp. in Haig & Ball (1988)	<i>Hemipagurus haigae</i> , sp. nov.	present study
<i>Catapagurus holthuisi</i> McLaughlin, 1997	<i>Hemipagurus holthuisi</i> , comb. nov.	present study
<i>Catapagurus tanimbarensis</i> McLaughlin, 1997	<i>Hemipagurus tanimbarensis</i> , comb. nov.	present study
<i>Catapagurus oculocrassus</i> McLaughlin, 1997	<i>Hemipagurus oculocrassus</i> , comb. nov.	present study
<i>Catapagurus alcocki</i> McLaughlin, 1998	<i>Hemipagurus alcocki</i> , comb. nov.	present study
<i>Catapagurus</i> sp. in McLaughlin & Hogarth, 1998	<i>Hemipagurus maclaughlinae</i> , sp. nov.	present study
<i>Catapagurus ensifer</i> in Lewinsohn (1969)	<i>Hemipagurus lewinsohni</i> , sp. nov.	present study
<i>Hemipagurus albatrossae</i> , sp. nov.		present study
<i>Hemipagurus kosugei</i> , sp. nov.		present study
<i>Hemipagurus imperialis</i> , sp. nov.		present study
<i>Hemipagurus hirayamai</i> , sp. nov.		present study
<i>Hemipagurus toyoshioae</i> , sp. nov.		present study
<i>Icelopagurus tuberculosus</i> Asakura, 1999	<i>Catapagurus tuberculosus</i> , comb. nov.	present study

*Catapagurus ensifer*. Alcock's (1905a, b) brief description and illustration of '*C. ensifer*' from the Maldives Islands was the first report following Henderson's original description. Very recently, Alcock's specimen was discovered in the collection of the Cambridge University Museum, re-examined and described in detail as *Catapagurus alcocki* McLaughlin, 1998 (in Hogarth *et al.* 1998). Lewinsohn (1969) attributed specimens from the Red Sea to *Catapagurus ensifer*, remarking that despite several differences from the original description of Henderson (1896), he was provisionally assigning it to Henderson's taxon. Haig and Ball (1988) assigned two males and one juvenile to *Catapagurus ensifer*, which were collected during the joint United States–Australian–Indonesian expedition to northern Australia and Indonesia aboard the R/V Alpha Helix. Haig and Ball (1988) also reported a single ovigerous female as an unidentified *Catapagurus* species from the Arafura Sea, very closely allied to *C. ensifer*.

*Catapagurus granulatus* was described by Edmondson (1951) from Hawaii. However, there has been no subsequent record of this species from any locality.

A number of species of *Catapagurus* have been reported from Japanese waters. Doflein (1902) described *Catapagurus doederleini* from Sagami Bay. Terao (1914) described *Catapagurus misakiensis* from a single male specimen collected in Sagami Nada. He placed the genus *Cestopagurus* Bouvier, 1897 in synonymy with *Catapagurus*, although subsequent workers did not adopt his proposition. Following the original description of *Catapagurus misaki-*

*ensis*, this species was apparently not seen again until Miyake (1978) reported it from Sagami Bay. He transferred it to *Cestopagurus* without stating a reason.

*Catapagurus japonicus* was described by Yokoya (1933) based on specimens collected from six localities off Japan by the R/V S. S. Soyo-maru during the years 1923 to 1933. Miyake (1978) briefly redescribed *C. japonicus*, based on two males and three females collected from Sagami Bay.

Melin (1939) described *Eupagurus* (*Catapagurus*) *vallatus* and *Eupagurus* (*Catapagurus*) *fragilis*, based on the specimens collected from the Bonin (= Ogasawara) Islands during Prof. Dr Sixten Bock's Expedition in 1914. Melin's classification of the Paguridae was unusual in that he subdivided the genus '*Eupagurus*' into a number of subgenera, among them the subgenus *Catapagurus sensu lato* (not *Catapagurus* A. Milne-Edwards). He further subdivided his subgenus *Catapagurus* into *sharreri*-, *olfaciens*- and *fragilis*-groups, noting that the first group was the same as the original *Catapagurus* A. Milne-Edwards and the second the same as *Cestopagurus* Bouvier. He put his new species, *Eupagurus* (*Catapagurus*) *vallatus*, in the *olfaciens*-group and *Eupagurus* (*Catapagurus*) *fragilis* in the *fragilis*-group. However, carcinologists after Melin did not adopt his classification. De Saint Laurent (1968a, b, c, 1969, 1970a, b) transferred Melin's *Eupagurus* (*Catapagurus*) *vallatus* to *Nematopagurus* and *Eupagurus* (*Catapagurus*) *fragilis* to *Catapaguroides* (Table 1).

Recently *Catapagurus holthuisi* McLaughlin, 1997, *C. tanimbarensis* McLaughlin, 1997 and *C. oculocrassus* McLaughlin, 1997 were described from Indonesia.

## Material, abbreviations and terminology

Specimens deposited in the following museums and institutions were examined: American Museum of Natural History, New York (AMNH); Australian Museum, Sydney (AM); Bernice P. Bishop Museum, Hawaii (BPBM); Biological Laboratory, Imperial Household, Tsukuba (NSMT-Cr); Faculty of Fisheries, University of Tokyo, Tokyo (FFUT); Hayama Shiwosai Museum, Kanagawa (HSM); Kitakyushu Museum of Natural History, Kitakyushu (KMNH); Museum of Comparative Zoology, Harvard University (MCZ); Muséum National d'Histoire Naturelle, Paris (MNHN); Nationaal Natuurhistorisch Museum, Leiden (RMNH); National Museum of Natural History, Smithsonian Institution, Washington D. C. (USNM); Natural History Museum and Institute, Chiba (CBM-ZC); Natural History Museum, London (NHM); Osaka Museum of Natural History, Osaka (OMNH); Tel-Aviv University, Tel-Aviv (TAU); University Museum, University of Tokyo, Tokyo (UMUT); Western Australian Museum, Perth (WAM); and Zoologische Staatssammlung, München (ZSSM).

Particularly useful were the specimens obtained during the U. S. Fisheries Steamer Albatross's Expeditions to Hawaii in 1902, the Philippines in 1908, and Indonesia in 1909, and deposited at the USNM. This material was preliminarily identified by Jacques Forest of the Muséum National d'Histoire Naturelle, Paris.

Shield length (SL), measured from the tip of the rostrum to the posterior margin of the shield, is used as an indication of size. The length of the cheliped and ambulatory leg segments is measured along each dorsomedian margin.

General terminology used herein follows McLaughlin (1974); for descriptions of lineae and plates of the posterior carapace, terminology follows Pilgrim (1973), Morgan and Forest (1991) and Lemaitre (1995); for fourth pereopods, McLaughlin (1997); and for gills, McLaughlin and de Saint Laurent (1998). The accessory portions of the shield (*sensu* Lemaitre 1995) are a pair of calcified regions adjoined to the lateral margin of the shield and are separated from the shield by the cervical groove; they are the extreme lateral parts of the internal cervical ridge to which the fourth epimeral attractor muscle attaches (Pilgrim 1973). The posteromedian plate (*sensu* Pilgrim 1973) on the posterior carapace is a narrow, partially calcified region posterior to the linea transversalis. The posterolateral plates (*sensu* Pilgrim 1973) are a pair of partially calcified regions on the posterior carapace diverging from the posteromedian plate and curving around the outer corner of the posterior portions of the branchiostegites.

### Genus *Catapagurus* A. Milne-Edwards

*Catapagurus* A. Milne-Edwards, 1880: 46. – Smith, 1882: 14 (in part, see remarks); Henderson, 1888: 75 (in part, see remarks); A. Milne-Edwards & Bouvier, 1893: 125 (in part, see remarks); Forest & de Saint Laurent, 1968: 151 (in part, see remarks); de Saint Laurent, 1970a: 1456 (in part, see remarks).

*Hemipagurus* Smith, 1881a: 143 (in part, see remarks). – Smith, 1881b: 422 (in part, see remarks).

Not *Catapagurus*: Alcock, 1905b: 114 (see remarks). – Terao, 1914: 469 (see remarks); Miyake, 1978: 141 (see remarks); Miyake, 1982: 232 (see remarks); McLaughlin, 1997: 494 (see remarks).

Type species: *Catapagurus sharreri* A. Milne-Edwards, 1880.

Gender: Masculine.

Other species: *Catapagurus tuberculosus* (Asakura, 1999), comb. nov.

### Diagnosis

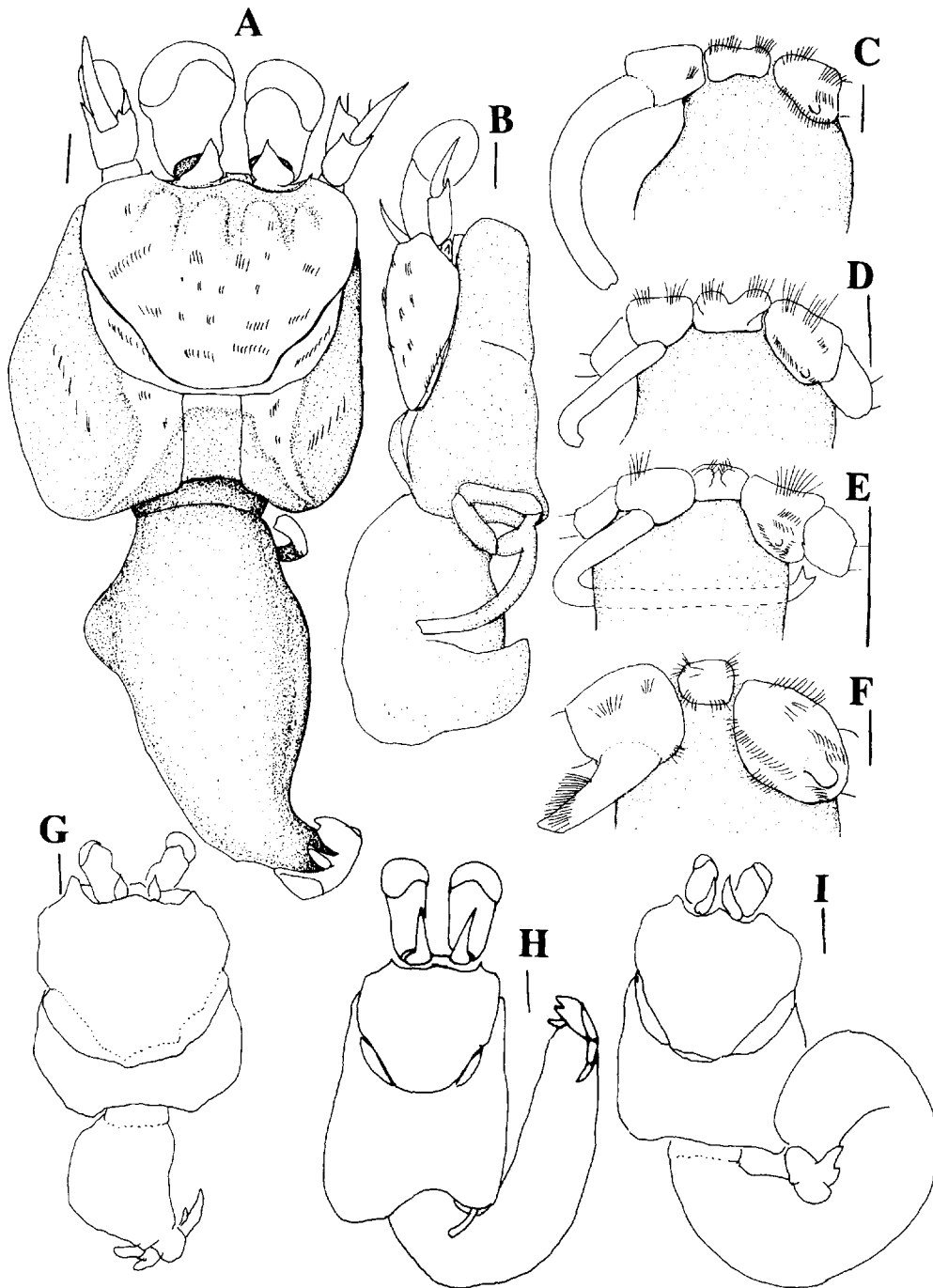
Eleven pairs of biserial phyllobranchiate gills; two pairs of arthrobranchiae on either side of each arthroal membrane

of third maxilliped and first to fourth pereopods; one pair of pleurobranchiae on either side of pleural plate of seventh thoracic somite (= above fourth pereopod). Shield well calcified, somewhat vaulted; accessory portions of shield broad, well calcified; cervical grooves between shield and accessory portions sometimes not decalcified; ocular peduncles and ocular acicles short, set widely apart; antennal peduncles with supernumerary segmentation; ischia of third maxillipeds with crista dentata somewhat reduced to moderately developed, each with accessory tooth.

Chelipeds elongate, unequal, right stouter than left; fourth pereopods semichelate, dactyl with few corneous spines on ventral margin and with prominent preungual process, propodal rasp consisting of single row of corneous scales. Female with coxae of third pereopods each with gonopore; male with right coxa of fifth pereopod bearing moderately short to moderately long sexual tube, curving over right lateral side of abdomen, left coxa with gonopore and occasionally very slightly protruding vas deferens. Sternite of third pereopods divided into anterior and posterior plates by shallow transverse groove, posterior plate very broad, subdivided into two lobes by longitudinal median groove. Males with three unpaired left uniramous pleopods on third to fifth abdominal somites; females without unpaired first pleopod, with three unpaired left biramous pleopods on second to fourth abdominal somites and with or without unpaired left uniramous pleopod on fifth abdominal somite; tergite of sixth calcified, divided into anterior and posterior lobes by shallow transverse groove; telson with lateral constriction, posterior lobes separated by median cleft.

### Affinities

Although Smith (1881a, b) regarded his two new species *Hemipagurus socialis* Smith (now *Catapagurus sharreri*) and *H. gracilis* Smith (subsequently *Catapagurus gracilis*) congeneric, the two species differ in some important morphological characters. *Catapagurus sharreri* has: a well calcified, vaulted shield with well calcified, broad accessory portions; cervical grooves between the shield with the accessory portions not decalcified in large individuals (>4.3 mm in shield length); very broad sternites of the second and third pereopods (more than 2.0 times broader than long in the second and 3.0 times in the third); and a relatively short and stout right sexual tube that is not curved up over the abdomen or at most reaches the midline of the dorsal face of the abdomen in males (Fig. 1A–C). In contrast, *C. gracilis* has: a moderately calcified shield with moderately calcified small and narrow accessory portions that are clearly separated from the shield by a well decalcified, soft cervical groove; moderately broad sternites of the second and third pereopods (1.6–1.7 times broader than long in both second and third); and a long and slender sexual tube that is curved up and across the dorsal face of the



**Fig. 1.** *Catapagurus sharreri* A. Milne-Edwards: A–C, male, SL = 5.00 mm, off Martha's Vineyard, Atlantic Ocean, USNM 34094. *Catapagurus tuberculosus* (Asakura), comb. nov.: D, G, paratype male, SL = 4.90 mm, Okinawa, Japan, CBM ZC 4701. *Hemipagurus granulatus* (Edmondson), comb. nov.: E, holotype male, SL = 2.58 mm, Hawaii, BPBM 5446. *Icelopagurus crosnieri* McLaughlin: F, I, male, SL = 5.15 mm, St. 5166 of Albatross Expedition, Tawi Tawi Group, Sulu Archipelago, Philippines, USNM. *Hemipagurus gracilis* Smith: H, lectotype male, SL = 2.50 mm, off Martha's Vineyard, Atlantic Ocean, USNM 5081. Cephalothorax and abdomen: dorsal view: A, G, H, I; right lateral view, B. Coxae and sexual tube in male (ventral view): C–F. Schematic diagram indicating proportion of body: G, H, I (dorsal view).

abdomen, reaching or overreaching the midline of the abdomen toward the left side in males (Fig. 1H).

Seven species previously assigned to *Catapagurus*, i.e. *C. alcocki*, *C. granulatus*, *C. ensifer*, *C. tanimbarensis*,

*C. holthuisi*, *C. oculocrassus* and *C. japonicus*, also share the characters of *C. gracilis*. For this reason, I herein reinstate the genus *Hemipagurus* for the aforementioned eight species with *H. gracilis* as the type. All eight species new to science

**Table 2. Comparison of selected morphological characters of *Catapagurus*, *Hemipagurus* and *Icelopagurus***

Character	<i>Catapagurus</i>	<i>Hemipagurus</i>	<i>Icelopagurus</i>
Size	Moderately large >5.0 mm	Small <3.1 mm (mostly 2.0–2.8 mm)	Moderately large >5.0 mm
Carapace			
Dorsal surface of shield	Rugose, 2 or 4 elevated areas or 4 large tubercles anteriorly	Smooth	Smooth
Accessory portion of shield	Well calcified, broad	Moderately calcified, narrow <sup>a</sup>	Moderately calcified, broad
Cervical groove	Not decalcified in large individuals	Well decalcified	Well decalcified
Posterior carapace	Short (0.4 length of shield)	Moderately long (0.6–0.7 length of shield) <sup>b</sup>	Moderately long (0.55–0.6 length of shield)
Posterolateral plates	Triangular	Elongate band /very elongate, triangular	Elongate, triangular
Ocular peduncles	Set apart distally	Set apart distally	Comparatively closely set
Ocular acicles	Short, set widely apart	Generally long <sup>c</sup> , set widely apart	Moderately long, closely set, distal
Chelipeds and ambulatory legs	Strongly tuberculate, strongly calcified	Granular or smooth, moderately calcified	Tuberculate or minutely spinulose, moderately calcified
Dactyls of 2nd and 3rd pereopods	Blade-shaped	Blade-shaped /not blade-shaped	Slightly blade-shaped
Right sexual tube in male	Moderately short, moderately stout	Long to moderately long, slender	Short, stout
Sternite of 2nd pereopods	Very broad (2.0–2.1 broader than long)	Moderately broad (1.6–1.7 broader than long)	Moderately narrow (1.1–1.2 broader than long)
Posterior plate of sternite of 3rd pereopods	Very broad	Moderately broad	Moderately broad
Abdomen	(3.0–3.1 broader than long) Short (1.4–1.8 length of carapace)	(1.6–1.7 broader than long) Moderately long (2.0–2.5 length of carapace) <sup>d</sup>	(1.6–1.7 broader than long) Moderately long (2.2–2.5 length of carapace)

<sup>a</sup>Except for *H. albatrossae*; <sup>b</sup>except for *H. albatrossae* (0.4 length); <sup>c</sup>except for *H. lewinoehni* and *H. toyoshioae*; <sup>d</sup>except for *H. kosugei* and *H. albatrossae* (0.7 length)

described herein also share the generic characters of *Hemipagurus* (Table 2).

With the present emendation of the generic diagnosis of *Catapagurus*, it is clear that the recently described *Icelopagurus tuberculatus* (Fig. 1D, G) shares more generic characters with *Catapagurus* than *Icelopagurus* and is herein transferred to the former genus.

In addition to the generic characters of the genus, the two species now assigned to *Catapagurus* (*C. sharreri* and *C. tuberculatus*) share a considerable number of morphological attributes such as body size, armature of the shield, shapes of the ocular peduncles, ocular acicles, chelipeds and ambulatory legs and proportions of the carapace and abdomen (Table 2).

*Icelopagurus* is now, again, a monotypic genus (*I. crosnieri* McLaughlin, 1997; fig. 1I) and differs from both *Catapagurus* and *Hemipagurus* in having very short ocular peduncles that are set approximated, ocular acicles that are approximated distally, the shorter and stouter sexual tube of males with many long setae apically, and a row of corneous spines on lateral margins of the telsonal posterior lobes (Table 2).

*Catapagurus doederleini* agrees with all of the diagnostic characters of *Parapagurodes* proposed by McLaughlin and Haig (1973) and is here transferred to the latter genus. *Parapagurodes* differs greatly from *Catapagurus* and *Hemipagurus* in having a strong submarginal spine on each ocular acicle, very stout chelipeds and ambulatory legs, and a very short, right sexual tube in males.

#### Remarks

Generic diagnoses by Henderson (1888: 75), A. Milne-Edwards and Bouvier (1893: 125), Forest and de Saint Laurent (1968: 151), and de Saint Laurent (1970a: 1456) are applicable to both *Catapagurus sharreri* and the species formerly assigned to *Catapagurus sensu lato*. Generic diagnoses by Alcock (1905b: 114) and McLaughlin (1997: 494) are applicable to *Hemipagurus*.

When Terao (1914) described his new species, *Catapagurus misakiensis*, he proposed *Cestopagurus* be placed in synonymy with *Catapagurus*. He stated that his male specimen agreed well with the generic characters of *Catapagurus* defined by A. Milne-Edwards (1880) except for the very long right sexual tube directed anteriorly on the

ventral face of the cephalothorax, which is characteristic of *Cestopagurus*. He incorrectly believed that the direction of the sexual tube was the only criterion that separated these two genera though, in fact, several other morphological differences actually exist between them. For example, species of *Cestopagurus* have very stout and cylindrical ambulatory pereopods, quadriserial phyllobranchiate gills and fourth pereopods without a preungual process (de Saint Laurent 1968c). On the other hand, *Catapagurus* has slender and lateromesially flattened ambulatory pereopods, biserial phyllobranchiate gills and fourth pereopods with a distinct preungual process. As Terao's specimen is no longer extant, its taxonomic position cannot be evaluated.

Miyake's (1978, 1982) generic diagnoses of *Catapagurus* and couplets of *Catapagurus* in the key to Japanese genera of the Paguridae were based on the characters of both *Catapagurus* (now *Hemipagurus*) *japonicus* and *Catapagurus* (now *Parapagurodes*) *doederleini*. Miyake (1978: 142) stated for the sexual tube in males, only the 'right tube usually protruded', and he did not refer to the length and direction of the tube. Further, Miyake (1982: 224) mentioned 'the sexual tube is extended along the right side of the abdomen and curved up on it, or the tube is short and protruded' in his couplets of *Catapagurus* (as *Catapagurus*, typographical error, couplet 12) in the key to Japanese genera of the Paguridae; the former character is attributable to *Hemipagurus* and the latter to *Parapagurodes* respectively.

Additionally, Miyake's (1978, 1982) generic diagnosis of *Catapagurus* involved a serious error that resulted from his observations of an atypical specimen of *Hemipagurus japonicus* (one male, NSMT-Cr 1474). My re-examination of that specimen revealed that it has a vestigial accessory tooth on the crista dentata, which had led Miyake to conclude that the third maxilliped might or might not have an accessory tooth on the crista dentata (Miyake, 1978: 142; 1982: 232). However, my examination of other specimens of *H. japonicus* has shown that a typical accessory tooth is normally developed in this species (see description of *H. japonicus*).

### *Catapagurus sharreri* A. Milne-Edwards

(Figs 1A–C, 2A–M)

*Catapagurus sharreri* A. Milne-Edwards, 1880: 46. – Smith, 1883: 31; Smith, 1884: 353, pl. IV, figs 1–2; Smith, 1886: 642; A. Milne-Edwards & Bouvier, 1893: 127, pl. 9, figs 19–24; Alcock, 1905b: 184; Fowler, 1912: 580 (list); Gordan, 1956: 307 (list).

*Hemipagurus socialis* Smith, 1881b: 423.

*Catapagurus socialis* Smith, 1882: 16.

### Material examined

*Lectotype* (herein selected). **Off Barbados:** ♂, SL = 2.85 mm, St. 299, Blake 1878–1879 Expedition, Atlantic Ocean, 13° 50'N 59° 39'40'W, 256 m, coll. A. Agassiz, 10.iii.1879, MCZ 4029a.

*Paralectotypes* (herein selected). **Off Barbados:** 3 ♂, SL = 2.10, 2.65, 2.70 mm, 2 ovi. ♀, SL = 2.30, 2.65 mm, same data as lectotype, MCZ 4029; 1 ♂, SL = 3.60 mm, St. 291, Blake 1878–1879 Expedition, Atlantic Ocean, 13° 12'N 59° 41'W, 366 m, coll. A. Agassiz, 9.iii.1879, MCZ 2722; 2 ♂, SL = 3.30 mm, St. 280, Blake 1878–1879 Expedition, Atlantic Ocean, 12° 57'66"N 59° 36'8"W, 404 m, coll. A. Agassiz, 6.iii.1879, MCZ 4031.

*Syntypes of Hemipagurus socialis.* **USA: off Martha's Vineyard:** 4 ♂, SL = 3.40, 4.20, 5.10, 5.20 mm, fine sand and mud, St. 877, U. S. Fish Com., Atlantic Ocean, 39° 56'00"N 70° 54'18"W, 225 m, 13.ix.1880, USNM 34094; 4 ♂, SL = 2.75, 3.00, 3.15, 4.00 mm, 4 ovi. ♀, SL = 2.90, 3.00, 3.05, 3.05 mm, mud and fine sand, St. 871, U. S. Fish Com., Atlantic Ocean, 40° 02'54"N 70° 23'40"W, 210 m, 4.ix.1880, USNM 21408.

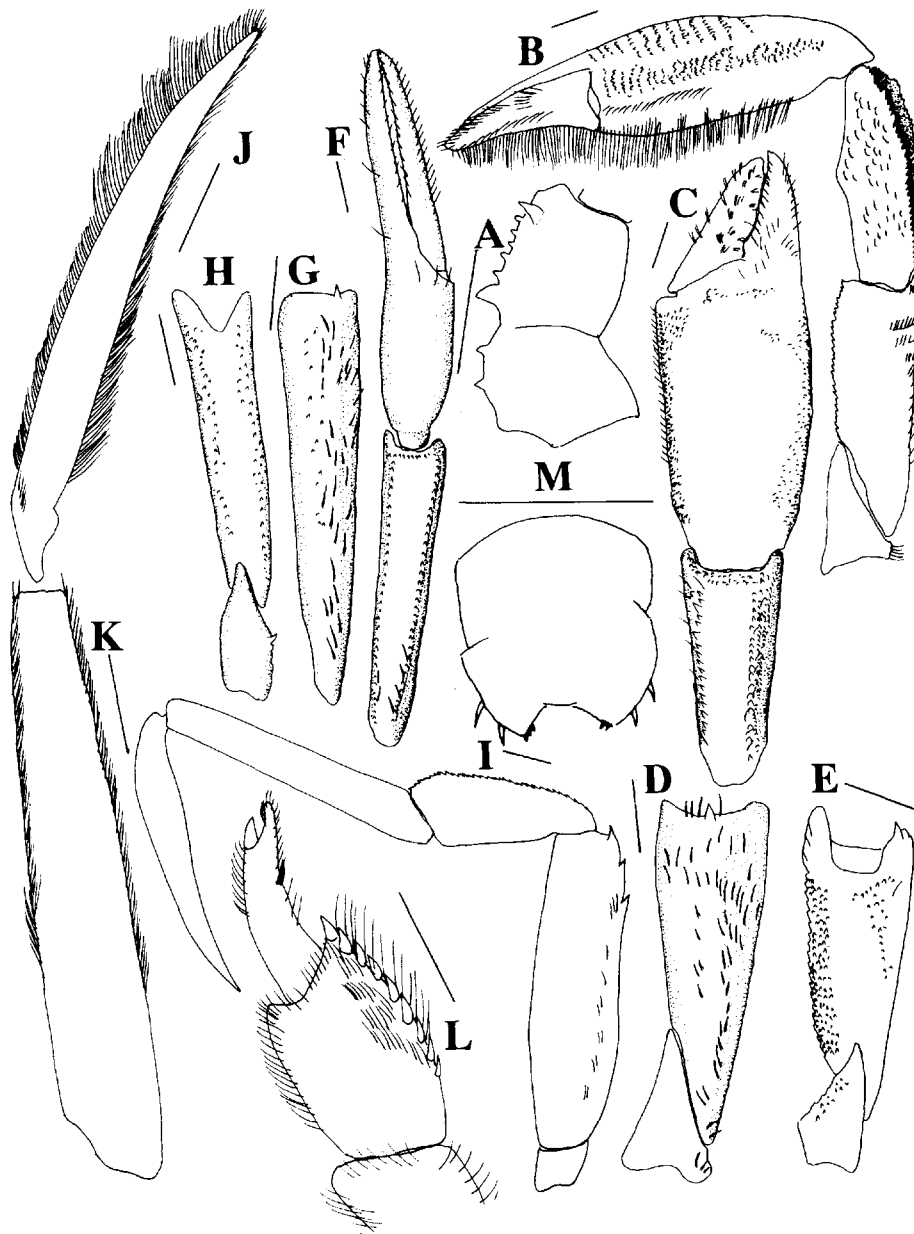
*Additional material.* **USA: Florida:** 1 ovi. ♀, Pompano, AMNH 11486; 1 ♂, 1 ovi. ♀, off Delray, AMNH 10252; **North Carolina:** 1 ♂, off Cape Fear, USNM 9865; **Chesapeake Bay:** 1 ♂, 72 km east of the bay, AMNH 12240 (holotype of *Catapagurus hudsonicus* Boone MS, invalid name, see remarks); 16 ♂, 1 ovi. ♀, same data as 12240, AMNH 12241 (paratypes of *Catapagurus hudsonicus* Boone MS, invalid name, see remarks).

### Redescription

Shield (Fig. 1A) 1.20–1.40 times broader than long, well calcified, vaulted; anterior margin between rostrum and lateral projections concave; in large males (SL > 4.3 mm) dorsal surface with anterior region bearing transverse row of two or four elevated areas (hardly recognisable in specimens less than 4.3 mm or females); rostral lobe broadly rounded, overreached by lateral projections; lateral projections produced, triangular. Accessory portion of shield (Fig. 1A) very broad, well calcified; in large males (SL > 4.3 mm) cervical grooves not decalcified. Linea transversalis calcified in large males (SL > 4.3 mm). Posterior carapace with triangular posterolateral plates and very short posteromedian plate (Fig. 1A). Branchiostegites (Fig. 1B) not calcified, unarmed.

Ocular peduncles (including corneas) (Fig. 1A) short, 0.55–0.65 length of shield, each with constriction near base of cornea. Corneas dilated (Fig. 1A). Ocular acicles (Fig. 1A) short, triangular, subacute; separated basally by breadth of rostral lobe; mesial margins fringed with few thick setae. Interocular plate rectangular, calcified; separated from surrounding region by soft membrane.

Antennular peduncles long, when fully extended penultimate segments reaching distal margins of corneas; ultimate and penultimate segments unarmed; basal segment slightly produced distomesially, with 1 acute spinule at ventrodistal mesial angle. Antennal peduncles short, when fully extended first segments slightly overreaching corneas; fifth and fourth segments unarmed; third segment with ventrodistal angle produced; second segment with dorso-lateral distal angle terminating in strong spine accompanied ventrally by short accessory spine, dorsolateral face with several tubercles, dorsomesial distal angle with strong spine; first segment with strong hook-shaped spine laterally, strong spine at ventrodistal margin mesially. Antennal acicles



**Fig. 2.** *Catapagurus sharreri* A. Milne-Edwards: male, SL = 5.00 mm, off Martha's Vineyard, Atlantic Ocean, USNM 34094. A, ischium and basis of third maxilliped (left, external view). Right cheliped: B, mesial view; C, chela and carpus (dorsal view); D, merus (dorsal view); E, same (ventral view). Left cheliped: F, chela and carpus (dorsal view); G, merus (dorsal view); H, same (ventral view). Left third pereopod: I, lateral view; J, dactyl (mesial view); K, propodus (mesial view). L, dactyl and propodus of fourth pereopod (right, lateral view). M, telson. Scale bars: A, L, M = 0.5 mm; B–K = 1.0 mm.

moderately short, overreaching ocular peduncles, straight, subacute-tipped.

Third maxilliped with merus bearing acute dorsodistal spine; ischium (Fig. 2A) with crista dentata somewhat reduced, composed of 7–10 corneous teeth and with one strong accessory tooth; 2–3 acute corneous teeth on basis (Fig. 2A).

Right cheliped (Fig. 2B–E) compressed dorsoventrally; males with soft and very long, dense setae on mesial faces of

dactyl and palm (Fig. 2B). Dactyl short, 0.35–0.45 length of palm; dorsal face convex; tuberculate laterally; cutting edge with prominent blunt-tipped calcareous tooth medially. Fixed finger with cutting edge bearing minute calcareous teeth. Palm very long, 1.35–1.45 length of carpus; dorsomesial and dorsolateral surfaces covered with tubercles. Carpus as long as merus; dorsal surface flat, dorsolateral and dorsomesial margins forming distinct ridges, each armed with strong spiniform tubercles; lateral

and mesial faces strongly tuberculate. Merus (Fig. 2D, E) with dorsal face bearing irregular row of thick setae, dorsodistal angle bearing large spine; lateral, mesial, and ventral faces strongly tuberculate; ventromesial and ventrolateral distal angles each bearing very strong spine. Ischium (Fig. 2E) tuberculate ventrally. Coxa with strong spine at ventromesial distal angle.

Left cheliped (Fig. 2F–H) slender. Dactyl long, 1.25–1.35 length of palm; mesial face with setae. Palm 0.55–0.60 length of carpus, slightly tuberculate mesially. Carpus 0.90–1.00 length of merus; lateral and mesial faces with numerous blunt or spiniform tubercles, dorsolateral and dorsomesial margins each armed with row of small spines. Merus (Fig. 2G, H) with dorsodistal angle bearing large spine; ventromesial and ventrolateral distal angles only produced and unarmed. Ischium (Fig. 2H) with acute spine at ventrolateral distal angle. Coxa with ventromesial and ventrolateral distal angles each bearing strong spine.

Second and third pereopods (Fig. 2I–K) morphologically similar, third 1.10–1.15 length of second; row of very dense, soft long setae present on dorsal and ventral margins of dactyl and distal 0.60–0.75 of propodi. Dactyls as long as propodi (Fig. 2J), blade-shaped, broad, each terminating in corneous claw. Propodi (Fig. 2K) 1.50–1.60 length of carpi; lateral face tuberculate. Carpi 0.50–0.60 length of meri; dorsal margins each with distal spine and irregular row of spines and spiniform tubercle; lateral and mesial surfaces covered with tubercles or spines. Meri strongly tuberculate laterally, mesially and ventrally; dorsal faces each with very strong distal spine and two very strong subdistal spines; ventrolateral distal angles slightly protruding (third), ventromesial distal angles unarmed. In large individuals, sternites of second pereopods and anterior lobes of third pereopod sternites armed anteriorly with few sharp spines.

Fourth pereopods (Fig. 2L) with dactyl bearing 1–3 short corneous spines on ventral margin and with slender preungual process covered by dense short setae; carpus with blunt-tipped spine at dorsodistal angle. Males with right coxa of fifth pereopods bearing moderately short sexual tube directed to exterior, gonopore of left coxa with vas deferens only slightly protruding if at all, obscured by dense short setae (Fig. 1C); female with nearly symmetrical coxae.

Sternite of third pereopods very broad; in large individuals, anterior lobe with tubercles or spines on anterolateral angles.

Telson (Fig. 2M) with posterior lobes separated by very broad median cleft, mesial margins with few spine-like processes, lateral margins each with two corneous spines.

#### Sexual dimorphism

Setae on mesial face of dactyl and palm of right cheliped scarce in females.

#### Colouration

Not known.

#### Distribution

East coast of the Atlantic Ocean from off Martha's Vineyard, Massachusetts, USA, through Chesapeake Bay, Florida, to off Barbados; 207–694 m.

#### Affinities

The ambulatory dactyls of *Catapagurus sharreri* are fringed with very dense long setae (Fig. 2J) that are lacking in *C. tuberculosus*. The latter species has a row of corneous spines on either the dorsal or ventral portion of the mesial faces of the ambulatory dactyls.

#### Remarks

This species is fully described for the first time. The syntypes of this species are the specimens collected during the Blake 1878–1879 Expedition to Barbados. The male specimen is in the best condition (MCZ 4029a) and is here designated as the lectotype for the stability of the nomenclature. The remaining specimens are paralectotypes.

I re-examined the syntypes of *Hemipagurus socialis* Smith (USNM 34094, 21408) and confirmed that they are conspecific with *Catapagurus sharreri*. Lee Boone designated a holotype and paratypes of *Catapagurus hudsonicus*, sp. nov. (AMNH 12240, 12241). Since the description was apparently never published, it is an invalid name. My re-examination of Boone's specimens revealed that they are actually *C. sharreri*.

#### *Catapagurus tuberculosus* (Asakura), comb. nov.

(Figs 1D, G, 51)

*Icelopagurus tuberculosus* Asakura, 1999: 381.

#### Description

See Asakura (1999).

#### Distribution

Known only from the type locality, Kumejima, Okinawa (Fig. 51).

#### Affinities

See 'Affinities' under *Catapagurus sharreri*.

#### Genus *Hemipagurus* Smith, reinstated

*Hemipagurus* Smith, 1881a: 143 (in part). – Smith, 1881b: 422 (in part).

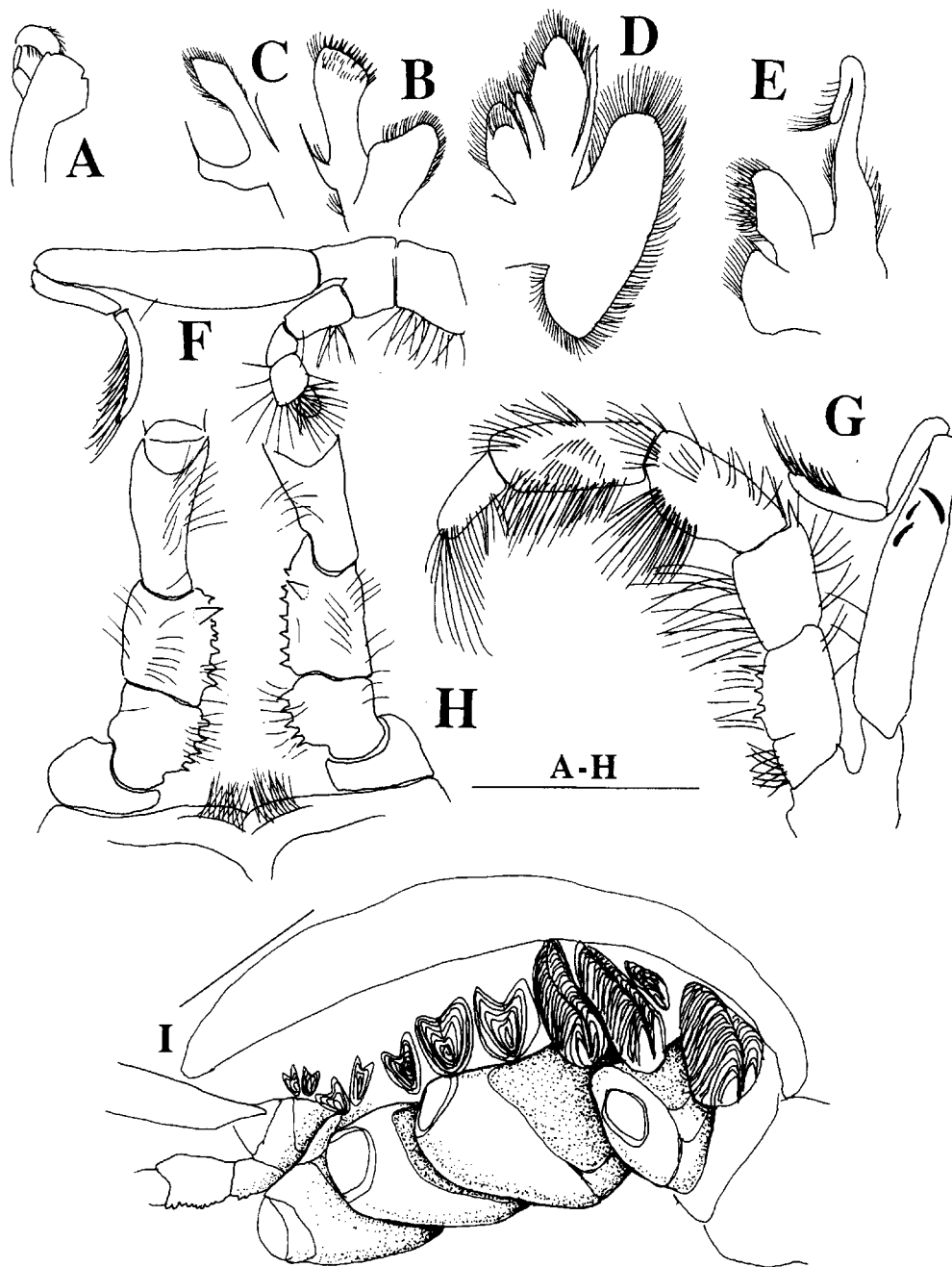
*Catapagurus* Henderson, 1888: 75 (in part). – A. Milne-Edwards & Bouvier, 1893: 125 (in part); Alcock, 1905b: 114 (in part); Forest & de Saint Laurent, 1968: 151 (in part); de Saint Laurent, 1970a: 1456 (in part); Miyake, 1978: 141 (in part); Miyake, 1982: 232 (in part); McLaughlin, 1997: 494.

Type species: *Hemipagurus gracilis* Smith, 1881b.

Gender: Masculine

Other species: *Hemipagurus ensifer* (Henderson, 1893), comb. nov.; *H. alcocki* (McLaughlin, 1998), comb. nov.; *H. granulosus* (Edmondson, 1951), comb. nov.; *H. haigae*, sp. nov.; *H. kosugei*,





**Fig. 3.** *Hemipagurus granulatus* (Edmondson), comb. nov.: paratype male, SL = 2.05 mm, off the south coast of Oahu, Hawaii, BPBM 5514. Mouthparts (left): *A*, mandible (external view); *B*, maxillule (external view); *C*, same, endopod; *D*, maxilla (internal view); *E*, first maxilliped (internal view); *F*, second maxilliped (internal view); *G*, third maxilliped (internal view); *H*, third maxillipeds and its sternite (ventral view). Gill: *I*. Scale bars = 1.0 mm.

sp. nov.; *H. lewinsohni*, sp. nov.; *H. maclaughlinae*, sp. nov.; *H. albatrossae*, sp. nov.; *H. japonicus* (Yokoya, 1933), comb. nov.; *H. imperialis*, sp. nov.; *H. hirayamai*, sp. nov.; *H. toyoshioae*, sp. nov.; *H. holthuisi* (McLaughlin, 1997); comb. nov., *H. tanimbarensis* (McLaughlin, 1997); comb. nov.; and *H. oculocrassus* (McLaughlin, 1997), comb. nov.

#### Diagnosis

Eleven pairs of biserial phyllobranchiate gills (Fig. 3*I*): two pairs of arthrobranchiae on either side of each arthrodial membrane of third maxilliped and first to fourth pereopods; one pair of pleurobranchiae on either side of pleural plate of

seventh thoracic somite (= above fourth pereopod) (Fig. 3*J*). Shield calcified; accessory portions of shield generally small, partially calcified or not calcified, clearly separated from shield by soft, well decalcified cervical groove; ocular peduncles and ocular acicles set widely apart; antennal peduncles with supernumerary segmentation; ischia of third maxillipeds with crista dentata somewhat reduced to moderately developed, each with accessory tooth (Fig. 3*G, H*).

Chelipeds elongate, unequal, right stouter than left; fourth pereopods semichelate, dactyl with few spines on ventral margin and with prominent preungual process, propodal rasp consisting single row of corneous scales. Female with coxae of third pereopods each with gonopore; male with right coxa of fifth pereopod bearing very long sexual tube curving over dorsal surface of abdomen toward left side, left coxa with gonopore or very slightly protruding vas deferens. Sternite of third pereopods divided into anterior and posterior plates by shallow transverse groove, posterior plate moderately broad, subdivided into two lobes by longitudinal median groove. Male with three unpaired left uniramous pleopods on third to fifth abdominal somites (Fig. 6*D–F*); female with three unpaired left biramous pleopods on second to fourth abdominal somites and with unpaired left uniramous pleopod on fifth abdominal somite (Fig. 6*G–J*); tergite of sixth abdominal somite calcified, divided into anterior and posterior lobes by shallow, transverse groove; telson with lateral constriction, posterior lobes separated by median cleft.

#### Remarks

See 'Affinities' and 'Remarks' under the generic diagnosis of *Catapagurus* for differences between *Catapagurus* and *Hemipagurus* and synonymic relations between these genera respectively.

The species of *Hemipagurus* from the Indo-West Pacific are provisionally divided into two groups in this paper. The *ensifer*-group has blade-shaped ambulatory dactyls, defined as having the widest portion located around the mid-length of the dactyl. The *japonicus*-group has non-blade-shaped ambulatory dactyls, defined as having the widest portion located on the proximal or subproximal portion of the dactyl. However, when the various morphological characters are considered among the species, only the shape of the ambulatory dactyls is sufficiently consistent to permit clustering of species into these two groups. The shape of the ambulatory dactyls is not considered of sufficient significance to warrant separation into two genera or subgenera.

The *ensifer*-group includes *H. ensifer*, *H. alcocki*, *H. granulatus*, *H. haigae*, sp. nov., *H. kosugei*, sp. nov., *H. lewinsohni*, sp. nov., *H. maclaughlinae*, sp. nov. and *H. albatrossae*, sp. nov. The *japonicus*-group includes *H. japonicus*, *H. imperialis*, sp. nov., *H. hirayamai*, sp. nov., *H. toyoshioae*, sp. nov., *H. holthuisi*, *H. tanimbarensis* and *H. oculocrassus*.

### *Hemipagurus gracilis* Smith

(Figs 1*H, 4A–S*)

*Hemipagurus gracilis* Smith, 1881*b*: 426.

*Catapagurus gracilis* Smith, 1882: 19. – Smith, 1883: 33; Smith, 1884: pl. III, figs 2, 3; Smith, 1887: 642; A. Milne-Edwards & Bouvier, 1893: pl. 9, figs 15–30; Alcock, 1905*b*: 185; Fowler, 1912: 580 (list); Gordan, 1956: 306 (list).

#### Material examined

*Lectotype* (herein selected). **USA: off Martha's Vineyard:** ♂, SL = 2.50 mm, St. 874, U. S. Fish. Com., Eish Hank, Atlantic Ocean, 40°00'00"N 70°57'00"W, 156 m, 13.ix.1880, USNM 5081.

*Paralectotypes.* **USA: off Martha's Vineyard:** 4 ♂, SL = 1.65–1.90 mm, 1 ♀, SL = 1.85 mm, same data as lectotype, USNM1000218

*Additional material.* **USA: off New Jersey:** 1 ♂, USNM 185582.

#### Redescription

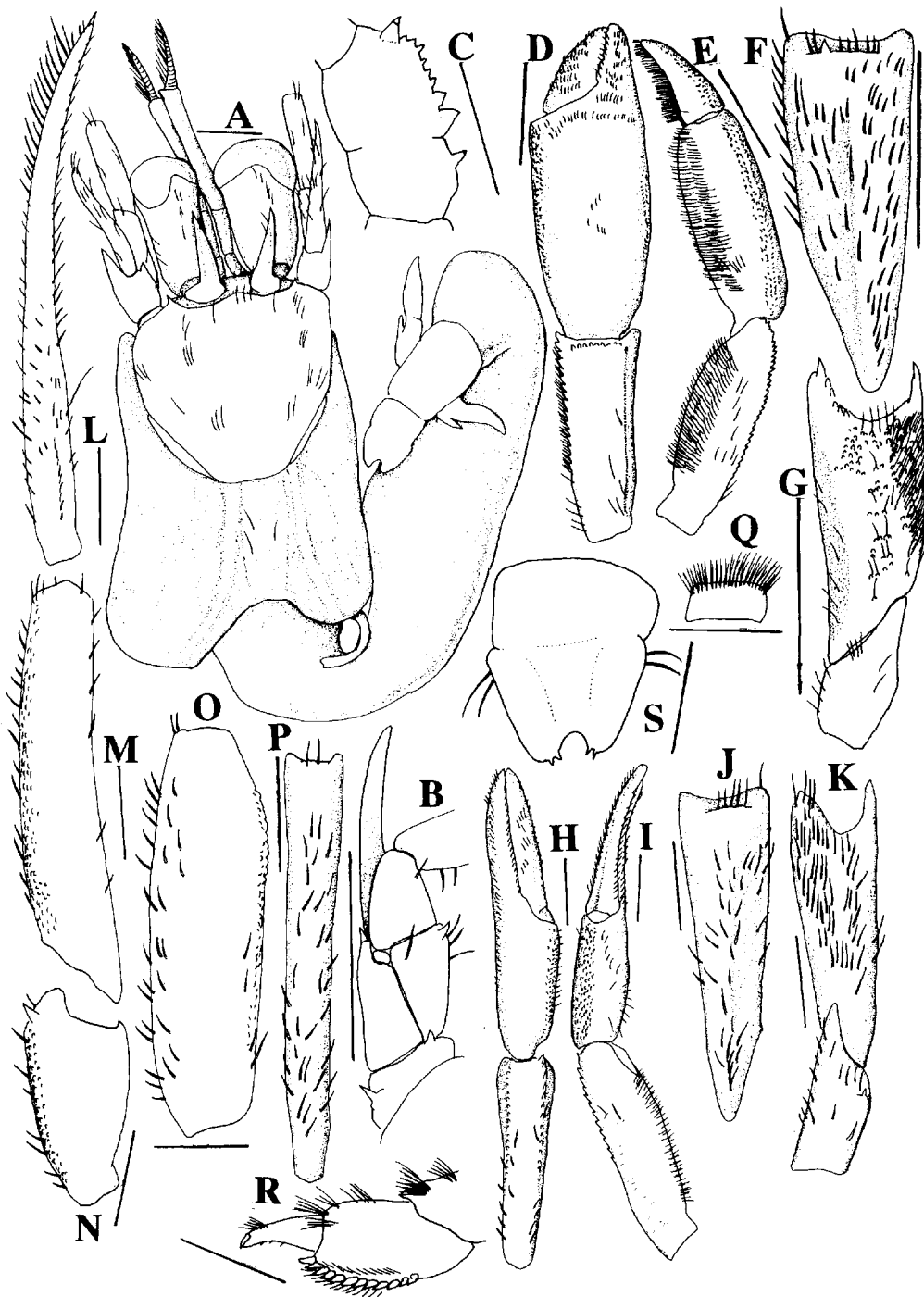
Shield (Fig. 4*A*) 1.05–1.20 times broader than long; anterior margin between rostrum and lateral projections concave; dorsal surface smooth with scattered setae; rostral lobe broadly rounded, overreached by lateral projections; lateral projections produced, triangular; accessory portions of shield small. Posterior carapace with very narrow posterolateral plates (Fig. 4*A*); branchiostegites not calcified, unarmed.

Ocular peduncles (including corneas) (Fig. 4*A*) 0.70–0.75 length of shield, dorsal surfaces with several long stiff setae. Corneas (Fig. 4*A*) slightly dilated. Ocular acicles (Fig. 4*A*) elongate, triangular, acute, separated basally by breadth of rostral lobe.

Antennular peduncles (Fig. 4*A*) long, when fully extended ultimate segment exceeding ocular peduncles 0.8 own length, unarmed; penultimate segments unarmed; basal segment slightly produced distomesially, with 1 acute spinule at ventrodistal mesial angle. Antennal peduncles (Fig. 4*A, B*) moderately long, when fully extended distal margin of fourth segment reaching base of corneas; fifth and fourth segments unarmed; third segment with ventrodistal angle bearing strong spine; second segment with dorsolateral distal angle produced, terminating in strong spine sometimes accompanied ventrally by short accessory spine, dorsomesial distal angle with strong spine; first segment with strong ventrolateral and ventrodistal spines; antennal acicle very long, unarmed.

Third maxilliped with merus bearing acute dorsodistal spine; ischium (Fig. 4*C*) with crista dentata somewhat reduced, composed of 6–10 corneous teeth and one strong accessory tooth; basis with 1–3 acute teeth (Fig. 4*C*).

Right cheliped (Fig. 4*D–G*) compressed dorsoventrally; males with dense setae on dorsomesial faces of dactyl, palm, carpus and merus. Dactyl short, 0.30–0.40 length of palm; dorsal face convex, granular mesially, with scattered setae. Palm very long, 1.15–1.25 length of carpus; dorsal face with scattered very short setae, dorsomesial and dorsolateral surfaces granular. Carpus as long as merus; dorsal surface



**Fig. 4.** *Hemipagurus gracilis* Smith: lectotype male, SL = 2.50 mm, off Martha's Vineyard, Atlantic Ocean, USNM 5081. *A*, cephalothorax and abdomen; *B*, antennal peduncle (right, ventral view); *C*, ischium and basis of third maxilliped (right, external view). Right cheliped: *D*, chela and carpus (dorsal view); *E*, same (mesial view); *F*, merus (dorsal view); *G*, same (ventral view). Left cheliped: *H*, chela and carpus (dorsal view); *I*, same (mesial view); *J*, merus (dorsal view); *K*, same (ventral view). Left third pereopod: *L*, dactyl (mesial view); *M*, propodus (mesial view); *N*, carpus (mesial view); *O*, merus (mesial view); *P*, same (dorsal view). *Q*, sternite of third pereopods; *R*, dactyl and propodus of fourth pereopod (left, lateral view); *S*, telson. Scale bars: *A*, *B*, *D*–*P* = 1.0 mm; *C*, *Q*–*S* = 0.5 mm.

flat, dorsomesial margin with row of spines and setae, dorsodistal margin with row of spiniform tubercles. Merus (Fig. 4*F*, *G*) with dorsal face bearing irregular rows of thick, long setae, dorsodistal angle bearing large spine; ventral face

tuberculate, ventromesial and ventrolateral distal angles bearing spine. Ischium (Fig. 4*G*) and coxa unarmed.

Left cheliped (Fig. 4*H*–*K*) slender. Dactyl as long as palm, slightly tuberculate mesially. Palm 0.65–0.75 length of

carpus; dorsal face with setae laterally and mesially, slightly tuberculate mesially. Carpus as long as merus; dorsolateral and dorsomesial margins each armed with row of spines; ventral face with moderately dense setae. Merus (Fig. 4J, K) with dorsodistal margin and dorsal and ventral surfaces bearing many long, stiff setae; ventromesial and ventrolateral distal angles each with blunt-tipped spine. Ischium (Fig. 4K) with tiny subdistal spine ventrolaterally. Coxa unarmed.

Second and third pereopods (Fig. 4L–P) similar, third slightly longer than second. Dactyls (Fig. 4L) long, 1.20–1.40 length of propodi; not blade-shaped, each terminating in corneous claw; mesial faces flat, with dorsal and ventral rows of moderately long setae; lateral faces convex. Propodi (Fig. 4M) 1.80–1.90 length of carpi; lateral faces granular dorsally; mesial faces bearing dorsal and ventral rows of moderately long setae. Carpi (Fig. 4N) 0.45–0.55 length of meri; each with very strong spine at dorsodistal angle, dorsal surfaces granular or tuberculate. Meri (Fig. 4O, P) unarmed; dorsal surfaces with irregular rows of thick long setae.

Fourth pereopod (Fig. 4R) with dactyl bearing few short corneous spines on ventral margin and with prominent preungual process covered by dense short setae apically; carpus with blunt-tipped spine at dorsodistal angle. Male with right coxa of fifth pereopods bearing moderately long sexual tube with forked tip curving over dorsal surface of abdomen toward left side (Fig. 4A), gonopore of left coxa with vas deferens only slightly protruding; female with nearly symmetrical coxae.

Sternite of third pereopods (Fig. 4Q) with broad anterior lobe, semitriangular, with setae anteriorly. Sternite of fifth pereopods with pair of small, round projections.

Telson (Fig. 4S) with triangular posterior lobes separated by small median cleft; terminal margins with 2 spine-like processes, lateral margins each with 2 stiff setae.

#### Sexual dimorphism

Right cheliped smaller and less hairy in females than in males.

#### Colouration

Not known.

#### Distribution

East coast of the Atlantic Ocean from off Martha's Vineyard to Chesapeake Bay, USA; 90–156 m.

#### Affinities

This species differs from all of the other species of *Hemipagurus* in having dense short setae on the ventromesial faces of the dactyl, palm, carpus and merus of the right cheliped in males (Fig. 4E, G). It is distinguishable from all other species with non-blade shaped ambulatory dactyls except for *H. imperialis*, sp. nov. in having unarmed dorsal faces of the meri of the ambulatory legs (Fig. 4O, P),

the other species have one or two strong spines on the same area (Fig. 41). *Hemipagurus gracilis* differs from *H. imperialis* in having only granules on the dorsal faces of the carpi of the ambulatory legs (Fig. 4N), *H. imperialis* has a row of spines on the same location (Fig. 39B).

#### Remarks

This species is herein fully described for the first time. The syntypes consist of five males and one female collected from Martha's Vineyard, east coast of the USA. The largest specimen in the best condition is designated as the lectotype for the stability of the nomenclature. The remaining specimens are paralectotypes.

#### Key to the Indo-West Pacific species of *Hemipagurus*

1. Dactyls of ambulatory legs blade-shaped (*ensifer*-group) (Fig. 36) ..... 2  
Dactyls of ambulatory legs not blade-shaped (*japonicus*-group) (Fig. 37) ..... 9
2. Protopods of uropods strongly protruding posteriorly (Fig. 12F) ..... *H. albatrossae*, sp. nov.  
Protopods of uropods not protruding ..... 3
3. Ocular acicles short, reaching proximal 0.2–0.3 of ocular peduncles (Fig. 17E). Dorsodistal margins of propodi of ambulatory legs without spine-like setae (Fig. 38E) ..... *H. lewinsohni*, sp. nov.  
Ocular acicles long, reaching or overreaching mid-length of ocular peduncles (Fig. 17A–D, 18A). Dorsodistal margins of propodi of ambulatory legs with one or two spine-like setae (Fig. 38A–D, F, G) ..... 4
4. Second pereopods each with one strong subdistal spine on dorsal face of merus (Fig. 40D). Coxae of both chelipeds in males each with strong ventromesial spine (Fig. 7C) ..... *H. granulatus*  
Second pereopods each with two or more strong subdistal spines on dorsal face of merus. Coxae of both chelipeds unarmed ..... 5
5. Dactyls of third pereopods each with row of very dense (50–60) spine-like setae on mesial face ventrally (Fig. 36C) ..... *H. haigae*, sp. nov.  
Dactyls of third pereopods each with row of 15–30 spinules or short spine-like setae on mesial face ventrally (Fig. 36A, D, H) ..... 6
6. Ambulatory dactyls very broad (breadth 0.17–0.20 of length) (Fig. 36A) ..... *H. ensifer*  
Ambulatory dactyls relatively narrow (breadth 0.10–0.15 of length) (Fig. 36D, F, H) ..... 7
7. Meri of ambulatory legs each with vestigial spine at ventrolateral distal angle or unarmed with weak subdistal spines on dorsal face (Fig. 40T) ..... *H. maclaughlinae*, sp. nov.  
Meri of ambulatory legs each with strong spine at ventrolateral distal angle and with strong subdistal spines on dorsal face (Fig. 40L, N, X, Z) ..... 8
8. Ambulatory legs with carpi unarmed (Fig. 38D), dactyl usually with flat mesial faces (Fig. 36D), and meri each with two simple subdistal spines on dorsal faces (Fig. 40L, N) ..... *H. kosugei*, sp. nov.  
Ambulatory legs with carpi bearing strong dorsodistal spines, dactyls with longitudinally-concave mesial faces (Fig. 36H), meri with two usually bifid or trifold strong subdistal spines on dorsal faces (Fig. 40X, Z) ..... *H. alcocki*

9. Ocular peduncles not broadened distally (Fig. 18D). Corneas not dilated (Fig. 18D). Antennal acicles short, less than half length of ocular peduncles. . . . . *H. hirayamai*, sp. nov.  
 Ocular peduncles broadened distally (Fig. 18B, C, E). Corneas dilated (Fig. 18B, C, E). Antennal acicles long, overreaching distal margins of corneas . . . . . 10
10. Telson with narrow V-shaped median cleft. Mesial faces of dactyls of ambulatory legs each with dorsal row of widely separated short corneous spinules (less than 20, usually mostly broken off) (Fig. 37F) . . . . . *H. tanimbarensis*  
 Telson with broad median cleft. Mesial faces of dactyls of ambulatory legs each with dorsal row of dense (more than 30) corneous spines or spine-like setae (Fig. 37A, B, D, E) . . . . . 11
11. Dorsal faces of meri of ambulatory legs without subdistal spines (Fig. 41D, E) . . . . . *H. imperialis*, sp. nov.  
 Dorsal faces of meri of ambulatory legs with two or more subdistal spines . . . . . 12
12. Antennular peduncles very long, over three times length of ocular peduncles (including corneas). Antennal acicles very long, over twice length of ocular peduncles . . . . . *H. oculocrassus*  
 Antennular peduncles moderately long, about twice length of ocular peduncles (including corneas). Antennal acicles reaching or slightly overreaching distal margins of ocular peduncles . . . . . 13
13. Ocular peduncles (including corneas) moderately short, 0.45–0.55 length of shield (Fig. 13A). Median cleft of telson U- or O-shaped (Fig. 44H) . . . . . *H. japonicus*  
 Ocular peduncles (including corneas) moderately long, 0.65–0.75 length of shield. Median cleft of telson trapezoidal; terminal margins of posterior lobes widely separated distally, or median cleft rectangular . . . . . 14
14. Median cleft of telson trapezoidal (Fig. 44J). Ambulatory legs slender, propodi of third with length 8.4–8.6 times width (Fig. 39D) . . . . . *H. toyoshioae*, sp. nov.  
 Median cleft of telson rectangular. Ambulatory legs moderately slender, propodi of third with length 6.1–6.4 times width . . . . . *H. holthuisi*

***Hemipagurus ensifer* (Henderson), comb. nov.**

(Figs 5, 6, 17A, 19A, 21A–B, 22A, 23, 29A–B, 31A–D, 34A, 36A, 38A, 40A–C, 42A–B, 44A, 48)

*Catapagurus ensifer* Henderson, 1893: 424, pl. 38, figs 16–19.

– Gordan, 1956: 306 (list) (in part, see remarks).

?*Catapagurus ensifer*: Southwell, 1906: 216 (see remarks).

– Laurie, 1926: 161 (see remarks); Haig & Ball, 1988: 180 (see remarks).

not *Catapagurus ensifer*: Alcock, 1905a: 835. – Alcock, 1905b: 115, pl. 13, fig. 3. [= *Hemipagurus alcocki* (McLaughlin, 1998)].

not *Catapagurus ensifer*: Lewinsohn, 1969: 79 (= *Hemipagurus lewinsohni*, sp. nov.).

**Material examined**

**Lectotype** (herein selected). **Myanmar**: ♂, SL = 2.40 mm, Gulf of Martaban, NHM 1888.34.

**Paralectotypes** (herein selected). **Myanmar**: 1 ♂, SL = 2.35 mm, 1 ♀, SL = 2.40 mm, same data as lectotype, NHM 1888.34.

**Redescription**

Shield (Fig. 5A) 1.10–1.15 times broader than long, dorsal outline nearly circular; anterior margin between rostrum and lateral projections concave, anterolateral margins rounded;

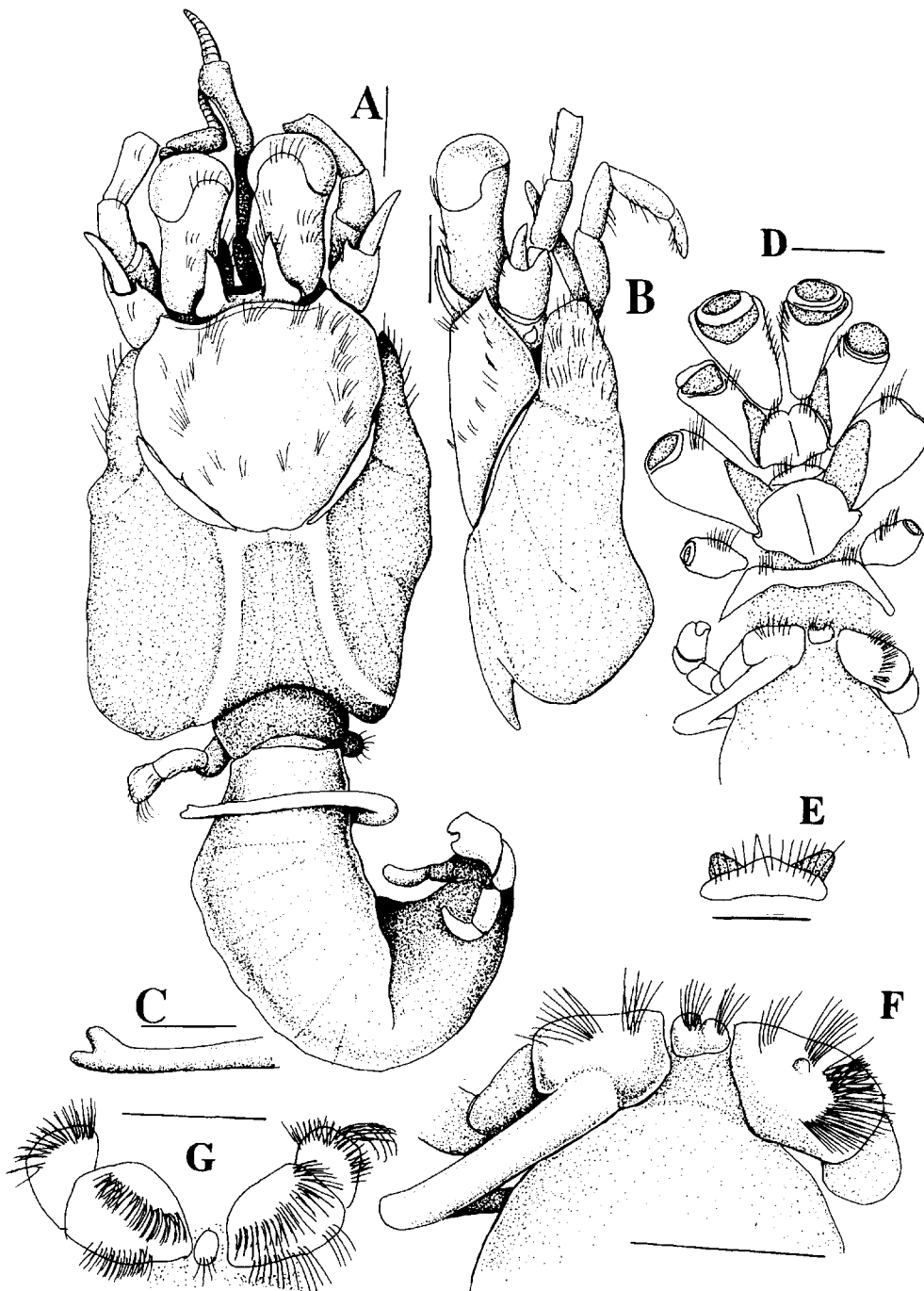
dorsal surface slightly convex, with pair of longitudinal rows of setae tufts and transverse rows of setae tufts anteriorly and posteriorly; rostral lobe (Fig. 17A) very broad, overreached by lateral projections; lateral projections (Fig. 17A) triangular, each terminating in subacute spine. Posterior carapace (Fig. 5A) with very narrow posterolateral plates and very short posteromedian plate. Branchiostegites (Fig. 5A) not calcified, unarmed, anterior margins protruding ventrally.

Ocular peduncles (including corneas) (Figs 5A, 17A) approximately 0.70 times as long as shield, with medial constriction; dorsal and mesial surfaces with few tufts of short stiff setae, dorsomesial faces with short stiff setae distally. Corneas (Fig. 17A) dilated. Ocular acicles (Fig. 17A) moderately long, narrowly triangular, acute; reaching middle portion of ocular peduncles; widely separated basally by breadth of rostral lobe; mesial and lateral margins with several very long setae and few short setae respectively.

Antennular peduncles (Figs 5A, 19A) long, when fully extended second peduncular segments overreaching distal margins of corneas by approximately 0.60 own length; ultimate segment with dorsolateral margin bearing few very long setae distally; penultimate segment unarmed; basal segment with acute spine at ventrodiscal mesial angle. Antennal peduncles (Figs 5A, 21A, B) short and stout, when fully extended exceeding distal margins of corneas by approximately 0.25 length of ultimate segment; fifth and fourth segments unarmed; third segment with ventrodiscal angle produced; second segment distinctly expanded mesially, dorsolateral distal angle produced, terminating in strong spine, dorsomesial distal angle with strong spine; first segment with strong hook-shaped spine laterally and strong spine at ventrodiscal margin. Antennal acicles (Fig. 21A) moderately short, reaching only base of corneas; moderately broad, slightly arcuate, subacute. Antennal flagella with full length unknown; articles each with one or two very short setae on distal margins of lateral and mesial faces.

Third maxilliped with merus bearing acute dorsodistal spine; ischium (Fig. 22A) with reduced crista dentata, composed of 5–7 teeth and strong accessory tooth; basis (Fig. 22A) with three or four acute teeth.

Right cheliped of male (Fig. 23A–D) large and stout, chela flattened dorsoventrally. Dactyl short, 0.45–0.50 length of palm, blunt-tipped; dorsal face granular, with tufts of long setae, dorsomesial face strongly granular or tuberculate; cutting edge (Fig. 29A) with numerous very minute calcareous teeth on entire margin and large blunt-tipped tooth medially. Fixed finger blunt-tipped; dorsolateral surface granular, with tufts of long setae; entire cutting edge with minute calcareous teeth (Fig. 29A). Palm long, 1.30–1.35 length of carpus; dorsal surface granular, dorsomesial and dorsolateral proximal angles slightly protruding, covered by dense granules; mesial and lateral surfaces densely covered by minute granules. Carpus 0.85–0.90 length of merus; dorsal surface flat, with scattered blunt or spiniform tubercles, dorsolateral and dorsomesial margins nearly



**Fig. 5.** *Hemipagurus ensifer* (Henderson), comb. nov.: lectotype male, A–F, SL = 2.40 mm, Gulf of Martaban, Myanmar, NHM 1888.34; paralectotype female, G, SL = 2.45 mm, Gulf of Martaban, Myanmar, NHM 1888.34. A, dorsal view; B, cephalothorax and part of cephalic appendages (right, lateral view); C, tip of male sexual tube; D, cephalothorax (ventral view); E, anterior lobe of sternite of third pereopods; F, G, coxae of fifth pereopods (ventral view). Scale bars: C, E = 0.5 mm; A, B, D, F, G = 1.0 mm.

straight, each forming distinct ridge armed with row of blunt or spiniform tubercles; lateral and mesial surfaces covered with tubercles or granules. Merus (Fig. 23C, D) with distal half of dorsal face bearing few short, transverse, sometimes denticulate ridges accompanied anteriorly by thick, long setae; dorsodistal margin protruding medially, with strong

spine flanked by few thick long setae; lateral and mesial faces granular or tuberculate; ventral surface covered with numerous tubercles, ventromesial and ventrolateral distal angles protruding, each bearing one or two strong blunt-tipped spines. Ischium (Fig. 23D) with numerous tubercles ventrolaterally. Coxa unarmed (Fig. 5D).

Left cheliped (Fig. 31A–D) slender. Dactyl equalling length of or slightly longer than palm, weakly granular, with tufts of long setae; terminating in strong corneous claw; entire cutting edge with minute corneous teeth (Fig. 34A). Fixed finger nearly smooth, with tufts of long setae; terminating in strong corneous claw; cutting edge (Fig. 34A) with numerous minute corneous teeth on proximal 0.65–0.70 and few minute, blunt-tipped calcareous teeth interspersed with few, minute corneous teeth on distal 0.30–0.35. Palm 0.70–0.75 length of carpus, granular dorsally and laterally, but tuberculate mesially. Carpus elongate, equalling length of merus; dorsal surface with scattered granules or tubercles, dorsolateral and dorsomesial margins straight, each armed with row of tubercles or spiniform tubercles. Merus (Fig. 31C, D) with dorsal, lateral, and mesial surfaces granular; dorsodistal angle produced, with small acute spine flanked by few, thick long setae, dorsal face with few short, setose transverse ridges on distal 0.30–0.35 and row of several long stiff setae on proximal 0.60; ventral surface covered with numerous blunt or spiniform tubercles, ventromesial and ventrolateral distal angles each with strong spine. Ischium (Fig. 31D) and coxa (Fig. 5D) unarmed.

Second and third pereopods (Figs 6A, B) similar, but third appreciably longer, in particular, dactyls and propodi of third much longer, 1.35–1.40 and 1.15–1.20 lengths respectively, than of those of second. Dactyls (Fig. 36A) blade-shaped, very broad; long, equalling length (second) or 1.05–1.10 length (third) of propodi; left 1.20–1.30 (second) or 1.05–1.10 (third) times as long as right; each terminating in corneous claw; mesial faces strongly concave longitudinally, each with dorsal row of 24–27 (second) or 30–34 (third) and ventral row of 14–20 (second) or 18–24 (third) thick spiniform bristles and with scattered short setae; lateral face strongly convex, with scattered short setae. Propodi (Fig. 38A) long, 1.90 (second) or 2.15–2.20 (third) length of carpi; minutely granular laterally and mesially; mesial faces each with dorsal row of 2–4 (second) or 2–5 (third) and ventral row of 2–4 (second) or 1–3 (third) strong spine-like setae on distal 0.30 interspersed with several very fine setae, and dorsodistally with pair of strong spine-like setae. Carpi (Fig. 38A) short, 0.55–0.60 length of meri; dorsal surfaces covered with numerous granules or tubercles, dorsodistal angles each with 1–4 acute, strong spines; lateral surfaces granular; mesial faces nearly smooth. Meri (Fig. 40A–C) distinctly more swollen lateromesially in third, each with large spine on dorsodistal margin medially, dorsal face subdistally with second large spine, sometimes accompanied mesially by spinule, followed posteriorly by third large spine slightly displaced laterally, each flanked by one or two thick long setae, remainder of dorsal surface with irregular rows of thick long setae; ventrolateral distal margins each armed with acute spine, ventromesial distal margins unarmed; ventral faces granular or tuberculate.

Fourth pereopod (Fig. 42A, B) with dactyl bearing 3–6 very long corneous spines on ventral margin and with prominent preungual process covered by dense short setae apically; propodal rasp along 0.70–0.85 length of ventral margin; carpus with tiny blunt-tipped dorsodistal spine or unarmed. Male with right coxa of fifth pereopods bearing very long sexual tube with forked tip curving over dorsal surface of abdomen toward left side (Fig. 5A, C, F); gonopore of left coxa with vas deferens only slightly protruding and with long setae laterally (Fig. 5F); female with coxae each bearing transverse rows of very long setae (Fig. 5G).

Sternite of third pereopods (Fig. 5E) with broad anterior lobe, semitriangular, with setae anteriorly. Sternite of fifth pereopods with pair of small round projections (Fig. 5F).

Uropods (Fig. 6K) with right protopod bearing indentation or spinules posteriorly; left protopod unarmed.

Telson (Fig. 44A) with posterior lobes separated by broad median cleft, each terminating in strong corneous spine, mesial margins fringed with very short setae, lateral margins each with pair of thick long setae.

#### *Sexual dimorphism*

The right cheliped of female (Fig. 23E–H) is more slender than and differs in armature from that of the male as follows: dactyl long, 1.30–1.35 length of palm, terminating in strong corneous claw, cutting edge (Fig. 29B) with large, blunt-tipped calcareous tooth subproximally, numerous minute calcareous teeth on proximal 0.65–0.70, minute corneous teeth on distal 0.30–0.35; fixed finger terminating in strong corneous claw, cutting edge (Fig. 29B) with numerous minute calcareous teeth on proximal 0.65–0.70 and few, widely spaced calcareous teeth interspersed with few minute corneous teeth on distal 0.30–0.35; palm 0.80–0.85 length of carpus; carpus equalling length of merus; merus (Fig. 23G, H) with dorsal face bearing row of thick long setae, dorsodistal angle produced; and ischium (Fig. 23H) with strong subdistal spine ventrolaterally.

#### *Colouration*

Not known.

#### *Shell*

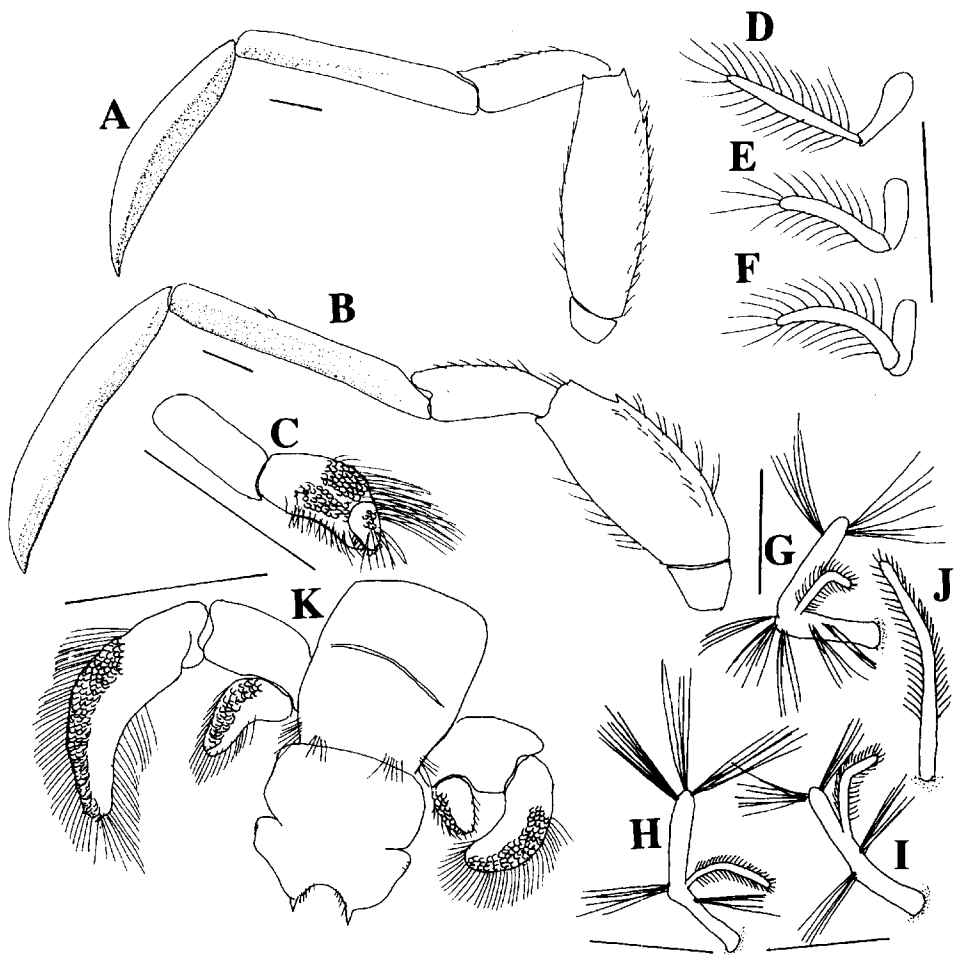
*Niotha* sp., *Naticarius* sp.

#### *Distribution*

Gulf of Martaban, Myanmar; ?Gulf of Mannar, Sri Lanka (see remarks); ?Torres Strait, Arafura Sea (see remarks); ?Providence Island and Cargados Carajos, western Indian Ocean (see remarks).

#### *Affinities*

*Hemipagurus ensifer* is distinguished from all other species of the *Hemipagurus ensifer*-group in having very broad



**Fig. 6.** *Hemipagurus ensifer* (Henderson), comb. nov.: *A-F*, K, lectotype male, SL = 2.40 mm, Gulf of Martaban, Myanmar, NHM 1888.34; *G-J*, paralectotype female, SL = 2.45 mm, Gulf of Martaban, Myanmar, NHM 1888.34. *A*, second pereopod (left, lateral view); *B*, third pereopod (left, lateral view); *C*, fifth pereopod; *D-F*, first to third pleopods; *G-J*, first to fourth pleopods; *K*, tergite of sixth abdominal somite, uropods and telson. Scale bars = 1.0 mm.

ambulatory dactyls (Fig. 36*A*), stout antennular peduncles (Fig. 19*A*), mesially expanded antennal peduncles (Fig. 21*A, B*), short preungual processes of the fourth pereopods that do not exceed the terminal claws of the dactyls (Fig. 42*A, B*) and very long spines on the ventral margins of the dactyls (Fig. 42*B*).

#### Remarks

The male specimen in the best condition is here designated as the lectotype for the stability of the nomenclature. The remaining specimens are paralectotypes.

Gordan's (1956) references to *Catapagurus ensifer* were a compilation from the literature and included taxa other than *Hemipagurus ensifer sensu stricto*.

Southwell (1906) reported five specimens of *Catapagurus ensifer* from the Gulf of Mannar, coast of Ceylon (now Sri Lanka), without comment, and these could

not be located. The specimens reported by Laurie (1926) as *C. ensifer* from the western Indian Ocean (an ovigerous female from Providence Is. and a male from Cargados Carajos) collected during the H. M. S. Sealark Expedition have also been lost (Drs Ray Symonds and Paul F. Clark, personal communication). Because it is not possible to determine the accuracy of the identification of these specimens, I can only questionably assign these specimens to *Hemipagurus ensifer sensu stricto*.

The specimens reported under the name of *Catapagurus ensifer* by Alcock (1905*a, b*) from India and by Lewinsohn (1969) from the Red Sea are *Hemipagurus alcocki* (McLaughlin, 1998) and *Hemipagurus lewinsohni*, sp. nov. respectively.

Haig and Ball (1988) reported *Catapagurus ensifer* from Torres Strait, Arafura Sea. According to these authors, those specimens were deposited at the National Institute of



Oceanography, Jakarta, Indonesia. Dr Dwi Listyo Rahayu searched for the specimens at my request without success. Similarly, most of Haig's collection were deposited at the Allan Hancock Foundation and presumably transferred subsequently to the Natural History Museum of Los Angeles County. Dr George E. Davis of that museum searched for the *Catapagurus* specimens at my request without success. They have probably been lost.

***Hemipagurus granulatus*** (Edmondson), comb. nov.

(Figs 1E, 3, 7, 17B, 19B, 21C–D, 22B, 24, 29C–D, 31E–H, 34B, 36B, 38B, 40D–H, 42C–D, 44B, 49)

*Catapagurus granulatus* Edmondson, 1951: 198, fig. 8, a–f. – Gordan 1956: 307 (list).

**Material examined**

**Holotype.** **Hawaii:** ♂, SL = 2.58 mm, off Bird Island, 58–79 m, BPBM 5446.

**Paratypes.** **Hawaii:** 2 ♂, SL = 2.00, 2.05 mm, off the south coast of Oahu, 36–49 m, BPBM 5514.

**Additional material.** **Hawaii:** 1 ♀, south-east of Honolulu Light, south coast of Oahu, USNM 291232; 1 ovi. ♀, Nihoa Island, USNM 291233; 1 ♂, Auau Channel and Mokuhooniki Islet between Maui Island and Lanai Island, USNM 291229; 2 ♂, south-east of Nawiliwili Light, Kauai Island, USNM 291237.

**Redescription**

Shield (Fig. 7A) 1.10–1.15 times broader than long; anterior margin between rostrum and lateral projections concave, anterolateral margins rounded; lateral margin convex; posterior margin truncate; dorsal surface slightly convex, with pair of longitudinal rows of setae tufts and transverse rows of setae tufts anteriorly and posteriorly; rostral lobe (Fig. 17B) very broad, overreached by lateral projections; lateral projections (Fig. 17B) triangular, each terminating in acute spine. Posterior carapace (Fig. 7A) with very narrow posterolateral plates and very short posteromedian plate. Branchiostegites (Fig. 7B) not calcified, unarmed; dorsal portions of distal margins slightly protruding.

Ocular peduncles (including corneas) (Figs 7A, 17B) 0.65–0.70 length of shield, with weak medial constriction; dorsal and mesial surfaces with few stiff short setae, distal margins of dorsomesial faces fringed with moderately long stiff setae. Corneas (Fig. 17B) dilated. Ocular acicles (Fig. 17B) moderately long, narrowly triangular, acute; reaching proximal 0.40–0.50 length of ocular peduncles; widely separated basally by breadth of rostral lobe; mesial and lateral margins with several very long setae and few short setae respectively.

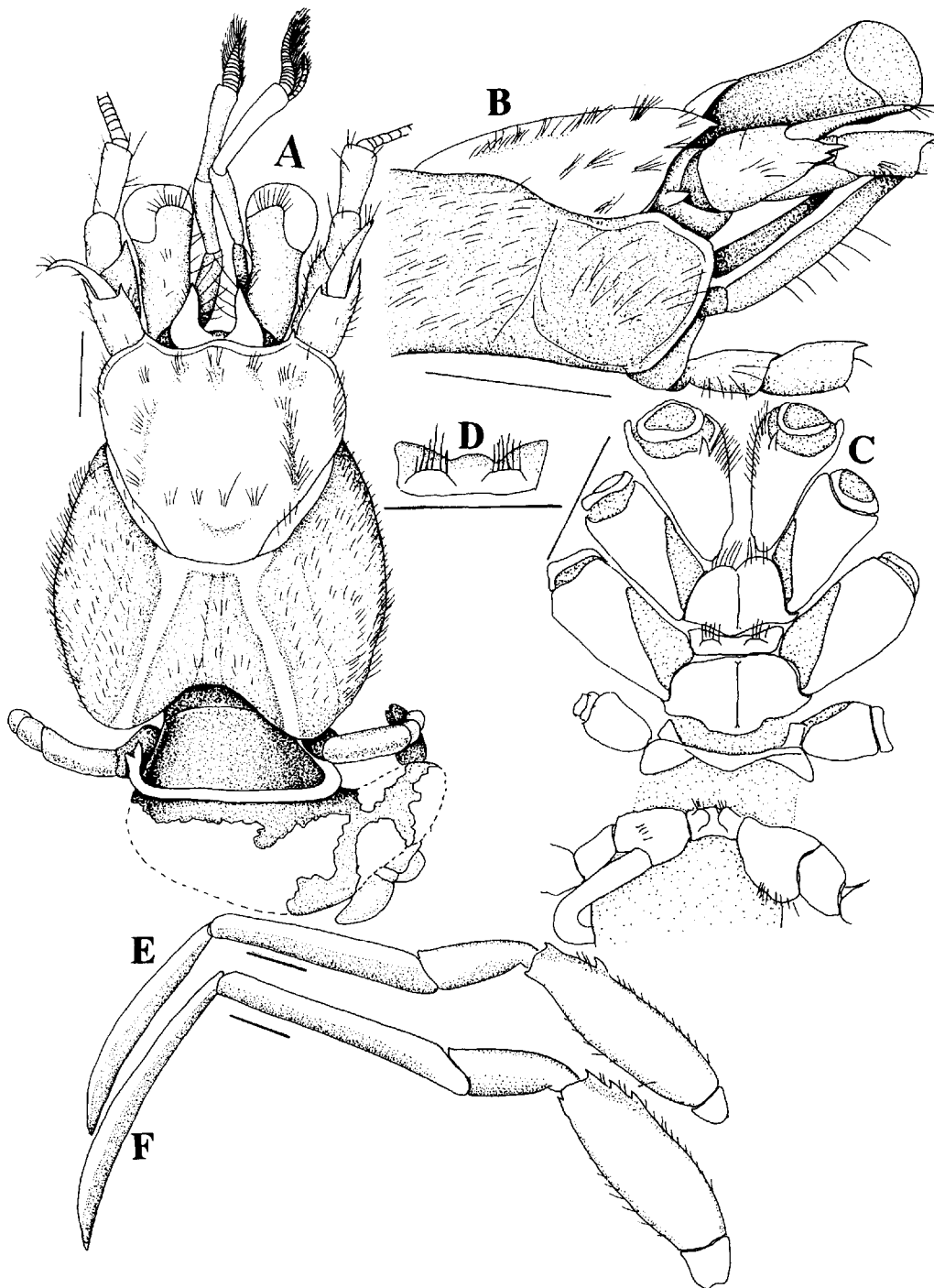
Antennular peduncles (Figs 7A, 19B) long, when fully extended second peduncular segment exceeding distal margins of corneas by approximately 0.50–0.60 own length; ultimate segment with dorsolateral margin bearing short setae distally; penultimate segment unarmed; basal segment

with acute spine at ventrodistal mesial angle. Antennal peduncles (Figs 7A, 21C, D) slender, moderately long, when fully extended exceeding distal margins of corneas by approximately 0.30–0.40 length of ultimate segment; fifth and fourth segments unarmed; third segment with ventrodistal angle produced; second segment with dorsolateral distal angle produced, terminating in strong spine accompanied ventrally by short accessory spine; dorsomesial distal angle with strong spine; first segment with strong hook-shaped spine laterally and strong acute spine at ventrodistal margin. Antennal acicles (Fig. 21C) moderately short, not reaching distal margins of corneas; slender, slightly to distinctly arcuate. Antennal flagella very long, 6–8 times of shield, composed of 80–100 articles, each article with one or two very short setae on distal margins of lateral and mesial faces.

Third maxilliped with merus bearing acute dorsodistal spine (Fig. 4G); ischium (Fig. 22B) with reduced crista dentata, composed of 5–8 teeth and strong accessory tooth; basis (Fig. 22B) with 3–6 acute teeth.

Right cheliped of male (Fig. 24A–D) long and slender; chela flattened dorsoventrally; propodal–carpal articulation twisted clockwise approximately 45°. Dactyl short, 0.70–0.75 length of palm; dorsal face slightly convex, with few tufts of long setae, dorsomesial margin with tufts of long setae; cutting edge (Fig. 29C) with large calcareous teeth subproximally, several calcareous teeth of various sizes medially, many small corneous teeth on distal 0.3. Fixed finger terminating in small calcareous claw; cutting edge (Fig. 29C) with numerous calcareous teeth of various sizes. Palm 0.75–0.85 length of carpus, dorsal surface covered with dense granules and ventromesially with spiniform tubercles. Carpus elongate, approximately equalling length of merus; dorsal surface flat, covered with numerous blunt or spiniform tubercles, dorsolateral and dorsomesial margins straight, each forming ridge armed with distinct row of spiniform tubercles; lateral, mesial, and ventral surfaces covered with minute granules. Merus (Fig. 24C, D) with dorsal face bearing irregular rows of thick long setae, dorsodistal margin medially with strong upturned spine directed slightly obliquely lateral and flanked by few, very thick long setae; ventral surface covered with numerous spiniform tubercles, ventromesial margin with row of granules, ventromesial and ventrolateral distal angles each with acute spine. Ischium (Fig. 24D) with strong, simple or bifid ventrolateral subdistal spine. Coxa (Fig. 7C) with strong spine at ventromesial distal angle.

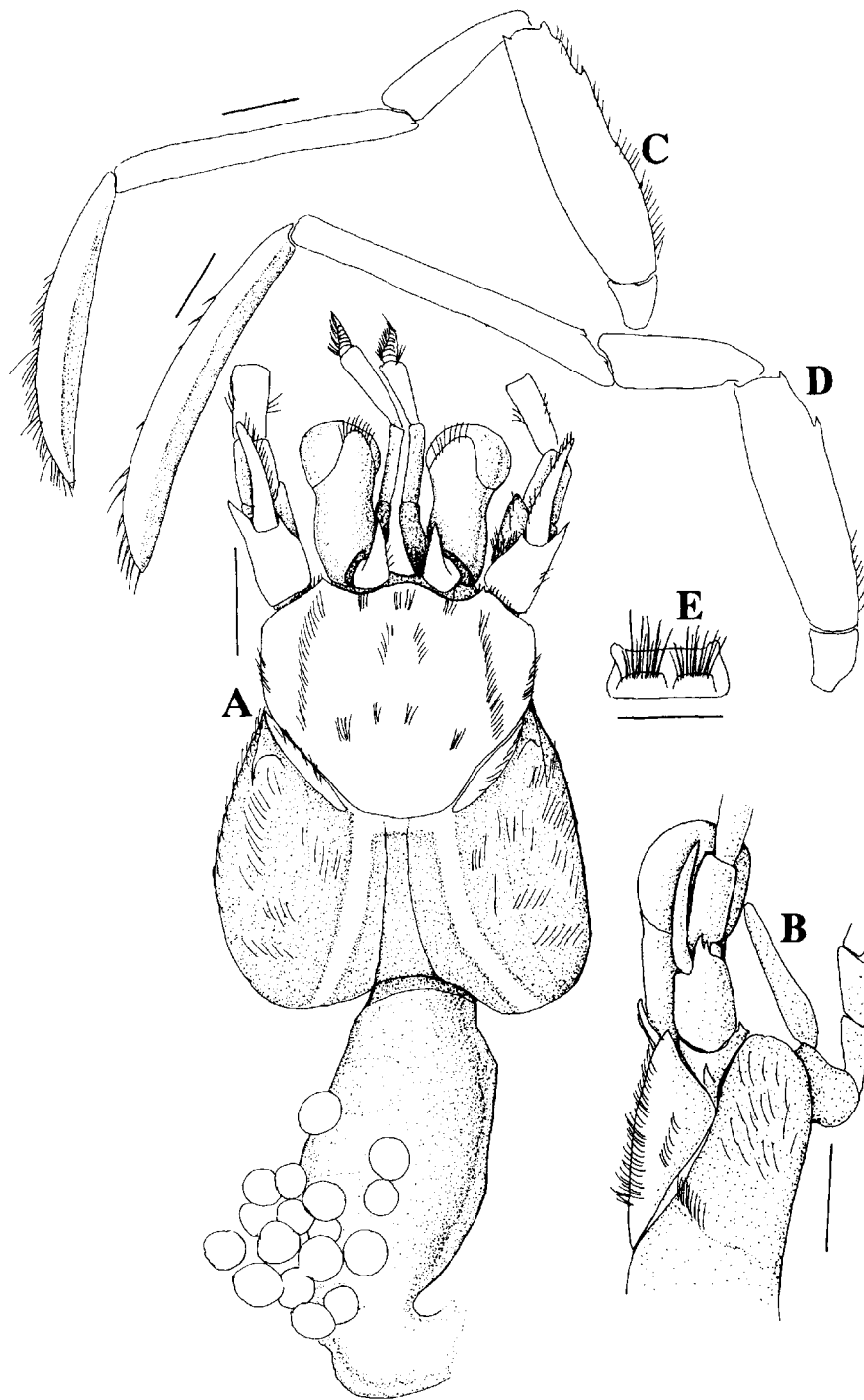
Left cheliped (Fig. 31E–H) 0.95–1.00 length of right; more slender than right, particularly palm and carpus 0.80–0.85 and 0.60–0.65 maximum widths respectively. Dactyl long, 1.10–1.15 length of palm, terminating in strong corneous claw; dorsal and mesial surfaces granular, with tufts of long setae; entire cutting edge with minute corneous teeth (Fig. 34B). Fixed finger terminating in strong corneous



**Fig. 7.** *Hemipagurus granulatus* (Edmondson), comb. nov.: holotype male, SL = 2.58 mm, off Bird Island, Hawaii, BPBM No. 5446. *A*, dorsal view; *B*, anterior portion of cephalothorax and part of cephalic appendages (right, lateral view); *C*, ventral view of cephalothorax; *D*, anterior lobe of sternite of third pereopods; *E*, second pereopod (left, lateral view); *F*, third pereopod (left, lateral view). Scale bars = 1.0 mm.

claw; dorsal and lateral surfaces granular, with tufts of long setae; cutting edge (Fig. 34*B*) with numerous minute corneous teeth on proximal 0.65–0.70, few calcareous teeth interspersed, few minute corneous teeth on distal 0.35. Palm

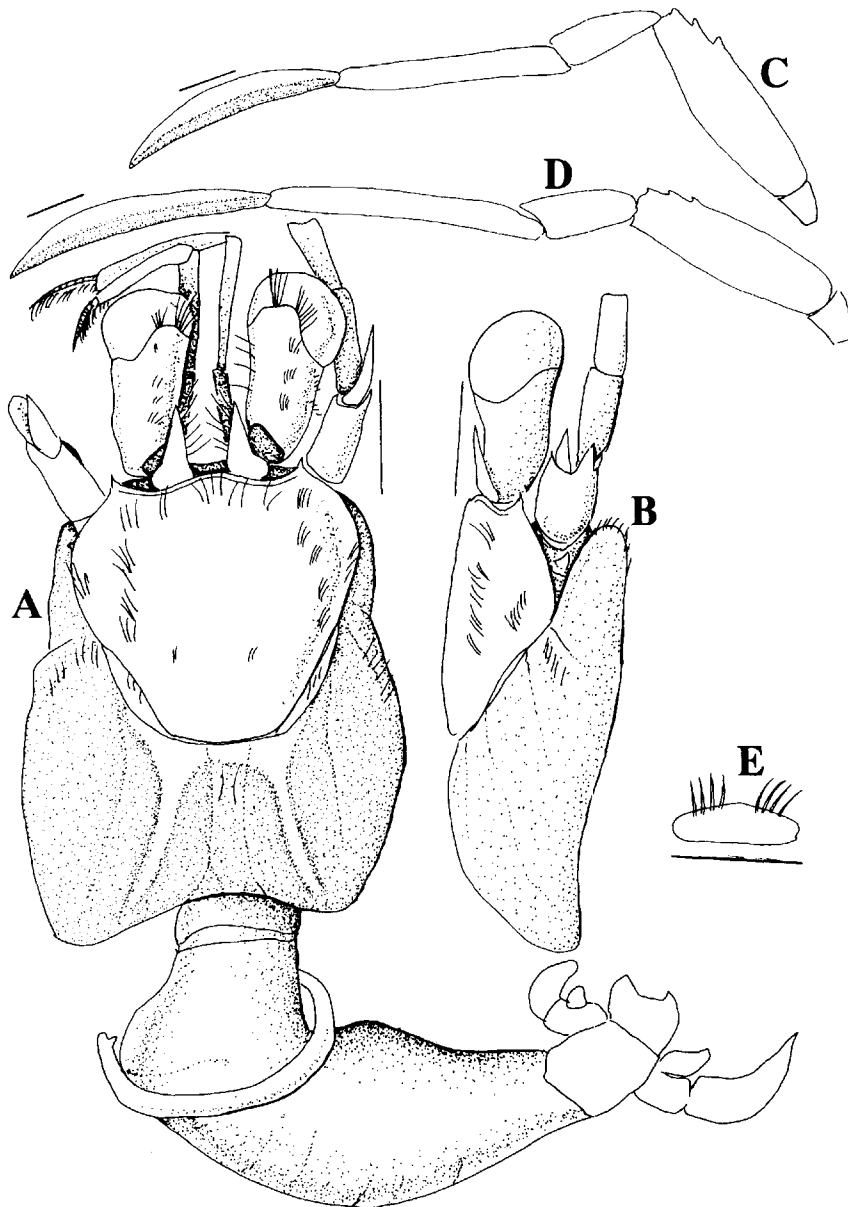
short, 0.55–0.60 length of carpus; dorsal and lateral surfaces densely granular, with scattered long setae. Carpus as long as merus; dorsal surface covered with numerous blunt or spiniform tubercles, dorsolateral and dorsomesial margins



**Fig. 8.** *Hemipagurus haigae*, sp. nov.: holotype female (ovigerous), SL = 2.15 mm, Torres Strait, Arafura Sea, AM P37730. *A*, dorsal view; *B*, anterior portion of cephalothorax and part of cephalic appendages (right, lateral view); *C*, second pereopod (left, lateral view); *D*, third pereopod (left, lateral view); *E*, anterior lobe of sternite of third pereopods. Scale bars: *A–D* = 1.0 mm; *E* = 0.5 mm.

straight, each forming ridge armed with distinct row of spiniform tubercles. Merus (Fig. 31*G, H*) with lateral and mesial surfaces granular; dorsal face with irregular rows of very thick long setae, dorsodistal angle with strong upturned spine flanked by few very thick long setae; ventral surface

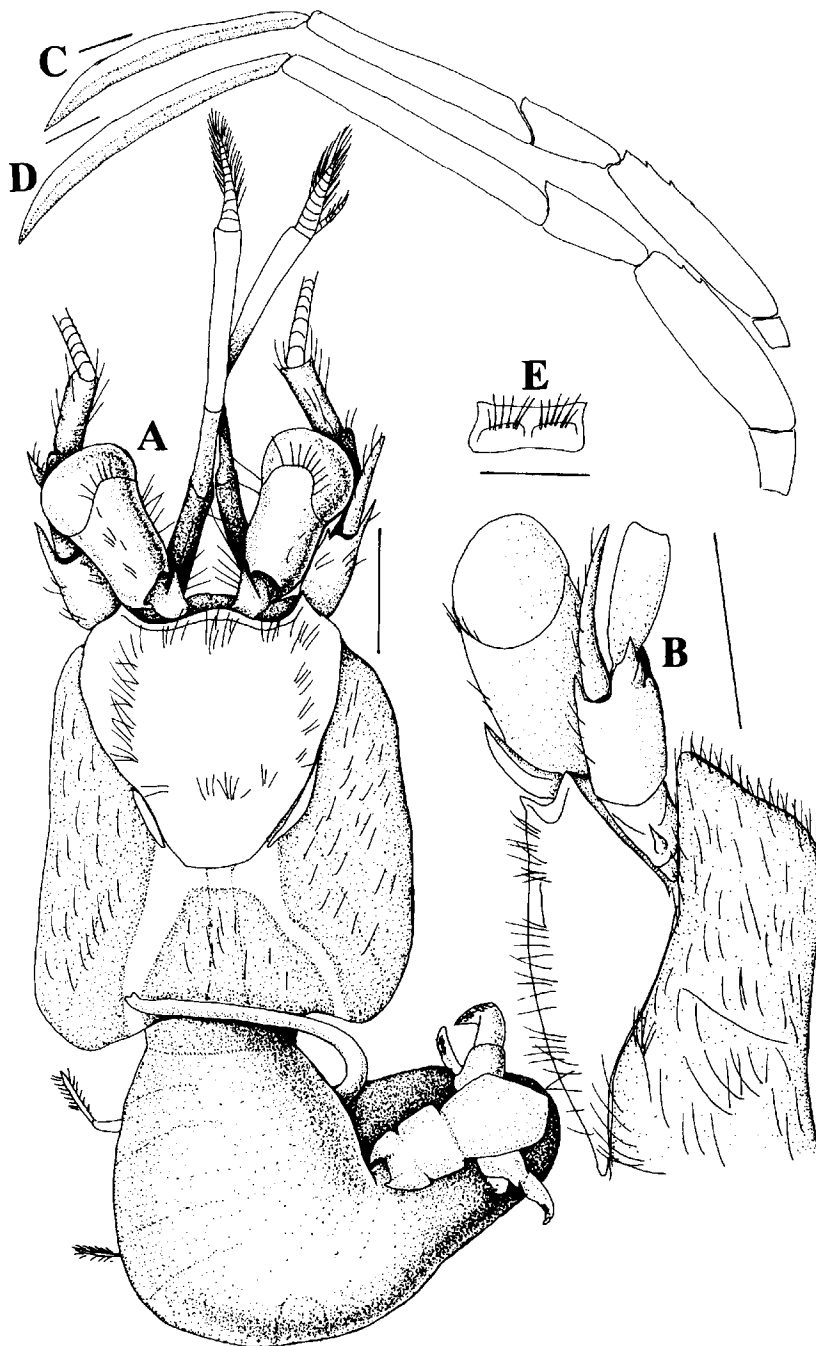
covered with numerous spiniform tubercles, ventromesial and ventrolateral distal angles each bearing acute spine. Ischium (Fig. 31*H*) with strong subdistal spine ventrolaterally. Coxa (Fig. 7*C*) with strong spine at ventromesial distal angle.



**Fig. 9.** *Hemipagurus kosugei*, sp. nov.: holotype male, SL = 2.45 mm, Ishigaki-jima, Okinawa, CBM-ZC 6205. *A*, dorsal view; *B*, cephalothorax and part of cephalic appendages (right, lateral view); *C*, second pereopod (left, lateral view); *D*, third pereopod (left, lateral view); *E*, anterior lobe of sternite of third pereopods. Scale bars for *A–D* = 1.0 mm. Scale bar: *E* = 0.5 mm.

Second and third pereopods (Fig. 7*E, F*) similar except for armature of meri; third appreciably longer than second, particularly dactyls (1.25–1.30 length of second) and propodi (1.15–1.20 length of second). Right pereopod 1.05–1.20 (second) or 1.05–1.15 (third) length of left. Dactyls (Fig. 36*B*) blade-shaped, moderately broad, long, 1.10–1.15 (second) or 1.20 (third) length of propodi; each terminating in strong corneous claw; mesial faces strongly concave longitudinally, each with dorsal row of 27–36 (second) or

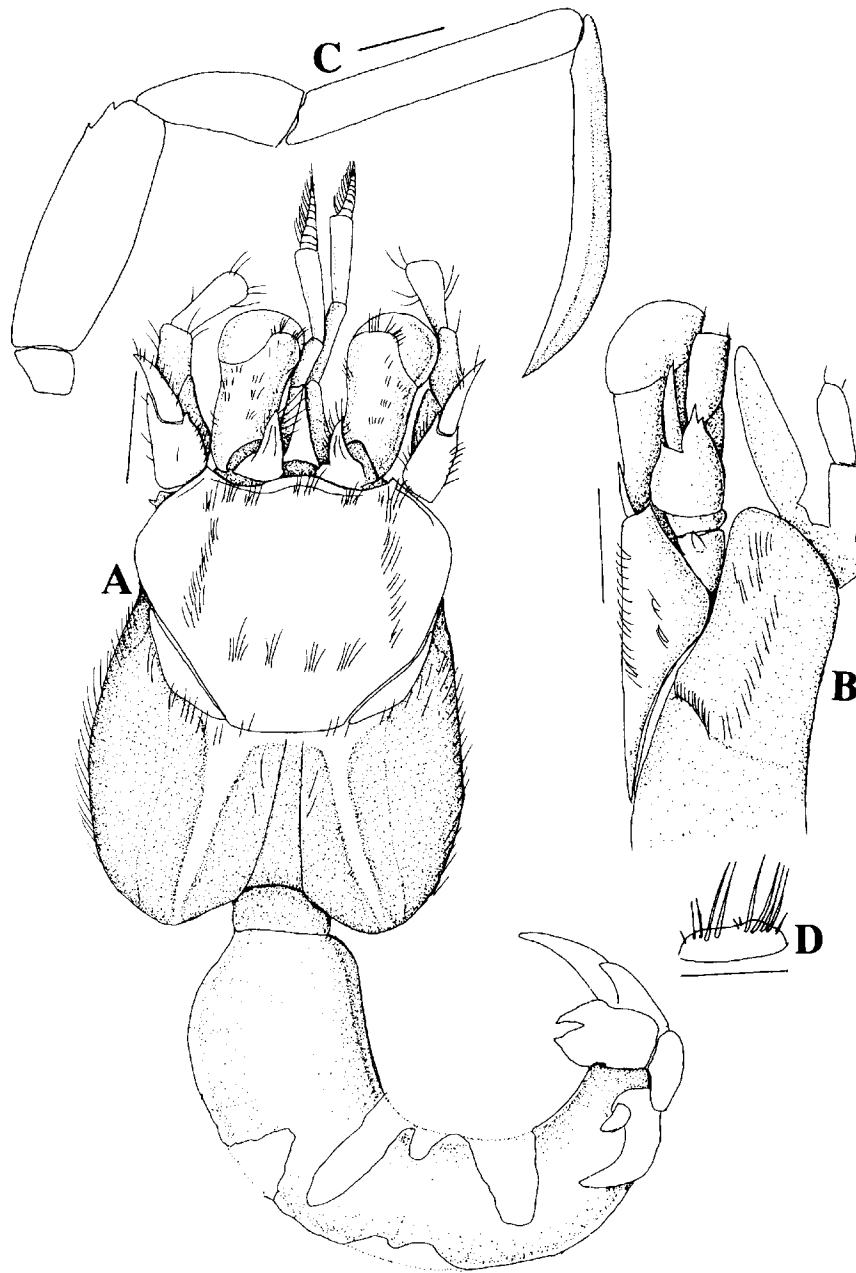
25–31 (third) and ventral row of 20–24 (second) or 19–23 (third) thick spiniform bristles and scattered short setae; lateral faces strongly convex longitudinally, with scattered setae. Propodi (Fig. 38*B*) long, 2.00–2.05 (second) or 2.40 (third) length of carpi, minutely granular dorsally, laterally and mesially; mesial faces each with dorsal row of 2–4 (second) or 1–3 (third) and ventral row of 2–4 (second) or 1–5 (third) strong spine-like setae, interspersed with several very thin, short setae, and dorsodistally with pair of strong



**Fig. 10.** *Hemipagurus lewinsohni*, sp. nov.: holotype male, SL = 1.90 mm, Dahllark Archipelago, Red Sea, TAU-1390. *A*, dorsal view; *B*, anterior portion of cephalothorax and part of cephalic appendages (right, lateral view); *C*, second pereopod (left, lateral view); *D*, third pereopod (left, lateral view); *E*, anterior lobe of sternite of third pereopods. Scale bars: *A–D* = 1.0 mm; *E* = 0.5 mm.

spine-like setae. Carpi (Fig. 38*B*) short, 0.45–0.50 length of meri; each with dorsal surface covered with blunt or spiniform tubercles, dorsodistal angle with three or four acute spines; lateral and mesial surfaces covered with numerous granules. Meri (Fig. 40*D–H*) granular; dorsal

margins each with strong spine near distal margin, dorsal faces of second (Fig. 40*D*) each with very large spine subdistally, dorsal faces of third (Fig. 40*F, H*) each with very large spine subdistally followed posteriorly by additional very large spine slightly displaced laterally, dorsal spines of



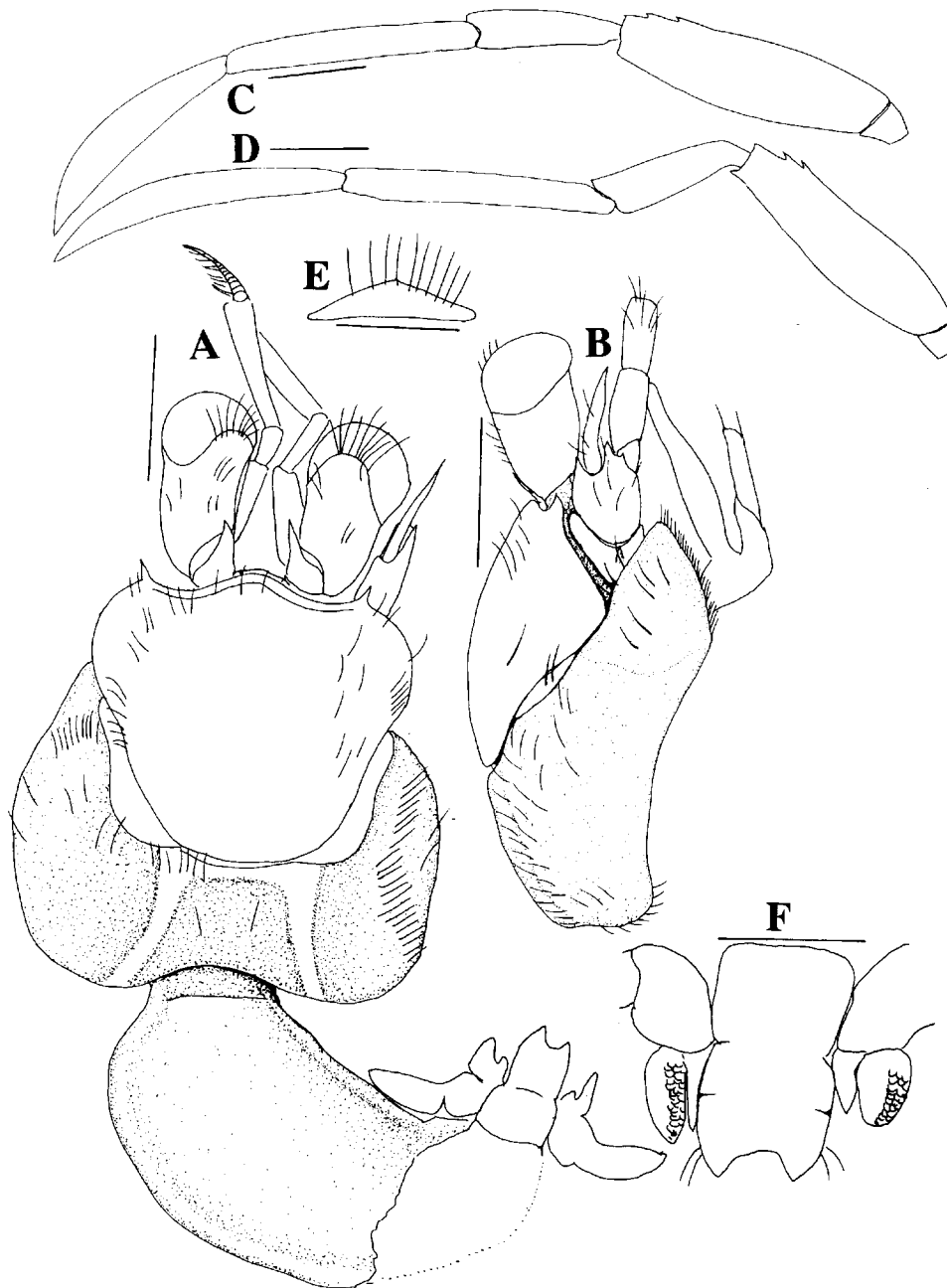
**Fig. 11.** *Hemipagurus maclaughlinae*, sp. nov.: holotype female (ovigerous), SL = 2.40 mm, Northeast of Mahé, Seychelles, RMNH D47877. *A*, dorsal view; *B*, anterior portion of cephalothorax and part of cephalic appendages (right, lateral view); *C*, third pereopod (right, lateral view); *D*, anterior lobe of sternite of third pereopods. Scale bars: *A*–*C* = 1.0 mm; *D* = 0.5 mm.

both second and third each flanked by one or two thick long setae, remainder of dorsal surfaces each with irregular row of thick long setae (Fig. 40*H*); ventrolateral distal margins each armed with acute spine, ventromesial distal margins unarmed; ventral faces covered with blunt or spiniform tubercles.

Fourth pereopod (Fig. 42*C, D*) with dactyl bearing four short corneous spines on ventral margin, with prominent preungual process covered by short setae apically; propodal

rasp 0.70–0.80 length of ventral margin; carpus with blunt-tipped spine at dorsodistal angle or spine vestigial. Male with right coxa of fifth pereopods bearing very long sexual tube with forked tip curving over dorsal surface of abdomen toward left side (Fig. 7*A*); left coxa with gonopore obscured by rows of dense short setae posteriorly and dense medium-length setae anteriorly.

Sternite of third pereopods (Fig. 7*C, D*) with broad anterior lobe, with two small projections fringed anteriorly



**Fig. 12.** *Hemipagurus albatrossae*, sp. nov.: holotype female, SL = 2.00 mm, Philippines, USNM 298349. *A*, dorsal view; *B*, cephalothorax and part of cephalic appendages (lateral view, right); *C*, second pereopod (left, lateral view); *D*, third pereopod (left, lateral view); *E*, anterior lobe of sternite of third pereopod; *F*, proximal portion of uropods. Scale bar: *A–D* = 1.0 mm; *E, F* = 0.5 mm.

with setae. Sternite of fifth pereopods (Fig. 7*C*) reduced with pair of round projections.

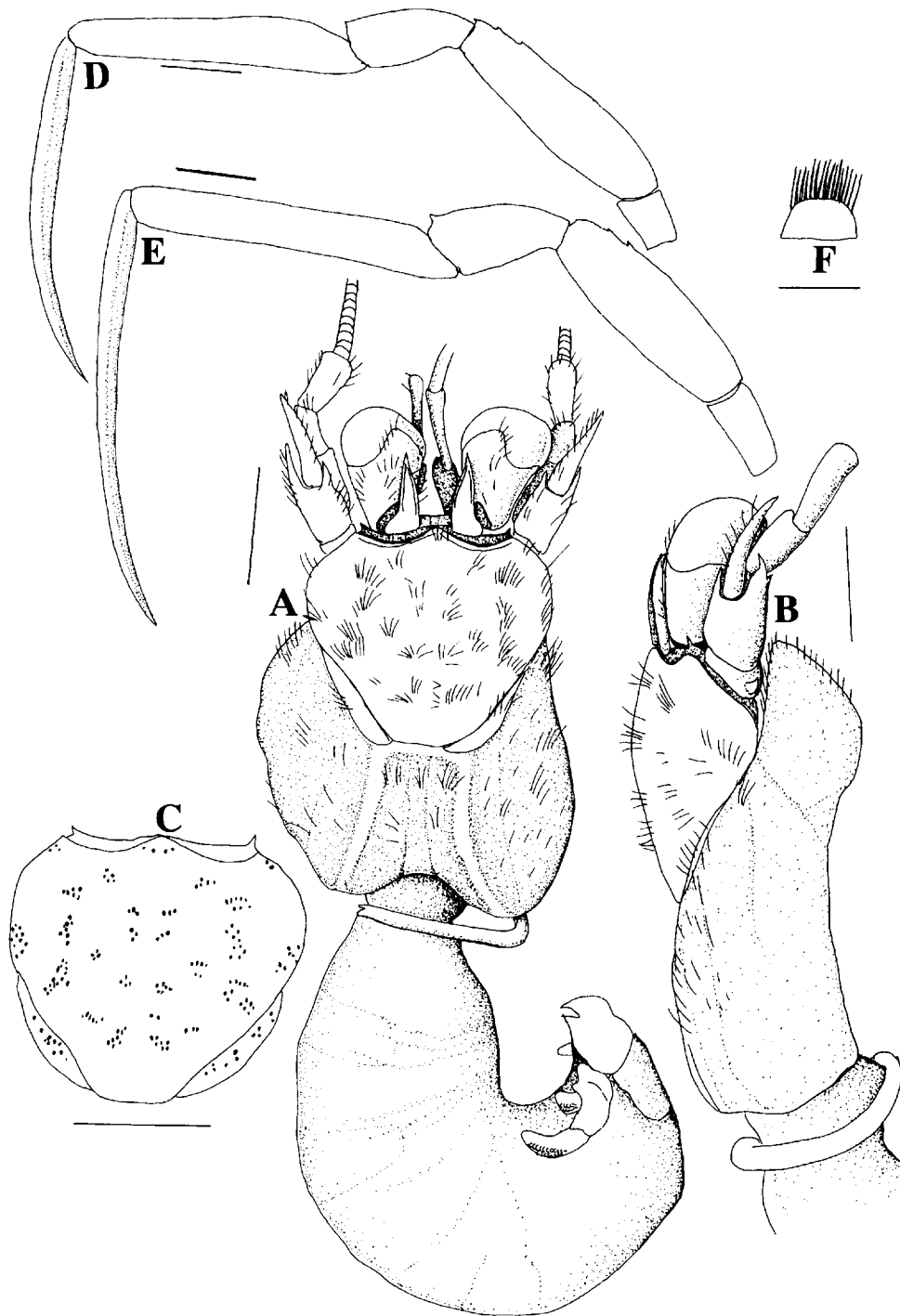
Uropodal protopods unarmed.

Telson (Fig. 44*B*) with posterior lobes separated by very broad, deep median cleft, terminal margins each with acute corneous spine, mesial margins fringed with very short

setae, and lateral margins each with pair of thick long setae.

#### *Sexual dimorphism*

Right cheliped of female (Fig. 24*E–H*) much more slender and less granular than that of male; cutting edges of dactyl



**Fig. 13.** *Hemipagurus japonicus* (Yokoya), comb. nov.: male, SL = 2.20 mm, Sagami Bay, Japan, NSMT-Cr 1474. *A*, dorsal view; *B*, cephalothorax, part of cephalic appendages and anterior portion of abdomen (right, lateral view); *C*, schematic diagram of position of setae on shield; *D*, second pereopod (left, lateral view); *E*, third pereopod (left, lateral view); *F*, anterior lobe of sternite of third pereopods. Scale bars: *A–E* = 1.0 mm; *F* = 0.5 mm.

and fixed finger (Fig. 29D) of female armed with numerous small calcareous teeth on proximal half and widely separated calcareous teeth interspersed with 1–3 corneous teeth on distal half.

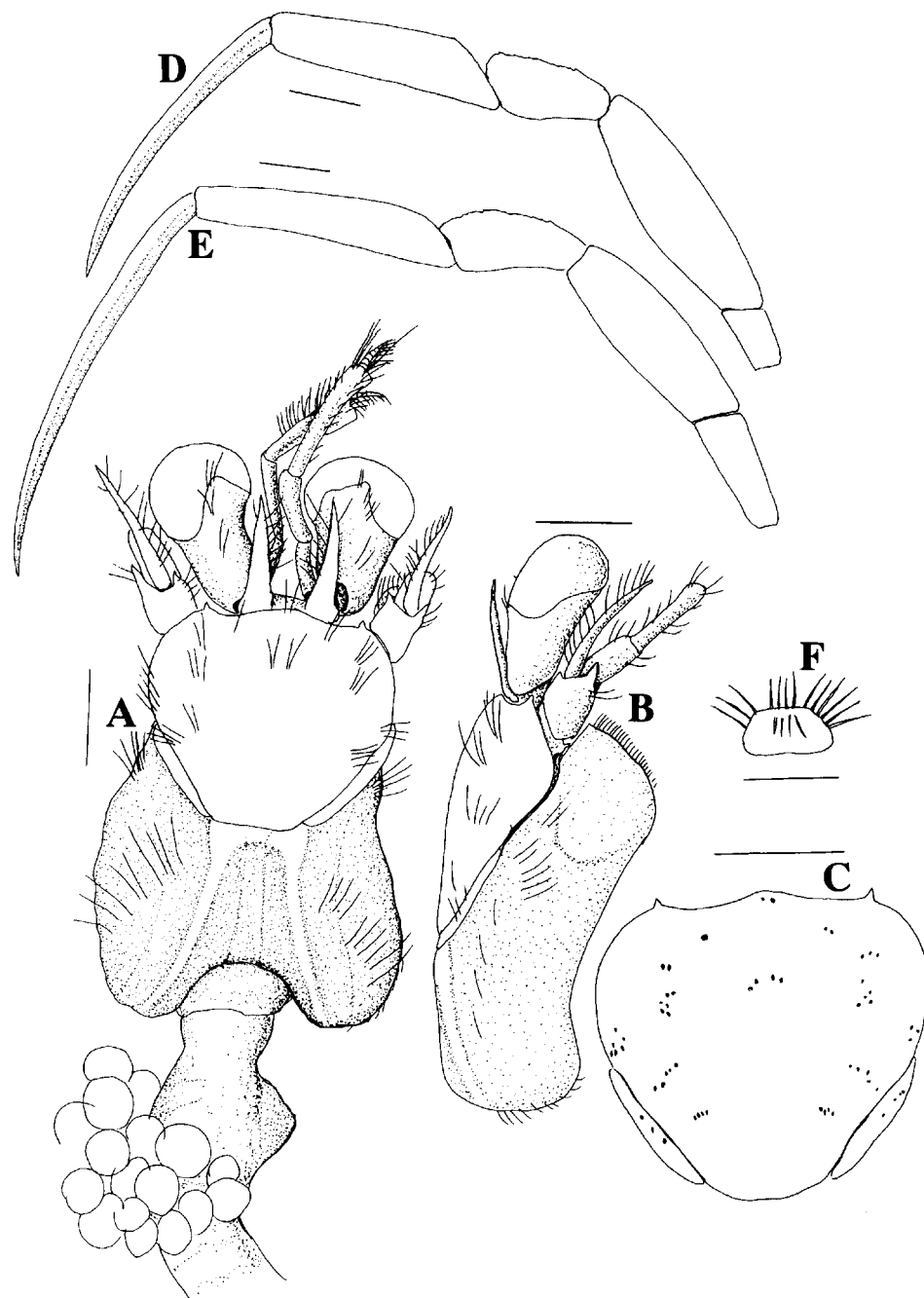
*Colouration*

Not known.

*Shell*

Not known.





**Fig. 14.** *Hemipagurus imperialis*, sp. nov.: holotype female (ovigerous), SL = 2.55 mm, Sagami Bay, Japan, NSMT-Cr 4080. *A*, dorsal view; *B*, cephalothorax and part of cephalic appendages (right, lateral view); *C*, schematic diagram of position of setae on shield; *D*, second pereopod (left, lateral view); *E*, third pereopod (left, lateral view); *F*, anterior lobe of sternite of third pereopods. Scale bars: *A–E* = 1.0 mm; *F* = 0.5 mm.

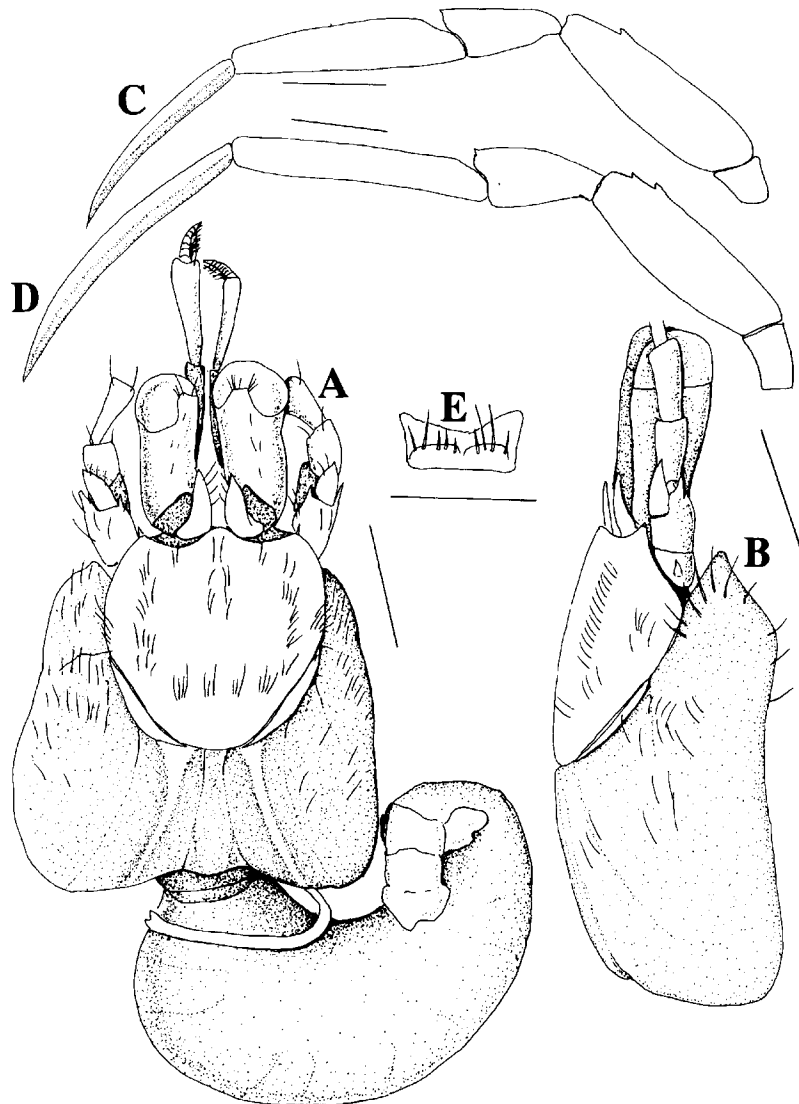
#### *Distribution*

Hawaii; 36–432 m.

#### *Affinities*

*Hemipagurus granulatus* is the only species among the *ensifer*-group that has a strong spine on the ventro-

mesial distal angle of the coxa of each cheliped in males (Fig. 7C). In other species, the coxae of the chelipeds are unarmed. However, this spine is sometimes vestigial in small females and juveniles of *H. granulatus*, in which case, they can be distinguished from other species by having only one subdistal dorsal



**Fig. 15.** *Hemipagurus hirayamai*, sp. nov.: holotype male, SL = 1.85 mm, Suruga Bay, Japan, CBM-ZC 6208. *A*, dorsal view; *B*, cephalothorax and part of cephalic appendages (right, lateral view); *C*, second pereopod (left, lateral view); *D*, third pereopod (left, lateral view); *E*, anterior lobe of sternite of third pereopods. Scale bars: *A–D* = 1.0 mm; *E* = 0.5 mm.

spine on the merus of the second pereopods (Fig. 40D); all other species of the *ensifer*-group have at least two spines on the same areas (Fig. 40A–C, E–Z). Further, the dorsodistal spines of the meri of the chelipeds of male *H. granulatus* are upturned and directed slightly obliquely in a lateral direction (Fig. 24C, 31G). In contrast, in all other *ensifer*-group species these spines are directed horizontally toward the anterior.

#### Remarks

The female specimens are first reported for this species.

#### *Hemipagurus haigae*, sp. nov.

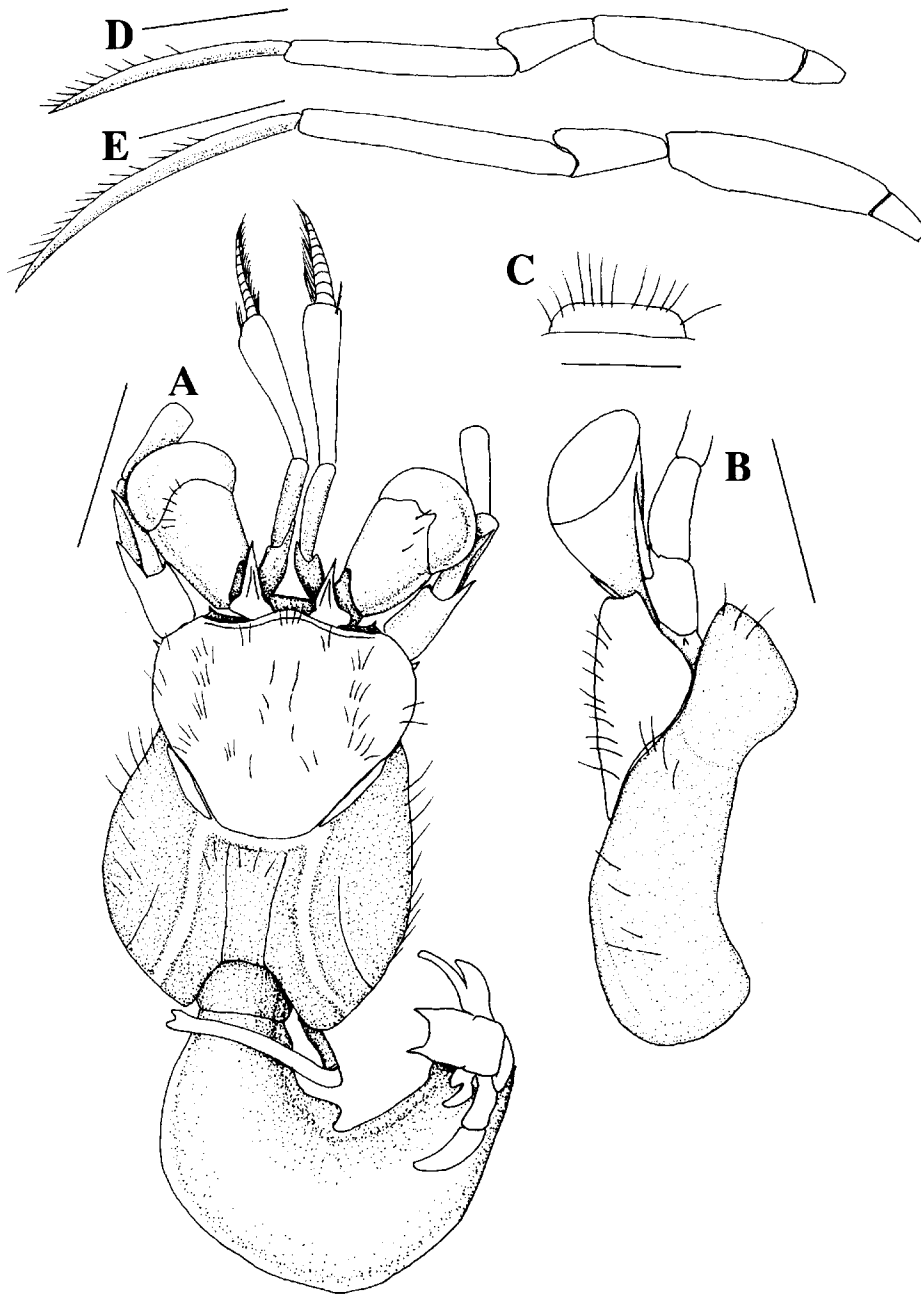
(Figs 8, 17C, 19C, 21E–F, 22C, 25A–D, 29E, 31I–L, 34C, 36C, 38C, 40I–K, 42E–F, 44C, 48)

*Catapagurus* sp. Haig & Ball, 1988: 181, fig. 10A–F. – McLaughlin (in press).

#### Material examined

*Holotype.* **Arafura Sea:** ovi. ♀, SL = 2.15 mm, Torres Strait, St. 3 of Alpha Helix Expedition, 10°39.0'S 140°29.5'E, trawl, 50 m, 16.iii.1975, AM P37730 (see Haig and Ball 1988: 152, fig. 1 for map).

*Paratypes.* **Philippines:** 3 ovi. ♀, SL = 1.65, 2.10, 2.15 mm, St. 5104, Albatross Station, 2.1 km off north-east of Sueste Point Light, off



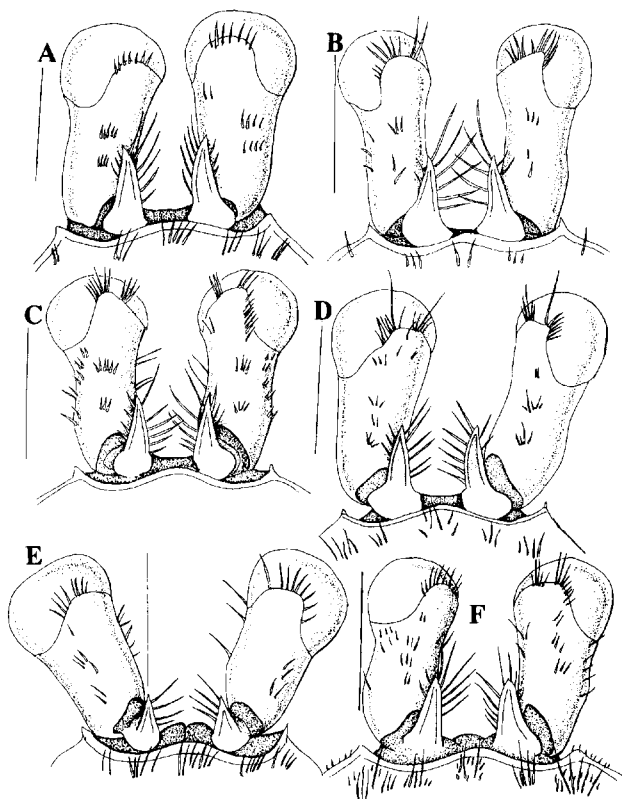
**Fig. 16.** *Hemipagurus toyoshioae*, sp. nov.: holotype male, SL = 1.10 mm, Amami-oshima Island, Japan, CBM-ZC 6203. *A*, dorsal view; *B*, cephalothorax and part of cephalic appendages (lateral view, right); *C*, anterior lobe of sternite of third pereopods; *D*, second pereopod (left, lateral view); *E*, third pereopod (left, lateral view). Scale bars: *A*, *B*, *D*, *E* = 1.0 mm; *C* = 0.25 mm.

southern Luzon, China Sea, 14°45'48"N 120°12'20"E, Tanner Beam Trawl, 59 m, 3.i.1908, USNM 298350.

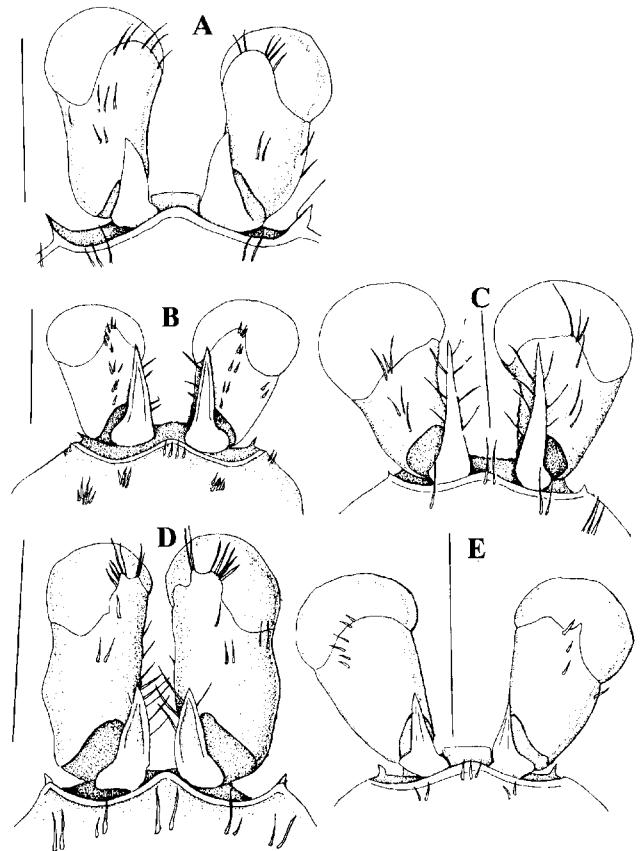
#### *Description*

Shield (Fig. 8*A*) 1.10–1.15 times broader than long; anterior margins between rostrum and lateral projections concave,

anterolateral margins sloping; dorsal surface slightly convex, with two pairs of longitudinal rows of setae tufts laterally and medially and transverse rows of setae tufts anteriorly and posteriorly; rostral lobe (Fig. 17*C*) very broad, overreached by lateral projections; lateral projections (Fig. 17*C*) triangular, each terminating in acute spine. Posterior



**Fig. 17.** Ocular peduncles and ocular acicles: *A*, *Hemipagurus ensifer* (Henderson), comb. nov., lectotype; *B*, *H. granulatus* (Edmondson), comb. nov., holotype; *C*, *H. haigae*, sp. nov., holotype; *D*, *H. kosugei*, sp. nov., holotype; *E*, *H. lewinoehni*, sp. nov., holotype; *F*, *H. maclaughlinae*, sp. nov., holotype. Scale bars = 1.0 mm.



**Fig. 18.** Ocular peduncles and ocular acicles: *A*, *Hemipagurus albatrossae*, sp. nov., holotype; *B*, *H. japonicus* (Yokoya), comb. nov., NSMT; *C*, *H. imperialis*, sp. nov., holotype; *D*, *H. hirayamai*, sp. nov., holotype; *E*, *H. toyoshioae*, sp. nov., holotype. Scale bars = 1.0 mm.

carapace (Fig. 8A) with very narrow posterolateral plates and very short posteromedian plate. Branchiostegites (Fig. 8A) not calcified, unarmed; anterior margins rounded.

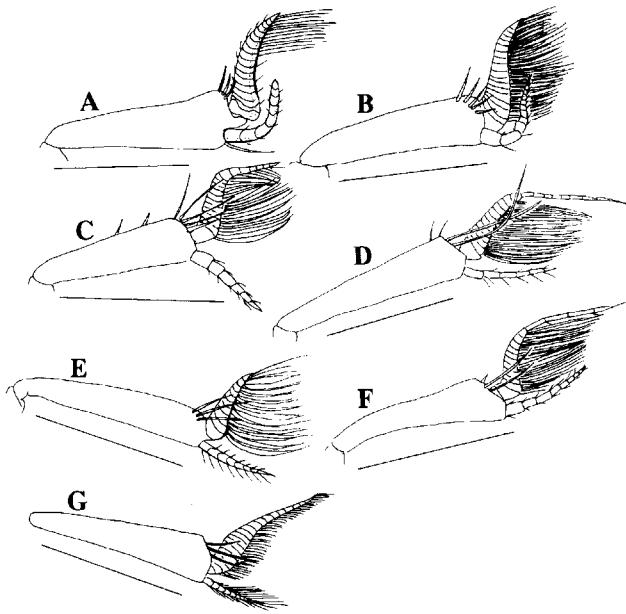
Ocular peduncles (including corneas) (Figs 8A, 17C) 0.55–0.70 times as long as shield, with medial constriction; dorsal and mesial surfaces with stiff short setae, distal margins of dorsomesial faces fringed with stiff setae. Corneas (Fig. 17C) dilated. Ocular acicles (Fig. 17C) moderately long, narrowly triangular, acute; reaching to proximal 0.35–0.45 length of ocular peduncles; widely separated basally by breadth of rostral lobe; mesial and lateral margins with several very long setae and few short setae respectively.

Antennular peduncles (Figs 8A, 19C) moderately long, when fully extended second peduncular segments exceeding distal margins of corneas by approximately half own length; ultimate segment with dorsolateral margin bearing few very long setae distally; penultimate segment unarmed; basal segment with acute spine at ventrodistal angle. Antennal peduncles (Figs 8A, 21E, F) moderately long, when fully extended exceeding distal margins of corneas by

approximately 0.30–0.40 length of ultimate segments; fifth and fourth segments unarmed; third segment with ventrodistal angle produced; second segment with dorsolateral distal angle produced, terminating in strong spine accompanied ventrally with submarginal small spine, dorsomesial distal angle with strong acute spine; first segment with strong hook-shaped spine laterally and acute spine at ventrodistal margin. Antennal acicles (Fig. 21E) long and slender, reaching well beyond level of corneas; slightly arcuate, blunt-tipped. Antennal flagella with full length unknown; articles each with one or two very short setae on distal margins of lateral and mesial faces.

Third maxilliped with merus bearing small dorsodistal spine; ischium (Fig. 22C) bearing moderately-reduced crista dentata, composed of 5–9 teeth and with strong accessory tooth; basis (Fig. 22C) with six acute teeth.

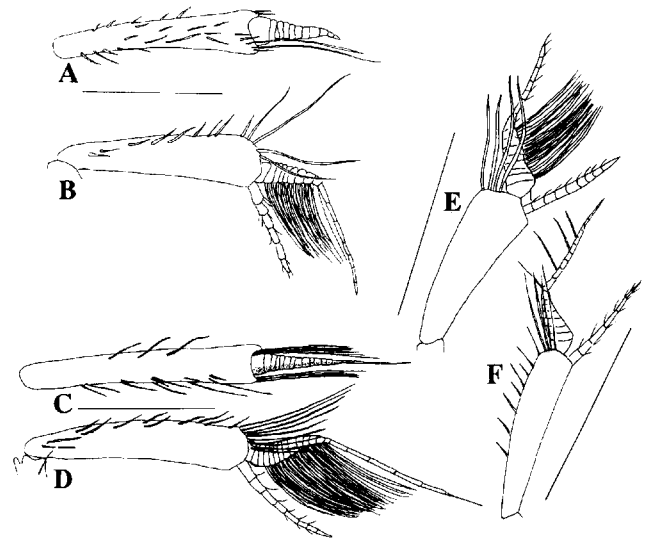
Right cheliped (Fig. 25A–D) of female slender, chela flattened dorsoventrally. Dactyl short, 0.65–0.75 length of palm, terminating in corneous claw; dorsal face slightly convex, with tufts of long setae; dorsomesial margin with tufts of long setae; cutting edge (Fig. 29E) with variously



**Fig. 19.** Distal portion of antennule (right, lateral view): *A*, *Hemipagurus ensifer* (Henderson), comb. nov., lectotype; *B*, *H. granulatus* (Edmondson), comb. nov., holotype; *C*, *H. haigae*, sp. nov., holotype; *D*, *H. kosugei*, sp. nov., holotype; *E*, *H. lewinsohni*, sp. nov., holotype; *F*, *H. maclaughlinae*, sp. nov., holotype; *G*, *H. albatrossae*, sp. nov., holotype. Scale bars = 1.0 mm.

sized calcareous teeth on entire margin and large calcareous tooth subproximally. Fixed finger granular, terminating in corneous claw; cutting edge (Fig. 29E) with minute calcareous teeth on proximal half and few calcareous teeth interspersed with two or three minute corneous teeth on distal half. Palm moderately short, 0.70–0.80 length of carpus; granular and with scattered short setae. Carpus equalling length of merus; dorsal face flat, with scattered granules or tubercles, dorsolateral and dorsomesial margins straight, each armed with distinct row of blunt or spiniform tubercles; lateral and mesial surfaces covered with granules or tubercles. Merus (Fig. 25C, D) with dorsal face bearing irregular rows of thick long setae, dorsodistal margin with strong spine flanked by few thick long setae; ventromesial and ventrolateral distal angles each with acute spine; ventral surface covered with numerous granules or tubercles. Ischium (Fig. 25D) with ventral surface slightly granular, with subdistal acute spine and thick long seta ventrolaterally. Coxa unarmed.

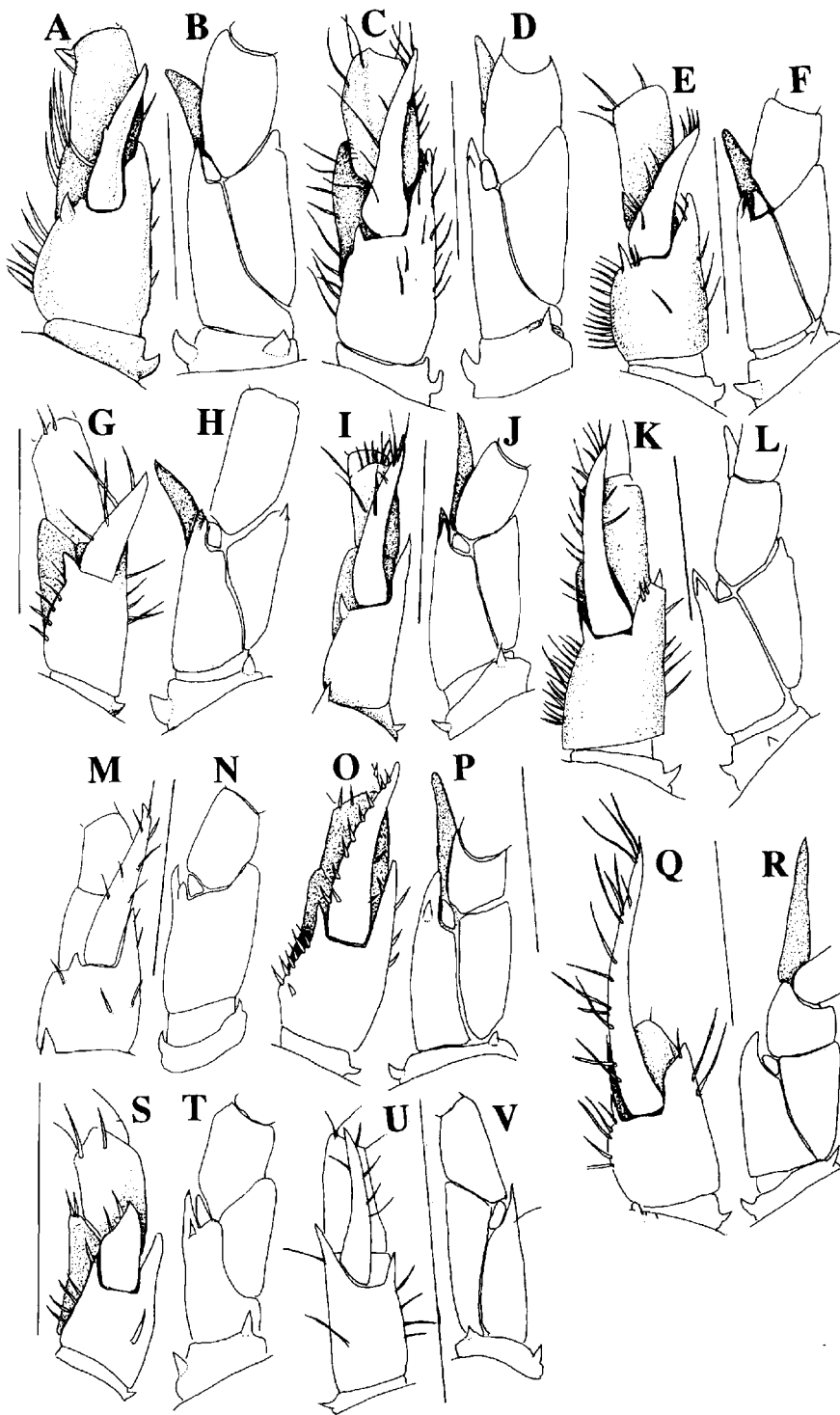
Left cheliped (Fig. 31I–L) much more slender than right. Dactyl long, 1.00–1.25 length of palm, weakly granular, with tufts of long setae; terminating in strong corneous claw; entire cutting edge with minute corneous teeth (Fig. 34C). Fixed finger nearly smooth, with tufts of long setae; terminating in strong corneous claw; cutting edge (Fig. 34C) with few, widely spaced calcareous teeth interspersed with several minute corneous teeth. Palm moderately short,



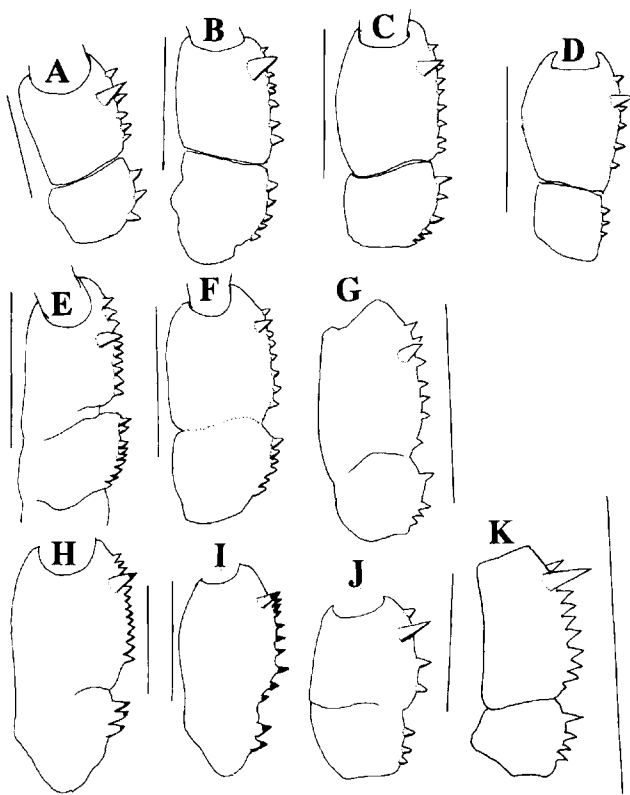
**Fig. 20.** Distal portion of antennule (right): *A*, *B*, *Hemipagurus japonicus* (Yokoya), comb. nov., NSMT; *C*, *D*, *H. imperialis*, sp. nov., holotype; *E*, *H. hirayamai*, sp. nov., holotype; *F*, *H. toyoshioae*, sp. nov., holotype. *B*, *D*, *E*–*G*, lateral view; *A*, *C*, dorsal view. Scale bars = 1.0 mm.

approximately half length of carpus, weakly granular. Carpus elongate, as long as merus; dorsal surface flat, with scattered blunt or spiniform tubercles, dorsolateral and dorsomesial margins straight, each armed with row of granules or tubercles. Merus (Fig. 31K, L) very weakly granular dorsally; dorsal face with few irregular rows of thick long setae; ventral surface scattered with tubercles or granules, ventromesial and ventrolateral distal angles each bearing acute spine. Ischium (Fig. 31L) with subdistal acute spine ventrolaterally. Coxa unarmed.

Second and third pereopods (Fig. 8C, D) morphologically similar. Third longer than second, particularly dactyls and propodi (1.20–1.30 and 1.10–1.20 length respectively). Dactyls (Fig. 36C) blade-shaped, broad; long, 1.00–1.35 length of propodi; each terminating in corneous claw; mesial faces flat, each with dorsal row of 30–40 (second) or 36–60 (third) thick setae, longer distally, ventral row of 41–48 (second) or 50–60 (third) spiniform setae, and medially with several short, fine setae; lateral face strongly convex, with scattered short setae. Propodi (Fig. 38C) long, 2.15–2.35 (second) or 1.85–1.95 (third) length of carpi, minutely granular laterally and mesially; dorsal faces each with row of very fine short setae; mesial faces each with ventral row of 3–12 strong spine-like setae, dorsal and ventral rows of several fine setae, and dorsodistally with pair of thick spine-like setae. Carpi (Fig. 38C) short, 0.50–0.65 length of meri; dorsal surfaces covered with numerous blunt or spiniform tubercles, with 1–5 dorsodistal spines; lateral surfaces granular; mesial faces nearly smooth. Meri (Fig. 40I–K)



**Fig. 21.** Peduncular segments of antenna (right): *A, B, Hemipagurus ensifer* (Henderson), comb. nov., lectotype; *C, D, H. granulatus* (Edmondson), comb. nov., holotype; *E, F, H. haigae*, sp. nov., holotype; *G, H, H. kosugei*, sp. nov., holotype; *I, J, H. lewinsohni*, sp. nov., holotype; *K, L, H. maclaughlinae*, sp. nov., holotype; *M, N, H. albatrossae*, sp. nov., holotype; *O, P, H. japonicus* (Yokoya), comb. nov., NSMT; *Q, R, H. imperialis*, sp. nov., holotype; *S, T, H. hirayamai*, sp. nov., holotype; *U, V, H. toyoshioae*, sp. nov., holotype. *A, C, E, G, I, K, M, O, Q, S, U*, dorsal view; *B, D, F, H, J, L, N, P, R, T, V*, ventral view (setae omitted). Scale bars = 1.0 mm.



**Fig. 22.** Basis and ischium of third maxilliped (right, external view): *A*, *Hemipagurus ensifer* (Henderson), comb. nov., lectotype; *B*, *H. granulatus* (Edmondson), comb. nov., paratype; *C*, *H. haigae*, sp. nov., holotype; *D*, *H. kosugei*, sp. nov., holotype; *E*, *H. lewinoohni*, sp. nov., holotype; *F*, *H. mclaughlinae*, sp. nov., holotype; *G*, *H. albatrossae*, sp. nov., holotype; *H*, *H. japonicus* (Yokoya), comb. nov., NSMT; *I*, *H. imperialis*, sp. nov., holotype; *J*, *H. hirayamai*, sp. nov., holotype; *K*, *H. toyoshioae*, sp. nov., holotype. Scale bars = 0.5 mm.

distinctly more swollen lateromesially in third; each with dorsodistal margin medially with large spine flanked by few thick setae, dorsal face with second large spine subdistally followed posteriorly by third large spine slightly displaced laterally, remainder of dorsal surface with several irregular rows of moderately short to long thick setae; ventrolateral distal margins each armed with strong spine, ventromesial distal margins unarmed; ventral faces granular or tuberculate.

Fourth pereopod (Fig. 42E, F) with dactyl bearing three short corneous spines on ventral margin and with prominent preungual process covered by dense short setae apically; propodal rasp along 0.70–0.90 length of ventral margin; carpus with tiny blunt-tipped spine at dorsodistal angle.

Sternite of third pereopods (Fig. 8E) with broad anterior lobe with pair of small projections and setae anteriorly.

Sternite of fifth pereopods reduced to narrow transverse rod, with pair of small round projections

Uropods with right protopod bearing spinules posteriorly; left protopod unarmed.

Telson (Fig. 44C) with posterior lobes separated by narrow, deep median cleft, each terminating in strong corneous spine, lateral margins each with pair of thick long setae anteriorly, mesial margins fringed with very short setae.

#### *Sexual dimorphism*

Male unknown.

#### *Colouration*

According to Haig and Ball (1988): in life, corneas grey, distal portions of second and third pereopods transparent, rest of body mottled with red and white chromatophores.

#### *Shell*

Not known.

#### *Etymology*

This species is dedicated to the late Janet Haig, a noted carcinologist who first suggested that this species belonged to an undescribed taxon.

#### *Distribution*

Torres Strait, Arafura Sea, now the Philippine Islands, and additionally, according to McLaughlin (in press), off Phuket, Thailand, Andaman Sea; 50–59 m.

#### *Affinities*

*Hemipagurus haigae*, sp. nov. greatly differs from the other *ensifer*-group species in having a row of numerous (41–48 in second and 50–60 in third) spiniform setae on each ventromesial portion of the ambulatory dactyl (Fig. 36C). No other species has such dense setae (Fig. 36A, B, D–H). Morphological structures of the cutting edges of both chelipeds (Figs 29E, 34C) and setation of dorsal faces of the meri of ambulatory legs of this species (Fig. 40K) are also greatly different from those of the other members (Figs 29A–D, F–K; 40A–J, L–Z).

#### *Remarks*

The specimen herein designated as holotype was first reported by Haig and Ball (1988) as *Catapagurus* sp. Although they suggested that it belonged to an undescribed taxon, they elected to leave it unnamed because of the pronounced sexual dimorphism recognised within the genus, thus avoiding a description based on only a single specimen. Three specimens of this species were also collected during the U. S. Albatross Expedition to the Philippines in 1908 and have also been examined. It was also recorded very recently from Thailand (McLaughlin, in press).

*Hemipagurus kosugei*, sp. nov.

(Figs 9, 17D, 19D, 21G–H, 22D, 25E–L, 29F–G, 32A–D, 34D, 36D, 38D, 40L–N, 42G–H, 44D, 51)

*Material examined*

*Holotype*. **Okinawa**: ♂, SL = 2.45 mm, off Miyara, Ishigaki-jima, Yaeyama Islands, Japan, coll. Takeharu Kosuge, 40 m, vi.1997, CBM-ZC 6205.

*Paratypes*. **Okinawa**: 2 ♂, SL = 1.95–2.30 mm, 1 ovi. ♀, 2.05 mm, same data as holotype, CBM-ZC 6207; 1 ♂, SL = 2.05 mm, 1 ovi. ♀, 2.05 mm, same data as holotype, WAM C 24975.

*Description*

Shield (Fig. 9A) 1.05–1.10 times broader than long; anterior margin between rostrum and lateral projections concave, anterolateral margins rounded; lateral margins nearly straight or slightly irregular; dorsal surface slightly convex, with pair of longitudinal rows of setae tufts laterally and transverse row of setae tufts anteriorly and also often posteriorly; rostral lobe (Fig. 17D) very broad, overreached by lateral projections; lateral projections (Fig. 17D) triangular, each terminating in acute spinule. Posterior carapace (Fig. 9A) with very narrow posterolateral plates and very short posteromedian plate. Branchiostegites (Fig. 9B) unarmed; anterior margins rounded.

Ocular peduncles (including corneas) (Figs 9A, 17D) 0.65–0.70 times as long as shield, with weak medial constriction; dorsal and mesial surfaces with few tufts of stiff short setae, distal margins of dorsomesial faces fringed with stiff setae. Corneas (Fig. 17D) dilated. Ocular acicles (Fig. 17D) moderately long, narrowly triangular, acute; widely separated basally by breadth of rostral lobe; with several very long setae along mesial margins and few moderately short setae along lateral margins.

Antennular peduncles (Figs 9A, 19D) long, when fully extended second peduncular segment exceeding corneas by approximately half own length; ultimate segment with dorsolateral distal angle bearing two short and two long setae; penultimate segment unarmed; basal segment with acute spine at ventrodistal mesial angle. Antennal peduncles (Figs 9A, 21G, H) moderately long, when fully extended exceeding corneas by approximately 0.25–0.35 length of ultimate segment; fifth and fourth segments unarmed; third segment with ventrodistal angle produced; second segment slightly expanded laterally, dorsolateral distal angle produced, terminating in strong spine accompanied ventrally with small subdistal spine, dorsomesial distal angle with strong spine; first segment with strong hook-shaped spine laterally and strong acute spine at ventrodistal margin. Antennal acicles (Fig. 21G) moderately short and moderately broad. Antennal flagella with full length unknown; articles each with one or two very short setae on distal margins of lateral and mesial faces.

Third maxilliped with merus bearing acute dorsodistal spine; ischium (Fig. 22D) with reduced crista dentata,

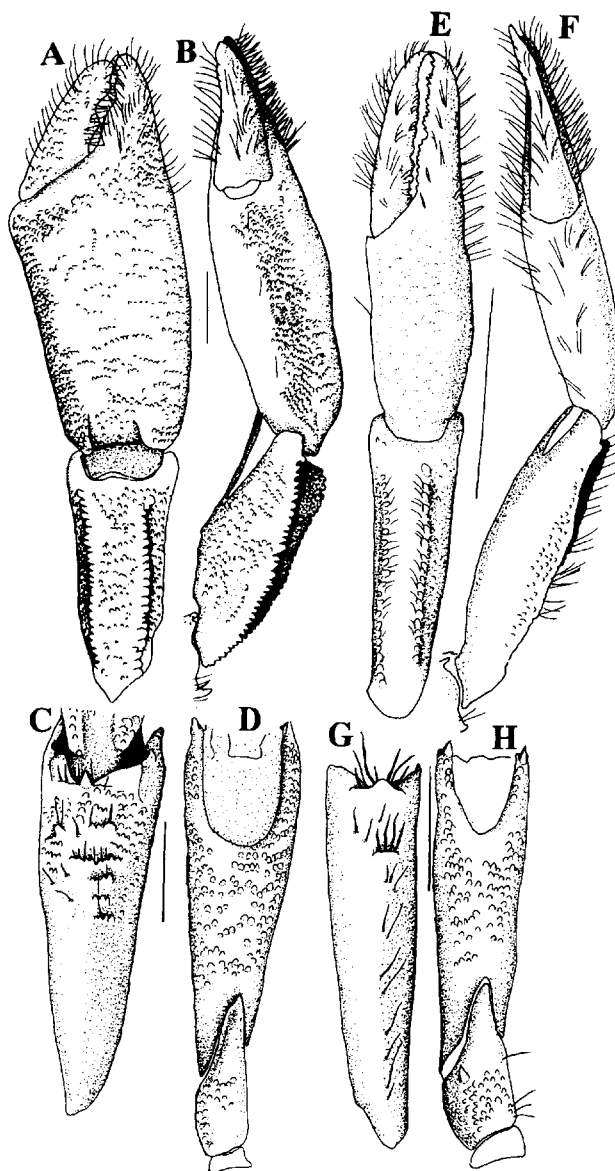


Fig. 23. Right cheliped: *Hemipagurus ensifer* (Henderson), comb. nov.; A–D, lectotype male; E–H, paralectotype female. Dactyl, propodus, and carpus: A, E, dorsal view; B, F, mesial view. Merus: C, G, dorsal view; D, H, ventral view. Scale bars = 1.0 mm.

composed of 5–7 teeth and strong accessory tooth; basis (Fig. 22D) with three or four acute teeth.

Right cheliped of male (Fig. 25E–H) large and stout, chela flattened dorsoventrally. Dactyl short, 0.55–0.60 length of palm, blunt-tipped; dorsal face granular, with tufts of long setae; cutting edge (Fig. 29F) with very large, blunt-tipped calcareous tooth medially, and entire edge including tooth bearing numerous minute calcareous teeth. Fixed finger blunt-tipped; dorsolateral surface granular, with tufts of long setae; entire cutting edge with minute calcareous



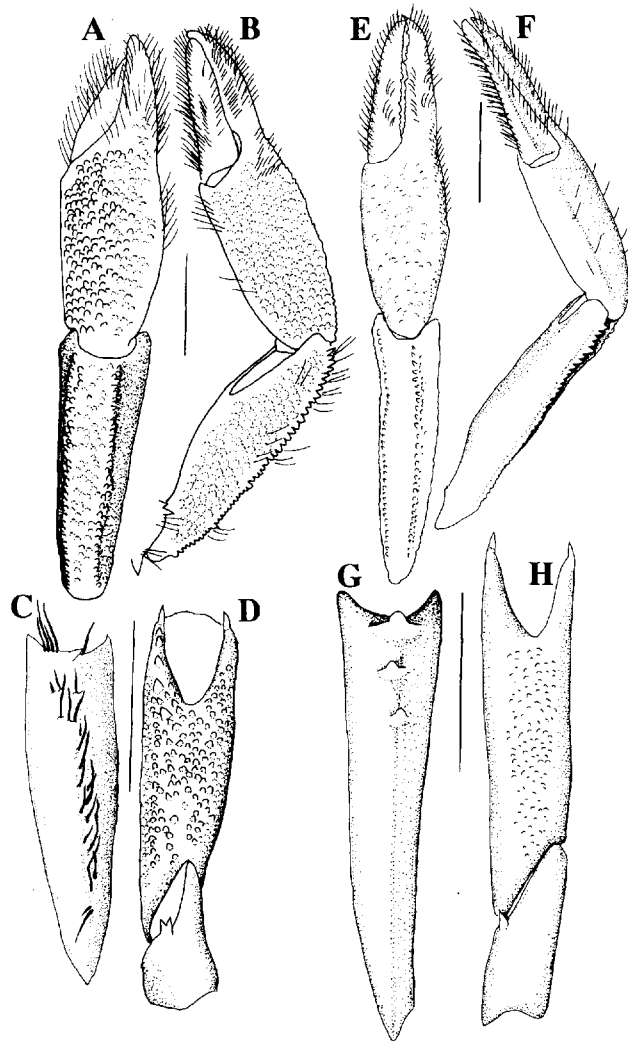


Fig. 24. Right cheliped: *Hemipagurus granulatus* (Edmondson), comb. nov.; A–D, holotype male; E–H, female, USNM. Dactyl, propodus, and carpus: A, E, dorsal view; B, F, mesial view. Merus: C, G, dorsal view; D, H, ventral view. Scale bars = 1.0 mm.

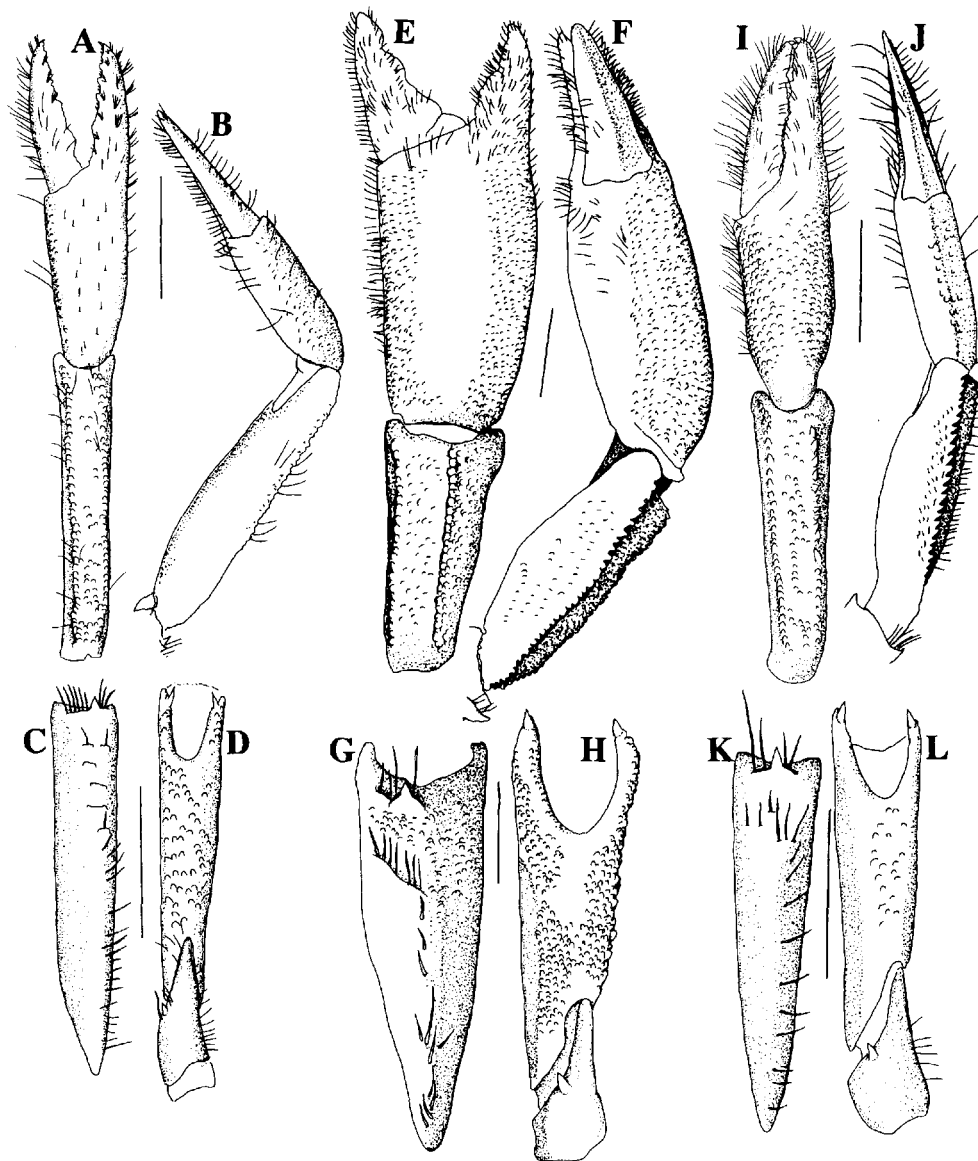
teeth (Fig. 29F). Palm 1.20–1.25 length of carpus; dorsal, mesial and lateral surfaces granular. Carpus short, 0.85–0.90 length of merus; dorsal surface flat, with scattered blunt or spiniform tubercles, dorsolateral and dorsomesial margins nearly straight, each forming distinct ridge armed with blunt or spiniform tubercles; lateral and mesial surfaces tuberculate or granular. Merus (Fig. 25G, H) with dorsal face bearing short transverse ridge subdistally and row of thick long setae, dorsodistal margin protruding, with strong spine flanked by few thick long setae; lateral and mesial faces granular or tuberculate; ventral surface covered with numerous small tubercles, ventromesial and ventrolateral distal angles protruding, each bearing strong spine. Ischium

(Fig. 25H) with strong subdistal spine ventrolaterally. Coxa unarmed.

Left cheliped (Fig. 32A–D) with dactyl equalling length of palm, weakly granular, with tufts of long setae; terminating in strong corneous claw; entire cutting edge (Fig. 34D) with minute corneous teeth. Fixed finger nearly smooth, with tufts of long setae; terminating in strong corneous claw; cutting edge (Fig. 34D) with few widely spaced, calcareous teeth on distal 0.30–0.35 and minute corneous teeth along entire length. Palm short, 0.50–0.55 length of carpus, granular. Carpus elongate, equalling length of merus; dorsal surface covered with numerous tubercles, dorsolateral and dorsomesial margins straight, each armed with distinct row of spiniform tubercles. Merus (Fig. 32C, D) with dorsal, lateral, and mesial surfaces granular; dorsal face with 1–3 irregular rows of thick long setae, dorsodistal angle produced, with small acute spine flanked by few long, thick setae; ventral surface covered with numerous blunt or spiniform tubercles, ventromesial and ventrolateral distal angles each bearing strong spine. Ischium (Fig. 32D) with strong subdistal spine ventrolaterally. Coxa unarmed.

Second and third pereopods (Fig. 8C, D) similar, but third longer than second, particularly dactyls and propodi (1.25–1.30 and 1.10–1.15 lengths respectively). Dactyls (Fig. 36D) blade-shaped, broad; long, equalling (second) or 1.05–1.10 (third) length of propodi; each terminating in strong corneous claw; mesial faces nearly flat or concave longitudinally, each with dorsal row of 19–23 (second) or 23–30 (third) thick spine-like setae, increasing in length distally, and ventral row of 12–19 (second) or 17–21 (third) thick spine-like setae, medially with scattered short setae; lateral face strongly convex, with scattered short setae. Propodi (Fig. 38D) long, 2.20–2.25 (second) or 2.70–2.75 (third) length of carpi, minutely granular dorsally and laterally; mesial faces each with dorsal row of 2–5 (second) or 1–4 (third) and ventral rows of 1–4 strong spine-like setae, dorsodistally with pair of strong spine-like setae. Carpi (Fig. 38D) short, 0.45–0.50 length of meri, each without dorsodistal spine, dorsal and dorsolateral surfaces tuberculate or granular. Meri (Fig. 40L–N) distinctly more swollen lateromesially in third; each with dorsodistal margin medially with large spine, dorsal face with second very large spine subdistally followed posteriorly by third large spine slightly displaced laterally, each flanked by one or two thick long setae, remainder of dorsal surface with irregular rows of thick long setae; ventrolateral distal margins each armed with acute spine, ventromesial distal margins unarmed; ventral faces granular or tuberculate.

Fourth pereopod (Fig. 42G, H) with dactyl bearing three short corneous spines on ventral margin and with prominent preungual process covered by dense short setae apically; propodal rasp along 0.8 length of ventral margin; carpus with tiny blunt-tipped spine at dorsodistal angle. Male with right coxa of fifth pereopods bearing very long sexual tube with



**Fig. 25.** Right cheliped: *A–D*, *Hemipagurus haigae*, sp. nov., holotype female; *E–H*, *H. kosugei*, sp. nov., holotype male; *I–L*, *H. kosugei*, sp. nov., paratype female. Dactyl, propodus, and carpus: *A, E, I*, dorsal view; *B, F, J*, mesial view. Merus: *C, G, K*, dorsal view; *D, H, L*, ventral view. Scale bars = 1.0 mm.

forked tip curving over dorsal surface of abdomen toward left side (Fig. 9A); left coxa with vas deferens only slightly protruding and with setae on lateral half of ventral surface; female with coxae each with semi-encircular row of very long setae posteriorly.

Sternite of third pereopods (Fig. 9E) with broad, subtriangular anterior lobe with setae anteriorly. Sternite of fifth pereopods with pair of small round projections.

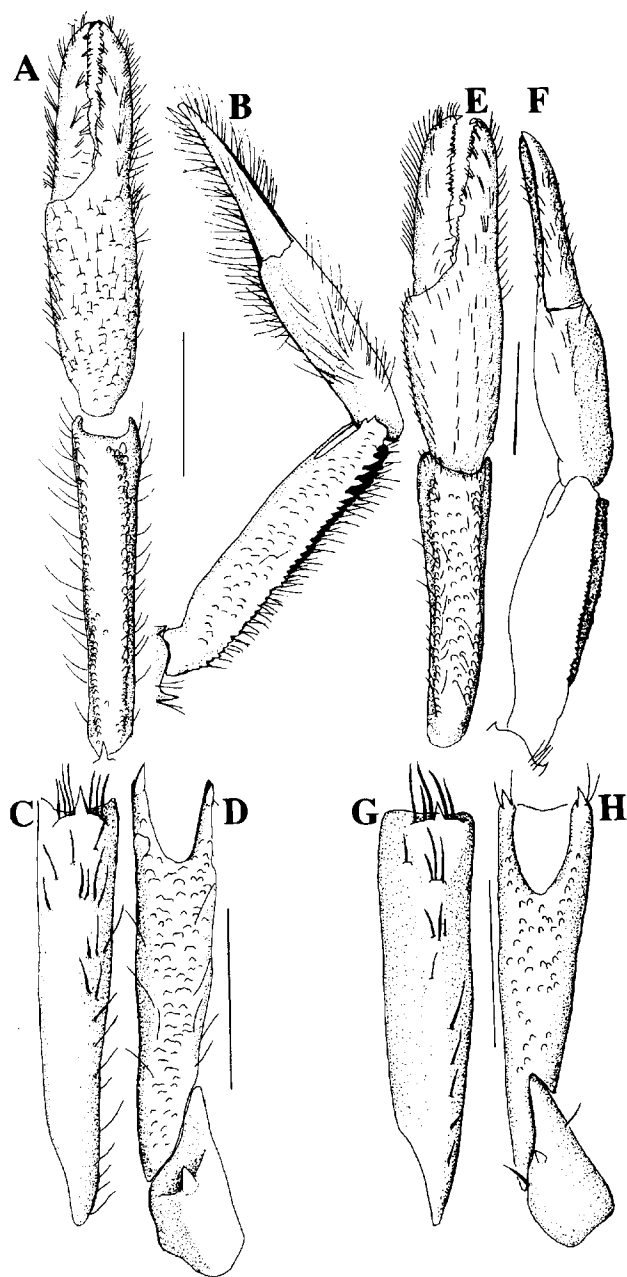
Uropods with protopod of right bearing indentation posteriorly; protopod of left unarmed.

Telson (Fig. 44D) with posterior lobes separated by broad, deep median cleft, each terminating in strong corneous

spine, lateral margins each with pair of thick long setae anteriorly, mesial margins fringed with very short setae.

#### *Sexual dimorphism*

The right cheliped in females (Fig. 25I–L) is more slender than that of males and differs as follows: dactyl as long as palm, terminating in strong corneous claw, cutting edge (Fig. 29G) with three widely separated, medium-sized calcareous teeth interspersed with several minute calcareous teeth; fixed finger terminating in strong corneous claw; cutting edge (Fig. 29G) with medium-sized calcareous teeth on distal 0.3 and numerous calcareous teeth along entire



**Fig. 26.** Right cheliped: *A–D*, *Hemipagurus lewinoehni*, sp. nov., ?male (paratype); *E–H*, *H. maclaughlinae*, sp. nov., holotype female. Dactyl, propodus, and carpus: *A*, *E*, dorsal view; *B*, *F*, mesial view. Merus: *C*, *G*, dorsal view; *D*, *H*, ventral view. Scale bars = 1.0 mm.

length; palm short, 0.55–0.60 length of carpus; carpus equalling length of merus; ventral surface of merus (Fig. 25*K, L*) less granular than male.

#### Colouration

Colour slide of living animal by T. Kosuge: generally semi-transparent; no conspicuous colour patterns on chelipeds and ambulatory legs.

#### Shell

Not known.

#### Etymology

This species is named for Dr Takeharu Kosuge, who collected the specimens.

#### Distribution

Known only from the type locality, Ishigaki-jima, Okinawa; 40 m.

#### Affinities

*Hemipagurus kosugei*, sp. nov. is closely allied to *H. alcocki*. However, the ambulatory legs of *H. kosugei* with the unarmed carpi (Fig. 38*D*), the usually flat mesial faces of the dactyls (Fig. 36*D*) and two simple subdistal spines on each dorsal face of the meri (Fig. 40*L, N*) separate it from *H. alcocki* which has ambulatory legs with carpi bearing strong dorsodistal spines, dactyls with longitudinally-concave mesial faces (Fig. 36*H*), and meri with two very stout, usually bifid or trifid subdistal spines on dorsal faces (Fig. 40*X, Z*).

This species is also similar to *Hemipagurus ensifer*, although, as already stated in 'Affinities' for that species, several characters easily separate *H. ensifer* from other members of the *ensifer*-group, including *H. kosugei*. *Hemipagurus kosugei* is further distinguished from *H. ensifer* by a very strong spine on the ischium of each cheliped in males (Figs 25*H, 32D*), often flattened mesial faces of the dactyls (Fig. 36*D*) and carpus of the ambulatory legs either unarmed or with a vestigial dorsodistal spine (Fig. 38*D*). In contrast, the cheliped ischia of males of *H. ensifer* are unarmed (Fig. 23*D, 31D*), the carpi of the ambulatory legs each have a few strong dorsodistal spines (Fig. 38*A*) and the mesial faces of the ambulatory leg dactyls are deeply concave (Fig. 36*A*). The number of thick spine-like setae in dorsal rows on the mesial faces of the ambulatory dactyls are 19–23 (second) or 23–30 (third, fig. 36*D*) in *H. kosugei* but 24–27 (second) or 30–34 (third, fig. 36*A*) in *H. ensifer*.

#### *Hemipagurus lewinoehni*, sp. nov.

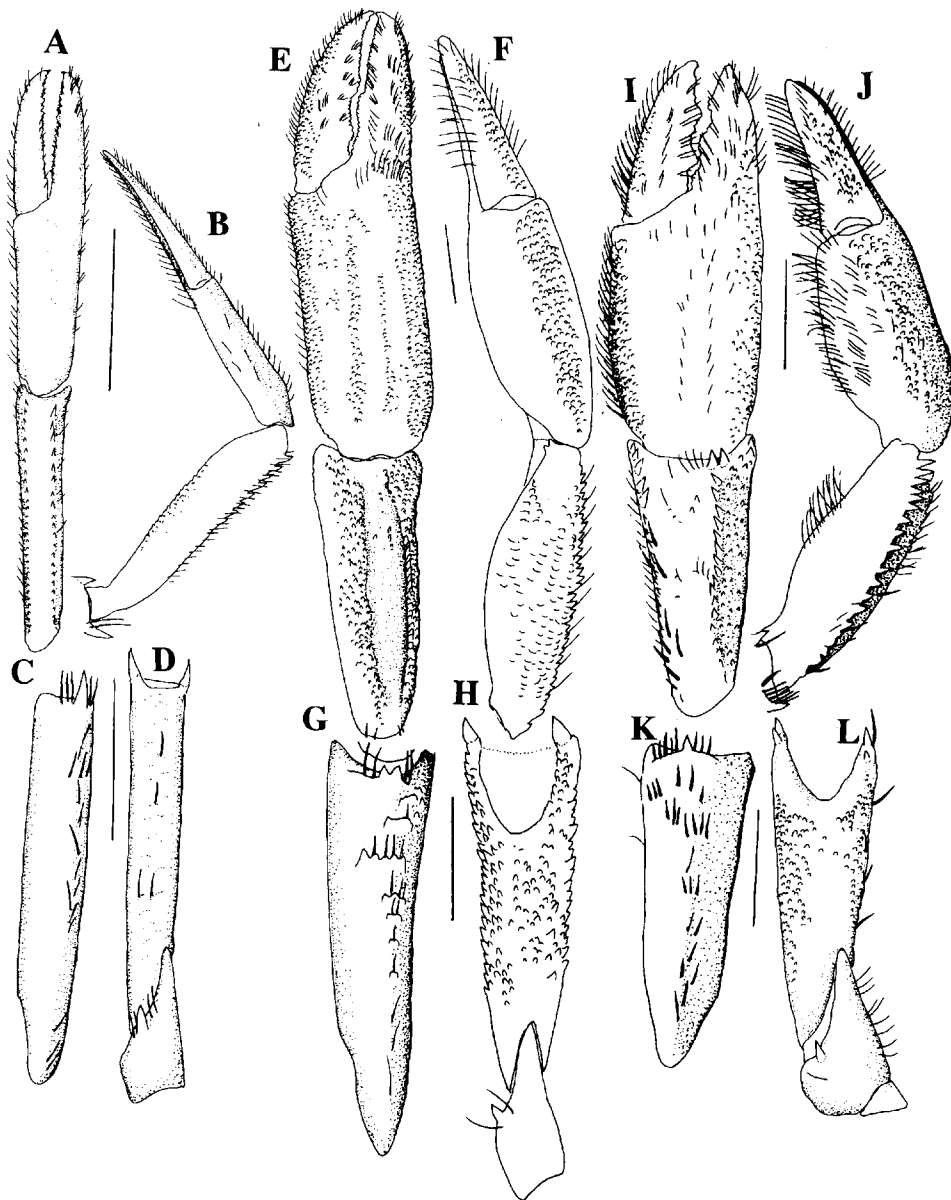
(Figs 10, 17*E, 19E, 21I–J, 22E, 26A–D, 29G, 32E–H, 34E, 36E, 38E, 40O–Q, 42I–J, 44E, 50*)

*Catapagurus ensifer* Lewinsohn, 1969: 79 (not *Catapagurus ensifer* Henderson, 1893).

#### Material examined

**Holotype.** Red Sea: ♂, SL = 1.90 mm, St. 10, Dahlark Archipelago, Eritrea, Ethiopia, 15°30'N 40°00'E, 42 m, 23.x.1965, coll. L. Fishelson, TAU-1930.

**Paratypes.** Red Sea: 1 ♂, SL = 1.85 mm, 2 ♀, SL = 1.75, 1.80 mm, same data as holotype, TAU-1930; 1 ovi. ♀, SL = 2.25 mm, 66–80 m, Elath, Gulf of Aqaba, Israel, 7.ix.1966, coll. Ch. Lewinsohn, TAU-1194.



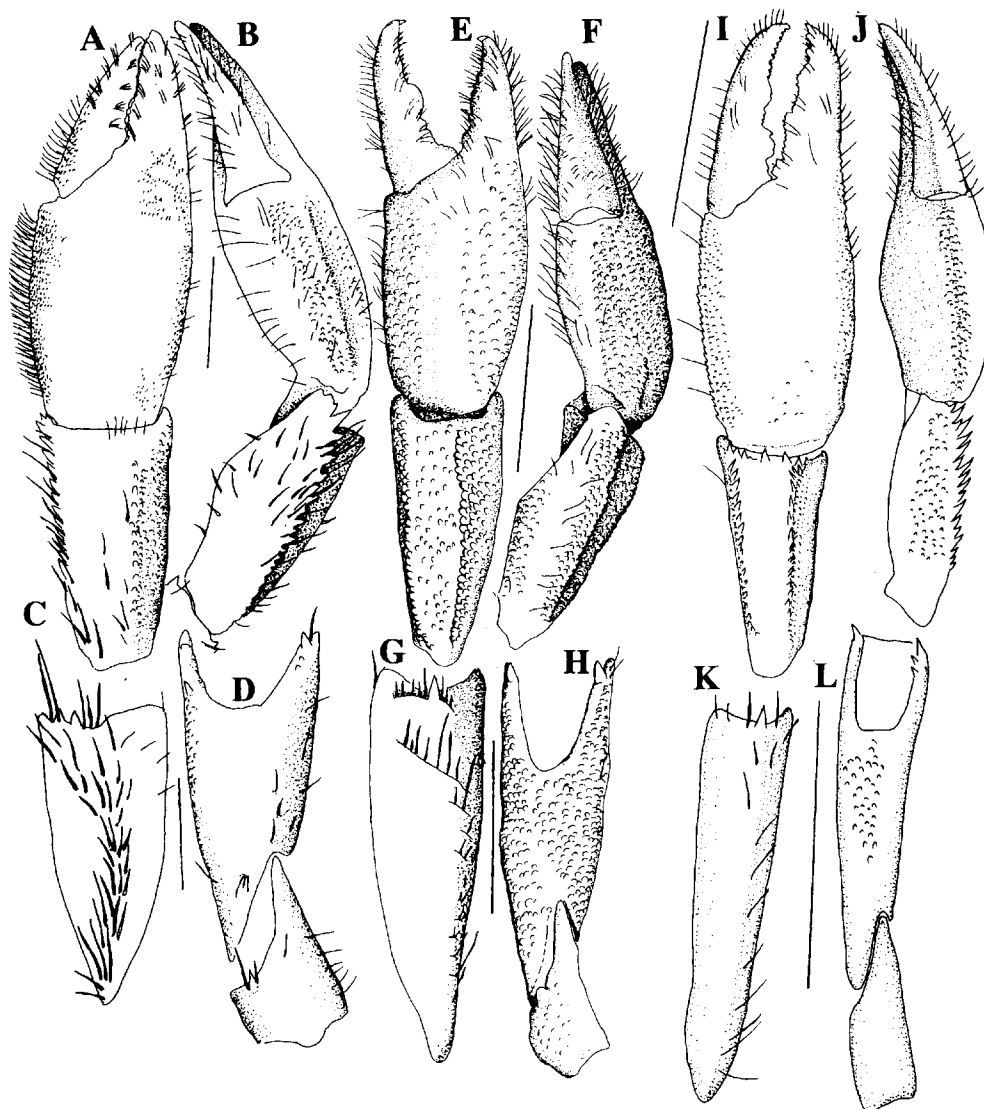
**Fig. 27.** Right cheliped: *A–D*, *Hemipagurus alcocki* (McLaughlin), comb. nov., male, USNM; *E–H*, *H. albatrossae*, sp. nov., holotype female; *I–L*, *H. japonicus* (Yokoya), comb. nov., female, NSMT. Dactyl, propodus, and carpus: *A, E, I*, dorsal view; *B, F, J*, mesial view. Merus: *C, G, K*, dorsal view; *D, H, L*, ventral view. Scale bars = 1.0 mm.

### Description

Shield (Fig. 10*A*) approximately as long as broad, outline nearly subtriangular; anterior margin between rostrum and lateral projections considerably concave, anterolateral margins sloping; lateral margins nearly straight or slightly concave on posterior portion; dorsal surface slightly convex, with pair of longitudinal rows of setae tufts laterally and transverse rows of setae tufts anteriorly and posteriorly; rostral lobe (Fig. 17*E*) very broad, distinctly overreached by

lateral projections; lateral projections (Fig. 17*E*) triangular, each terminating in acute spinule. Posterior carapace (Fig. 10*A*) with very narrow posterolateral plates and very short posteromedian plate. Branchiostegites (Fig. 10*B*) not calcified, unarmed; anterior margins slightly protruding dorsally.

Ocular peduncles (including corneas) (Figs 10*A*, 17*E*) 0.65–0.70 times as long as shield, with medial constriction not conspicuous; dorsal surfaces with few tufts of setae, distal margins of dorsomesial faces fringed with long setae.



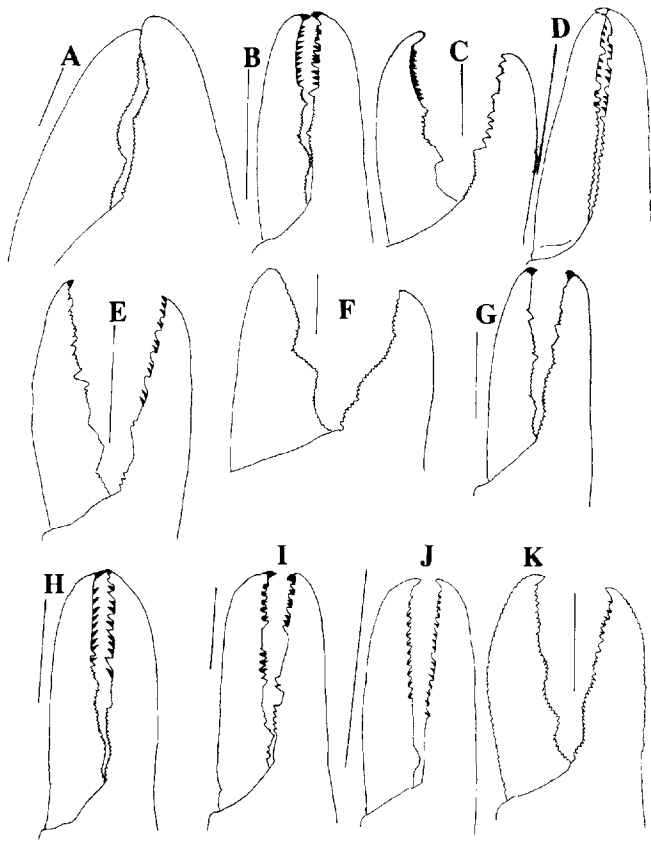
**Fig. 28.** Right cheliped: *A–D*, *Hemipagurus imperialis*, sp. nov., holotype female; *E–H*, *H. hirayamai*, sp. nov., holotype male; *I–L*, *H. toyoshioae*, sp. nov., holotype male. Dactyl, propodus, and carpus: *A, E, I*, dorsal view; *B, F, J*, mesial view. Merus: *C, G, K*, dorsal view; *D, H, L*, ventral view. Scale bars = 1.0 mm.

Corneas (Fig. 17*E*) strongly dilated. Ocular acicles (Fig. 17*E*) short, triangular, acute; with several very long setae along mesial margins; separated basally by breadth of rostral lobe; interocular process with or without pair of low projections.

Antennular peduncles (Figs 10*A*, 19*E*) long, when fully extended second peduncular segment overreaching distal margins of corneas by approximately 0.70–0.75 own length; ultimate segment with dorsolateral distal angle bearing few very long setae; penultimate segment unarmed; basal segment with acute spine at ventrodistal mesial angle. Antennal peduncles (Figs 10*A*, 21*I*, *J*) moderately long, when fully extended second segment reaching distal margins

of corneas; fifth and fourth segments with few scattered long setae; third segment with ventrodistal angle produced; second segment with dorsolateral distal angle produced, terminating in strong spine accompanied by small subdistal spine ventrally; dorsomesial distal angle with acute spine; first segment with strong spine laterally and strong acute spine at ventrodistal margin. Antennal acicles (Fig. 21*I*) moderately long, arcuate, acute-tipped, with scattered setae mesially. Antennal flagella with full length unknown; articles each with one or two very short setae on lateral and mesial faces distally.

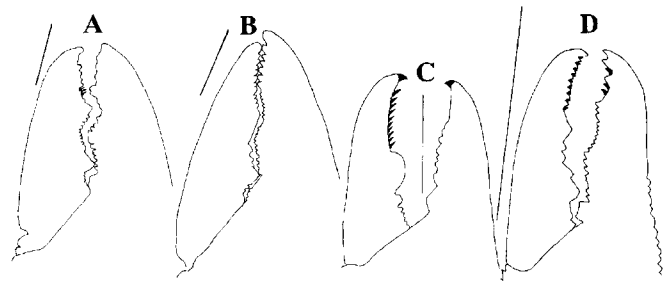
Third maxilliped with merus bearing acute, dorsodistal lateral spine; ischium (Fig. 22*E*) with crista dentata



**Fig. 29.** Cutting edges of right cheliped (setae omitted, dorsal view): *A*, *Hemipagurus ensifer* (Henderson), comb. nov., lectotype male; *B*, same, paralectotype female; *C*, *H. granulatus* (Edmondson), comb. nov., holotype male; *D*, same, female, USNM; *E*, *H. haigae*, sp. nov., holotype female; *F*, *H. kosugei*, sp. nov., holotype male; *G*, same, paratype female; *H*, *H. lewinsohni*, sp. nov., ?male (paratype); *I*, *H. maclaughlinae*, sp. nov., holotype female; *J*, *H. albatrossae*, sp. nov., holotype female, USNM; *K*, *H. alcocki* (McLaughlin), comb. nov., male, USNM. Scale bars = 0.5 mm.

moderately developed, composed of 5–9 teeth and strong accessory tooth; basis (Fig. 22E) with 3–9 acute teeth.

Right cheliped (Fig. 26A–D) long and slender, chela flattened dorsoventrally. Dactyl short, 0.75–0.80 length of palm; terminating in strong corneous claw; dorsal face slightly convex, unarmed, with tufts of long setae, dorsomesial face with tufts of long setae; cutting edge (Fig. 29H) with numerous tiny calcareous teeth on proximal half and numerous corneous teeth on distal half. Fixed finger terminating in strong corneous claw; cutting edge (Fig. 29H) with numerous tiny calcareous teeth on proximal half and few, widely spaced small calcareous teeth interspersed with 1–3 corneous teeth on distal half. Palm with dorsal surface bearing numerous short transverse ridges accompanied anteriorly by thick setae; mesial, lateral and ventral faces unarmed. Carpus elongate, equalling length of merus; dorsal

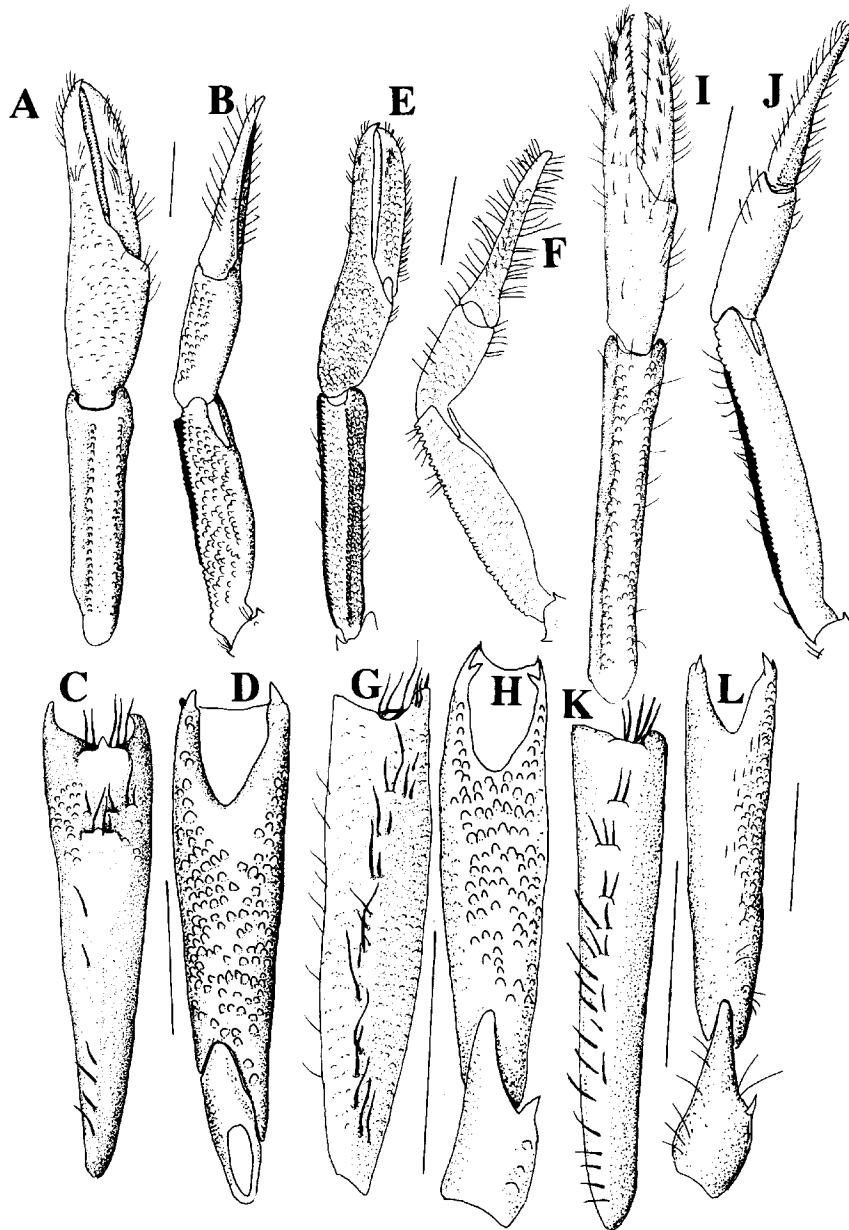


**Fig. 30.** Cutting edges of right cheliped (setae omitted, dorsal view): *A*, *Hemipagurus japonicus* (Yokoya), comb. nov., male, NSMT; *B*, *H. imperialis*, sp. nov., holotype female; *C*, *H. hirayamai*, sp. nov., holotype male; *D*, *H. toyoshioae*, sp. nov., holotype male. Scale bars = 0.5 mm.

surface flat, dorsolateral and dorsomesial margins straight, each forming ridge armed with distinct row of spiniform tubercles; lateral surface covered with tubercles; mesial face granular. Merus (Fig. 26C, D) with dorsal face bearing irregular rows of thick long setae, dorsodistal angle with strong spine flanked by few thick long setae; ventromesial and ventrolateral distal angles each with acute spine; ventral surface covered with tubercles or protuberances and with scattered long setae. Ischium (Fig. 26D) with strong subdistal spine ventrolaterally. Coxa unarmed.

Left cheliped (Fig. 32E–H) long and slender; propodal–carpal articulation twisted counter clockwise approximately 20°. Dactyl as long as palm, weakly granular dorsally, with tufts of long setae; terminating in strong corneous claw; entire cutting edge (Fig. 34E) with row of numerous calcareous teeth interspersed by corneous teeth. Fixed finger nearly smooth, with tufts of long setae; terminating in strong corneous claw; entire cutting edge (Fig. 34E) with widely spaced calcareous teeth interspersed with few corneous teeth. Palm approximately half length of carpus, slightly granular dorsally. Carpus elongate, equalling length of merus; dorsolateral and dorsomesial margins straight, each forming ridge armed with distinct row of spiniform tubercles; lateral face slightly granular. Merus (Fig. 32G, H) with dorsodistal angle bearing one or two acute spines and thick long setae; ventral surface granular, ventromesial and ventrolateral distal angles each with acute spine. Ischium (Fig. 32H) with strong subdistal spine ventrolaterally. Coxa unarmed.

Second and third pereopods (Fig. 10C, D) morphologically similar, but second shorter, 0.80–0.90 length of third. Dactyls (Fig. 36E) blade-shaped, moderately slender; long, 1.25–1.30 length of propodi; each terminating in sharp corneous claw; mesial faces strongly concave longitudinally, each with dorsal row of 18–25 (second) or 23–35 (third) and ventral row of 14–25 (second) or 16–30 (third) thick spine-like setae, and medially with scattered short setae; lateral



**Fig. 31.** Left cheliped: *A–D*, *Hemipagurus ensifer* (Henderson), comb. nov., lectotype; *E–H*, *H. granulatus* (Edmondson), comb. nov., holotype; *I–L*, *H. haigae*, sp. nov., holotype. Dactyl, propodus, and carpus: *A, E, I*, dorsal view; *B, F, J*, mesial view. Merus: *C, G, K*, dorsal view; *D, H, L*, ventral view. Scale bars = 1.0 mm.

face strongly convex, with scattered short setae. Propodi (Fig. 38*E*) long, 2.45–2.50 (second) or 2.85–2.90 (third) length of carpi, granular dorsally; mesial faces each with dorsal row of 0–2 (second) or 1–5 (third) and ventral row of 2–3 (second) or 1–6 (third) stiff setae on distal 0.60 and also dorsal and ventral rows of numerous short fine setae. Carpi (Fig. 38*E*) short, 0.45–0.50 (second) or 0.50–0.55 (third) length of meri, granular; dorsal surfaces with numerous

granules or tubercles and many long setae, dorsodistal angles each with small acute spine sometimes accompanied ventrally by two or three small spines. Meri (Fig. 40*O–Q*) distinctly more swollen lateromesially in third; dorsodistal margins each with strong spine, dorsal face with second very large spine subdistally followed posteriorly by third large spine slightly displaced laterally, each flanked by one or two thick long setae, remainder of dorsal surface with thick long

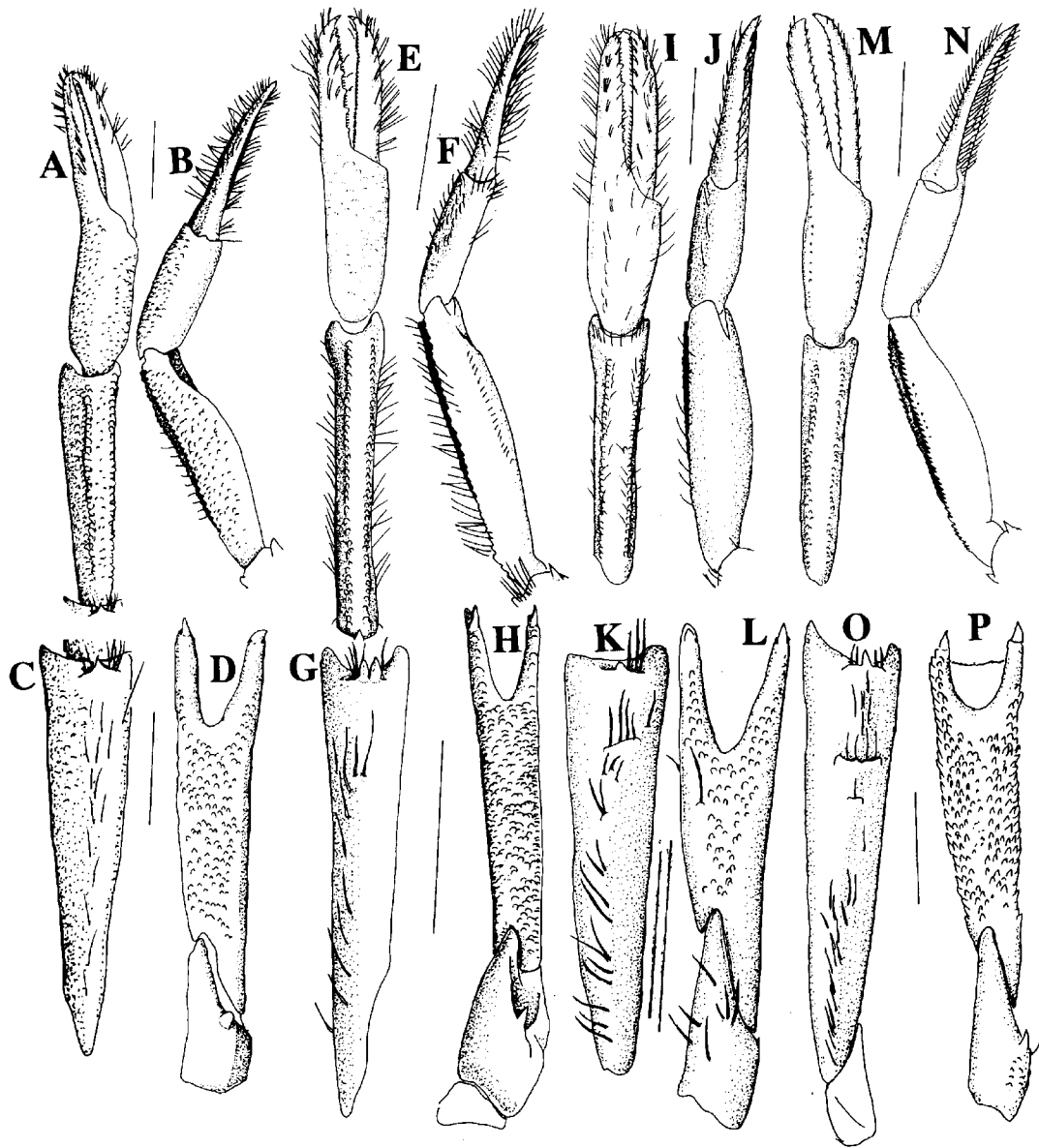


Fig. 32. Left cheliped: A–D, *Hemipagurus kosugei*, sp. nov., holotype; E–H, *H. lewinoehni*, sp. nov. (holotype or paratypes); I–L, *H. maclaughlinae*, sp. nov., holotype; M–P, *H. alcocki* (McLaughlin), comb. nov., USNM. Dactyl, propodus, and carpus: A, E, I, M, dorsal view; B, F, J, N, mesial view. Merus: C, G, K, O, dorsal view; D, H, L, P, ventral view. Scale bars = 1.0 mm.

setae; ventrolateral distal margins each armed with acute spine, ventromesial distal margins unarmed; ventral faces granular.

Fourth pereopod (Fig. 42I, J) with dactyl bearing six or seven short corneous spines on ventral margin and prominent preungual process covered by dense short setae apically; propodal rasp 0.70 length of ventral margin; carpus with tiny blunt-tipped spine at dorsodistal angle. Male with right coxa of fifth pereopods bearing very long sexual tube with forked tip curving over dorsal surface of abdomen

toward left side (Fig. 10A); left coxa with gonopore and setae on lateral half of ventral surface.

Sternite of third pereopods (Fig. 10E) with broad anterior lobe, with two small projections fringed anteriorly with setae. Sternite of fifth pereopods with pair of very small round projections (male) or only single small projection medially (female).

Male with four unpaired left uniramous pleopods. Female with three unpaired left biramous pleopods and with one unpaired left uniramous pleopod.



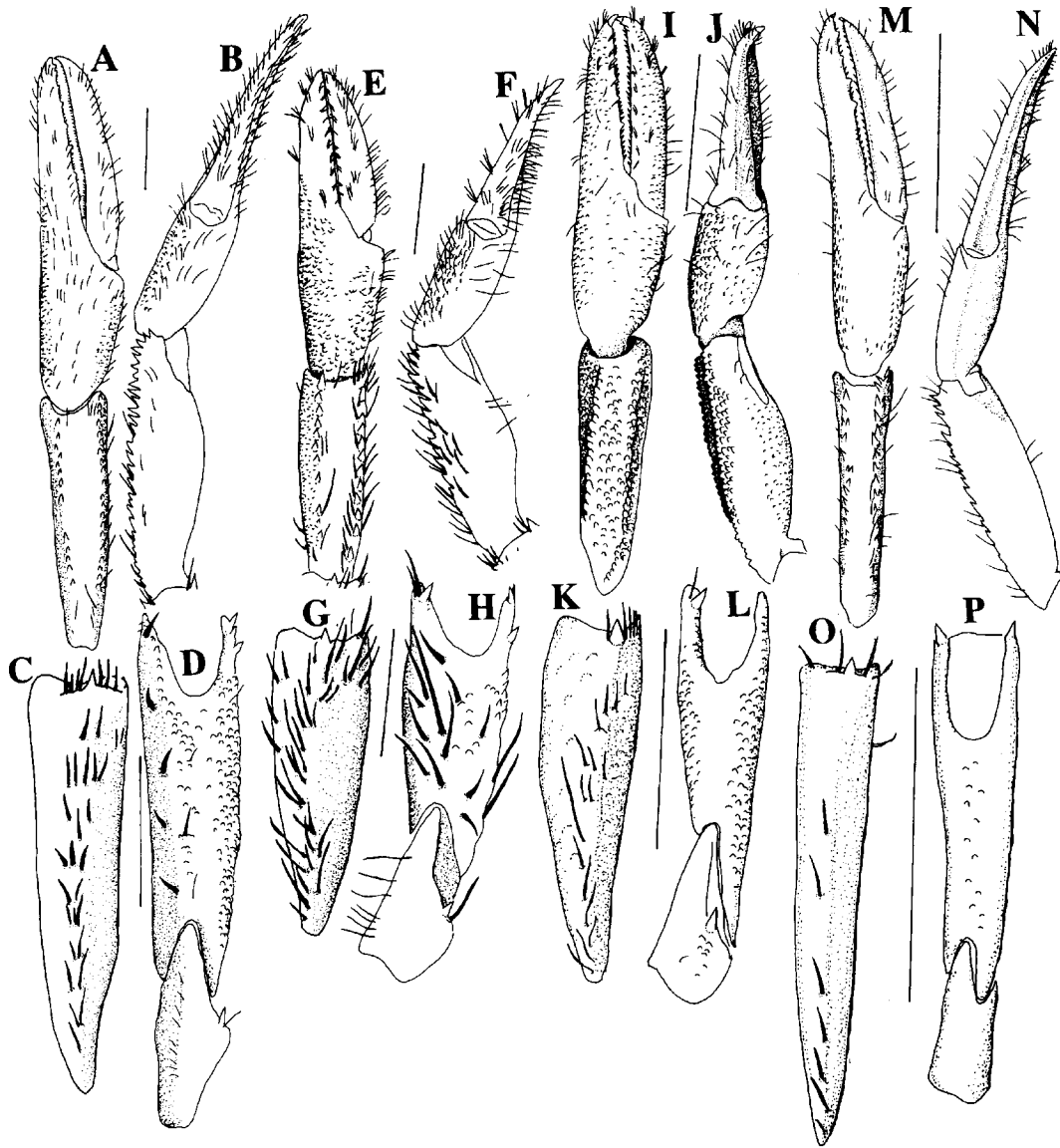


Fig. 33. Left cheliped: A–D, *Hemipagurus japonicus* (Yokoya), comb. nov., NSMT; E–H, *H. imperialis*, sp. nov., holotype; I–L, *H. hirayamai*, sp. nov., holotype; M–P, *H. toyoshioae*, sp. nov., holotype. Dactyl, propodus, and carpus: A, E, I, M, dorsal view; B, F, J, N, mesial view. Merus: C, G, K, O, dorsal view; D, H, L, P, ventral view. Scale bars = 1.0 mm.

Uropodal protopods unarmed.

Telson (Fig. 44E) with posterior lobes separated by broad, deep median cleft, with pair of long setae laterally; terminal margins each with acute corneous spinule.

#### Sexual dimorphism

The chelipeds of all specimens examined were detached from the bodies; however, since all chelipeds were quite similar in morphology, it would appear that little or no sexual dimorphism exists in this species.

#### Colouration

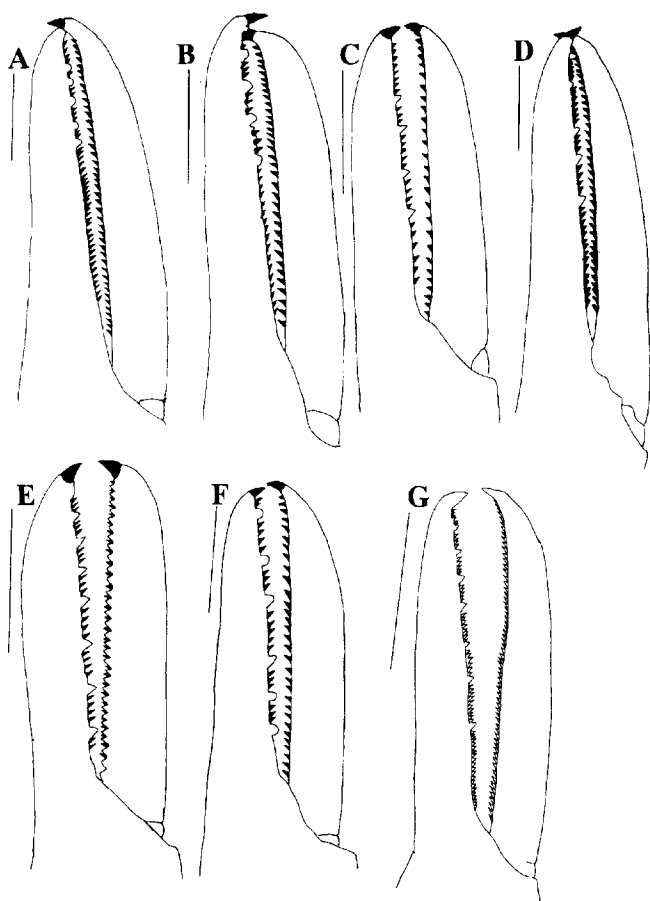
Not known.

#### Shell

Not known.

#### Etymology

This species is named after the late eminent carcinologist Dr Chanan Lewinsohn, who first reported the specimens from the Red Sea.



**Fig. 34.** Cutting edges of left cheliped (setae omitted, dorsal view): *A*, *Hemipagurus ensifer* (Henderson), comb. nov., lectotype; *B*, *H. granulatus* (Edmondson), comb. nov., holotype; *C*, *H. haigae*, sp. nov., holotype; *D*, *H. kosugei*, sp. nov., holotype; *E*, *H. lewinsohni*, sp. nov., (paratypes); *F*, *H. maclaughlinae*, sp. nov., holotype; *G*, *H. alcocki* (McLaughlin), comb. nov. USNM. Scale bars = 0.5 mm.

#### Distribution

The Dahlark Archipelago and Gulf of Aqaba, the Red Sea; 42–80 m.

#### Affinities

*Hemipagurus lewinsohni*, sp. nov. is distinguished from the other members of the *Hemipagurus ensifer*-group in having shorter ocular acicles reaching only to the proximal 0.2–0.3 length of the ocular peduncles (Fig. 17E), much more slender dactyls of the ambulatory legs (Fig. 36E), and no special setae or structures on the dorsodistal margins of the propodi of the ambulatory legs (Fig. 38E). In contrast, all other species of the *ensifer*-group have longer ocular acicles (Figs 17A–D, F, 18A), broader ambulatory dactyls (Fig. 36A–D, F–H) and a pair of spine-like setae on the distal margins of the ambulatory propodi (Fig. 38A–D, F–G).

#### Remarks

Although he compared the specimens with the syntypes of *Catapagurus ensifer* (now *Hemipagurus ensifer*) and noted

several minor morphological differences, Lewinsohn (1969) first reported these specimens as *Catapagurus ensifer*.

#### *Hemipagurus maclaughlinae*, sp. nov.

(Figs 11, 17F, 19F, 21K–L, 22F, 26E–H, 29I, 32I–L, 34F, 36F, 38F, 40R–T, 44F, 50)

*Catapagurus* sp. McLaughlin & Hogarth, 1998: 23, figs 14–18.

#### Material examined

**Holotype.** Seychelles: ovi. ♀, SL = 2.40 mm, St. 700 of Oceanic Reefs Expedition (Netherlands Indian Ocean Programme) to Seychelles, north-east of Mahé, 4°33'S 55°50'E, van Veen Grab, 38 m, 15.xii.1992, RMNH D47877.

**Paratype.** Seychelles: ovi. ♀, SL = 1.60 mm, same data as holotype, RMNH D48030.

#### Description

Shield (Fig. 11A) 1.20–1.25 times broader than long; anterior margin between rostrum and lateral projections concave, anterolateral margins roundly angular; dorsal surface slightly convex, with pair of longitudinal rows of setae tufts and transverse rows of setae tufts anteriorly and posteriorly; rostral lobe (Fig. 17F) broadly rounded, not reached beyond lateral projections; lateral projections (Fig. 17F) subtriangular. Posterior carapace (Fig. 11A) with very narrow posterolateral plates and very short posteromedian plate. Branchiostegites (Fig. 11B) unarmed; anterior margin slightly protruding dorsally.

Ocular peduncles (including corneas) (Figs 11A, 17F) 0.70–0.80 times as long as shield, with medial constriction; dorsal and mesial surfaces with few tufts of stiff setae, distal margins of dorsomesial faces fringed with stiff setae. Corneas (Fig. 17F) dilated. Ocular acicles (Fig. 17F) moderately long, narrowly triangular, acute; widely separated basally by breadth of rostral lobe; with several very long setae and few short setae along mesial and lateral margins.

Antennular peduncles (Figs 11A, 19F) long, when fully extended penultimate segment exceeding corneas by approximately half own length; ultimate segment with dorsolateral distal angle bearing few very long setae; penultimate segment unarmed; basal segment with acute spine at ventrodistal angle. Antennal peduncles (Figs 11A, 21K, L) moderately long, when fully extended exceeding corneas by approximately half length of ultimate segment; fifth and fourth segments unarmed; third segment with ventrodistal angle produced; second segment expanded laterally, dorsolateral distal angle produced, terminating in strong spine accompanied ventrally by small subdistal spine, dorsomesial distal angle with strong spine; first segment with strong hook-shaped spine laterally and strong acute spine at ventrodistal margin. Antennal acicles (Figs 11A, 21K, L) moderately short and moderately broad, slightly arcuate, acute. Antennal flagella with full length unknown;

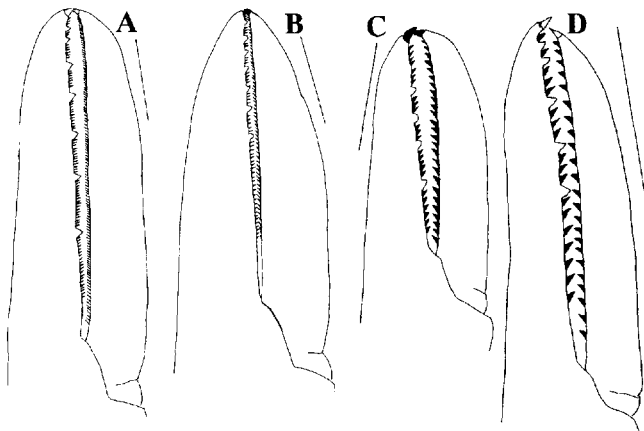


Fig. 35. Cutting edges of left cheliped (setae omitted, dorsal view): A, *Hemipagurus japonicus* (Yokoya), comb. nov., NSMT; B, *H. imperialis*, sp. nov., holotype; C, *H. hirayamai*, sp. nov., holotype; D, *H. toyoshioae*, sp. nov., holotype. Scale bars = 0.5 mm.

articles each with one or two very short setae on distal margins of lateral and mesial faces.

Third maxilliped with merus bearing acute dorsodistal spine; ischium (Fig. 22F) bearing reduced crista dentata, composed of 5–7 teeth, with strong accessory tooth; basis (Fig. 22F) with six acute teeth.

Right cheliped of female (Fig. 26E–H) slender, chela flattened dorsoventrally. Dactyl 0.90 length of palm, terminating in strong corneous claw; dorsal face slightly convex, with tufts of long setae; dorsomesial margin with tufts of long setae; cutting edge (Fig. 29I) with variously-sized calcareous teeth on proximal half and many small calcareous teeth interspersed by corneous teeth on distal half. Fixed finger terminating in strong corneous claw; cutting edge (Fig. 29I) with variously-sized calcareous teeth on proximal half and few calcareous teeth interspersed with minute corneous teeth on distal 0.35. Palm short, 0.60 length of carpus, with dorsal surface granular and with scattered short setae. Carpus equalling length of merus; dorsolateral and dorsomesial margins straight, each armed with distinct row of spiniform (lateral) or blunt (mesial) tubercles; lateral and mesial surfaces covered with granules or tubercles. Merus (Fig. 26G, H) with dorsal face bearing row of thick long setae, dorsodistal margin bearing strong spine flanked by thick long setae; ventral surface covered with granules or tubercles, ventromesial and ventrolateral distal angles each with acute spine. Ischium (Fig. 26H) with small subdistal spine ventrolaterally. Coxa unarmed.

Left cheliped (Fig. 32I–L) slightly more slender than right. Dactyl 0.80 length of palm, weakly granular, with tufts of long setae; terminating in strong corneous claw; entire cutting edge (Fig. 34F) with minute corneous teeth. Fixed finger nearly smooth, with tufts of long setae; terminating in strong corneous claw; cutting edge (Fig. 34F) with numerous

minute corneous teeth on proximal 0.60 and few calcareous teeth interspersed with minute corneous teeth on distal 0.30. Palm short, 0.60 length of carpus, granular, with scattered short setae. Carpus elongate, equalling length of merus; dorsal surface minutely granular, dorsolateral and dorsomesial margins straight, each armed with row of tubercles. Merus (Fig. 32K, L) granular; dorsal face with short, setose, subdistal transverse ridge, dorsodistal angle protruding medially, bearing thick long setae; ventral surface granular, ventromesial and ventrolateral distal angles each bearing small spine. Ischium (Fig. 32L) and coxa unarmed.

Second and left third pereopods missing. Right third pereopod (Fig. 11C) with blade-shaped, moderately broad dactyl (Fig. 36F); long, equalling length of propodus; terminating in sharp corneous claw; mesial face concave longitudinally, with dorsal row of 30 long spine-like setae and ventral row of 19 short spine-like setae, and scattered short setae; lateral face strongly convex longitudinally, with scattered short setae. Propodus (Fig. 38F) long, 1.80 length of carpus, minutely granular; dorsal face with row of very fine, short setae; mesial face dorsally with two and ventrally with one spine-like setae, and dorsodistally with pair of strong spine-like setae. Carpus (Fig. 38F) short, approximately half length of merus; dorsal surface with irregular row of tubercles; lateral surface granular; mesial face nearly smooth. Merus (Fig. 40R–T) with small spine medially on dorsodistal margin, dorsal face with second large spine subdistally followed posteriorly by third large spine slightly displaced laterally, remainder of dorsal surface with irregular rows of thick long setae; ventrolateral and ventromesial distal margins unarmed; ventral face granular or tuberculate.

Sternite of third pereopods (Fig. 11D) with broad, subrectangular anterior lobe, with setae anteriorly. Sternite of fifth pereopods with small round projection.

Uropods with right protopod bearing corneous spinules posteriorly; left protopod unarmed.

Telson (Fig. 44F) with posterior lobes separated by broad deep median cleft, each terminating in strong corneous spine, lateral margins each with pair of thick long setae anteriorly, mesial margins fringed with very short setae.

#### *Sexual dimorphism*

Male unknown.

#### *Colouration*

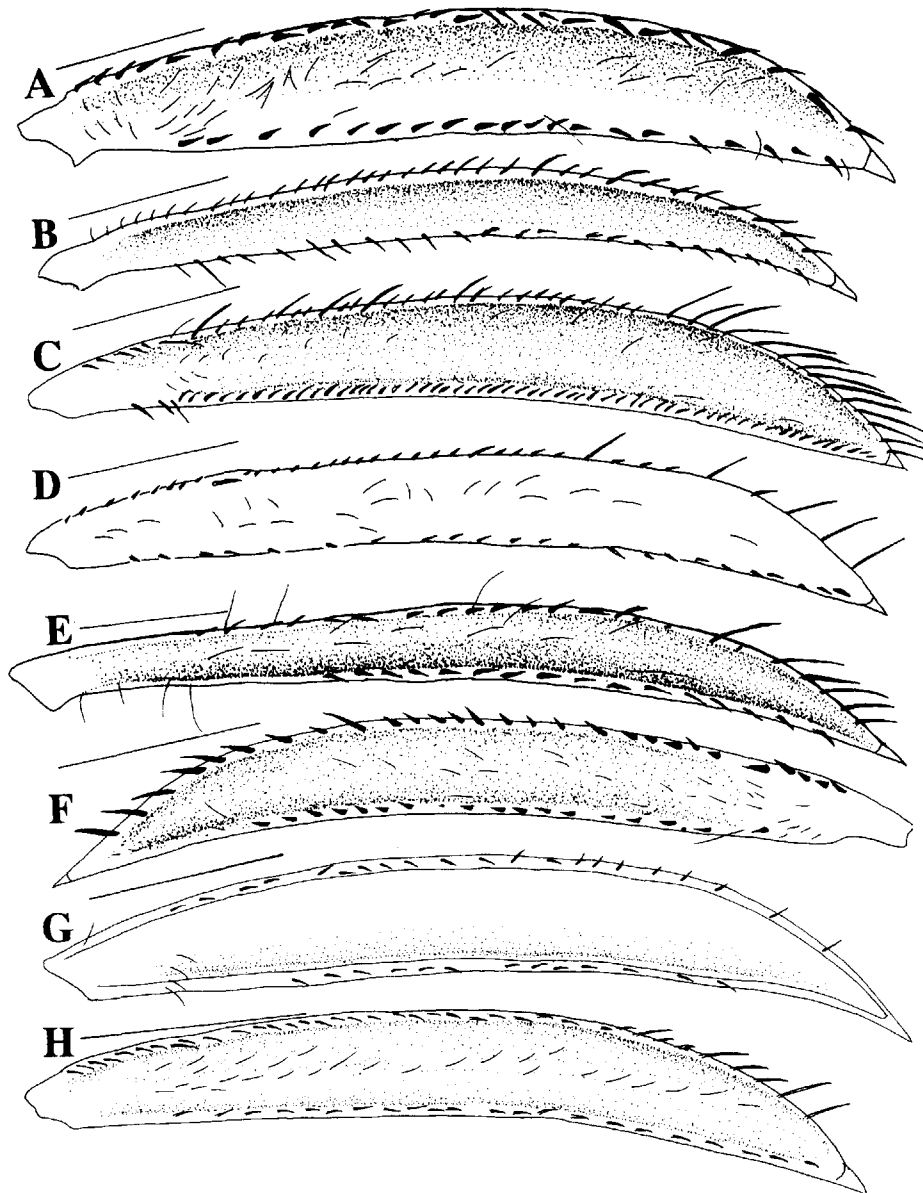
Not known.

#### *Shell*

*Polinices* sp.

#### *Etymology*

This species is named for Dr Patsy A. McLaughlin, who first suggested that this species belonged to undescribed taxon and was very kind to give me the chance to describe it.



**Fig. 36.** Mesial face of dactyl of third pereopod: A–E, G–H, left; F, right. A, *Hemipagurus ensifer* (Henderson), comb. nov., lectotype; B, *H. granulatus* (Edmondson), comb. nov., holotype; C, *H. haigae*, sp. nov., holotype; D, *H. kosugei*, sp. nov., holotype; E, *H. lewinoehni*, sp. nov., holotype; F, *H. maclaughlinae*, sp. nov., holotype; G, *H. albatrossae*, sp. nov., holotype; H, *H. alcocki* (McLaughlin), comb. nov., USNM. Scale bars = 1.0 mm.

#### Distribution

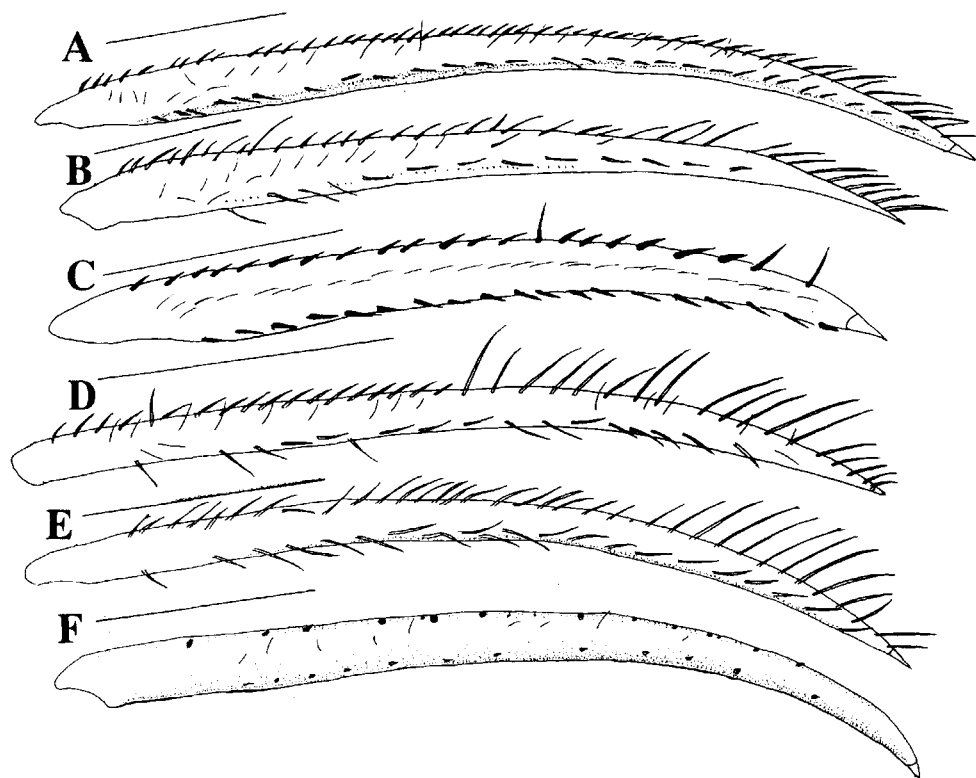
Seychelles, Indian Ocean; 38 m.

#### Affinities

*Hemipagurus maclaughlinae*, sp. nov. is distinguished from all other species of the *ensifer*-group in having very weak development of the dorsal spines of the carpi (Fig. 38F) and meri (Fig. 44R–T). Morphological characteristics of the cheliped cutting edges of *H. maclaughlinae* (Figs 29I, 34F)

are apparently different from those of any other members of the *ensifer*-group.

This new species has a superficial resemblance to *H. ensifer*. However, *H. maclaughlinae* has a broader shield than *H. ensifer*; 1.20–1.25 times broader than long in the former (Fig. 11A) but 1.10–1.15 times in the latter (Fig. 5A). Further *H. maclaughlinae* has more slender dactyls of the third pereopods than *H. ensifer*; width/length ratio is 0.10–0.11 in the former (Fig. 36F) but 0.14–0.15 in the latter (Fig. 36A).



**Fig. 37.** Mesial face of dactyl of third pereopod (left). *A*, *Hemipagurus japonicus* (Yokoya), comb. nov., NSMT; *B*, *H. imperialis*, sp. nov., holotype; *C*, *H. hirayamai*, sp. nov., holotype; *D*, *H. toyoshioae*, sp. nov., holotype; *E*, *H. holthuisi* (McLaughlin), comb. nov.; *F*, *H. tanimbarensis* (McLaughlin), comb. nov. Scale bars = 1.0 mm.

#### Remarks

According to McLaughlin and Hogarth (1998: 23), the ambulatory legs are similar to each other, but only one right third pereopod now remains.

#### *Hemipagurus albatrossae*, sp. nov.

(Figs 12, 18A, 19G, 21M–N, 22G, 27A–D, 29J, 32M–P, 34G, 36G, 38G, 40U–W, 42K–L, 44G, 48)

#### Material examined

**Holotype.** **Philippines:** ♀, SL = 2.00 mm, St. D5152 of Albatross Station, 3.2 km north-east of west Pagumajan Island, Tapul Group, Sulu Archipelago, 5°22'45"N 120°15'45"E, Agassiz beam trawl, 61 m, 18.ii.1908, USNM 298349.

#### Description

Shield (Fig. 12A) 1.10 times broader than long, anterior margin between rostrum and lateral projections concave, anterolateral margins rounded; dorsal surface vaulted, with pair of longitudinal rows of setae tufts; rostral lobe (Fig. 18A)

very broad, overreached by lateral projections; lateral projections (Fig. 18A) triangular, each terminating in very strong spine. Accessory portion of shield broad. Posterior carapace (Fig. 12A) with very narrow posterolateral plates and very short posteromedian plate. Branchiostegites (Fig. 12B) not calcified, unarmed.

Ocular peduncles (including corneas) (Figs 12A, 18A) approximately 0.60 times as long as shield; dorsal surfaces bearing several long stiff setae, distal margins of dorsomesial faces with long stiff setae. Corneas (Fig. 18A) dilated. Ocular acicles (Fig. 18A) moderately long, triangular, acute; widely separated basally by breadth of rostral lobe.

Antennular peduncles (Figs 12A, 19G) long, when fully extended second peduncular segments exceeding distal margins of corneas by approximately half own length; ultimate segment with few very long setae laterodistally; penultimate segment unarmed; basal segment with acute spine at ventrodistal mesial angle. Antennal peduncles (Figs 12A, 21M–N) short and stout, when fully extended exceeding distal margins of corneas by approximately 0.30 length of ultimate segments; with supernumerary segmentation; fifth and fourth segments unarmed; third segment

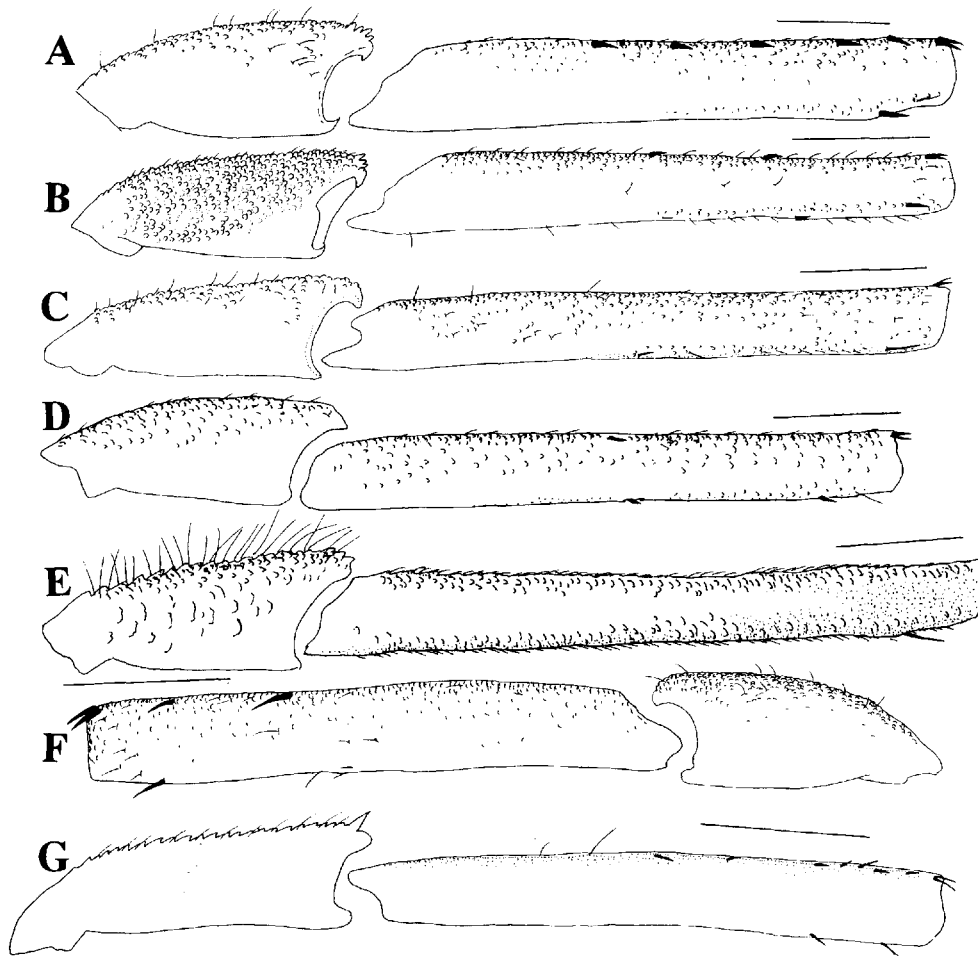


Fig. 38. Mesial faces of propodus and carpus of third pereopod: *A*, *Hemipagurus ensifer* (Henderson), comb. nov., lectotype; *B*, *H. granulatus* (Edmondson), comb. nov., holotype; *C*, *H. haigae*, sp. nov., holotype; *D*, *H. kosugei*, sp. nov., holotype; *E*, *H. lewinozni*, sp. nov., holotype; *F*, *H. maclaughlinae*, sp. nov., holotype; *G*, *H. albatrossae*, sp. nov., holotype. *A*–*E*, *G*, left; *F*, right. Scale bars = 1.0 mm.

with ventrodistal angle produced; second segment with dorsolateral distal angle produced, terminating in strong spine, dorsomesial distal angle with strong spine; first segment with strong hook-shaped spine laterally and strong spine at ventrodistal margin. Antennal acicles (Fig. 21*M*) moderately short, reaching distal ends of corneas, subacute.

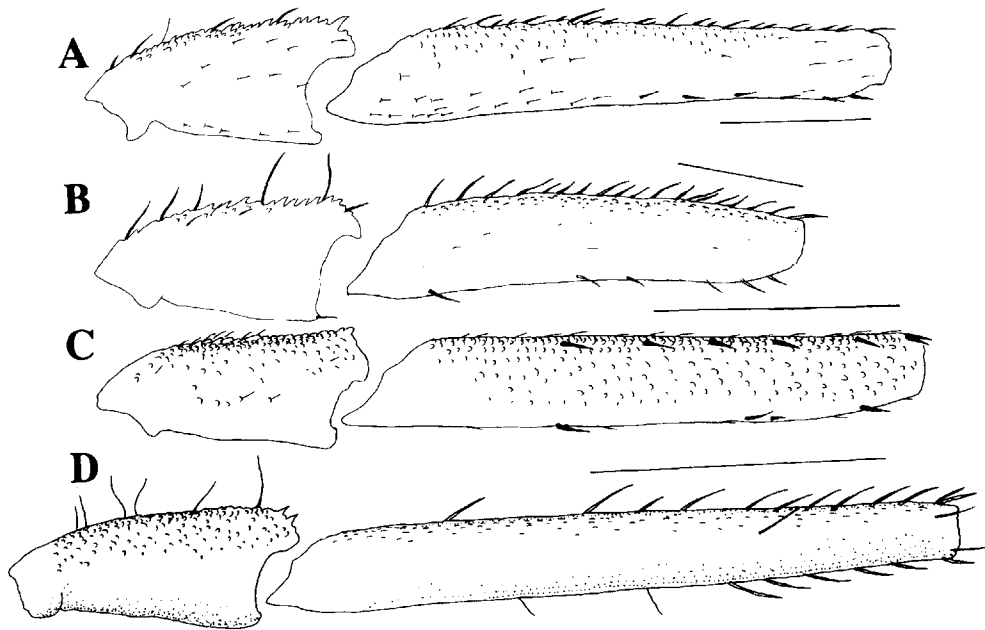
Third maxilliped with merus bearing acute dorsodistal spine; ischium (Fig. 22*G*) with reduced crista dentata, composed of 7–8 teeth and strong accessory tooth; basis (Fig. 22*G*) with 3–5 acute teeth.

Right cheliped of female (Fig. 27*A*–*D*) slender, chela flattened dorsoventrally. Dactyl moderately long, 0.90 length of palm, terminating acutely; dorsal face smooth, with tufts of short setae mesially; entire cutting edge (Fig. 29*J*) with numerous minute calcareous and corneous teeth. Fixed finger terminating acutely; dorsolateral surface with tufts of long setae; cutting edge (Fig. 29*J*) with widely separated

calcareous teeth interspersed with few corneous teeth. Palm moderately short, 0.65 length of carpus; dorsal surface smooth, dorsomesial and dorsolateral surfaces with tufts of setae. Carpus as long as merus; dorsal surface flat, with dorsolateral and dorsomesial margins each with row of tiny short spines; ventral face tuberculate. Merus (Fig. 27*C*, *D*) with dorsodistal margin with very strong spine and few thick long setae, dorsal face with irregular rows of thick long setae; ventral surface nearly smooth, with few thick long setae, ventromesial and ventrolateral distal angles protruding, each bearing very strong spine. Ischium with strong subdistal spine ventrolaterally. Coxa unarmed.

Left cheliped missing.

Second and third pereopods (Fig. 12*C*, *D*) morphologically similar, but third slightly longer, 1.10 length of second. Dactyls (Fig. 36*G*) blade-shaped, broad, very thin, nearly transparent; long, similar (second) or 1.15–1.25



**Fig. 39.** Mesial faces of propodus and carpus of third pereopod (left): *A*, *H. japonicus* (Yokoya), comb. nov., NSMT; *B*, *H. imperialis*, sp. nov., holotype; *C*, *H. hirayamai*, sp. nov., holotype; *D*, *H. toyoshioae*, sp. nov., holotype. Scale bars = 1.0 mm.

(third) length of propodi; each terminating in strong corneous claw; mesial faces nearly flat or very slightly concave longitudinally, each with dorsal row of 21–26 and ventral row of 13–17 short spiniform bristles; lateral face nearly flat, with scattered short setae. Propodi (Fig. 38G) long, 1.70–1.80 length of carpi; mesial faces each with dorsal row of 6–8 and ventral row of 2–4 strong spine-like setae and dorsodistally with pair of strong spine-like setae. Carpi (Fig. 38G) 0.50–0.60 length of meri; dorsal surface with few irregular rows of small spines, dorsodistal angles each with strong spine. Meri (Fig. 40U–W) distinctly more swollen lateromesially in third than second; dorsodistal margin with large, medial spine, dorsal face subdistally with second large spine followed posteriorly by third large spine slightly displaced laterally, each flanked by one or two thick long setae, remainder of dorsal surface with irregular rows of long setae; ventrolateral distal margins armed with strong spine, ventromesial distal margins unarmed; ventral faces highly tuberculate.

Fourth pereopod (Fig. 42K, L) with dactyl bearing 1–3 short corneous spines on ventral margin and prominent preungual process covered by dense short setae apically; propodal rasp 0.80 length of ventral margin; carpus with tiny blunt-tipped spine at dorsodistal angle or unarmed.

Sternite of third pereopods (Fig. 12E) with broad, semitriangular anterior lobe with setae anteriorly.

Female with three unpaired left biramous pleopods and with one unpaired left uniramous pleopod.

Uropodal protopods strongly protruding posteriorly (Fig. 12F).

Telson with posterior lobes separated by very broad median cleft, each lobe blunt-tipped, lateral margins of each with two thick long setae anteriorly (Fig. 44G).

#### *Sexual dimorphism*

Male unknown.

#### *Colouration:*

Not known.

#### *Shell*

Not known.

#### *Etymology*

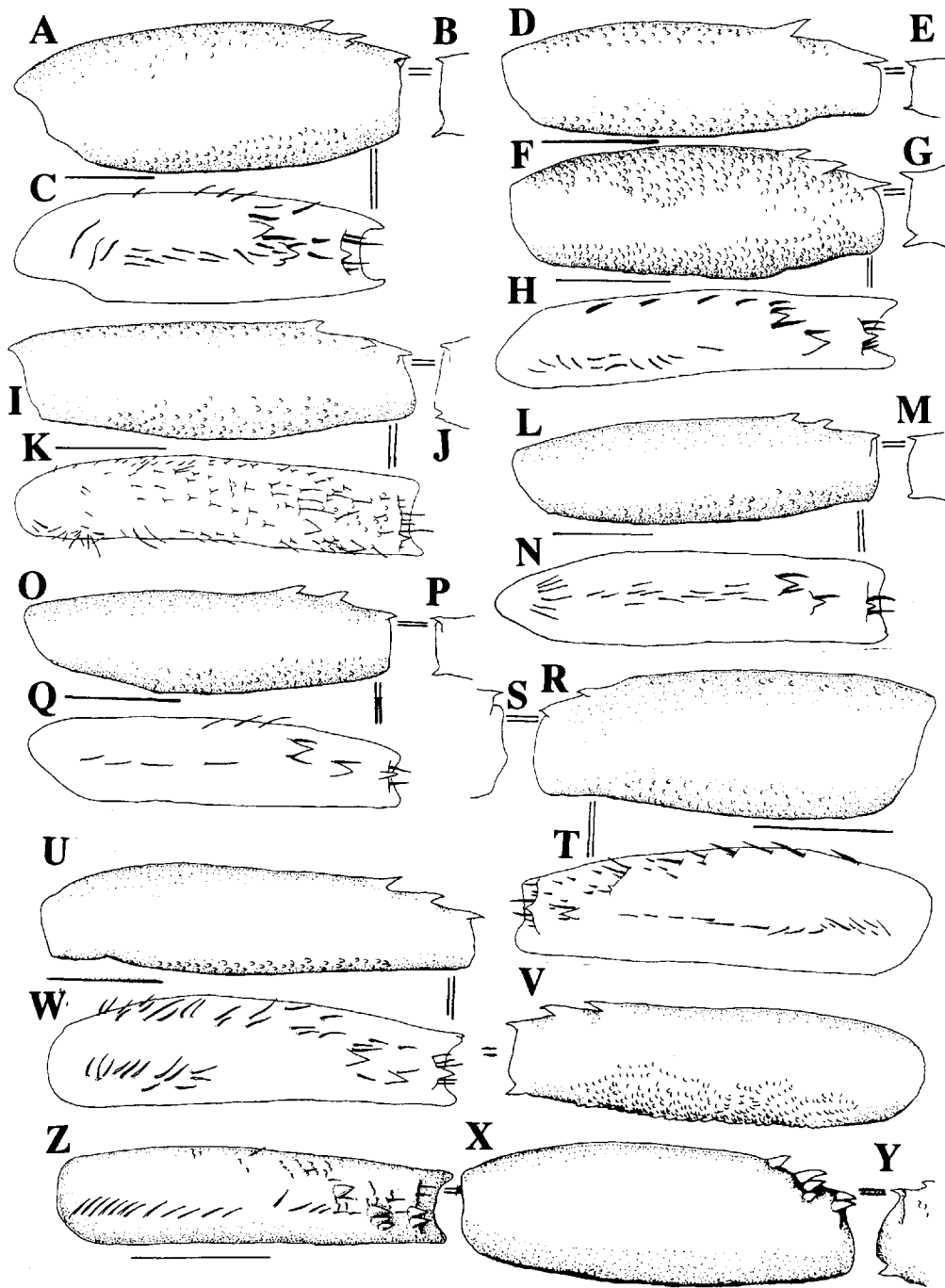
This species is named for the research vessel 'Albatross' of the U. S. Fish Commission, which was used in an expedition to the Philippines in 1908.

#### *Distribution*

Known only from the type locality, Tapul Group, Sulu Archipelago, Philippines; 61 m.

#### *Affinities*

*Hemipagurus albatrossae*, sp. nov. is easily distinguished from the other species of the *Hemipagurus ensifer*-group in having uropodal protopods that strongly protrude toward the



**Fig. 40.** Merus of third pereopod: A–C, *Hemipagurus ensifer* (Henderson), comb. nov., lectotype; F–H, *H. granulatus* (Edmondson), comb. nov., holotype; I–K, *H. haigae*, sp. nov., holotype; L–N, *H. kosugei*, sp. nov., holotype; O–Q, *H. lewinsohni*, sp. nov., holotype; R–T, *H. maclaughlinae*, sp. nov., holotype; U–W, *H. albatrossae*, sp. nov., holotype; X–Z, *H. alcocki* (McLaughlin), comb. nov., USNM. A–Q, X–Z, left; R–T, right; A, F, I, L, O, R, U, X, mesial view (setae omitted); B, G, J, M, P, S, Y, lateral view (distal portion, setae omitted); V, whole lateral view; C, H, K, N, Q, T, W, Z, dorsal view. Merus of left second pereopod: D–E, *H. granulatus* (Edmondson), comb. nov., holotype; D, mesial view (setae omitted); E, lateral view (distal portion, setae omitted). Scale bars = 1.0 mm.

posterior (Fig. 12F), very strong lateral projections of the shield (Fig. 18A), a well-developed accessory portion of the shield (Fig. 12A), highly tubercular ventral faces of the meri of the ambulatory legs (Fig. 40V) and nearly flat or very

slightly convex lateral face of the ambulatory dactyls (Fig. 36G). The other species have uropodal protopods that do not protrude toward the posterior, weaker lateral projections (Fig. 17A–F) and less well-developed accessory



portions of the shield (Figs 5A, 7A, 8A, 9A, 10A, 11A), less tubercular meri of the ambulatory legs (Fig. 40A–T, X–Z) and strongly convex lateral faces of the ambulatory dactyls (Fig. 36A–F, G).

***Hemipagurus alcocki*** (McLaughlin), comb. nov.

(Figs 27E–H, 29K, 32M–P, 36H, 40X–Z, 48)

*Catapagurus alcocki* McLaughlin, 1998 (in McLaughlin & Hogarth, 1998): 25 (*nomen nudum*, see remarks).

*Catapagurus alcocki* McLaughlin, 1998 (in Hogarth *et al.* 1998): 162, fig. 7.

*Catapagurus ensifer*: Alcock, 1905b: 115, pl. 3, fig. 3. (not *Catapagurus ensifer* Henderson, 1893; see remarks).

**Material examined**

**Holotype.** **Maldives:** ovi. ♀, SL = 2.0 mm, Gardiner sta. Mul 5, UMZC (not examined).

**Paratype.** **Maldives:** ovi. ♀, SL = 2.03 mm, Hogarth sta. 95 ML08D, NHM 97.000.

**Additional material.** **Philippines:** 2 ♂, 4.4 km south-west of North Tinakta Island, Tawi Tawi Group, Sulu Archipelago, USNM 298348.

**Description**

Only the right cheliped of male is described as McLaughlin (1998) provided a full description of this species except for this appendage. Right cheliped of male (Fig. 27E–H) large and stout, chela flattened dorsoventrally. Dactyl moderately short, 0.60–0.65 length of palm, blunt-tipped; dorsal face granular, with tufts of long setae, dorsomesial face strongly granular or tuberculate; entire cutting edge (Fig. 29K) with minute calcareous teeth. Fixed finger blunt-tipped; dorso-lateral surface tuberculate or granular, with tufts of long setae; cutting edge (Fig. 29K) with minute calcareous teeth along entire length and several corneous teeth on distal 0.30–0.40. Palm long, 1.10–1.15 length of carpus; dorsal surface granular, dorsomesial and dorsolateral surfaces densely covered by minute granules or tubercles. Carpus 0.85–0.90 length of merus; dorsal surface flat, with scattered granules and spiniform tubercles, dorsolateral and dorso-mesial margins each forming distinct ridge armed with row of blunt or spiniform tubercles; lateral and mesial surfaces covered with blunt or spiniform tubercles. Merus (Fig. 27G, H) with distal half of dorsal face bearing few short transverse, sometimes denticulate, ridges accompanied anteriorly by thick long setae, dorsodistal margin protruding with strong simple or bifid spine flanked by few thick long setae; lateral and mesial faces granular or tuberculate; ventral surface covered with numerous large tubercles or spines, ventro-mesial and ventrolateral distal angles protruding, each bearing strong spine. Ischium with strong subdistal spine ventrolaterally. Coxa unarmed.

**Sexual dimorphism**

Right cheliped in males much more stout than in females.

**Colouration**

Not known.

**Distribution**

Maldives Islands and now Philippines; 22 m.

**Affinities**

Very strong spines on the dorsal faces of the meri of the ambulatory legs (Fig. 40X, Z) are conspicuously characteristic of this species. Although basic patterns of spination in this species are similar to those of other species, i.e. dorsodistal spine plus two subdistal spines present, the spines in this species are sometimes bifid or even trifid, elevated above the dorsal face and often becoming hook-shaped (Fig. 40X, Z). However, all the other species of the *ensifer*-group have comparatively weaker spines that are not hook-shaped and are usually simple or very rarely bifid (Fig. 40A–W).

In this species, dorsal rows of setae on the mesial faces of the ambulatory dactyls are long distally 0.3–0.5 but short on the remainder of the segment (Fig. 36H). A similar setal condition in the ambulatory dactyls is seen in *H. haigae*, sp. nov., *H. kosugei*, sp. nov., *H. lewinsohni*, sp. nov. and *H. maclaughlinae*, sp. nov. (Fig. 36C, D, E, F). However, *H. haigae*, *H. kosugei* and *H. maclaughlinae* have unarmed carpi of the ambulatory legs (Fig. 38C, D, F), whereas *H. alcocki* has one or two strong dorsodistal spines (see also McLaughlin, 1998: 165, fig. 7d). Further *H. haigae* has a row of numerous (50–60 on third) long setae on the ventral portions of the mesial faces of the dactyls (Fig. 36C). On the other hand, *H. alcocki* has only 20–30 comparatively short bristles on the same surface (Fig. 36H). *Hemipagurus lewinsohni* differs from *H. alcocki* in having shorter ocular acicles (Fig. 17E) and much slenderer (breadth 0.06–0.10 of length) ambulatory dactyls (Fig. 36E) than *H. alcocki* (dactyl breadth 0.12–0.15 of length) (Fig. 36H).

McLaughlin (1998) in Hogarth *et al.* (1998) documented the differences between this species and *Hemipagurus* (as *Catapagurus*) *ensifer*, *H.* (as *Catapagurus*) *granulatus* and Haig and Ball's (1988) unnamed specimen (now, *H. haigae*, sp. nov.).

**Remarks**

This species was described by McLaughlin (1998) in Hogarth *et al.* (1998) based on the specimens reported as *Catapagurus ensifer* by Alcock (1905b). When McLaughlin and Hogarth (1998) discussed the affinities of *Catapagurus* spp. with *C. alcocki*, the original description of *C. alcocki* McLaughlin (in Hogarth *et al.* 1998) had not been published. Thus, their reference to *C. alcocki* is a *nomen nudum*. The present specimens from the Albatross Expedition to the Philippines (USNM 298348) are the first record of this species from outside the Indian Ocean.

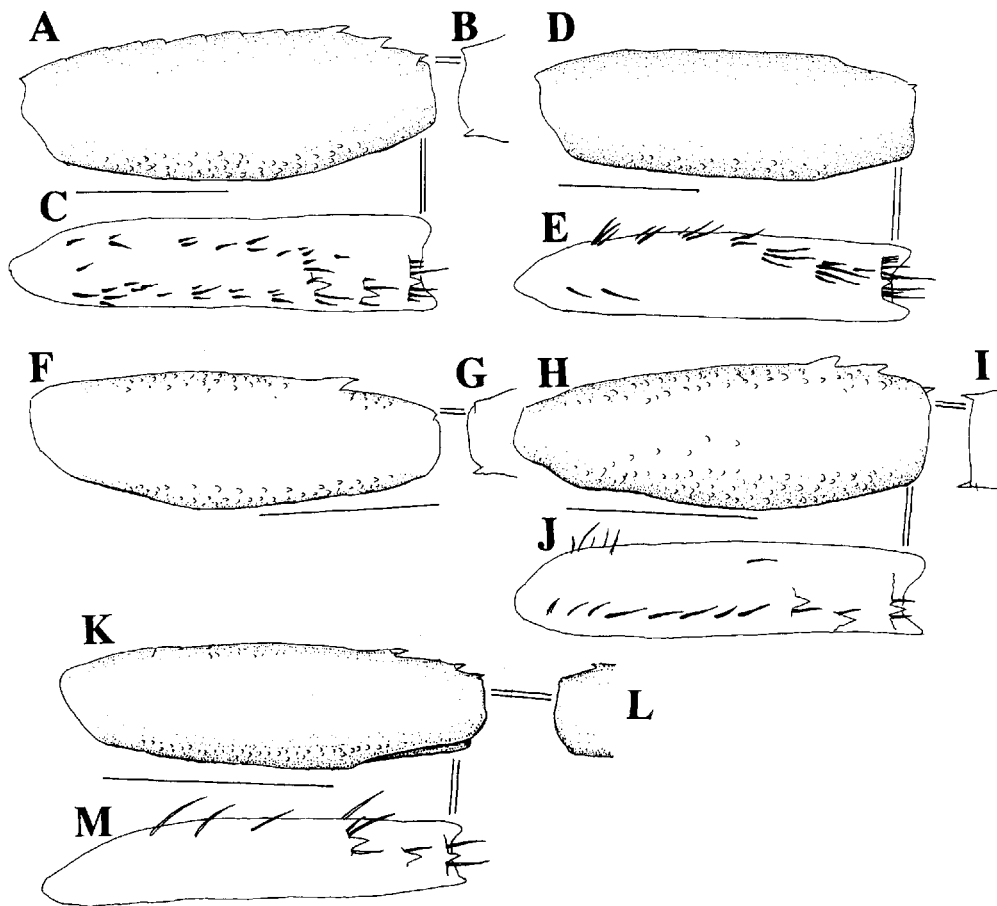


Fig. 41. Merus of left third pereopod: A–C, *H. japonicus* (Yokoya), comb. nov., NSMT; D–E, *H. imperialis*, sp. nov., holotype; F–J, *H. hirayamai*, sp. nov., holotype; K–M, *H. toyoshioae*, sp. nov., holotype. A, D, H, K, mesial view (setae omitted); B, I, L, lateral view (distal portion, setae omitted); C, E, J, M, dorsal view. Merus of left second pereopod: F–G, *H. hirayamai*, sp. nov., holotype; F, mesial view (setae omitted); G, lateral view (distal portion, setae omitted). Scale bars = 1.0 mm.

***Hemipagurus japonicus* (Yokoya), comb. nov.**

(Figs 13, 18B, 20A–B, 21O–P, 22G, 27I–L, 30A, 33A–D, 35A, 37A, 39A, 41A–C, 43A–B, 44H, 51)

?*Catapagurus misakiensis* Terao, 1914: 470, text fig. (see remarks).

*Catapagurus japonicus* Yokoya, 1933: 91, text fig. 35. – Miyake, 1947: 736, fig. 2129; Miyake, 1965: 648, fig. 1097; Miyake, 1978: 144, text fig. 56.

*Cestopagurus misakiensis*: Miyake, 1978: 146, text fig. 57 (see remarks).

**Material examined**

**Syntypes.** **Bungo Strait:** 3 ♂, SL = 2.10, 2.60, 2.90 mm, St. 324 of S. S. Soyo-Maruru cruise 1923–1933, 106 m, 21.vii.1928, KMNH324.

**Additional material.** **Sagami Bay:** 1 ♂, Maruyamadashi, Amadaiba, NSMT-Cr 1474; 1 ♂, Aoyamadashi-Maruyamadashi, Amadaiba, NSMT-Cr 3551; 1 ovi. ♀, Aoyamadashi-Amadaiba, NSMT-Cr 2029; 1 ovi. ♀, 2.4 km south-west of Jyougashima Island, NSMT-Cr 1615 (specimen reported as *Cestopagurus misakiensis* by Miyake, 1978); 1 ovi. ♀, 4 km south-west of Jyougashima, NSMT-Cr 2113 (*ibid.*).

**Type localities**

According to Yokoya (1933): South of Shimoda, Sagami Bay; Maisaka, Shizuoka-ken, Suruga Bay; west of Muroto-zaki; east of Ariake Bay, Kagoshima-ken; Bungo Strait; strait between Nagasaki and Koshiki Islands.

**Redescription**

Shield (Fig. 13A) 1.05–1.20 times broader than long; anterior margin between rostrum and lateral projections shallowly concave, anterolateral margins rounded; lateral margins posteriorly straight; dorsal surface slightly convex, with numerous tufts of setae (Fig. 13C); rostral lobe (Fig. 18B) broad, obtusely triangular, almost equal to lateral projections; lateral projections (Fig. 18B) triangular, each with submarginal spine. Posterior carapace (Fig. 13A) with very narrow posterolateral plates and very short posteromedian plate. Branchiostegites (Fig. 13B) not calcified, unarmed; dorsal portions of distal margins protruding.

Ocular peduncle (including corneas) (Figs 13A, 18B) 0.45–0.60 length of shield, broader distally; dorsal surface with row of few tufts of stiff short setae. Corneas (Fig. 18B) dilated. Ocular acicles (Fig. 18B) long, reaching to proximal portion of corneas; very narrowly triangular, acute; with several very long setae along mesial margins; separated basally by breadth of rostral lobe.

Antennular peduncles (Figs 13A, 20A, B) long, when fully extended second peduncular segment exceeding corneas by approximately 0.40–0.60 own length; ultimate segment with dorsal face bearing row of long setae on lateral margin, several very long setae on distal margin laterally and few short setae on mesial margin; penultimate segment unarmed; basal segment with acute spine at ventrodistal mesial angle. Antennal peduncles (Figs 13A, 21O, P) moderately long, when fully extended exceeding corneas by approximately 0.55–0.65 length of penultimate segment; fifth and fourth segments unarmed; third segment with ventrodistal angle produced; second segment with dorsolateral distal angle terminating in strong spine accompanied ventrally by submarginal spine, dorsomesial distal angle with strong spine; first segment with strong hook-shaped spine laterally and strong spine at ventrodistal margin. Antennal acicles (Fig. 21O) moderately long, slightly arcuate, acute. Antennal flagella very long; articles each with one or two very short setae on lateral and mesial faces distally.

Third maxilliped with merus bearing very strong dorsodistal spine; ischium (Fig. 22G) with crista dentata well developed, composed of 10–13 teeth and with strong accessory tooth; basis (Fig. 22G) with 1–3 acute teeth.

Right cheliped (Fig. 27I–L) large, stout, chela flattened dorsoventrally. Dactyl short, 0.55–0.70 length of palm; dorsal face convex, with tufts of long setae, dorsomesial face granular, with tufts of long setae; cutting edge (Fig. 30A) with irregularly sized calcareous teeth along entire length and large, blunt-tipped calcareous teeth medially. Fixed finger with dorsolateral surface granular, with tufts of long setae; cutting edge (Fig. 30A) with irregularly sized calcareous teeth. Palm 0.70–0.85 length of carpus; dorsal face flat, nearly smooth medially, tuberculate dorsomesially and granular dorsolaterally; dorsomesial face with dense tufts of long setae. Carpus as long as merus; dorsal surface flat, with scattered granules, few small spines and several thick spine-like setae mesially, dorsolateral and dorsomesial margins distinct and straight, each armed with row of strong spines; lateral surface tuberculate. Merus (Fig. 27K, L) with dorsodistal margin protruding, with large spine flanked by few, thick spine-like setae, dorsal face with irregular rows of thick spine-like setae; ventromesial and ventrolateral distal angles protruding, bearing one or two strong spines; ventral surface covered with numerous granules. Ischium (Fig. 27L) with subdistal acute spine ventrolaterally. Coxa unarmed.

Left cheliped (Fig. 33A–D) slender, particularly palm and carpus (0.60–0.70 and 0.65–0.75 maximum width

respectively of those of right); almost equal to length of right. Dactyl long, 1.30–1.45 length of palm, terminating in strong corneous claw; entire cutting edge (Fig. 35A) with row of numerous small corneous teeth. Fixed finger terminating in strong corneous claw; dorsal face with tufts of long setae; entire cutting edge (Fig. 35A) with numerous corneous teeth and widely spaced calcareous teeth. Palm short, 0.60–0.75 length of carpus; dorsal face with scattered tufts of setae, granular dorsomesially and dorsolaterally. Carpus as long as merus; dorsal surface flat, with several thick, spine-like setae mesially, dorsolateral and dorsomesial margins distinct and straight, each armed with row of strong spines; lateral surface tuberculate or granular. Merus (Fig. 33C, D) with dorsal face bearing irregular rows of thick spine-like setae, dorsodistal margin protruding with medial large spine flanked by few thick, spine-like setae; ventral surface tuberculate or granular, ventromesial and ventrolateral distal angles protruding, bearing 1–3 spines; ventromesial surface with several thick, spine-like setae. Ischium (Fig. 33D) with acute spine medially on ventrolateral margin.

Second and third pereopods (Fig. 13D, E) morphologically very similar; left second shorter than left third, in particular dactyl 0.75–0.85 length; right second and right third similar in length; left second and left third 1.05–1.15 and 1.15–1.25 length of right second and right third respectively. Dactyls (Fig. 37A) not blade-shaped; long, 1.10–1.25 (second) or 1.30–1.45 (third) length of propodi; each terminating in sharp corneous claw; mesial faces nearly flat or slightly convex, each with dorsal and ventral rows of thick spine-like setae and with medial row of fine long setae; lateral faces strongly convex longitudinally, with scattered setae. Propodi (Fig. 39A) long, 2.45–2.55 length of carpi, minutely granular dorsally; mesial faces each with dorsal and ventral rows of numerous thick long setae. Carpi (Fig. 39A) short, 0.40–0.55 (second) or 0.50–0.60 (third) length of meri, each with acute spine at dorsodistal angle; dorsal face with one (second) or 1–3 (third) irregular rows of strong spines and row of widely spaced, thick long setae. Meri (Fig. 41A–C) each with dorsodistal margin bearing strong spine, dorsal face with second large spine subdistally followed posteriorly by third large spine slightly displaced laterally, each flanked by one or two thick long setae, remainder of dorsal and dorsolateral faces with irregular rows of tufts of thick long setae; ventrolateral distal margins each armed with one acute spine, ventromesial distal margins unarmed; ventral faces tuberculate and with 2–6 large acute spines (second) or unarmed (third).

Fourth pereopod (Fig. 43A, B) with dactyl bearing four short corneous spines on ventral margin and prominent preungual process; propodal rasp 0.75–0.85 length of ventral margin; carpus with tiny blunt-tipped spine at dorsodistal angle. Male with right coxa of fifth pereopods bearing very long sexual tube with forked tip curving over dorsal surface

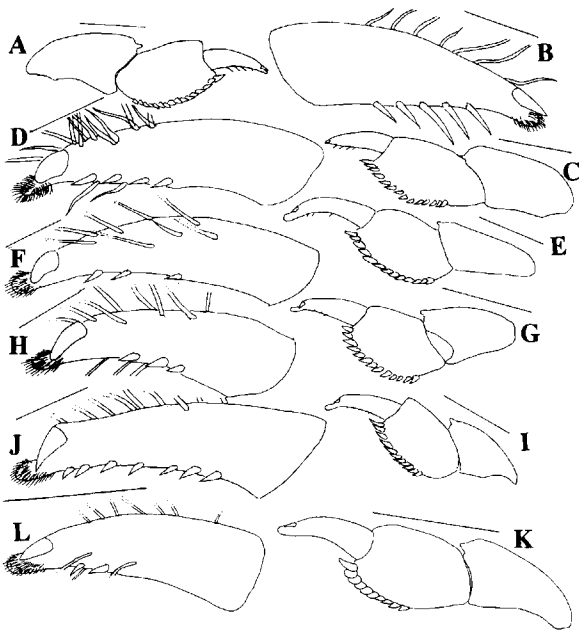


Fig. 42. Fourth pereopod (lateral view): A, B, right; C–K, left. A, B, *Hemipagurus ensifer* (Henderson), comb. nov. (lectotype or paralectotype); C, D, *H. granulatus* (Edmondson), comb. nov., holotype; E, F, *H. haigae*, sp. nov., holotype; G, H, *H. kosugei*, sp. nov., holotype; I, J, *H. lewinsohni*, sp. nov., holotype; K, L, *H. albatrossae*, sp. nov., holotype. A, C, E, G, I, K, dactyl, propodus and carpus; B, D, F, H, J, L, dactyl and preungual process. Scale bars: A, C, E, G, I, K = 0.5 mm; B, D, F, H, J, L = 0.125 mm.

of abdomen toward left side (Fig. 13A, B); left coxa with gonopore and setae.

Sternite of third pereopods (Fig. 13F) with anterior lobe subrectangular, with setae anteriorly. Sternite of fifth pereopods reduced with pair of very small round projections medially.

Abdomen with well-developed fleshy protuberance anteriorly on ventral portion. Uropodal protopods unarmed.

Telson (Fig. 44H) with posterior lobes separated by U- or nearly O-shaped deep median cleft, with one or two thick long setae on each lateral side, terminal margins acute.

#### Sexual dimorphism

Morphology of the male and female chelipeds is quite similar.

#### Colouration

Not known.

#### Shell

*Polinices* sp.

#### Distribution

Temperate Japan from Sagami Bay to Kagoshima-ken; Koshiki-jima Islands; 65–106 m.

#### Affinities

*Hemipagurus japonicus* differs from all other species of the *japonicus*-group in having a broad U- or nearly O-shaped median cleft of the telson (Fig. 44H v. fig. 44I, J). The species most closely related to *H. japonicus* is *H. holthuisi* (McLaughlin 1997), but the shape of the median cleft of the telson of *H. holthuisi* is rectangular (see McLaughlin 1997: 504, fig. 19j). Further *H. japonicus* has much shorter ocular peduncles (Fig. 13A), more elongate ambulatory legs with a dorsal and ventral row of much shorter setae on the mesial faces of the dactyls (Fig. 37A) and far stronger armatures of the carpi (Fig. 39A) than *H. holthuisi* (see McLaughlin 1997: 503–504, fig. 19d, f).

*Hemipagurus japonicus* is also similar to *H. imperialis*, sp. nov. However *H. japonicus* has two strong subdistal spines on the dorsal faces of the meri of the ambulatory legs (Fig. 41A–C) and several long setae only on the laterodistal margin of the ultimate segments of the antennules (Fig. 20A). In contrast, *H. imperialis* has no subdistal spines on the meri of the ambulatory legs (Fig. 41D–E) and a fringe of dense long setae on both lateral and mesial distal margins dorsally on the ultimate segment of the antennules (Fig. 20C). Further *H. japonicus* has much shorter ocular peduncles (Fig. 13A), much longer ambulatory legs (Fig. 13D, E) and distinctly denser setation on the dorsal face of the shield (Fig. 13C) than *H. imperialis* (Fig. 14A, C–E).

#### Remarks

Yokoya (1933) described *Catapagurus japonicus* based on nine males and eight females collected from six localities in Japan during the S. S. Soyo-Maru cruise 1923–1930. A part of the syntypes, now deposited at the Kitakyushu Museum of Natural History (KMNH) and labelled as 'st. 324', contains three males. However according to Yokoya (1933), the material from st. 324 consisted of two males and two females. The syntypes were first deposited at the University of Tokyo, then transferred to the Faculty of Agriculture, Kyushu University, and finally deposited at KMNH. It is most probable that during these transfers, errors and loss occurred. I searched for the remainder of Yokoya's material, which should have contained the remaining syntypes, in the University Museum, University of Tokyo (UMUT), Faculty of Fisheries, University of Tokyo (FFUT) and KMNH without success. They are probably no longer extant.

Before Yokoya, Terao (1914), who was a professor of Tokyo Imperial University (now University of Tokyo), described *Catapagurus misakiensis* based on a single male collected from Misaki, Sagami Bay. According to Terao's brief description and illustration, *C. misakiensis* has a superficial resemblance to *Hemipagurus japonicus* except for the direction of the sexual tube. He reported that it had a very long right sexual tube directed toward the anterior on the ventral face of the cephalothorax. However, Yokoya (1933) apparently did not consider Terao's species, because

Yokoya assumed that Terao correctly described the direction of the male sexual tube, and that would have eliminated it from consideration in the genus *Catapagurus*. I searched for Terao's specimen (the holotype male of *Catapagurus misakiensis*) in UMUT, FFUT, and KMNH without success. It too is probably no longer extant. Until the holotype is recovered or additional material is found, Terao's taxon must be considered *incertae sedis*.

In the illustrated encyclopaedias of the fauna of Japan, Miyake (1947, 1965) provided illustrations and brief descriptions of *Catapagurus japonicus*, which were apparently based on those in Yokoya (1933).

I re-examined the specimens reported by Miyake (1978) in his large monograph of Sagami Bay anomurans as *Catapagurus japonicus* (NSMT-Cr 1474, 2029, 3551) and confirmed his accurate identification. Miyake (1978) also reported *Cestopagurus misakiensis* from Sagami Bay. His record was based on six females and he may have believed that, if males of this species were found, they would have a sexual tube directed anteriorly on the ventral face of the cephalothorax. My re-examination of those specimens (NSMT-Cr 1615, 2113) has proved that all of them are females of *Hemipagurus japonicus*.

#### *Hemipagurus imperialis*, sp. nov.

(Figs 14, 18C, 20C–D, 21Q–R, 22I, 18H, 28A–D, 30B, 33E–H, 35B, 37B, 39B, 41D–E, 43C–D, 51)

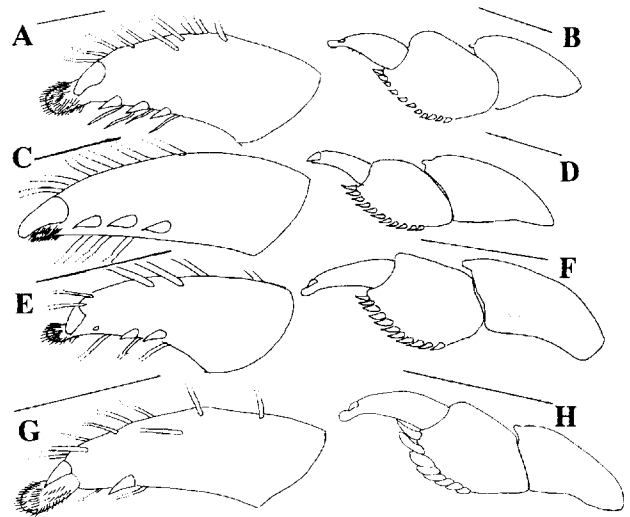
#### Material examined

*Holotype*. **Sagami Bay**: ovi. ♀, SL = 2.55 mm, Rokujudashi, off Shirahama, 200 m, 18.vii.1973, the late Japanese Emperor Hirohito's Collection, NSMT-Cr 4080.

#### Description

Shield (Fig. 14A) 1.10 times broader than long; anterior margin between rostrum and lateral projections shallowly concave, anterolateral margins rounded; lateral margin convex; dorsal surface slightly convex, with pair of longitudinal rows of widely spaced tufts of setae (Fig. 14C); rostral lobe (Fig. 18C) very broad, obtusely triangular, almost equal to lateral projections; lateral projections (Fig. 18C) triangular, with acute tip. Posterior carapace (Fig. 14A) with very narrow posterolateral plates and very short posteromedian plate. Branchiostegites (Fig. 14B) not calcified, unarmed; distal margins nearly straight.

Ocular peduncles (including corneas) (Figs 14A, 18C) 0.70 times as long as shield, stout, distinctly broader distally; dorsal surfaces with few tufts of very long setae. Corneas distinctly dilated. Ocular acicles (Fig. 18C) very long, reaching to proximal portion of corneas; very narrowly triangular, acute; lateral and mesial margins fringed with few, very long setae; separated basally by breadth of rostral lobe.



**Fig. 43.** Fourth pereopod (left, lateral view): A–B, *Hemipagurus japonicus* (Yokoya), comb. nov., NSMT; C–D, *H. imperialis*, sp. nov., holotype; E–F, *H. hirayamai*, sp. nov., holotype; G–H, *H. toyoshioae*, sp. nov., holotype. B, D, F, H, dactyl, propodus and carpus; A, C, E, G, dactyl and preungual process. Scale bars: A, C, E, G = 0.125 mm; B, D, F, H = 0.5 mm.

Antennular peduncles (Figs 14A, 20C, D) long, when fully extended second peduncular segment overreaching corneas by approximately half own length; ultimate segment with dorsolateral margin bearing row of several long setae, dorsomesial margin with row of few long setae, dorsolateral and dorsomesial distal margins fringed with very long setae; penultimate segment unarmed; basal segment with acute spine at ventrodistal mesial angle. Antennal peduncles (Figs 14A, 21Q, R) moderately long, when fully extended exceeding corneas by approximately half length of ultimate segment; fifth and fourth segments unarmed; third segment with ventrodistal angle slightly produced; second segment with dorsolateral distal angle terminating in acute tip, no submarginal spine, dorsomesial distal angle with long acute spine; first segment with strong, hook-shaped spine laterally and strong acute spine at ventrodistal margin. Antennal acicles (Fig. 21Q) long and slender; arcuate, acute, with very long setae mesially. Antennal flagella very long; articles each with one or two very short setae on lateral and mesial faces distally.

Third maxilliped with merus bearing strong dorsodistal spine; crista dentata of ischium (Fig. 22I) moderately developed, composed of 10–11 teeth and strong accessory tooth; basis (Fig. 22I) with three acute teeth.

Right cheliped of female (Fig. 28A–D) stout, chela flattened dorsoventrally. Dactyl short, 0.65 length of palm, blunt-tipped; dorsal face convex, with tufts of long setae, dorsomesial face granular proximally, with scattered long setae; cutting edge (Fig. 30B) with small calcareous teeth on entire margin and large, blunt-tipped calcareous teeth