

Morgan & Forest, 1991

Bull. Mus. natn. Hist. nat., Paris, 4<sup>e</sup> sér., 12, 1990 (1991),  
section A, n<sup>os</sup> 3-4 : 649-689.

## Seven new species of hermit crabs from Northern and Western Australia (Decapoda, Anomura, Diogenidae)

by Gary J. MORGAN and Jacques FOREST

**Abstract.** Seven new species of Diogenidae (three species of *Diogenes*, two of *Paguristes*, one of *Cancellus* one of *Calcinus*) are described after specimens from Western Australia, the Northern Territory, Queensland, Cocos (Keeling) Islands and Christmas Island (Indian Ocean).

**Résumé.** Sept nouvelles espèces de Diogenidae (trois espèces de *Diogenes*, deux de *Paguristes*, une de *Cancellus*, une de *Calcinus*) sont décrites d'après des spécimens récoltés au large de l'Australie occidentale, du Territoire du Nord, du Queensland, des îles Cocos (Keeling) et de l'île Christmas (océan Indien).

**Key words.** Decapoda, Diogenidae, *Diogenes*, *Paguristes*, *Cancellus*, *Calcinus*, Northern and Western Australian.

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### INTRODUCTION

In 1965 a large collection of Australian hermit crabs was sent to the Muséum national d'Histoire naturelle, Paris, from the Western Australian Museum by the then Curator of Crustacea of the latter institution, Dr. R. W. GEORGE. This material was examined preliminarily by one of us (J. F.) and M. DE SAINT LAURENT, sorted and some identifications made. This collection was re-examined recently by the present authors and found to contain several new species. Five of these are here described together with an additional new species of *Paguristes* and of *Calcinus* collected by one of the authors (G. J. M.). Several of the descriptions are based upon the pre-1965 material together with more recent material in the collection of the Western Australian Museum. Specimen size is presented as shield length (S. L.). Sampling areas are abbreviated as W.A. (Western Australia), N.W.A. (north Western Australia), S.W.A. (south Western Australia), N.T. (Northern Territory) and Qld (Queensland). Type material is deposited in the Western Australian Museum (WAM), Muséum national d'Histoire naturelle (MNHN) and Northern Territory Museum, Darwin (NTM).

## SYSTEMATICS

### ***Calcinus lineapropodus* sp. nov.**

(Figs 1, 2)

*Calcinus* sp. 1 ; WOOSTER, 1984 : 138.

*Calcinus* undescribed sp. ; HAIG and BALL, 1988 : 161.

HOLOTYPE. — ♂, SL 4.5 mm, Turk Reef, Cocos (Keeling) Islands (12°30' S, 97°00' E), 9-20 m, G. J. MORGAN, 13.02.1989, WAM.

PARATYPES. — 12 specs, SL 4.4 mm-2.7 mm (incl. 4 ovig. ♀♀), type locality, WAM 493-89 ; ♀, SL 3.1 mm, Horsburgh Island, C.(K.)Is, to 37 m, G. J. MORGAN, 9.02.1989, WAM 458-89 ; ♂, SL 4.1 mm, 2 ♀♀, SL 3.3 mm (ovig.), 3.2 mm, southeast of Horsburgh Island, C.(K.)Is, to 35 m, G. J. MORGAN, 20.02.1989, WAM 648-89 ; 4 ♀♀, SL 3.9 mm-1.4 mm (3 ovig.), southwest of Horsburgh Island, C.(K.)Is, to 30 m, G. J. MORGAN, 16.02.1989, WAM 551-89 ; 3 ♂♂, SL 3.5 mm, 3.2 mm, 2.4 mm, 4 ♂♂, SL 3.3 mm-1.7 mm, northwest end of North Keeling Island, C.(K.)Is, to 28 m, G. J. MORGAN, 23.02.1989, WAM 562-89 ; 3 ♂♂, SL 4.3 mm, 3.5 mm, 1.6 mm, northwest end of Direction Island, C.(K.)Is, to 18 m, G. J. MORGAN, 10.02.1989, WAM 503-89 ; 8 specs, SL 3.4 mm-2.0 mm (incl. 2 ovig. ♀♀), north of West Island, C.(K.)Is, to 30 m, G. J. MORGAN, 21.02.1989, MNHN Pg. 4456 ; ♂, SL 6.0 mm, Flying Fish Cove, Christmas Island (Indian Ocean), 9 m, G. J. MORGAN, 21.02.1987, WAM 26-90 ; 2 ♂♂, SL 2.8 mm, 1.5 mm, 3 ♀♀, SL 4.4 mm (ovig.), 2.5 mm, 2.5 mm, Flying Fish Cove, C.I.(I.O.), 1-10 m, coral rubble, G. J. MORGAN, 19.02.87, MNHN Pg 4488 ; ♂, SL 3.8 mm, ♀, SL 2.9 mm, Ethel Beach, C.I.(I.O.), 5-24 m, G. J. MORGAN, 20.02.87, WAM 25-90.

## DESCRIPTION

Shield (fig. 1a) distinctly longer than broad. Anterior margin between rostrum and lateral projections shallowly concave ; rostrum broadly triangular, weakly projecting with semi-acute or rounded apex ; lateral projections not extending as far as rostrum, sometimes terminating in weak distal spinule. Shield lacking spines, surface punctate especially anterolaterally ; very sparsely setose except lateral surfaces with long plumose setae, pinnules very short.

Ocular peduncles very elongate, longer than anterior margin of shield and on large specimens as long as or longer than shield ; peduncles strongly inflated proximally, weakly inflated distally. Ocular acicles with 3-6 spinules along distomesial margin ; acicles broad proximally, much narrower distally, with lateral margins concave, mesial margins nearly straight ; acicles separated proximally by a half to 2/3 width of one acicle but converging distally. Peduncles and acicles very sparsely setose.

Antennular peduncles distinctly shorter than ocular peduncles, unarmed except for 4-5 distolateral spinules on proximal segment. Antennal peduncles reaching to or beyond half length of ocular peduncles but shorter than antennular peduncles ; fifth segment unarmed ; fourth with distodorsal spine ; third with distoventral spine ; second with 1 or 2 distolateral spines, sometimes small spinule posterior to these, and 1 small distomesial spine ; first segment unarmed except for several minute lateral tubercles. Antennal acicle reaching to or slightly beyond base of fifth segment of peduncle ; acicle with terminal spine and 2 lateral and 3-4 mesial spines. Fifth segment sparsely setose with short simple setae ; other segments and acicle

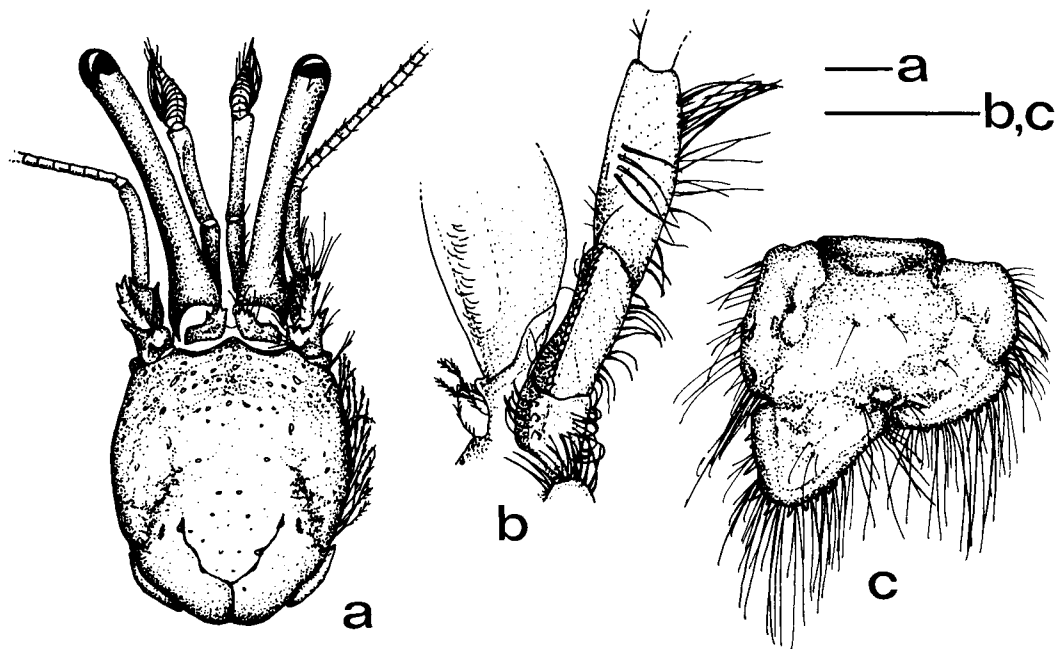


FIG. 1. — *Calcinus lineapropodus* sp. nov. Holotype ♂. a, shield and cephalic appendages, dorsal view (setae omitted left side); b, merus, ischium and basis of left third maxilliped, mesial view; c, telson, dorsal view. Scales = 1.0 mm.

with more numerous, longer setae, many very finely plumose. Antennal flagella similar length to or slightly longer than carapace, very slightly setose.

Third maxillipeds (fig. 1b) with merus unarmed; ischium with well developed crista dentata; basis with 3 small mesial spines.

Left cheliped (fig. 2a) much larger than right. Holotype typical of large males. Dactyl slightly longer than half of propodus; strongly curved and touching fixed finger only at tip; dorsal margin rounded, with obsolete tubercles slightly larger proximally and more distinct irregular ridge of tubercles on lateral surface ventral to dorsal margin; remainder of lateral surface almost smooth with only obsolete tubercles; cutting edge with 2-3 semi-acute teeth proximally and some small teeth distally; mesial surface unarmed, lightly punctate. Propodus about twice as long as its greatest width; dorsal margin of palm with irregular row of low spinules and tubercles, these extending slightly onto dorsolateral surface; lateral face with numerous minute tubercles, these rather larger ventrally and on lateral face of fixed finger; ventral margin sinuous, lacking distinct row of spines but with enlarged tubercles especially along fixed finger; cutting edge with several large teeth proximally, spaced small teeth distally; mesial surface punctate dorsally, tubercles extending some distance onto face from ventral margin, an enlarged tubercle ventromesially near base of fixed finger and distinct sulcus in face of finger distal to this. Carpus considerably broader than long; dorsal margin with 3-4 low spines and 1 longer spine at distodorsal angle; distolateral margin with row of small spines

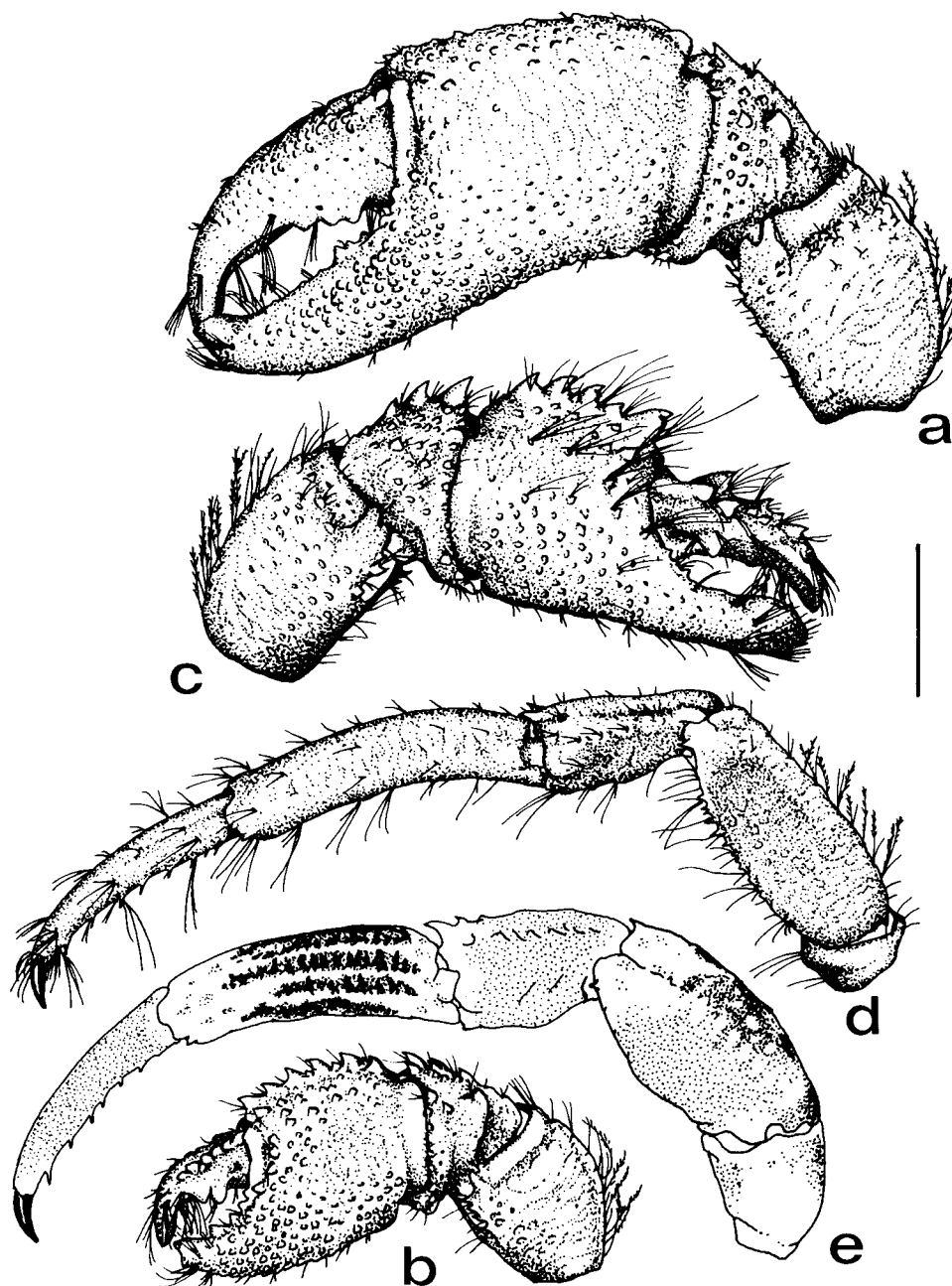


FIG. 2. *Calcinus lineapropodus* sp. nov. a, c-e, holotype ♂; b, paratype ♀ (SL 3.9 mm, WAM 551-89). a, left cheliped of ♂, lateral view; b, left cheliped of ♀, lateral view; c, right cheliped, lateral view; d, left second pereopod, lateral view; e, left third pereopod, lateral view, showing colour pattern. Scale = 2.0 mm.



along its entire length ; lateral surface with numerous semi-acute tubercles, several enlarged as small spines, 1 semi-acute tubercle much enlarged on dorsolateral face ; mesial face punctate with some dorsal tubercles, tubercles along distomesial margin obsolete. Merus only slightly compressed laterally ; dorsal margin slightly tuberculate or merely irregular at setal bases, usually larger spine at distodorsal angle ; dorsolateral margin with variable development of semi-acute tubercles or spinules especially dorsally ; lateral surface punctate with some obsolete tubercles ; ventrolateral margin with several small spines and tubercles distally, uneven proximally ; several spines and tubercles distally on ventromesial margin, 1 especially enlarged. Setation of cheliped very light ; tufts of short simple setae along dorsal and ventral margins and from bases of spines and larger tubercles.

Females and small males with fingers of left cheliped (fig. 2b) less attenuated and curved, cutting edges in contact for most of their lengths. Dorsal spines on dactyl and palm of propodus much larger and more distinctly forming a row ; tubercles on lateral face of propodus larger, more acute, some enlarged as blunt spines. Setation slightly heavier on females.

Right cheliped (fig. 2c) of holotype about  $\frac{3}{4}$  length of left. Dactyl length approximately half that of propodus, slightly greater than that of palm ; very curved, touching fixed finger only at tip ; dorsal margin with irregular row of large corneous-tipped spines, largest proximally, and second row ventrolateral to this ; cutting edge with 1 large proximal tooth, other teeth poorly developed ; mesial surface with some spinules extending from dorsal margin, remainder smooth. Propodus about twice as long as broad ; dorsal margin of palm with row of 4-6 very large corneous-tipped spines ; lateral face of palm with small tubercles, these larger ventrally and extending onto fixed finger, and some spines proximal to articulation of dactyl ; cutting edge with several small teeth proximally ; ventral margin broadly curved, almost flattened, with scattered broad spines and semi-acute tubercles extending along finger ; mesial surface punctate with some small tubercles near dorsal margin. Carpus with dorsal margin bearing sharp spines, 2-3 enlarged distally ; distolateral margin with spinules or acute tubercles along entire length, these largest ventrally ; lateral surface punctate and with scattered small semi-acute tubercles ; distomesial margin with some small tubercles along its length and several spines ventrally ; mesial surface with several low spines and tubercles dorsally. Merus with dorsal margin irregular, 1 spine at distodorsal angle and several spinules ventral to this along distolateral and distomesial margins ; ventrolateral margin with 2-3 spines distally, some tubercles proximal to these ; ventromesial margin with several irregularly sized spines. Setation heavier than on left cheliped, with tufts of long setae on dorsal and ventral margins and laterally on propodus and dactyl. Sexual and allometric differences insignificant on right cheliped.

Second pereopods distinctly longer than left cheliped. Left second pereopod (fig. 2d) with dactyl similar length to or slightly shorter than propodus, shallowly recurved ; ventral margin with 8-9 corneous spines. Propodus about 5 times as long as maximum width, distinctly curved ; unarmed except for 1 small ventrolateral, ventromesial, lateral and mesial spinule on distal margins, these sometimes obsolete, and sometimes 1 minute tubercle distodorsally. Carpus with large spine at distodorsal angle and usually 1-2 smaller spines on distal margin lateral to it, sometimes a second distal spine on dorsal margin, otherwise irregular at setal bases ; ventral margin irregular at setal bases. Merus dorsal margin irregular ; ventral margin with row of spines, largest distally, these sometimes very reduced ; usually larger spine at lateral distoventral angle. All segments with sparse clumps of simple setae, especially dorsally and ventrally, those ventrally longer ; some setae on dorsal margin of merus lightly plumose.

Right second pereopod longer than left, due mainly to greater length of dactyl and propodus ; ornamentation similar to left, up to 10 ventral spines on dactyl.

Left third pereopod (fig. 2e) shorter than left second. Dactyl somewhat shorter than that of second on most specimens, thought of similar length in holotype ; ventral margin with 7-9 corneous spines. Propodus shorter and stouter than on second pereopod, length about 3-4 times maximum width ; spination similar to second. Carpus wider than on second pereopod ; spination similar. Merus shorter than on second pereopod ; ventral spines less well developed, ventral margin often merely irregular ; sometimes a distodorsal spine. Ischium longer than on second pereopod. Setation similar to that of second pereopod except that ventral and lateral surfaces of dactyl somewhat more heavily setose with clumps of plumose setae.

Right third pereopod longer than left, with more elongate dactyl and propodus ; spination similar to left pereopod, up to 10 ventral spines on dactyl.

Sternite of third pereopods with anterior lobe broad and subrectangular with rounded lateral projections bearing long setae.

Tailfan very asymmetrical with left uropods much larger than right. Telson (fig. 1c) of similar length to width or slightly longer or wider ; left posterior lobe much larger than right, subtriangular ; right lobe with margin convex or sloping away from left lobe ; left lobe with 10-15 marginal spines, largest distolaterally ; right lobe with 9-12 slightly smaller marginal spines ; sometimes 1 or 2 spines on posterolateral angle of left anterior lobe of telson. Margins of telson with long setae, partly obscuring spination.

*Coloration* : Shield cream or pale brown, darker laterally, with variable development of submedial patches of olive green or brown. Ocular peduncles rosy pink, paler distally near corneas ; corneas black with silver flecking ; acicles pale pink and cream. Antennular peduncles pale brown proximally, proximal half of ultimate segment pale brown, distal half blue ; flagella orange. Antennal peduncles cream and pale orange ; flagella pale orange. Chelipeds with dactyl cream with some orange dots ; propodus finger and distal part of palm cream, remainder of palm pale grey-brown with dark brown spot slightly proximal to midlength on lateral and mesial faces ; carpus and merus pale grey-brown, tubercles paler and often tinged blue. Second and third pereopods with dactyl rosy pink with cream tip, claw black ; propodus cream with scattered orange flecks and 3 lateral and 3 mesial longitudinal deep brown or maroon bands, these bands sometimes anastomosing one with another and not reaching proximal or distal ends of propodus ; carpus mostly rosy pink, some cream proximally and distally ; merus cream with some orange spots, deep maroon patch mid-dorsally and large rosy pink patch laterally and ventrally. Fourth and fifth pereopods cream with patches of pale brown. Setae clear.

*HABITAT.* — *Calcinus lineapropodus* is found associated with live coral and coral rubble in the shallow sublittoral to at least 25 m depth. (The depths cited in the material examined refer to dive profiles, the precise depth of collection of each specimen not being recorded.) Shells utilised for shelter by the types were mostly very eroded and difficult to identify but included *Drupa ricinus* (Linnaeus), *Morula uva* (Roding), *Peristernia nassatula* (Lamarck) and species of *Cerithium*, *Clypeomorus* and *Coralliophila*.

*DISTRIBUTION.* — The species is known from Cocos (Keeling) and Christmas Islands, Indian Ocean, eastern New Guinea, Indonesia (HUMES, 1981 ; HAIG and BALL, 1988) and

Guam and other islands of the Marianas (ELDREDGE *et al.*, 1979 ; KROPP *et al.*, 1981 ; KROPP and ELDREDGE, 1982 ; WOOSTER, 1984).

ETYMOLOGY. — Named from the latin ‘*linea*’ (line for the striped coloration of the propodus of second and third pereopods.

#### REMARKS

For an heretofore undescribed species, *C. lineapropodus* has quite an extensive recent history in the scientific literature. Several workers have recognised the species as new. WOOSTER (1984) virtually described the species as his ‘*Calcinus* sp. 1’ but did not figure or name it, instead referring to its future description by Drs P. McLAUGHLIN and J. HAIG. HAIG and BALL (1988) also noted the species but observed that it would be described elsewhere. After collecting the species at several localities, one of us (G J. M.) contacted Dr. HAIG to enquire after its status and was informed that other commitments had forestalled the species description and kindly passed on responsibility for that task.

As noted by WOOSTER (1984) and HAIGH and BALL (1988), this species closely resembles *C. pulcher* Forest. That species as described and illustrated by FOREST (1958) and from comparison of specimens of *C. pulcher* in the WAM collection is similar to *C. lineapropodus* in proportions and spination of the cephalic appendages, chelipeds and pereopods. The species are of similar size and can occur sympatrically, for example in Indonesia (HAIG and BALL, 1988) and the Cocos (Keeling) Islands (MORGAN, 1989b).

As is common in the genus *Calcinus*, the two species are separated most easily by their respective coloration. In *C. pulcher*, second and third pereopods bear longitudinal flecks of dark red or brown on all segments, these flecks coalescing into an irregular median band except on the carpus of the second pereopod which is almost entirely covered by the band. The different pattern of coloration can be seen by comparing FOREST (1958 : fig. 16) with fig. 2e in this publication.

#### ***Cancellus quadraticoxa* sp. nov.**

(Figs 3, 4)

*Cancellus* sp. ; MORGAN, 1989a : 403.

HOLOTYPE. — ♂, SL 4.7 mm, southwest of Garden Island (32°24' S, 115°07' E), S.W.A., 219 m, in sponge, H.M.A.S. ‘Diamantina’ (stn 2), 14.03.1972, WAM 1756-86.

PARATYPES. — ♂, SL 4.6 mm, ♀, SL 3.7 mm, west of Rottneest Island, (32°00' S, 115°08' E), S.W.A., 137 m, C.S.I.R.O. (stn 144), 28.08.1963, MNHN Pg 4487 ; ♂, SL 4.4 mm, west of Garden Island (32°15' S, 115°06' E), S.W.A., 176-182 m, 18.03.1972, WAM 39-74.

#### DESCRIPTION

Shield (fig. 3a) broader than long. Anterior margin between rostrum and lateral projections shallowly angular. Front between lateral projections distinctly ridged with narrow

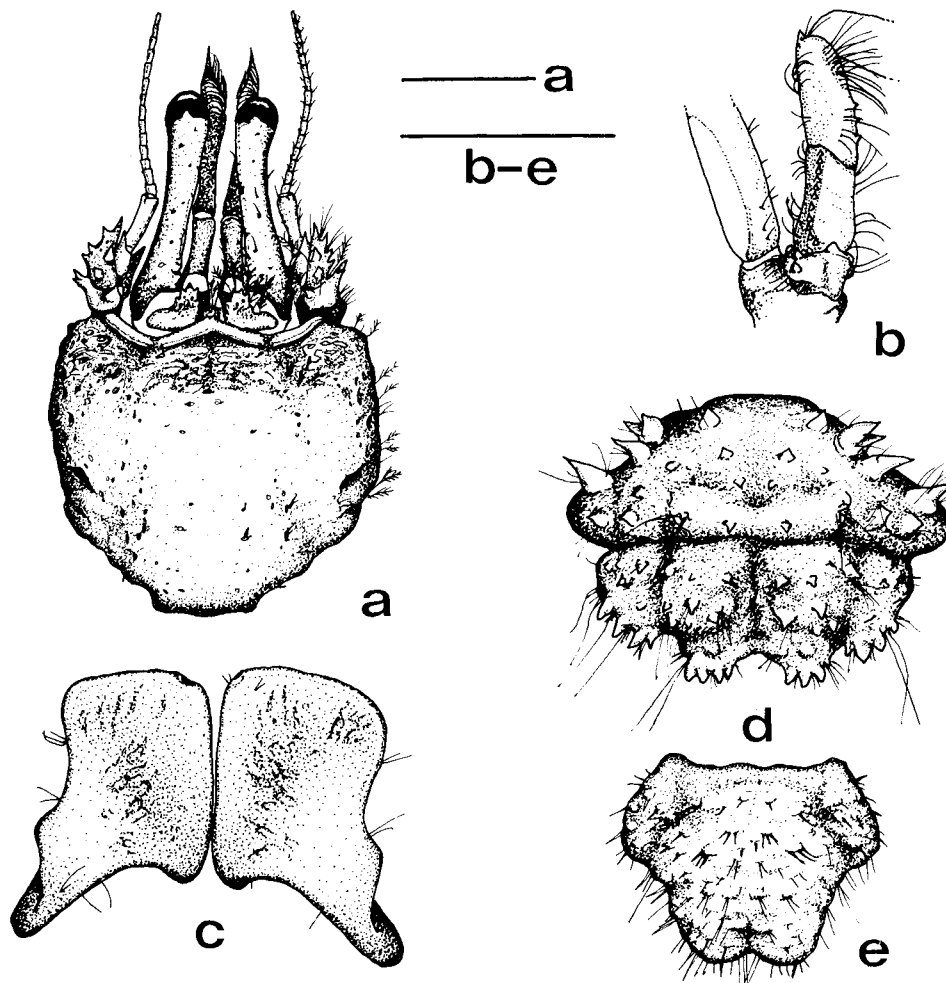


FIG. 3. — *Cancellus quadraticoxa* sp. nov. Holotype ♂. a, shield and cephalic appendages, dorsal view (setae omitted left side); b, merus, ischium and basis of left third maxilliped, mesial view; c, coxae of fifth pereopods, ventroposterior view; d, sixth abdominal segment, dorsal view; e, telson, dorsal view. Scales = 2.0 mm.

gaps in ridge posterior to ocular peduncles. Rostrum very broadly triangular, small spinule at apex, projecting as far as lateral projections. Dorsal surface of shield very sparsely setose; with obvious depressions posterior to rostrum and ocular peduncles, and irregular network of narrow channels and pores on anterior and anterolateral surface. Scattered pores posteriorly.

Ocular peduncles long and slender, slightly shorter than shield and width of front of shield, distally curving inwards towards midline, inflated proximally and less so distally; 1-2 spinules proximomesially on each peduncle; width of corneas about 1/5 length of peduncles. Light setation along length of peduncles. (Left peduncle of 1 male paratype slightly deformed and shortened.) Ocular acicles with 2-5 spinules, 1 or 2 usually larger than others; acicles short

and only just reaching bases of peduncles, almost twice as broad as long and with distolateral margins concave ; acicles bearing fringe of plumose setae.

Antennular peduncles of similar length to ocular peduncles ; ultimate and penultimate segments unarmed, proximal segment with 2-4 strong distolateral spines.

Antennal peduncles reaching just beyond half length of ocular peduncles. Fifth segment unarmed ; fourth with 1 or 2 distodorsal spines ; third segment with strong distal spine ; second with 1-2 lateral spines and 1 mesial spine ; first segment obscured from dorsal view, with a ventral spine and several small lateral spinules. Antennal acicle reaching to or shorter than half length of fifth peduncular segment ; 1 apical and 3 distolateral spines, sometimes 1 proximolateral spine, usually 1 proximodorsal spine. Peduncular segments with scattered simple and plumose setae. Antennal flagella shorter than shield, with 16-20 segments and very short setae.

Third maxillipeds (fig. 3b) with merus bearing distodorsal spine and 3 ventral spines ; ischium with well developed crista dentata ; basis with 2-3 mesial spines.

Chelipeds subequal (holotype with only left cheliped, fig. 4a), maximum propodal width about  $\frac{2}{3}$  its length. Dactyl with 2 enlarged cutting teeth ; densely tuberculate on dorsolateral surface with tubercles of various sizes, some spine-tipped ; mesial face with 2 or 3 longitudinal rows of blunt corneous-tipped tubercles. Propodus laterally compressed with opercular surface of palm flattened or slightly concave and densely covered by irregularly sized tubercles. Dorsal margin of palm with tubercles aggregated into 5-6 clusters separated by distinct hiatus. Ventrolateral surface of palm smooth except for several tubercles extending onto short fixed finger and distinct series of parallel transverse striae extending to ventral margin, latter with irregular row of acute tubercles. Mesial surface of propodus almost smooth except for corneous-tipped granules near dorsal margin. Carpus about half length of palm of propodus, compressed laterally and expanded dorsally into tuberculate crest forming posterior of opercular surface of cheliped ; crest divided into about 5 irregular lobes, dorsal 2 largest. Opercular surface of carpus tuberculate, lateral face with some small granules and punctations and small spinules at distolateral angle, mesial face almost smooth. Merus about  $\frac{2}{3}$  length of palm, laterally compressed, bearing little ornamentation except for 1 small spine at distodorsal angle and usually 1 posterior to this ; dorsal margin somewhat irregular ; ventrolateral margin with variable number of small denticles. Setation rather sparse on chelipeds, fairly numerous but short setae on opercular surface, clumps of longer setae on fingers, along ventral margin of palm and dorsally on carpus and merus.

Second and third pereopods similar on left and right sides. Second pereopod (fig. 4b) with dactyl about  $\frac{2}{3}$  length of propodus ; dactyl smooth on outer face ; dorsolateral margin with about 8 tubercles increasing in size and becoming compound proximally ; operculate face with small granules ; ventromesial margin with 5-6 corneous spines. Propodus laterally compressed ; outer face almost smooth ; dorsolateral margin deeply divided into 5 tuberculate lobes ; opercular face granular with its inner margin divided by short transverse grooves resulting in about 8 or 9 granular lobes ; mesial face smooth. Carpus about length of dactyl ; outer face smooth ; dorsolateral margin with about 4 tuberculate lobes ; opercular face granular with its inner margin bordered by sharp granules with irregular shallow grooves ; mesial face almost flat and smooth. Merus longer than propodus, slightly compressed laterally ; lateral and mesial faces smooth ; dorsal margin with irregularly distributed small denticles ; ventral margin with row of small spines.

Dactyl of third pereopod (fig. 4c) similar length to but narrower than that of second

pereiopod. Dorsal margin with 7-8 tubercles, ventral margin with 3-4 corneous spines ; lateral and mesial margins smooth. Propodus slightly shorter than that of second pereiopod but lacking pronounced granular lobes therefore appearing much more elongate ; dorsal margin with 7-8 tubercles of spines of various sizes ; ventral margin with slight protrusions at setae bases ; mesial and lateral faces smooth. Carpus lacking ornamentation except for several irregularly sized tubercles or protrusions on dorsal margin. Merus considerably shorter and narrower than that of second pereiopod, dorsal and ventral margins with irregular denticles.

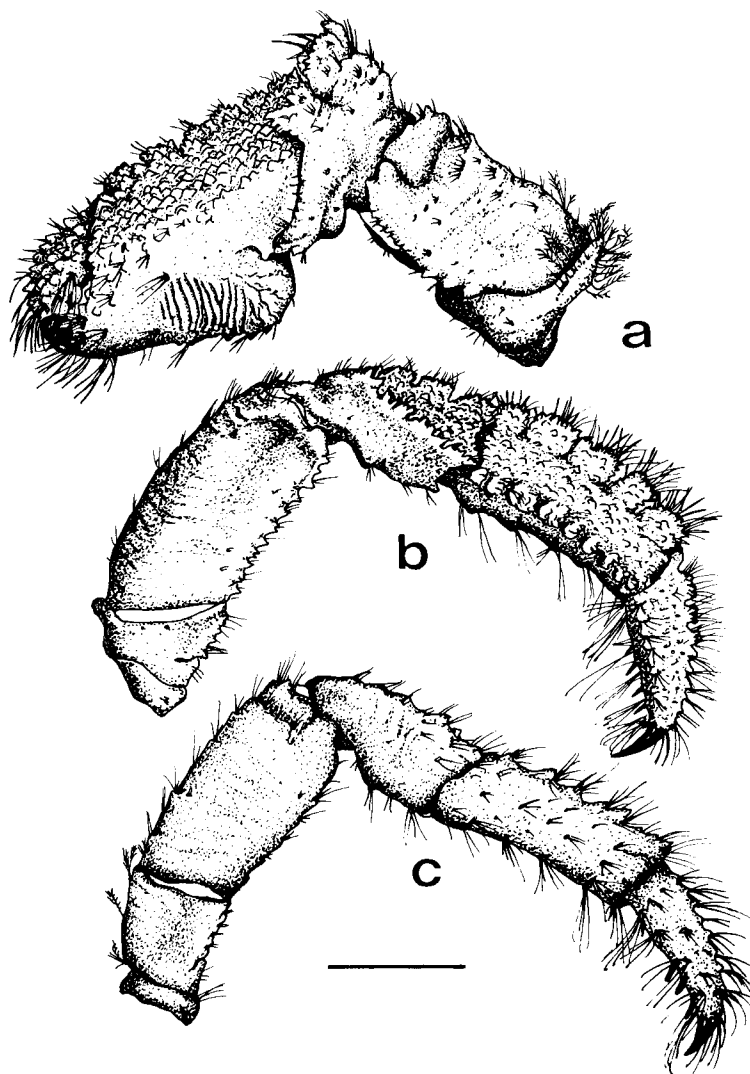


FIG. 4. — *Cancellus quadraticoxa* sp. nov. Holotype ♂. a, left cheliped, lateral view ; b, left second pereiopod, mesial view ; c, left third pereiopod, mesial view. Scale = 2.0 mm.

Second and third pereopods with simple setae concentrated in clumps mostly along outer and inner margins, especially on dactyl and propodus.

Fourth pereopod with dactyl reaching far short of apex of propodus, dactyl with 2-3 corneous granules in short lateral row. Most of propodus covered by large pad of corneous granules. Carpus with spine at distodorsal angle. Corneous granules on upper surface of propodus of fifth pereopod and in row on fixed finger and dactyl.

Coxae of fifth pereopods in males (fig. 3c) dorsoventrally flattened and subquadrate, lateral margins shallowly concave, anterior margins convex and mesial margins almost straight. Gonopores at distomesial angles. (Holotype with apparent pore of unknown function on ischium of right fifth pereopod, presumably an aberrant condition.) Females with pleopods on left side of abdomen.

Sixth abdominal tergite (fig. 3d) very spinose, especially on holotype. Anterior margin lacking spines but about 5 spines on anterolateral margins and 4 clumps of 3-4 spines on posterolateral margins; fairly symmetrically distributed spines on dorsal surface. Telson (fig. 3e) about as long as broad with convex anterolateral and concave posterolateral margins, and distinct median cleft; dorsal surface very uneven. Uropods subequal. Tailfan with scattered long simple setae, especially on margins.

*Coloration* : All material examined had been in preservative for a sufficient period to leach the natural colours. Even colour patterns could not be discerned implying that the species does not show a distinctive pattern of markedly contrasting colours.

*HABITAT*. — Specimens were collected from depths between 137 and 219 m.

*DISTRIBUTION*. — The species is known only from southwestern Australia, from the waters west of Rottnest and Garden Islands.

*ETYMOLOGY*. — Named from the latin adjective '*quadratus* (-a, -um)' (square) for the shape of the coxae of the fifth pereopods in males, these being flattened and nearly quadrate in ventral view.

#### REMARKS

To date only one nominal species of *Cancellus* has been recorded from Australian waters. *Cancellus typus* H. Milne Edwards, 1836 is not uncommon in shallow waters of the southeast and south of Australia and has been noted by several authors (e.g. HALE, 1927, 1941; POPE, 1944, 1947, 1953; MAYO, 1973). *C. typus* was redescribed and figured and its similarities to congeners discussed by MAYO (1973 : 44, fig. 18-20).

MORGAN (1989a) referred to the present species in a review of southwest Australian hermit crabs but did not describe it. The examination of material held in the MNHN made the present description possible. It should be noted that *C. typus* also occurs in the southwestern waters of Australia as evidenced by a male specimen from Cervantes Islands (MNHN Pg. 1555), a male from west of Point Leschenault (WAM 571-65) and a female from west of Garden Island (WAM 2008-86). Hence, *C. typus* appears to range from central New South Wales along the south coast, including Tasmania, as far west at least as Cervantes, Western Australia. In contrast, *C. quadraticoxa* is known presently only from a small area around Perth.

Several characters immediately separate the two species. In *C. quadraticoxa* the corneas are more inflated, the ocular acicles and sixth abdominal somite are more spinose and the telson is slightly longer. The propodus of the third pereopods is not distinctly lobed dorsally in *C. quadraticoxa* unlike that of *C. typus* and other Indo-West Pacific congeners. The most striking difference is in the shape of the coxae of the fifth pereopods in males. While the anteromesial margins of the coxae slope away from each other in *C. typus* (see H. MILNE EDWARDS, 1836 : pl. 14, fig. 3a ; MAYO, 1973 : fig. 18e), they are almost right angular in *C. quadraticoxa* and the mesial margins are nearly parallel. In addition, *C. typus* would appear somewhat more hirsute than *C. quadraticoxa*.

Although *C. typus* has been reported previously from waters to at least 82 m depth (MAYO, 1973) and the specimen WAM 571-65 was collected at 85 to 88 m depth, the species is often found in shallow inshore waters immediately below the subtidal. *C. quadraticoxa* has been collected only deeper than 137 m and hence the two species may partition by depth.

Despite the above differences, *C. quadraticoxa* resembles *C. typus* most closely of its congeners. No other described species of *Cancellus* has the coxal segments of the male fifth pereopods so distinctly expanded. The two species also share a frontal rim to the shield divided only behind the ocular peduncles, parallel striations on the ventrolateral face of the palm of chelipeds (presumably a stridulatory mechanism) and a telson with a distinct median cleft.

***Diogenes dorotheae* sp. nov.**

(Figs 4, 6)

HOLOTYPE. ♂, SL 2.0 mm, 16-32 km west of Cape Bossut, N.W.A., 22-46 m, R. W. GEORGE on 'Dorothea', 13.10.1962, WAM 374-65.

**DESCRIPTION**

Shield (fig. 5a) approximately as broad as long. Lateral margins slightly convex, with 5-6 long spines ; dorsolateral surfaces irregular with numerous tubercles some in short transverse rows. Anterior margin between rostrum and lateral projections concave ; rostrum broad and very short, much exceeded by acute lateral projections each bearing terminal spinule. Shield sparsely setose dorsally and laterally with many simple and some plumose setae.

Ocular peduncles subcylindrical, slightly inflated distally and proximally ; reaching to base of ultimate peduncular segment of antennules, shorter than anterior margin of shield and about 4/5 length of shield ; peduncles very sparsely setose along mesial borders. Corneal width approximately 1/3 length of peduncles. Ocular acicles broad, distally convex, mesially almost straight ; distal margin with 4-5 spinules, largest mesially ; acicles separated at bases by about 1/3 width of an acicle, sparsely setose. Intercalary rostral process shorter than acicles, subcliptical in shape with 2 distal spinules ; no ventral accessory spine.

Antennular peduncles slender ; all segments unarmed and very sparsely setose with long simple setae.

Antennal peduncles exceeding ocular peduncles and reaching to proximal 1/3 to a half of ultimate segment of antennular peduncles. Fifth segments of peduncle unarmed ; fourth unarmed or with minute distodorsal spinule ; third only very weakly projecting distoventrally ;



second segment with very strong dorsolateral spine and 5 strong spines along distolateral margin ventral to this, mesial spines absent ; first segment with only weak lateral spinule or tubercle and 2 strong ventrolateral spines. Antennal acicle not quite reaching half length of penultimate peduncular segment ; acicle with 3 very strong, and sometimes weak 4th, anteromesial spines, largest laterally. Acicle and peduncular segments very sparsely setose with long simple setae. Flagella comprising about 30 articles, as long as or slightly longer than carapace ; bearing long lightly plumose setae especially ventrally.

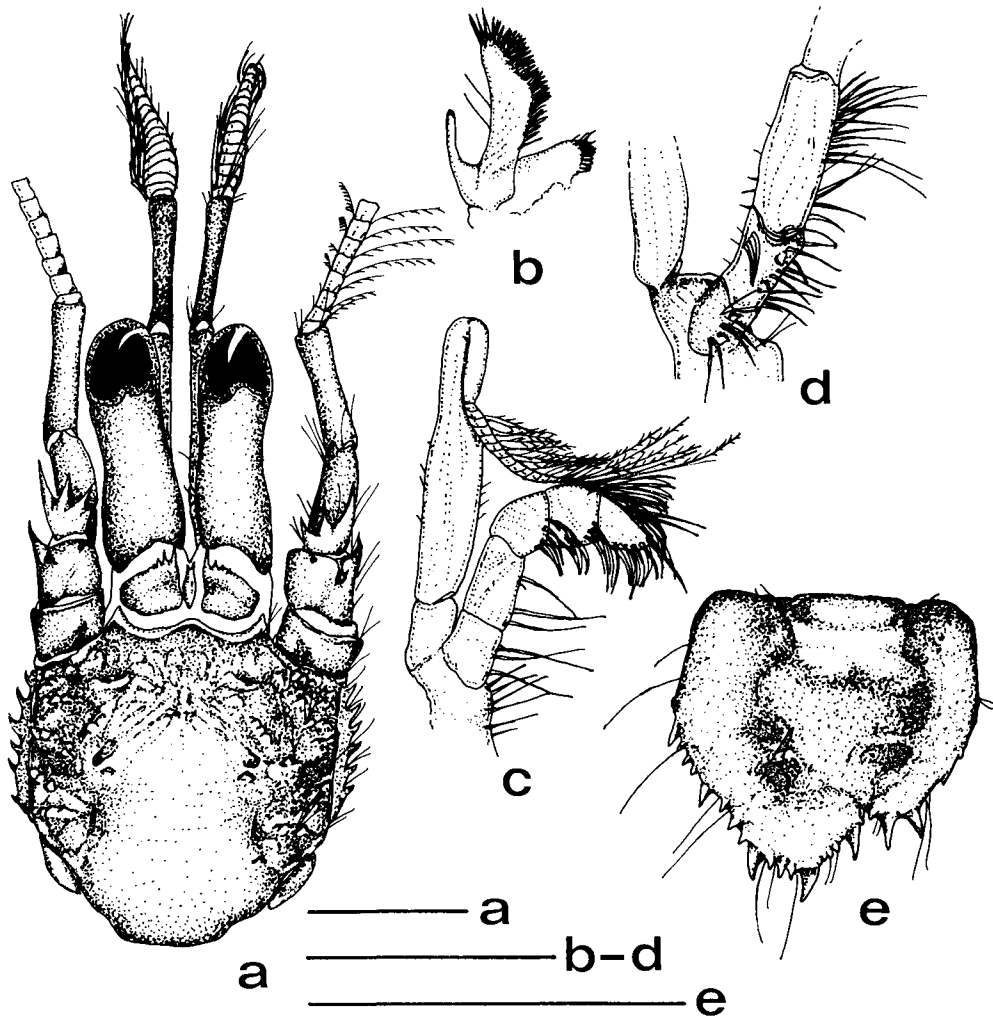


FIG. 5. — *Diogenes dorotheae* sp. nov. Holotype ♂. a, shield and cephalic appendages, dorsal view (setae omitted left side) ; b, left maxillule, mesial view ; c, left second maxilliped, mesial view ; d, merus, ischium and basis of left third maxilliped, mesial view ; e, telson, dorsal view. Scales = 1.0 mm.

Maxillules (fig. 5b) with endopodite lacking accessory flagellum. Second maxillipeds (fig. 5c) with exopodite exceeding by more than  $1/3$  its length recurved length of endopodite. Third maxillipeds (fig. 5d) with merus unarmed, ischium and basis each with 2 ventromesial spines.

Left cheliped (fig. 6a) much larger than right. Dactyl about half length of propodus, as broad as fixed finger, somewhat laterally compressed, strongly curved and slightly crossing fixed finger at tip; cutting edge with several pronounced teeth; lateral face with numerous acute tubercles, slightly enlarged in weak crest along dorsal margin; mesial face of dactyl almost smooth, with shallow longitudinal sulcus ventral to dorsal margin. Fixed finger shorter than dactyl, laterally compressed, distinctly deflexed from palm; several cutting teeth with 1 distinctly larger; lateral surface and ventral margin with numerous acute tubercles, ventral row

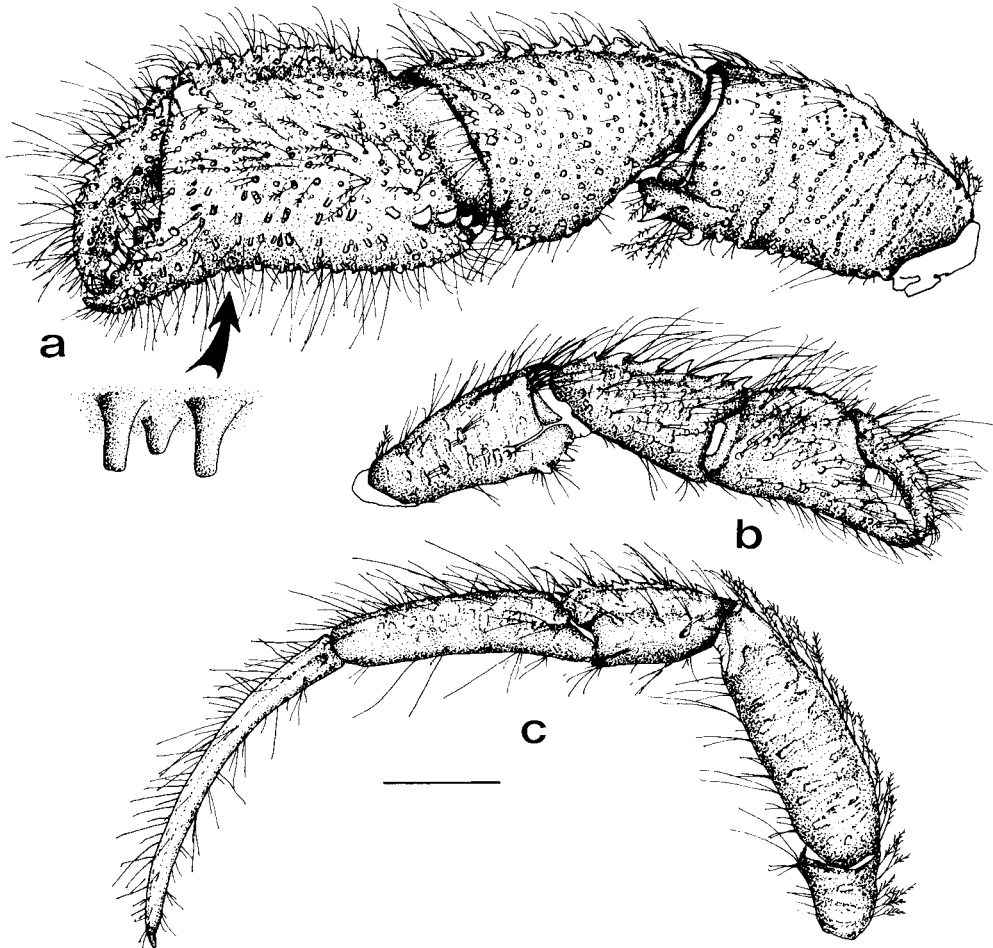


FIG. 6. — *Diogenes dorotheae* sp. nov. Holotype ♂. a, left cheliped, lateral view (with magnification of tubercles); b, right cheliped, lateral view; c, left second pereiopod, lateral view. Scale = 1.0 mm.

not clearly defined ; mesial surface with some minute tubercles. Palm longer than broad ; dorsal margin produced slightly in blunt crest, this covered with acute but broad tubercles ; lateral surface distinctly convex with numerous acute tubercles, these very short dorsolaterally and becoming progressively more elongate and subcylindrical ventrolaterally ; 4 large spines in short longitudinal row from proximoventral angle of propodus ; ventral margin with similar tubercles to lateral face, ventral row not clearly defined ; mesial face with numerous small blunt tubercles, mostly arranged in short transverse rows.

Carpus about as long as ventral margin of palm and longer than broad ; dorsal margin with row of 10 curved spines, largest distally ; lateral face very convex and covered with numerous small acute and blunt tubercles ; ventral margin with 2 or 3 tubercles enlarged ; mesial face with numerous small blunt tubercles. Merus similar length to carpus and not strongly compressed laterally ; dorsal margin lacking distinct row of tubercles, merely irregular ; lateral face with numerous small semi-acute and blunt tubercles ; ventrolateral margin with irregular row of enlarged tubercles, 2 distally curved and very acute as spines ; ventromesial margin with only small tubercles as have ventral and mesial faces. All segments with long, mostly simple setae on dorsal and ventral margins but setation heaviest on dactyl and propodus, these segments also with quite dense lateral setation, that of propodus including many plumose setae.

Length of right cheliped (fig. 6b) about  $\frac{3}{4}$  that of left. Dactyl longer than half length of propodus, strongly recurved and crossing fixed finger at tip, leaving distinct gape between fingers ; cutting teeth very poorly developed ; dorsal margin with several acute and blunt tubercles, these also present but smaller on lateral face ; mesial face with shallow longitudinal sulcus ventral to dorsal margin, with some scattered tubercles especially dorsally. Propodus with finger and palm of similar length, lateral face of both with scattered semi-acute and blunt tubercles ; tubercles slightly enlarged along dorsal margin of palm but not developed along ventral margin of palm or finger ; mesial face almost smooth except for setal pores. Carpus distinctly longer than palm ; with 6 large curved spines along dorsal margin ; lateral face with scattered small semi-acute and blunt tubercles ; ventral margin lacking tubercle row ; mesial face almost smooth except for occasional small tubercle. Merus slightly longer than carpus ; dorsal margin merely irregular at setal bases but 3 spines present just mesial to distodorsal angle ; lateral face with scattered small tubercles, ventral distolateral angle with 3 enlarged spines ; ventrolateral margin with tubercles similar to lateral face, ventromesial margin with tubercles slightly enlarged forming irregular row. Long simple setae on all segments, especially on dorsal margins, but particularly developed on propodus and dactyl.

Second pereopods (fig. 6c) longer than left cheliped. Dactyl much longer than propodus and shallowly recurved ; spination absent ; longitudinal sulcus present. Propodus slightly more than 4 times as long as its greatest width ; spines absent. Carpus length  $\frac{3}{4}$  that of propodus ; dorsal margin with row of 8 strong spines, remainder of segment unarmed. Merus slightly longer than propodus, distinctly compressed laterally ; spines absent. Segments bearing long setae, especially dorsally and ventrally ; most setae simple, some especially on merus plumose.

Third pereopods similar length to second ; segments similarly proportioned except merus shorter and ischium longer than second. All segments unarmed except carpus with 11 dorsal spines, these much smaller than on carpus of second pereopod. Setation like that of second pereopod.

Dactyl of fourth pereopods ending in corneous claw. Rasp occupying more than half ventral length of propodus. Carpus with small distodorsal spinule.

Male holotype with 4 uniramous pleopods, increasing in size from 1 to 3 and decreasing slightly to 4 ; pleopods bearing long plumose setae.

Tailfan very asymmetrical ; left uropods much larger than right. Telson (fig. 5e) as long as broad with subtriangular lobes, left much larger than right ; distinct median cleft. Posterior and posterolateral margins of lobes armed with numerous spines ; left lobe with 5 curved spines very much larger than other spines, right lobe with 2 large spines and 2 somewhat smaller. Telson with scattered long simple setae especially marginally.

*Coloration* : No pigmentation remains in preserved holotype.

*HABITAT*. — The species based upon the holotype is known only from waters of 22-46 m depth.

*DISTRIBUTION*. — At present the species is known only from northwestern Australia just south of Broome.

*ETYMOLOGY*. — Named after the vessel aboard which the holotype was collected during an early sampling of the Kimberley region.

#### REMARKS

Although described from only the holotype, *D. dorotheae* is readily distinguished from the most similar congeners. It resembles *D. lophochir* Morgan in general size and appearance but differs in having much shorter antennal acicles, no spines on the propodi of either second or third pereopods, quite different spination and tuberculation on the left cheliped and also heavier setation on that appendage (see MORGAN, 1989a). *D. costatus* Henderson also has larger acicles reaching the base of the ultimate peduncular segment, the propodus of the second pereopod has a spinose dorsal margin and the palm of the left cheliped has a distinct longitudinal lateral crest (HENDERSON, 1893 ; ALCOCK, 1905 ; LEWINSOHN, 1969).

There are two species of *Diogenes* described from Australia that have not been elaborated upon or rediscovered since their first description. *D. granulatus* Miers was described from Shark Bay, Western Australia, but differs from *D. dorotheae* in having the left cheliped 'hand' less granular than the 'wrist' and 'arm', the dactyl of left second and third pereopods 'rather short, scarcely exceeding the penultimate joint in length' and ophthalmic scales 'entire', presumably non-spinose (MIERS, 1880 (footnote) ; HASWELL, 1882). *D. guttatus* Henderson from Torres Strait, north Australia, has the propodus of the left chela with 'perfectly circular, drop-like, and flattened elevations' and the only spination on second and third pereopods is 'a few spinules on the anterior borders of the meral joints' (HENDERSON, 1888).

There is an additional difference between *D. dorotheae* and all of the above species. The one specimen examined here has the rostral process bispinose, while those of the other species are simple. It cannot be certain that all specimens of *D. dorotheae* possess a bispinose rostral process but if so then that will immediately separate the species from any similar congeners in Australian waters.

The condition of the maxillule, lacking an accessory flagellum on the endopodite, and the second maxillipeds, with the exopodite far exceeding the recurved length of the endopodite, place *D. dorotheae* in the 'group II' division of *Diogenes* proposed by FOREST (1952).

***Diogenes setocristatus* sp. nov.**

(Figs 7, 8)

*Diogenes* sp. A ; MORGAN, 1987a : 180.

HOLOTYPE : ♂, SL 4.2 mm, southwest of Peel Island, southeast Qld, dredged 9-11 m, in worn shell of ? *Vasum ceramicum* Linnaeus, University of Queensland, 5.12.1961, WAM 28-90.

PARATYPES : ♀ (ovig.), SL 4.1 mm, Broome, N.W.A., in buccinid shell, R. W. GEORGE on 'Dorothea', 15.10.1962, WAM 466-65 ; ♂, SL 2.6 mm, 96 km west of Cape Jaubert, N.W.A., 40 m, R. W. GEORGE on 'Dorothea', 13.10.1962, MNHN Pg. 4490 ; ♀, SL 3.5 mm, Hope Inlet, Shoal Bay, N.T., intertidal, 25.08.1972, NTM Cr. 007074 ; ♂, SL 3.1 mm, Orontes Reef west end, Port Essington, N.T., 14-17 m, in shell of ? *Favartia* sp., G. J. MORGAN, 9.08.1986, WAM 147-87 ; ♂, SL 3.5 mm, Orontes Reef west end, Port Essington, N.T., 11 m, in shell of ? *Favartia* sp., G. J. MORGAN, 10.08.1986, WAM 146-87.

DESCRIPTION

Shield (fig. 7a) almost as broad as long. Lateral margins nearly straight, with several stout spines on dorsolateral margins, lower lateral faces devoid of spines except for low spinules along their dorsal margins ; dorsal surface with short transverse rows of tubercles laterally. Anterior margin shallowly concave between rostrum and lateral projections ; rostrum broad and very short, barely extending as far as lateral projections ; lateral projections triangular, usually with terminal spinule and often some minute tubercles lateral to this. Shield with numerous large tufts of densely plumose setae symmetrically distributed over dorsal surface and along lateral margins ; shield deeply sculptured around setal bases.

Ocular peduncles long and slender, about as long as front of shield, 4/5 length of shield and reaching beyond base of ultimate segment of antennular peduncles ; ocular peduncles cylindrical, inflated basally but only very slightly distally ; bearing some clumps of plumose setae proximomesially and some small simple setae distal to these. Corneal width about 1/8 length of peduncles. Ocular acicles with 4-5 distal spines, 2 or 3 usually much larger than others ; acicles with anterolateral margins shallowly concave, mesial margins shallowly concave to slightly convex, proximal margins almost straight ; acicles separated at bases by less than 1/4 width of one acicle. Intercalary rostral process very small and simple, sometimes vestigial, not reaching to half length of ocular acicles. Acicles and process with distal plumose setae.

Antennular peduncles long and slender, unarmed, bearing sparse simple setae. Antennal peduncles shorter than antennular peduncles but longer than ocular peduncles ; fifth and fourth segments unarmed ; third with very weak distoventral protrusion ; second with distolateral spine of varying development, mesial spines absent ; first segment unarmed or weakly denticulate on distal margin. Antennal acicles reaching to or only slightly beyond half length

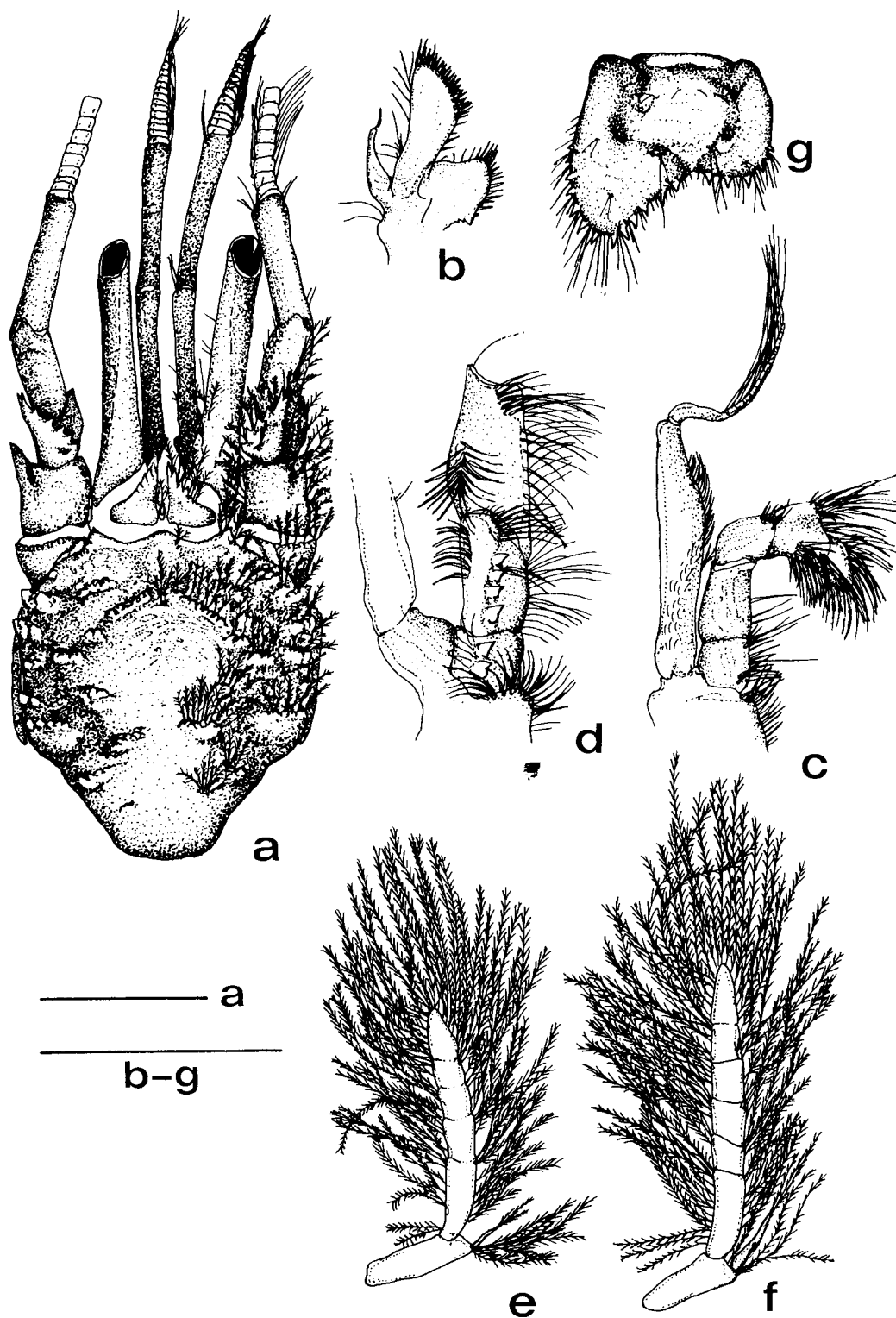


FIG. 7. — *Diogenes setocristatus* sp. nov. Holotype ♂. a, shield and cephalic appendages, dorsal view (setae omitted left side); b, left maxillule, mesial view; c, left second maxilliped, mesial view; d, merus, ischium and basis of left third maxilliped, mesial view; e, first pleopod, mesial view; f, second pleopod, mesial view; g, telson, dorsal view. Scales = 2.0 mm.

of penultimate segment of peduncle ; acicles with 6-8 spines along distomesial edge, spines largest distally. Segments 3-5 of antennal peduncles with scattered long simple setae, segments 1 and 2 and acicles with tufts of mostly plumose setae. Antennal flagella approximately same length as carapace, with scattered short setae dorsally and long simple setae ventrally.

Maxillules (fig. 7b) lacking accessory flagellum on endopodite. Second maxillipeds (fig. 7c) with exopodite exceeding by more than 1/3 its length recurved length of endopodite. Third maxillipeds (fig. 7d) with merus unarmed, ischium with 4 strong ventromesial spines, largest proximally, and basis with 2 strong ventromesial spines.

Left cheliped (fig. 8a) much larger than right. Features largely obscured by dense long plumose setae (fig. 8b). Dactyl about half length of propodus, broader than fixed finger, flattened laterally, strongly recurved and just crossing fixed finger at tip ; dorsal margin with row of large acute tubercles, numerous other tubercles ventral to these on lateral surface diminishing in size towards cutting edge ; several large cutting teeth ; mesial face smooth. Length of propodus less than twice maximum width. Fixed finger not markedly deflexed ; cutting edge with several large teeth ; lateral face coarsely tuberculate, tubercles stout and acute or semi-acute, larger ventrally and forming irregular row ; mesial face smooth. Palm slightly broader than long ; dorsal margin with 6-7 stout spines ; lateral face convex, sparsely tuberculate dorsolaterally with tubercles small and acute, these becoming denser and larger ventrally ; central face of palm virtually aspinose ; ventral margin with large tubercles and stout spines forming very irregular row, these spines largest proximally ; several large acute tubercles and spines extending from proximoventral angle along proximal margin of propodus towards dorsal edge ; mesial face smooth except for some spines of tubercles close to ventral margin. Carpus longer than dorsal margin of palm and broader than long ; dorsal margin with row of 5-6 curved spines, longest distally ; distolateral margin with several spines and tubercles, 1 or 2 long spines near midline of carpus ; lateral face with several tubercles and spines, 1 often distinctly enlarged, mesial face smooth. Merus slightly shorter than carpus ; dorsal margin with row of irregularly sized tubercles and spinules ; ventrolateral margin with irregular row of spines, some large and curved ; ventromesial margin with 2-3 stout spines or tubercles proximally ; lateral face with small tubercles, many arranged in short transverse crests ; ventral face smooth except for a few scattered tubercles ; mesial face almost smooth. Dactyl and propodus with dense coat of long plumose setae laterally, carpus and merus with setae mostly distally and ventrally but with some clumps of setae dorsally and laterally ; setation very sparse on mesial faces of all segments with small clumps of simple setae.

Right cheliped (fig. 8c) about 3/4 length of left but much less robust. Dactyl half length of propodus, not recurved, dorsal and lateral surfaces with scattered semi-acute tubercles ; cutting edge with numerous small similarly sized teeth associated in short lengths ; mesial face almost smooth. Propodus more than twice as long as broad ; fixed finger similar to dactyl but no development of ventral marginal spines or tubercles. Palm with spine at distodorsal angle and some small spinules or tubercles posterior to this along dorsal margin ; lateral face with only obsolete tubercles ; ventral margin only slightly irregular at setal bases ; mesial face smooth. Carpus with strong spine at distodorsal angle and 1 or more smaller spines or tubercles proximal to this along dorsal margin ; distal margin with several spinules, 1 or 2 distinctly enlarged as spines near midline ; lateral face with some scattered tubercles. Merus with low spinules or tubercles along dorsal margin, largest at distodorsal angle ; ventrolateral margin with irregular row of tubercles and spines, several enlarged and curved ; ventromesial margin

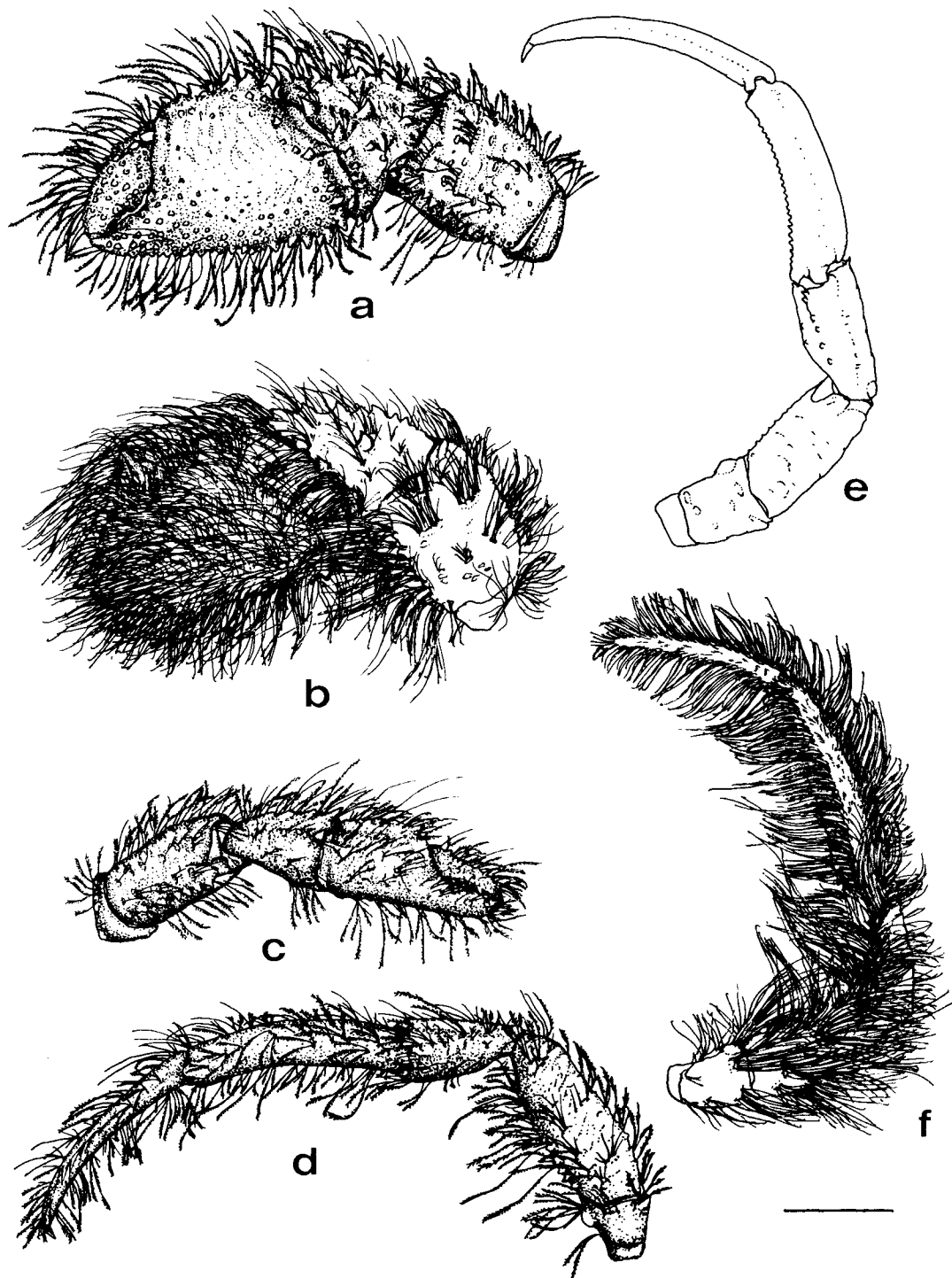


FIG. 8. — *Diogenes setocristatus* sp. nov. a, c-e, holotype ♂; b, f, paratype ♀ (SL 4.1 mm, WAM 466-65). a, left cheliped, lateral view (setation reduced on all segments and omitted from lateral face of propodus and dactyl); b, left cheliped, lateral view showing setation (pinnules of plumose setae omitted for clarity); c, right cheliped, lateral view (setation reduced on all segments); d, left second pereiopod, lateral view; e, left third pereiopod, lateral view (setation omitted); f, left third pereiopod, lateral view showing setation (pinnules of plumose setae omitted). Scale = 2.0 mm.



with a few tubercles or spinules ; lateral and ventral faces with some tubercles ; mesial face almost smooth. Setations similar to left cheliped but slightly less dense with larger areas of propodus unobscured laterally ; long simple setae from dorsomesial areas of segments.

Second left pereopod (fig. 8d) much longer than left cheliped. Dactyl very shallowly recurved, similar length to propodus ; spines absent ; very shallow longitudinal sulcus. Propodus about 6 times as long as broad ; spines absent. Carpus length  $\frac{2}{3}$  that of propodus ; unarmed except for several small tubercles along dorsal margin. Merus almost as long as propodus ; dorsal margin with row of low tubercles or spinules, especially developed proximally ; ventral margin with row of pronounced small spines, largest proximally ; lateral margin with short transverse tubercles. All segments with long plumose setae, especially along dorsal and ventral margins ; some lateral setae, particularly on dactyl and propodus.

Third left pereopod (fig. 8e) slightly shorter than second. Dactyl somewhat broader proximally than on second pereopod. Propodus shorter and broader, about 4 times as long as its maximum width ; ventral margin with row of acute spinules. Carpus with small distodorsal spine and several spinules in ventral row ; usually 1-2 spinules on distolateral margin. Merus distinctly shorter than on second pereopod ; unarmed except for several ventral spinules. Setae (fig. 8f) longer and more discretely distributed than on second pereopod ; dactyl and propodus with fringes of very long plumose setae along dorsolateral and ventral borders, very much shorter setae emanating from between these fringes ; ventral fringe continuing onto carpus and merus, dorso-lateral fringe continuing as lateral fringe on carpus and at least distal half of merus ; dorsal and dorsomesial surfaces of all segments also with plumose setae in less regular clumps.

Second right pereopod similarly proportioned to second left pereopod except propodus less elongate, an appendage somewhat less setose. Third right pereopod similar to second right but merus shorter and ischium longer ; propodus more elongate than on third left pereopod and lacking ventral row of spinules ; setation resembling that of second right pereopod, setae not forming distinct dorsolateral and ventral fringes obvious on third left pereopod.

Dactyl of fourth pereopod terminating in short corneous claw. Propodus with rasp covering more than half its ventral length. Distodorsal spine on propodus and carpus. Dense plumose setae, especially along dorsal and ventral margins.

Males with 4 unpaired pleopods increasing in size from 1 to 3, decreasing to 4. Pleopods very weakly biramous ; on holotype, endopodite very small and extremely attenuated on all pleopods, noticeably largest on pleopod 2 and smallest on pleopod 1 (fig 7e, f). Variation amongst paratypes in development of endopodite and small male (WAM 472-65) with endopodite absent on pleopods 1-3 and only minute papilla on pleopod 4. Females with 4 elongate unpaired biramous pleopods.

Tailfan very asymmetrical. Telson (fig. 7g) about as long as broad, with left lobe much larger and more elongate than right ; posterolateral and posterior margin with 13-14 spines on left lobe, 6-9 on right. Median cleft distinct. Marginal and some dorsal long simple setae.

*Coloration* : The following is slightly modified from MORGAN (1987a : 180). Shield cream or pale brown with darker brown patches especially laterally. Ocular peduncles cream dorsally, brown ventrally ; corneas black. Antennular and antennal peduncles cream or pale blue ; flagella pale orange. Chelipeds cream and brown, tubercles on dactyl and propodus cream or white, carpus and merus mottled. Second and third pereopods mottled red-brown and cream. Setae pale yellow or brown.

HABITAT. — The species has been collected from inshore waters from the intertidal to 40 m depth, apparently preferring soft substrates.

DISTRIBUTION. — The known range extends from the area of Cape Jaubert, northwestern Australia, north and east to Peel Island, near Brisbane.

ETYMOLOGY. — Named from the Latin adjective '*cristatus* (-a, -um)' (crested) for the distinctive fringes or crests of setae on the third left pereopod.

#### REMARKS

*Diogenes setocristatus* has been noted from northern Australia by MORGAN (1987a) as '*Diogenes* sp. A'. MORGAN (1987a) recorded some relevant details of the species but did not undertake a description due to the limited numbers of specimens available at that time.

As noted by MORGAN (1987a), *D. setocristatus* is assignable to the *Troglopagurus* Henderson group of species. These are regarded here as members of *Diogenes* in accordance with FOREST (1952), the small rostral process being considered homologous with that of other species of *Diogenes*. This character is much reduced in *D. setocristatus* and the other species in the *Troglopagurus* group and may be regarded as in process of being secondarily lost.

Several species have been described under the generic nomen *Troglopagurus*. *D. setocristatus* most closely resembles *D. jousseaumei* (Bouvier) according to the key of ALCOCK (1905 : 75). The type specimens of *D. jousseaumei* were examined at the MNHN and differ from *D. setocristatus* in having less spinose antennal acicles, longer dactyls on second and third pereopods and the setae on the third left pereopod not forming distinct fringes along the dorsolateral and ventral margins of the dactyl and propodus. The types of *D. jousseaumei* are much smaller than the larger specimens of *D. setocristatus* but these character differences appear to be consistent regardless of size. These differences also distinguish *D. setocristatus* from *D. stenops* also described in this paper.

*Diogenes manaarensis* (Henderson) was noted by ALCOCK (1905) to have the antennal acicles truncate and the ocular acicles spinulose along the entire anterior edge, not merely the distal margin. *D. jubatus* (Nobili) has the antennal acicle 'hardly acute' (ALCOCK, 1905). *D. persicus* (Nobili) is represented by the type specimen in the MNHN and although this is a very small animal (SL 1.8 mm) it can be recognized as distinct from *D. setocristatus* in lacking the heavy plumose setation on chelipeds and pereopods and having the left cheliped more strongly spinose and the lobes of the telson subequal. *D. mercatoris* Forest shows many of the characters of *Troglopagurus* as discussed by FOREST (1952) and can be readily distinguished from *D. setocristatus* by the spination on the left cheliped, especially the strong ventral spine on the merus of *D. mercatoris*, and the shape of the telson.

The most distinctive characters of *D. setocristatus* are the long fringes of plumose setae on the third left pereopod giving the dactyl and propodus a flattened appearance from the lateral view. Variation in the development of an endopodite on pleopods of males is discussed for *D. stenops*.

**Diogenes stenops** sp. nov.

(Figs 9, 10)

*Diogenes jousseaumei*; MORGAN, 1987a : 179 (not *Troglopagurus jousseaumei* Bouvier, 1897).

HOLOTYPE : ♂, SL 5.8 mm, Cape Bowling Green, near Townsville, Qld, W. GOODE, 23.11.1962, WAM 29-90.

PARATYPES : ♂, SL 45 mm, type locality, MNHN Pg. 4491 ; ♂, SL 2.7 mm, New Year Island, Qld, dredged 58 m, W. GOODE, 10.1962, WAM 403-65 ; ♂, SL 5.1 mm, 2 ♀♀, SL 4.4 mm, 3.2 mm, 40 km south of Cairns, Qld, trawled 29 m, W. GOODE, 8.11.1963, WAM 516-65 ; ♂ SL 3.7 mm, north end of Port Essington, N.T., trawled 20 m, mud, in *Murex brevispinus* Lamarck shell, G. J. MORGAN, 9-10.08.1986, WAM 145-87.

DESCRIPTION

Shield (fig. 9a) almost as broad as long. Lateral margins almost straight or slightly convex, with several large sharp spines on dorsolateral margins, lower lateral faces with some tubercles or spinules along dorsal edges ; dorsal surface of shield deeply channeled between nearly symmetrically arranged tubercles, these often in short transverse ridges. Anterior margin concave between rostrum and lateral projections. Rostrum broadly triangular, very short and not reaching as far as lateral projections ; lateral projections subtriangular, mesial margins usually slightly convex, tipped with small spinule ; some low tubercles from base of lateral projections onto anterolateral margins of shield. Tufts of plumose setae on dorsal and lateral surfaces of shield, most setae emanating from tubercles rows.

Ocular peduncles long and slender, about as long as front of shield, slightly shorter than shield and just reaching beyond base of ultimate segment of antennular peduncles ; ocular peduncles slightly inflated proximally but scarcely at all distally ; bearing clumps of plumose setae proximally, very sparse setae along mesial edges distally. Corneal width about 1/8 length of peduncles. Ocular acicles width 3-5 distal spines, decreasing in size proximolaterally ; acicles with mesial margins almost straight or slightly concave, lateral margins slightly concave, proximal margins usually slightly convex ; separated at bases by less than 1/4 width of one acicle. Intercalary rostral process very small, vestigial, not reaching half length of acicles. Acicles and rostral process with distal plumose setae.

Antennular peduncles long and slender, unarmed except for blunt lateral process on proximal segment, bearing sparse simple setae.

Antennal peduncles exceeding ocular peduncles, but not reaching half length of ultimate segment of antennular peduncles ; fifth and fourth segments unarmed ; third with distal projection faint or obsolete ; second with well developed dorsolateral spine, mesial spines absent ; first segment with variable number of acute denticles along distal margin. Antennal acicles not or only just reaching half length of penultimate segment of peduncles ; acicles with 3-4 spines along distomesial margin, largest distally. Scattered simple setae on segments 4 and 5, simple and plumose on segment 3, tufts of plumose setae on segments 1, 2 and acicles. Antennal flagella about as long as carapace ; with very short simple setae dorsally, long simple setae ventrally.

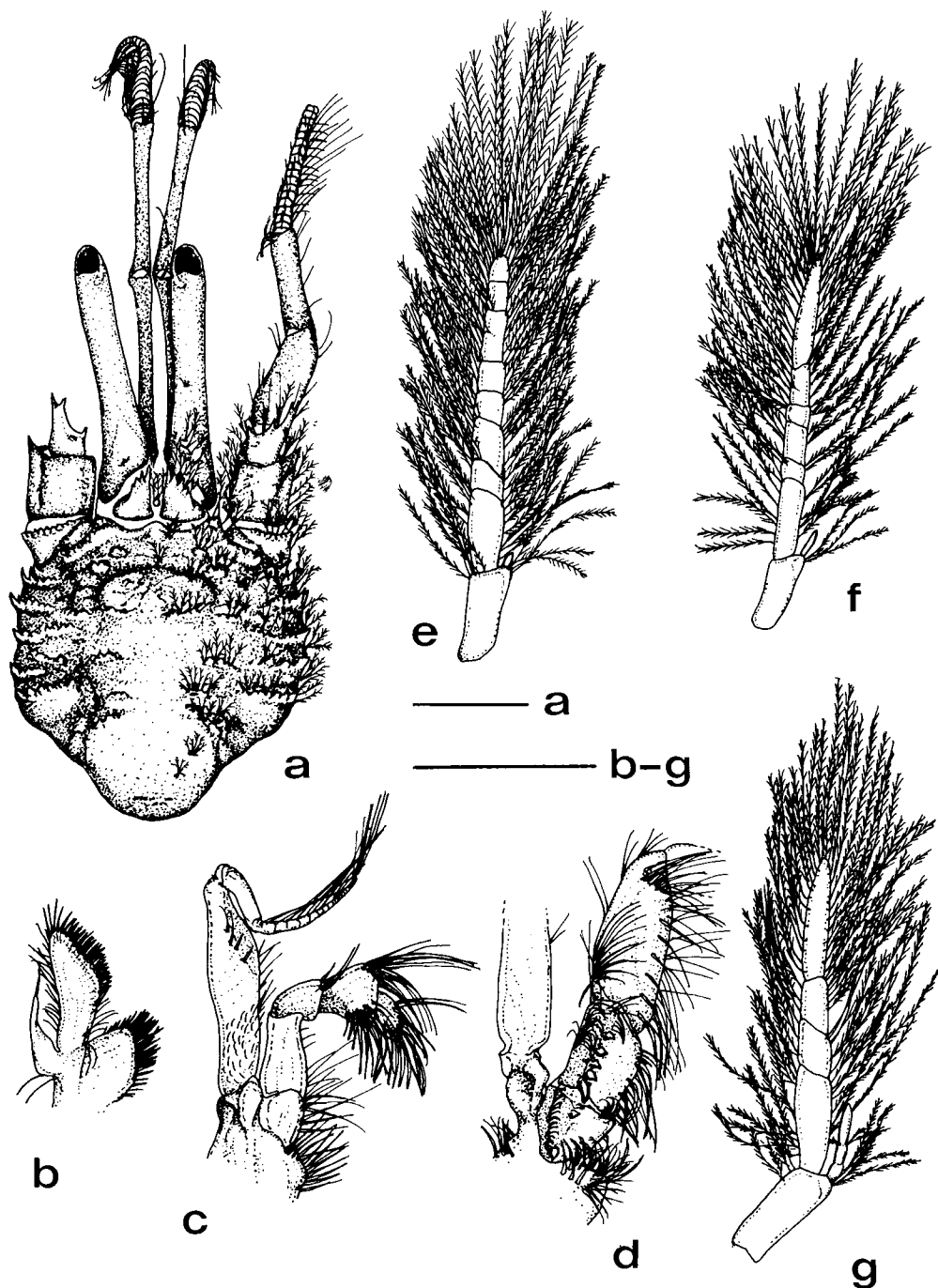


FIG. 9. — *Diogenes stenops* sp. nov. a-f, holotype ♂; g, paratype ♂ (SL 5.1 mm, WAM 516-65). a, shield and cephalic appendages, dorsal view (setae omitted left side); b, left maxillule, mesial view; c, left second maxilliped, mesial view; d, merus, ischium and basis of left third maxilliped, mesial view; e, third pleopod of holotype, mesial view; f, fourth pleopod of holotype, mesial view; g, second pleopod of paratype ♂, mesial view. Scales = 2.0 mm.

Maxillules (fig. 9b) lacking accessory flagellum on endopodite. Second maxillipeds (fig. 9c) with exopodite exceeding by at least 1/3 its length recurved length of endopodite. Third maxillipeds (fig. 9d) with merus unarmed, ischium with 5 strong ventromesial spines, largest spine proximal, and basis with 2 ventromesial spines.

Left cheliped (fig. 10a) much larger than right. Dense plumose setae obscuring features, especially on dactyl and propodus. Dactyl about half length of propodus, as broad or slightly broader than fixed finger, compressed laterally, strongly recurved and crossing fixed finger at tip; dorsal margin with irregular row of stout spines, largest proximally; lateral face with numerous stout spines and acute tubercles; cutting edge with several large teeth; mesial face almost smooth, with shallow dorsomesial sulcus. Fixed finger with well developed cutting teeth, 1 usually distinctly larger; lateral face with numerous acute tubercles of varying sizes; ventral margin with tubercles somewhat enlarged but ventral row very indistinct; mesial face almost smooth, with some tubercles near ventral edge. Palm about as broad as long; dorsal margin with 5-7 long stout recurved spines; lateral face sparsely tuberculate with small semi-acute tubercles; these largest distally and virtually absent along midline of palm; ventral margin with broad spines and acute tubercles in very irregular row(s); some enlarged spines extending dorsally from proximoventral angle of palm in vague row sometimes curving distally at midline; mesial face smooth except for some tubercles near dorsal and ventral margins. Carpus similar length to or longer than dorsal margin of palm, about as broad as long; dorsal margin with 6-7 spines, much larger and recurved distally; distolateral margin with several spines, 1 or 2 near midline much enlarged; lateral face with several spines or tubercles, 1 large spine near centre of face and often a second proximal to this; mesial face rather irregular dorsally, often several denticles along distomesial margin. Merus similar length to carpus; dorsal margin with row of acute tubercles; ventrolateral margin with row of irregularly sized spines and tubercles, some pronounced and recurved; ventromesial margin smooth or with obsolete tubercles; lateral face with scattered small semi-acute tubercles, some forming short transverse ridges; ventral face almost smooth with some tubercles especially near lateral edge; mesial face smooth. Lateral faces of dactyl and propodus covered with dense long plumose setae, these more isolated into discrete clumps on carpus and merus; long simple setae in clumps on dorsomesial surfaces of all segments.

Right cheliped (fig. 10b) approximately 3/4 length of left, much less robust. Dactyl half length of propodus, slightly curved, not laterally compressed; dorsal margin with row of small stout spines, largest proximally; lateral and mesial faces almost smooth; cutting edge with numerous similarly sized teeth. Propodus more than twice as long as broad; dorsal margin of palm with strong distal spine and some small spinules or tubercles posterior to this; lateral face with strong subdorsal depression in holotype, shallower in other specimens, face slightly irregular with protrusions at setal bases and scattered small semi-acute to acute tubercles distally on palm and along fixed finger; mesial face smooth; cutting edge with numerous similarly sized teeth. Carpus with strong spine at distodorsal angle and some obsolete tubercles posterior to this; distolateral margin with strong spine dorsal to midline and variable development of small spines or acute tubercles ventral to this; lateral face with dorsolateral sulcus, surface irregular with scattered low tubercles; mesial face almost smooth. Merus with distodorsal spine or spinule and row of irregularly sized spinules or tubercles posterior to this; ventrolateral margin with row of protrusions, these as sharp spines distally tending to blunt tubercles proximally; ventromesial margin unarmed or with some low tubercles; lateral face

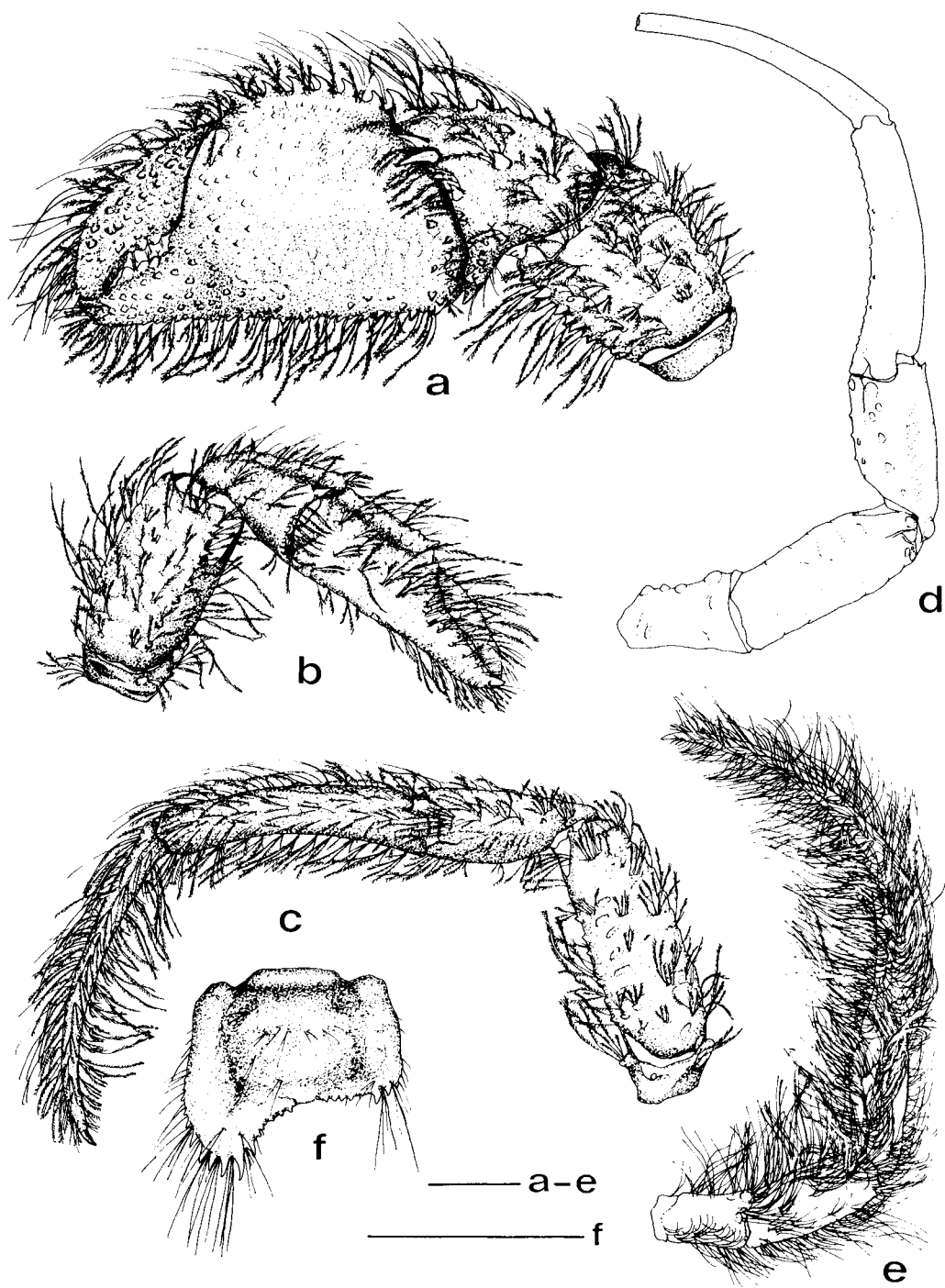


FIG. 10. — *Diogenes stenops* sp. nov. a-d, f, holotype ♂, e, paratype ♀ (SL 4.4 mm, WAM 516 -65). a, left cheliped, lateral view (setation reduced on all segments and omitted from lateral face of propodus and dactyl); b, right cheliped, lateral view (setation reduced); c, left second pereiopod, lateral view; d, left third pereiopod, lateral view (setation omitted); e, left third pereiopod, lateral view showing setation (pinnules of plumose setae omitted); f, telson, dorsal view. Scales = 2.0 mm.

with irregular surface of low tubercles ; ventral and mesial faces smoother. Long plumose setae on all segments especially laterally, and ventrally on carpus and merus ; long simple setae from mesial especially dorsomesial faces.

Second left pereiopod (fig. 10c) distinctly longer than left cheliped. Dactyl shallowly recurved, with faint longitudinal sulcus, longer than propodus ; spines absent. Propodus about 6 times as long as broad ; spines absent. Carpus length  $\frac{2}{3}$  that of propodus ; strong distodorsal spine and some slight irregularity along dorsal margin ; otherwise unarmed. Merus about as long as propodus ; dorsal margin merely irregular at setal bases ; ventral margin with row of spines, slightly larger proximally ; some low tubercles on ventrolateral face. All segments with long plumose setae in clumps on lateral faces and along dorsal and ventral margins, dactyl also with plumose setae on dorsomesial face ; carpus and merus with few mesial setae, dactyl and propodus with numerous dorsomesial setae, mostly simple.

Third left pereiopod (fig. 10d) similar length to second. Dactyl very slightly shorter than on second pereiopod ; spines absent. Propodus shorter and broader than on second, 4-5 times as long as maximum width ; row of spinules along ventral margin and sometimes some tubercles immediately lateral to this row, otherwise unarmed. Carpus with distodorsal spine and sometimes spinule at lateral distoventral angle ; several spinules along ventral margin ; some blunt tubercles over lateral and ventral faces. Merus unarmed except for obsolete tubercles or spinules along ventral margin, lateral face with some tubercles. Setation (fig. 10e) much heavier than on second pereiopod ; long plumose setae on dorsal, ventral and lateral surfaces of dactyl and propodus, not forming distinct fringes ; carpus and merus with long plumose setae more discretely clumped, mostly ventral to midline and along dorsal margin ; all segments with dorsomesial simple setae extending onto mesial faces of dactyl and propodus.

Second right pereiopod similar to second left but propodus less elongate and setation lighter. Third right pereiopod similar to third left but propodus lacking ventral row of spines and more elongate, similar to that of second left pereiopod, and setation considerably lighter on all segments especially dactyl and propodus.

Fourth pereiopods with dactyl terminating in small corneous claw. Propodus with rasp covering half or more than half ventral length. Strong distodorsal spine on propodus and carpus. Dense long plumose setae on all segments, especially dorsally along distal margins.

Males with 4 unpaired pleopods. Considerable variation in development of endopodite on pleopods. Holotype with pleopods 1 and 2 uniramous, pleopod 3 (fig. 9e) with minute lobe and 4 (fig. 9f) with small but elongate endopodite. Paratype males with all pleopods or pleopods 2-4 biramous, endopodites varying from small lobes to elongate and 3-segmented (fig. 9g). Variation does not appear distinctly size dependent nor is development of endopodite consistent with pleopod number. Females with 4 unpaired, elongate biramous pleopods.

Tailfan very asymmetrical. Telson (fig. 10f) about as long as broad, sometimes slightly longer or broader, left lobe much larger and more elongate than right ; posterolateral and posterior margins of lobes with numerous spines, 12-16 on left lobe, of these usually 6-8 distinctly larger, and 7-10 on right lobe, of which 2 or 3 usually somewhat larger. Median cleft distinct. Long simple setae around margins and in scattered clumps dorsally.

*Coloration* : The following is slightly modified from MORGAN (1987a). Shield cream and pale brown with darker patches. Ocular peduncles cream with some brown dorsally and ventrally ; corneas black with iridescent yellow speckling. Antennules and antennae cream.

Chelipeds cream and dark brown, Second and third pereiopods cream with grey-brown mottling, often with irregular brown band proximally on dactyl and at midlength of propodus, carpus and merus. Setae pale grey, yellow or brown.

HABITAT. — The species is known from waters shallower than 30 m, on mud substrates.

DISTRIBUTION. — Northern Australia from the Northern Territory east to the vicinity of Townsville, Queensland.

ETYMOLOGY. — Named from the Greek στενός (thin) and ὤψ (eye) for the elongate ocular peduncles that distinguish the species from the most similar congener.

#### REMARKS

*D. stenops* very closely resembles *D. jousseaumei* (Bouvier). General proportions and setation are similar but examination of syntypes and other specimens of *D. jousseaumei* from the Red Sea and Gulf of Aden in the MNHN revealed several differences deserved of specific separation. The new species displays larger spines on the propodus and carpus of the left cheliped, the carpus with 1 or 2 very large spines on the distolateral margin near the midline and another large spine proximal to these (fig. 10a). Small specimens of *D. jousseaumei* have spines on carpus and propodus approaching the condition of *D. stenops* but on larger animals, closer in size to the specimens of *D. stenops*, the propodal and carpal spines are smaller, the carpus without strong development of distolateral spines near the midline (fig. 11a). The setae of chelipeds and second and third pereiopods of *D. jousseaumei* appear to be rather sparse and less plumose than those of *D. stenops* but it is not possible to know what degree of ablation of setae has been effected on the types of *D. jousseaumei* by previous workers.

The major character distinguishing the species is the relative lengths and dimensions of the ocular peduncles. In *D. stenops* the peduncles are very slender and the corneas only slightly inflated (fig. 9a), while in *D. jousseaumei* the ocular peduncles are much stouter and the corneas more distinctly inflated (fig. 11b).

Given the close similarity of *D. stenops* and *D. jousseaumei*, the previous records of *D. jousseaumei* from Port Curtis, Queensland (GRANT and MCCULLOCH, 1906), must be regarded with some suspicion. The record of *D. jousseaumei* from the Northern Territory (MORGAN, 1987a) has been noted here already as referring to *D. stenops*. The records of *D. jousseaumei* from the Indian region (ALCOCK, 1905 ; SOUTHWELL, 1906) might also require substantiation.

*D. stenops* differs from *D. setocristatus*, also described in this paper, in several characters. In the present species, the ocular acicles are less spinose, dactyls on second and third pereiopods are longer and setae on the dactyl and propodus of the third left pereiopod do not form distinct fringes. From the species *D. manaarensis* (Henderson), *D. jubatus* (Nobili) and *D. persicus* (Nobili), all previously included in the genus *Troglopagurus*, and *D. mercatoris* Forest, very similar to the *Troglopagurus* group, *D. stenops* differs in the same characters that separate *D. setocristatus* from these species. A modified version of ALCOCK's (1905) key to *Troglopagurus* species is presented here with the species loosely regarded as members of a '*D.*



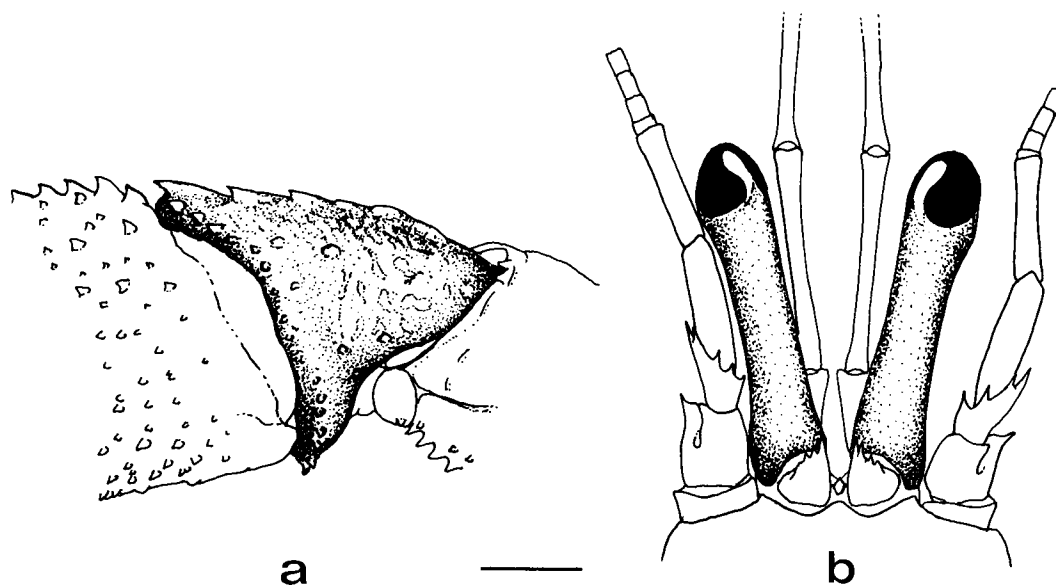


FIG. 11. — *Diogenes jousseaumei* (Bouvier). Syntype ♂, SL 4.0 mm (MNHN Pg. 1366). a, carpus of left cheliped, lateral view (setae omitted); b, ocular peduncles, dorsal view (setae omitted). Scale = 1.0 mm.

*jousseaumei* complex'. The single factor warranting their inclusion is the marked reduction in the size of the rostral process.

Prior to this paper, only two species of *Diogenes* had been recorded as having biramous pleopods in males. FOREST (1952) noted biramous pleopods in males of *D. mercatoris* a species that can be included in the *D. jousseaumei* complex, and MORGAN (1987a) noted this condition for *D. biramus*, a species which can not be regarded as part of this complex in that it has a well developed rostral process.

In this work, both *D. stenops* and *D. setocristatus* are recorded as bearing biramous pleopods in males but the development of the pleopod endopodite is variable in both species. MORGAN (*in press*) has noted that *D. biramus* also shows variation in the development of the endopodite.

Male syntypes of *D. jousseaumei* were examined for this character and were found to either lack pleopod endopodites or have some development of an endopodite on only the fourth pleopod. When present, the size of the endopodite varies considerably, from a minute barely visible projection to a still small but elongate lobe half the length of the basal segment of the exopodite. The largest non-type male in the MNHN collection (SL 3.9 mm) has the last three pleopods badly damaged or lost but there is an elongate endopodite lobe on the second pleopod. The condition of the third and fourth pleopods cannot be ascertained.

The single male described of *D. mercatoris* was noted (FOREST, 1952) as having four biramous pleopods with the endopodite about 1/3 the length of the exopodite.

Therefore, of the six species of *Diogenes* now shown to have some development of biramous pleopods in males, five display considerable variation in the size of the endopodite. The condition in *D. mercatoris* resembles the greatest development of an endopodite shown by *D. biramus* but variation in the former species cannot be evaluated.

KEY TO SPECIES OF *Diogenes jousseaumei* COMPLEX

1. Antennal acicle truncate ; ocular acicles spinose along entire distolateral margin .. *D. manaarensis*  
Antennal acicle not truncate ; ocular acicles spinose only distally ..... 2
2. Antennal acicle barely acute..... *D. jubatus*  
Antennal acicle acute ..... 3
3. Chelipeds and pereiopods 2 and 3 rather sparsely setose, setae not obscuring morphological features (telsonic lobes subequal) ..... *D. persicus*  
Chelipeds and pereiopods 2 and 3 heavily setose, setae obscuring at least partially morphological features ..... 4
4. Merus of left cheliped with very strong proximovenral spine ; telson lacking median cleft.....  
..... *D. mercatoris*  
Merus of left cheliped lacking strong proximovenral spine ; telson with median cleft ..... 5
5. Setae on left pereiopod 3 forming distinct fringes along dorsolateral and ventral margins of dactyl and propodus (fig. 8f)..... *D. setocristatus*  
Setae on left pereiopod 3 long but not arranged in fringes..... 6
6. Ocular peduncles relatively stout with corneas inflated (fig.11b)..... *D. jousseaumei*  
Ocular peduncles elongate with corneas uninflated (fig. 9a)..... *D. stenops*

***Paguristes laurentae* sp. nov.**

(Figs 12, 13)

HOLOTYPE. — ♂, SL 4.6 mm, west of West End of Rottnest Island, S.W.A., dredged 146 m, R. W. GEORGE on 'Bluefin', 10.08.1962, WAM 30-90.

PARATYPES. ♀ (ovig.), SL 2.4 mm, northwest of Carnarvon (24°04' S, 112°52' E), C.S.I.R.O. (stn 192), 137 m, 8.10.1963, MNHN Pg. 4489 ; 2♀♀ (both ovig.), SL 2.1 mm, 1.6 mm, southwest of Point Cloates (23°39' S, 113°11' E), W.A., 137 m, C.S.I.R.O. (stn 187), 7.10.1963, WAM 31-90 ; ♂, SL 1.8 mm, ♀, SL 1.4 mm, northwest of Point Cloates (22°52' S, 113°29' E), W.A., 134 m, C.S.I.R.O. (stn 178), 6.10.1963, WAM 531-65.

DESCRIPTION

Shield (fig. 12a) slightly longer than broad. Anterior margin between rostrum and lateral projections concave ; rostrum very broadly triangular with minute apical spinule, projecting but not as far as lateral projections ; lateral projections triangular, tipped by spinule. Dorsal surface of shield uneven, with punctations and small tubercles especially on anterolateral faces, sculptured posterior to rostrum ; lateral margins of shield with several small tubercles. Long plumose setae laterally and some clumps dorsolaterally.

Ocular peduncles long and slender, slightly shorter than width of anterior margin shield and about 3/5 length of shield ; inflated proximally and very slightly distally ; peduncles with

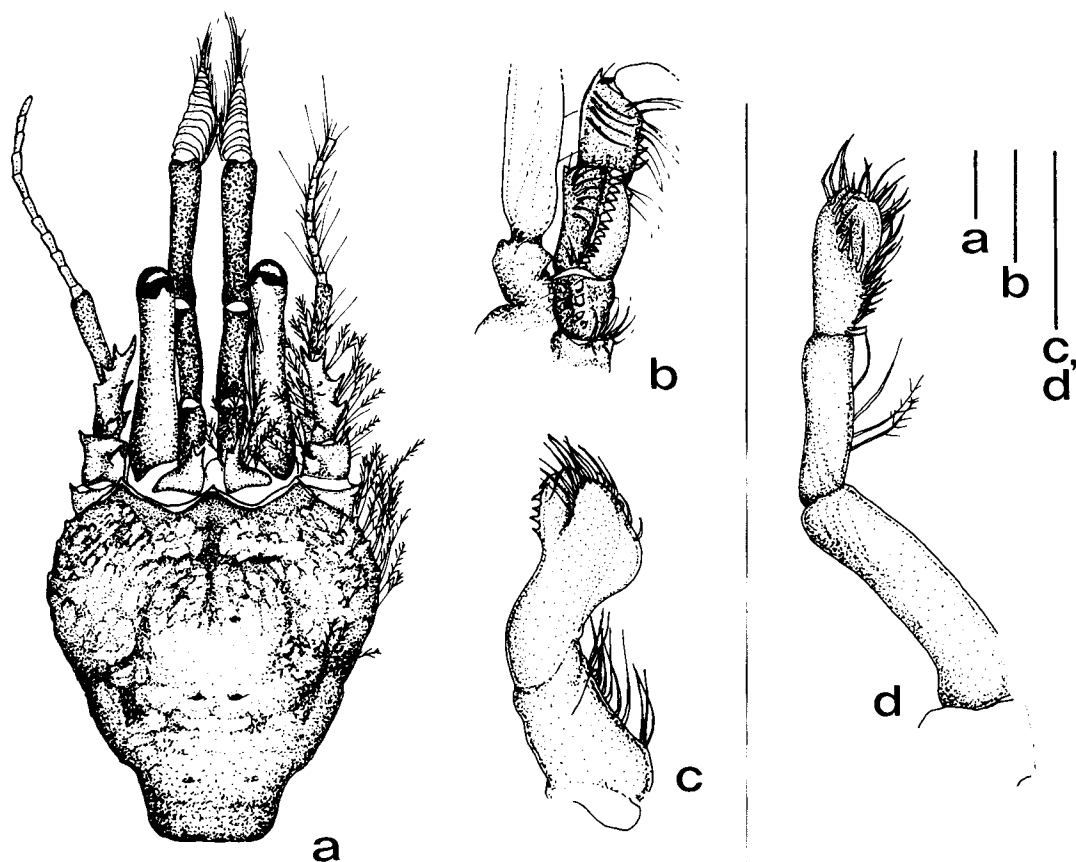


FIG. 12. — *Paguristes laurentae* sp. nov. Holotype ♂. a, shield and cephalic appendages, dorsal view (setae omitted left side); b, merus, ischium and basis of left third pereiopod, mesial view; c, left first pleopod of ♂, anterolateral view; d, left second pleopod of ♂, posteroventral view. Scales = 0.5 m.

several long setae along mesial margins. Corneal width about  $1/5$  to  $1/6$  length of peduncles. Ocular acicles with 2-3 terminal spinules, one usually distinctly largest; mesial margins slightly convex, lateral margins concave; bearing long plumose setae along anterior margins; acicles separated approximately half width of one acicle.

Antennular peduncles exceeding ocular peduncles by  $2/3$  to  $3/4$  length of ultimate peduncular segment; segments unarmed except for distoventral spine on basal segment.

Antennal peduncles slightly shorter than ocular peduncles. Fifth segment with distoventral spine; fourth and third segments each with very strong distoventral spine; second with 1 lateral and usually 1 smaller mesial spine; first segment with small lateral spinule. Antennal acicles reaching to about midlength of fifth peduncular segment; bearing terminal spine, 3 lateral spines and usually smaller proximal dorsomesial spine. All segments with clumps of long setae, mostly plumose on all but fifth segment with simple setae. Antennal flagella much shorter than carapace, shorter even than shield, with rather sparse long and short simple setae.

Third maxillipeds (fig. 12b) with merus bearing distodorsal spine and 4 ventrolateral spines ; ischium with well developed crista dentata, 1 distodorsal spine and distoventral spine ; basis with 4 mesial spines ; coxa with several ventral tubercles and spinules.

Chelipeds (fig. 13a, b) subequal or left slightly larger than right, spination similar. Dactyl longer than half length of propodus, with several cutting teeth largest proximally. Lateral and dorsal surfaces with large, acute tubercles or spines, these larger along dorsal margin, some smaller tubercles extending onto mesial face. Propodus about twice as long as broad ; fixed finger with several cutting teeth, lateral and ventral surfaces with numerous acute tubercles or broad spines ; small tubercles extending slightly onto ventral surface. Palm with 5-6 large dorsal spines ; lateral surface with numerous irregularly sized acute tubercles and spines, larger spines forming 2 or 3 very irregular rows ; small tubercles extending onto ventral surface of palm ; mesial surface with a few scattered tubercles. Carpus shorter than dactyl, with 4-5 large spines in row along dorsomesial margin, at least 1 additional spine at distodorsal angle, 5-6 spines in irregular midlateral row continuing one lateral spine row of propodus ; small tubercles also scattered over dorsolateral surface of carpus ; mesial surface smoother. Merus almost as long as propodus, slightly compressed, dorsal margin with row of stout spines or denticles, smaller proximally ; several spinules along distal margin of merus ; row of spinules along ventromesial and ventrolateral edges. All segments bearing clumps of long simple and plumose setae but spination not in any way obscured.

Second pereiopods (fig. 13c) longer than chelipeds, left and right pereiopods similar. Dactyl very long and elongate, longer than propodus ; devoid of spines. Propodus about 5 times as long as maximum width ; dorsal margin with 10-11 corneous spines on larger specimens, 7-8 on smaller animals, ventral margin only slightly irregular. Carpus about 2/3 length of propodus ; dorsal margin with 5-6 large spines and additional spine lateral to distalmost ; other surfaces unarmed. Merus slightly shorter than propodus but broader ; dorsal and ventral margins with irregular row of small spinules or denticles. Long simple and plumose setae on all segments, especially dorsal and ventral margins.

Third pereiopods (fig. 13d) slightly longer than second. Dactyl similar to that of second pereiopod. Propodus slightly narrower and unarmed or with several spinules proximomesially near dorsal margin. Carpus unarmed except for 1 distodorsal tubercle or spinule and sometimes 1 or 2 other minute tubercles proximally. Merus with dorsal row of spinules ; ventral margin irregular. Setation as for second pereiopods.

First and second pleopods of males paired (fig. 12c, d) ; male gonopores paired. Females with paired first pleopods and gonopores, broad pouch small and triangular, not covering eggs carried on pleopods.

Tailfan very asymmetrical, left uropods much larger than right. Sixth abdominal segment with 2 posterolateral spines on each side. Telson (fig. 13e) with left posterior lobe larger than right ; lobes subtriangular ; posterior margins with 2-3 very large spines on both left and right lobes ; anterior lobes and lateral margins of posterior lobes unarmed. Telson sparsely fringed with long simple setae, also with some clumps on dorsal surface.

*Coloration* : The specimens no longer retain patterns of pigmentation but the following colour notes were taken after a shorter duration in preservative : ' faint red pink transverse stripes on P2 and P3. Cheliped marbled orange red '.

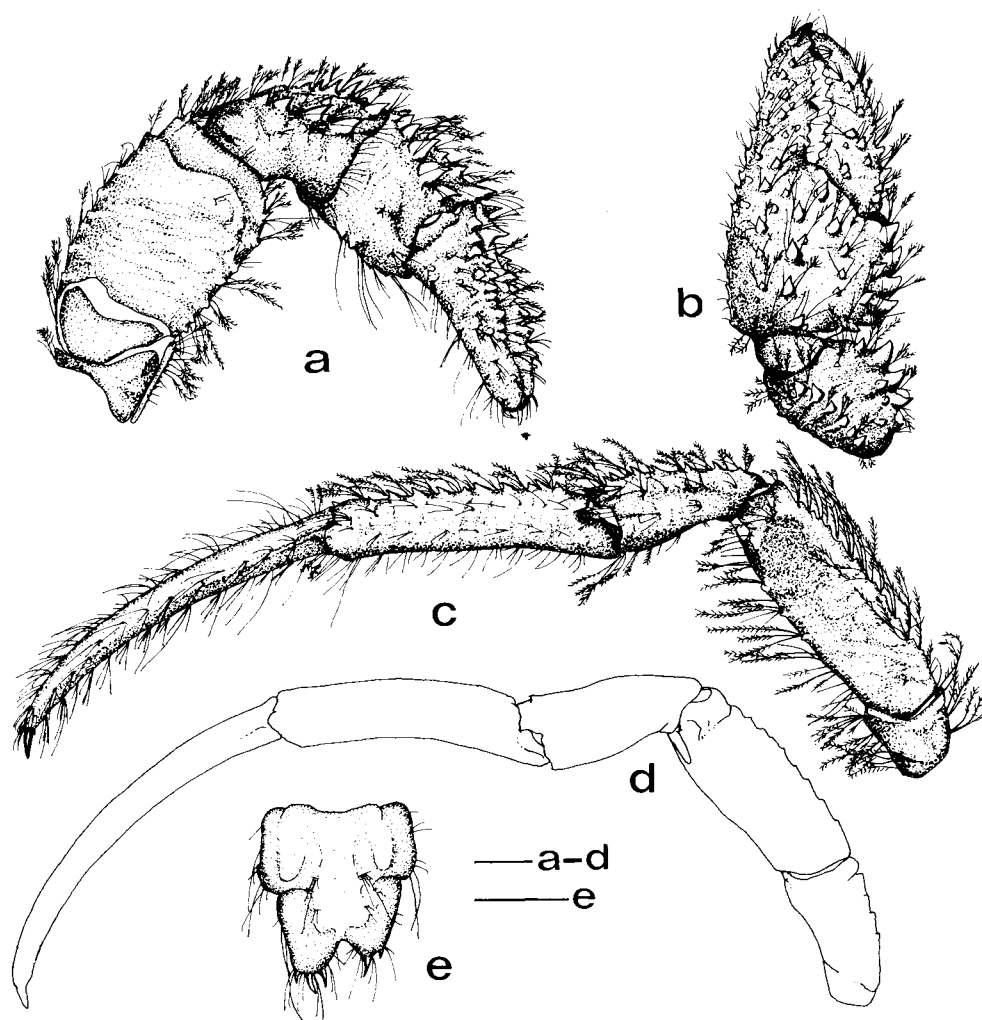


FIG. 13. — *Paguristes laurentae* sp. nov. Holotype ♂. a, left cheliped, mesial view ; b, left cheliped, dorsal view ; c, left second pereiopod, lateral view ; d, left third pereiopod, lateral view ; e, telson, dorsal view. Scales = 0.5 mm.

*Eggs* : The ovigerous female paratypes carry 3, 6, and 17 relatively large eggs (maximum diameter on largest female 0.8 mm).

*HABITAT*. — The type material was collected from depths between 134 m and 146 m.

*DISTRIBUTION*. — The species is presently known only from offshore waters of southwest Australia, from west of Rottnest Island, north to the vicinity of Point Cloates, Western Australia.

ETYMOLOGY. — Named after Dr. Michèle DE SAINT LAURENT who has published extensively on pagurid systematics and who assisted in preliminary identification of this material.

#### REMARKS

*Paguristes laurentae* can be distinguished from all other described congeners by the combined character states of the short rostrum, relatively long antennular peduncles and shape and spination of the telson.

In many characters it most closely resembles *P. incomitatus* Alcock and *P. puniceus* Henderson, notably in general shape, spination and setation of the chelipeds, relative lengths of the ocular and antennular peduncles and the short rostrum (see ALCOCK, 1905 ; MIYAKE, 1978). The shape and spination of the telson, however, immediately separate *P. laurentae* from both species. From *P. puniceus* it also differs in possessing much shorter antennal flagella. Given the size of the ovigerous female paratypes, it may be that *P. laurentae* is also a smaller species than either *P. incomitatus* or *P. puniceus*.

The eggs are relatively very large and even allowing for some loss during capture and preservation, the number per female is very low (up to 17 on the paratypes). This implies some level of abbreviated development as has been definitely recorded for some species of *Paguristes* (e.g. DECHANCÉ, 1963 ; MORGAN, 1987a) and suggested for others (e.g. MORGAN, 1987a).

#### ***Paguristes kimberleyensis* sp. nov.**

(Figs 14, 15)

HOLOTYPE. — ♂, SL 3.2 mm, Fenelon Island, N.W.A., 7-8 m, sand and coral, G. J. MORGAN, 18.07.1988, WAM 89-89.

#### DESCRIPTION

Shield (fig. 14a) distinctly longer than broad. Anterior margin between rostrum and lateral projections concave ; rostrum very pronounced and rather narrow, slightly inclined ventrally, reaching beyond half length of ocular acicles and well beyond lateral projections, tipped with spinule ; lateral projections broadly triangular, tipped by distinct spine. Dorsal surface deeply punctate, especially anteriorly ; dorsolateral and lateral margins with some scattered small spines, some strongly curved anteriorly. Long plumose setae in sparse clumps, especially laterally.

Ocular peduncles longer than anterior margin of shield and about 3/4 length of shield, moderately elongate, slightly inflated distally and proximally ; several sparse clumps of long simple and lightly plumose setae dorsomesially. Corneal width approximately 1/5 length of peduncles. Ocular acicles with 3 strong terminal spines ; mesial and lateral margins strongly concave ; bearing sparse plumose setae ; acicles separated basally by almost width of one acicle.

Antennular peduncles slightly shorter than ocular peduncles ; ultimate and penultimate segments unarmed, basal segment with distoventral and 2 lateral spines ; very sparse simple setae on last 2 segments, plumose setae on basal segment.

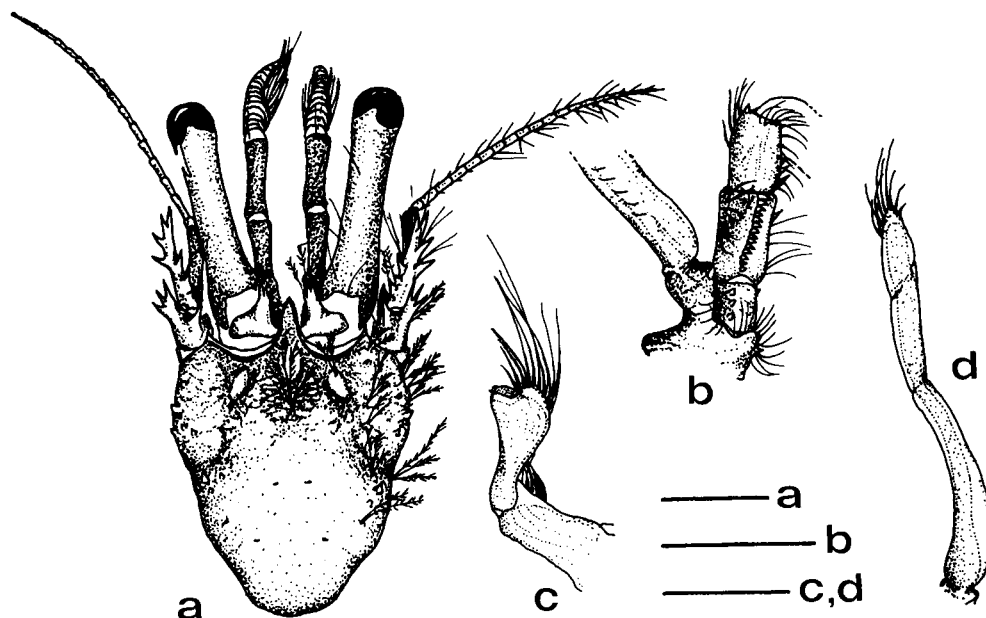


FIG. 14. — *Paguristes kimberleyensis* sp. nov. Holotype ♂. a, shield and cephalic appendages, dorsal view (setae omitted left side); b, merus, ischium and basis of left third maxilliped, mesial view; c, left first pleopod of ♂, anterolateral view; d, left second pleopod of ♂, posteroventral view. Scales = 1.0 mm (a, b), 0.5 mm (c, d).

Antennal peduncles reaching about as far as base of ultimate segment of antennular peduncles. Fifth segment unarmed; fourth with strong distodorsal spine; third with strong distoventral spine; second with 3 large lateral and 1 mesial spines; first segment unarmed except for small distoventral spine. Antennal acicles reaching close to distal end of ultimate peduncular segment, with 3 large distolateral spines, a strong terminal spine and 3-4 proximomesial spines. Setation very sparse on distal segments, heavier on second segment and acicle with long simple and plumose setae.

Third maxillipeds (fig. 14b) with merus bearing distodorsal spine and 5 strong ventrolateral spines, largest proximally; ischium with well developed crista dentata and strong distoventral spine; basis with 3 mesial spines and 1 distoventral spine; coxa with several ventral spines.

Chelipeds held with fingers moving almost horizontally; chelipeds dissimilar, left larger and more robust. Left cheliped (fig. 15a, b) with dactyl half length of propodus, cutting edge with numerous similarly sized teeth abutting those of fixed finger, leaving no gape. Dorsomesial margin with irregular row of large stout spines, largest proximally, smaller blunter tubercles adjacent to this row on dorsal surface; ventral face irregular with variously sized blunt tubercles. Propodus twice as long as broad; dorsomesial margin with row of 4 or 5 large spines; dorsal and lateral faces convex with densely arranged blunt or semi-acute tubercles, these so distributed as to give almost an imbricating appearance; tubercles extending over dorsal face of fixed finger with cutting edge of similarly sized teeth; no lateral row of spines,

tubercles more acute than dorsally and extending onto ventrolateral surface ; several sharper tubercles on dorsal surface proximally ; ventral surface of propodus with several blunt or semi-acute tubercles, 2 or 3 of these enlarged proximal to fixed finger as stout spines. Carpus about length of dactyl ; dorsomesial margin with 5 strong spines curving anteriorly ; dorsal surface with tubercles similarly arranged to those of propodus but tubercles more acute, especially dorsolaterally ; distal dorsolateral margin with several spines and acute tubercles, 1 particularly large spine near midline of carpus ; ventral face with scattered blunt tubercles. Merus slightly shorter than propodus ; dorsal margin with row of strong spines, largest distally ; ventrolateral and ventromesial margins also with rows of curved spines, along distal half of former and full length of latter ; faces of merus almost smooth except for some distolateral blunt tubercles. Dorsolateral and dorsomesial surfaces of all segments with long plumose setae, also proximally on dorsolateral face of propodus and around dorsolateral midline of carpus ; rosettes of short, stiff setae around anterior margins of tubercles on propodus and carpus and to a lesser extent on dactyl ; neither plumose setae nor rosettes obscuring pattern of tuberculation.

Right cheliped (fig. 15c) of similar length to left. Dactyl longer than half length of propodus and slightly narrower than fixed finger ; dorsomesial margin with row of curved stout spines, largest proximally ; dorsal surface with some acute tubercles adjacent to spine row, otherwise smooth ; cutting edge with numerous similarly sized teeth contacting fixed finger for entire length of dactyl ; ventral surface very convex, with some scattered blunt tubercles. Propodus more than twice as long as maximum width ; dorsomesial margin of palm with 4 very large curved spines ; dorsal face (facing anteriorly) with closely arranged semi-acute and blunt tubercles, similar to those on propodus of left cheliped, continuing less densely on fixed finger ; dorsolateral margin with row of curved spines continuing along fixed finger and diminishing in size near distal tip ; ventral surface of palm very convex, with several large blunt and semi-acute tubercles, 2 especially enlarged proximal to fixed finger. Carpus approximately  $\frac{2}{3}$  length of propodus, with dorsomesial margin bearing 5 large curved spines ; dorsal surface (held anterolaterally) with numerous tubercles similar to those of propodus but more acute, these larger and much sharper dorsolaterally and forming very irregular row ; other surfaces of carpus with irregularly distributed blunt and semi-acute tubercles. Merus of similar length to propodus, rather flattened laterally ; dorsal margin with row of curved spines, these large distally but becoming obsolete proximally ; ventrolateral and ventromesial margins with row of curved spines, along distal half of former, along full length of latter. Long plumose setae along dorsomesial and dorsolateral margins of dactyl, propodus and carpus, more sparsely on dorsal merus and ventral surfaces of propodus, carpus and merus ; also simple setae especially ventrally ; tubercles on propodus and carpus with rosettes of short stiff setae around anterior margins.

Second pereiopods (fig. 15d, e) considerably longer than left cheliped, left and right pereiopods similar. Dactyl only very weakly recurved, longer than propodus ; dorsal margin with row of strong spines, largest proximally, spines offset mesially ; ventral margin with 10 or 11 corneous spines, largest distally. Propodus about 3 times as long as broad ; dorsal margin with row of 7-8 strong spines ; ventral margin with pronounced protrusions at setal bases giving irregular outlines. Carpus  $\frac{3}{4}$  length of propodus ; dorsal margin with 5 strong spines, offset mesially, and additional strong spine at distodorsal angle. Merus as long as dactyl ; dorsal margin irregular at setal bases, these becoming small acute tubercles or spinules proximally ; sharp spine at distodorsal angle ; ventral margin with row of several curved spines.



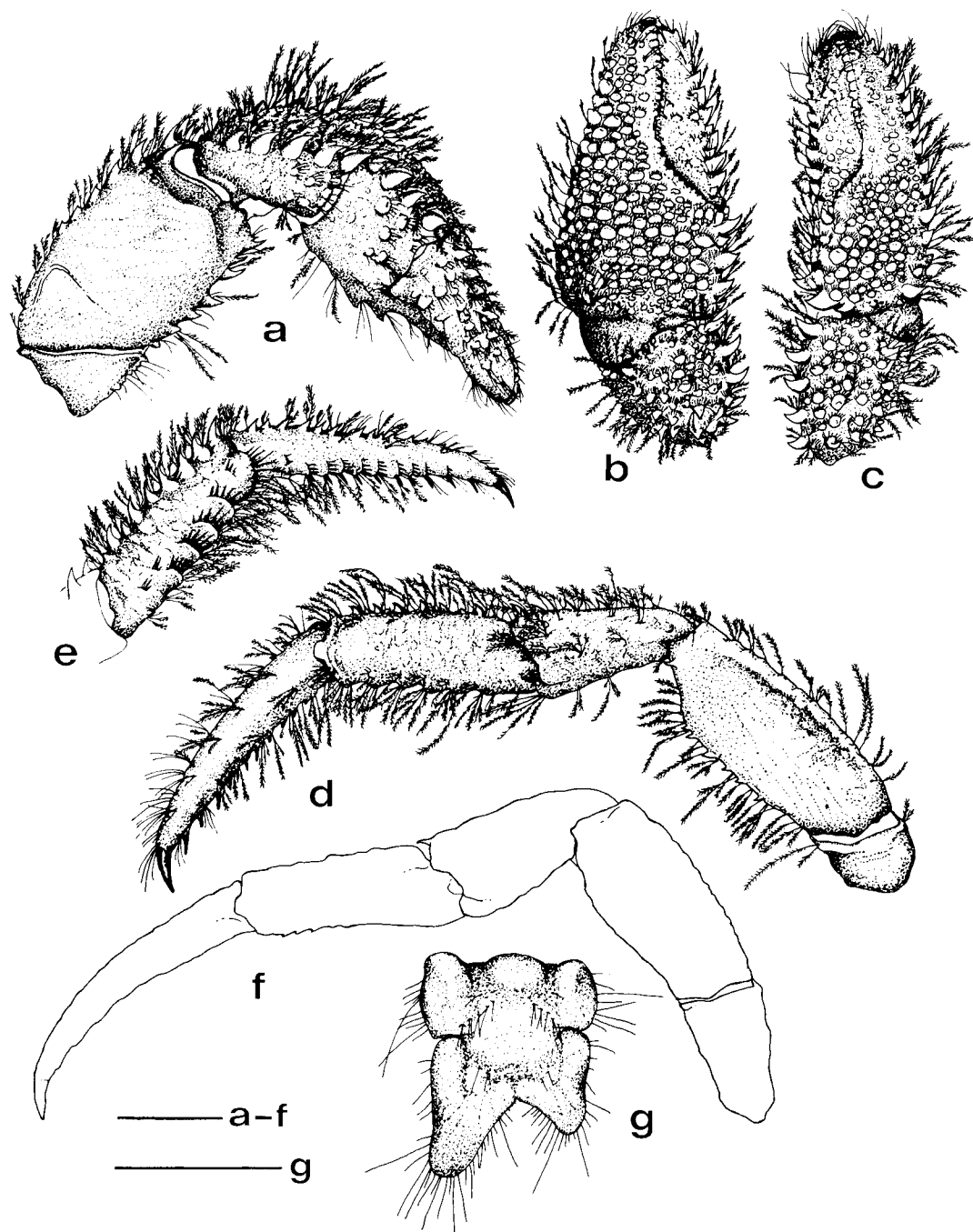


FIG. 15. — *Paguristes kimberleyensis* sp. nov. Holotype ♂. a, left cheliped, mesial view ; b, left cheliped, dorsal view ; c, right cheliped, dorsal view ; d, left second pereiopod, lateral view ; e, dactyl and propodus of left second pereiopod, mesial view ; f, left third pereiopod, lateral view ; g, telson, dorsal view. Scales = 1.0 mm.

All segments with long plumose setae along dorsal and ventral margins ; also some long simple setae especially on dactyl ; dactyl with short ventral transverse rows of stout simple setae on mesial face ; similar rows on mesial face of propodus but these more semicircular and with mostly stout plumose setae.

Third pereopods (fig. 15f) of similar length to second. Dactyl slightly narrower and more recurved than on second ; strong dorsal spines absent, dorsal margin merely irregular at setal bases ; ventral margin with 3 distal corneous spines, those proximal to these no more than stout setae. Propodus more elongate than on second pereopod, approximately 4 times as long as broad ; dorsal and ventral margins merely irregular at setal bases. Carpus with spine at distodorsal angle, otherwise unarmed. Merus shorter than on second pereopod ; small spine at distodorsal angle, otherwise unarmed. Setation of third pereopods similar to that of second.

Male holotype with paired gonopores and paired first and second pleopods (fig. 14c, d).

Tailfan very asymmetrical, left uropods much larger than right. Telson (fig. 15g) longer than broad, with left posterior lobe larger than right, both subtriangular with shallow lateral indentations ; lobes unarmed, bordered by long simple setae.

*Coloration* : Specimen retains almost no pigmentation except some orange proximally on ocular peduncles and very faint orange in subdistal and subproximal patches on dactyl and mid-dorsally on propodus and carpus of second and third pereopods.

*HABITAT*. — The type specimen was collected from a shallow (7-8 m) sand and coral habitat.

*DISTRIBUTION*. — Only known from the type locality.

*ETYMOLOGY*. — Named after the Kimberley region of Western Australia from which the type specimen was collected.

#### REMARKS

Although known from only a single specimen, *P. kimberleyensis* shows a combination of characters that are quite distinctive. It resembles most closely *P. balanophilus* Alcock and *P. longirostris* Dana in the ornamentation of the chelipeds. Both these species have dense tubercles on the palm distributed in an imbricating pattern somewhat similar to that of *P. kimberleyensis*.

Examination of specimens in the MNHN revealed several differences between the present and the above two species. *P. balanophilus* can be distinguished by possessing antennal flagella longer than the thorax and a much heavier tomentum of soft setae on the chelipeds. *P. longirostris* has antennae of similar length to *P. kimberleyensis* but the tubercles on the chelae are larger and flatter giving a much more squamiform appearance. In both *P. balanophilus* and *P. longirostris* the left and right chelipeds are of similar form and spination although the left is distinctly larger than the right in the former species. In *P. kimberleyensis* the left and right chelae are quite differently armed, the left lacking a row of large spines along the dorsolateral

margin. The dactyl of the second pereopod is also considerably more spinose in *P. kimberleyensis* than in either *P. balanophilus* or *P. longirostris*.

The combination of characters pertaining to length of antennal flagella, arrangement of tubercles and setation on the chelipeds and notable dissimilarity of spination of the left and right chelipeds permit separation of *P. kimberleyensis* from its congeners. It would appear to be very similar to the '*Paguristes* sp. a' of LEWINSOHN (1969). The comparisons he made of his unnamed species with other species of *Paguristes* would apply also to *P. kimberleyensis* and his description and figures are very close to the present species. Some differences are apparent but their significance is uncertain. LEWINSOHN's species has bispinose ocular acicles and the shield is relatively broader than in *P. kimberleyensis*. Although the left cheliped was noted as larger than the right, only one (the right) is illustrated and it might be assumed therefore that the chelae are similar in appearance. This markedly differs from the condition in the holotype of *P. kimberleyensis*.

There is also a single female specimen (SL 3.3 mm) of *Paguristes* recently collected from the Kimberley region at Long Reef, in 15 m of water (WAM 90-89). Although similar to *P. kimberleyensis* it differs in having simple ocular acicles, a shorter broader rostrum and the left and right cheliped similar in shape and spination. It is unlikely that these differences represent only sexual dimorphism and the specific status of the female is uncertain.

#### Acknowledgements

This study could be carried through thanks to the invitation for one of us (G. J. M.) by the Muséum national d'Histoire naturelle, Paris, on proposal of Prof. Y. COINEAU, Director of the Laboratoire de Zoologie (Arthropodes). We do express our gratitude to him, and also to the staff of the laboratory, for their assistance and kindness. The first author, as a guest, wishes to thank in particular the scientists whose friendly welcome and advices contributed to his pleasant and fruitful stay in Paris : M. DE SAINT LAURENT who collaborated to the preliminary identification of the Western Australian Pagurids, and D. GUINOT, both from the Museum, A. CROSNIER, from ORSTOM, and Kasim M. MOOSA, from the Centre for Oceanological Research and Development, Jakarta. Ms S. J. HARDER gave us, at the end, a precious help in typing the manuscript.

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