

## Taxonomy and ecology of the porcellanid crab *Polyonyx cometes* Walker, 1887 (Crustacea: Decapoda), with description of a new genus

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The taxonomy of the rare porcellanid crab, *Polyonyx cometes* Walker, 1887 (Crustacea Decapoda), is reconsidered in the light of fresh material from Singapore, as well as the newly obtained first zoeal stage. *Polyonyx cometes* possesses numerous adult and larval characters which warrant the establishment of a new genus for the species. The species is confirmed as a commensal of the worm *Chaetopterus* (Annelida, Polychaeta).

KEYWORDS: Porcellanidae, *Polyonyx cometes*, Crustacea, Brachyura, taxonomy, ecology.

### Introduction

The porcellanid genus *Polyonyx* Stimpson, 1858, contains 14 species from the Indo-West Pacific (Johnson, 1958, 1970; Haig, 1965; Sankolli, 1965; Ng and Sasekumar, in press; J. Haig, personal communication), and most are known or presumed commensals on sponges, worms and bivalves. One of the rarest and least-known species is *Polyonyx cometes* Walker, 1887.

This study of *Polyonyx cometes* is based on a detailed re-examination of two individuals recorded by Johnson (1967), a recently dredged individual, and examination of the first zoeal stage which were obtained from an ovigerous female reared in the laboratory. On the basis of the numerous distinguishing adult and larval characters of the species, a new genus is proposed for *Polyonyx cometes*. Notes on its ecology and behaviour are also provided. All measurements, in millimetres, are of the carapace width and length, respectively. The material is deposited in the Zoological Reference Collection (ZRC) of the Department of Zoology, National University of Singapore.

### Description

#### Family PORCELLANIDAE

#### *Eulenia* gen. nov.

*Type species.* *Polyonyx cometes* Walker, 1887, by present designation.

*Diagnosis.* Carapace ovoid (Figs 1 and 2A, G); frontal region produced forwards (Fig. 2B); frontal and lateral parts of carapace with dense coat of long, soft setae which obscures most of the margins, setae on posterolateral margins very extensive, extending to part of the dorsal surface of branchial regions; regions well defined by grooves; lateral and frontal margins appear subcristate, with very low submarginal crest on

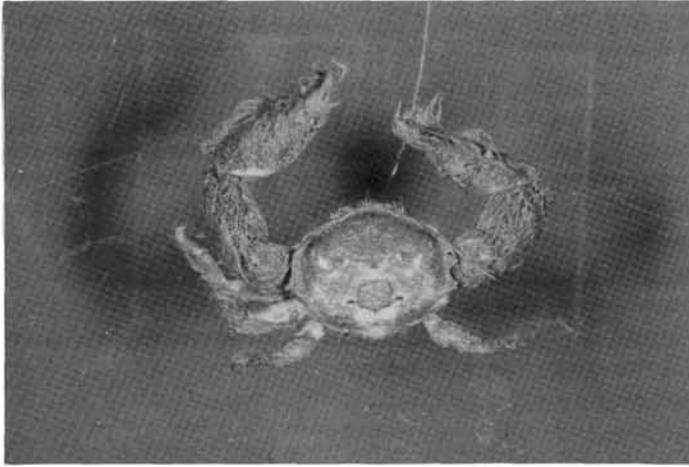


FIG. 1. *Eulenia cometes* (Walker, 1887). Female (9.0 × 7.2 mm) (ZRC 1992.10535), Pulau Semakau, Singapore.

which setae are attached; cervical and gastric grooves deep; frontal margin sharply deflexed downwards, appears almost straight from dorsal view (sometimes faintly trilobate); anterolateral margin entire, with broad and very shallow indentation at beginning of cervical groove. Chelipeds with dense coat of long, soft setae on outer surfaces, margins of palm, fingers, merus and carpus which entirely obscure the outline of the structure; outer surfaces and margins of palm, merus, carpus and fingers of larger cheliped smooth; outer surface of dactylus of smaller cheliped with submarginal row of granules which resembles stridulatory ridge (Fig. 3E, F); uncalcified articular cuticle between carpus, merus and propodus very large, forming a distinct triangular patch on the inner surface of the carpus on each side. Merus of ambulatory legs broad, short, margins without spines or teeth; outer surfaces and margins of merus, carpus and propodus densely covered with long, soft setae; dactylus (Fig. 4A–I) very short, strongly hooked, with one largely strongly curved main spine, one immovable minor dorsal spine, ventral margin with one or two small teeth (sometimes absent); ventral margin of propodus with two distal, one subdistal, and one median spine (sometimes absent).

*Remarks.* Johnson's partial revision (1958) of *Polyonyx* is still one of the main references to the genus. He recognized three groups for the 14 Indo-West Pacific species studied: the *P. denticulatus*, *P. biunguiculatus* and *P. sinensis* groups. However, Johnson did not recognize any of these groups as genera or subgenera. Nakasone and Miyake (1969) established a new genus *Aliaporcellana* for species which encompass most of the species in Johnson's *P. denticulatus* group (1958). Haig (1978) redefined *Aliaporcellana* only for species corresponding to Johnson's *P. denticulatus* group, with the addition of *A. kikuchii* Nakasone and Miyake, 1969. Possibly the *P. biunguiculatus* and *P. sinensis* groups (partim) should also be recognized as separate genera, each of the groups possessing several distinctive characters. We do not attempt such a revision here, since we do not have access to Atlantic and East Pacific species or to all of those from the Indo-West Pacific. The genus *Polyonyx* s. str. was established with *Porcellana macrocheles* Gibbes, 1850, as type species (Stimpson, 1858: (229). Haig (1956: 28) showed that *Porcellana macrocheles* Gibbes, 1850, was a junior homonym of *Porcellana macrocheles* Poëppig, 1836, and provided the replacement name, *P. gibbesi*.

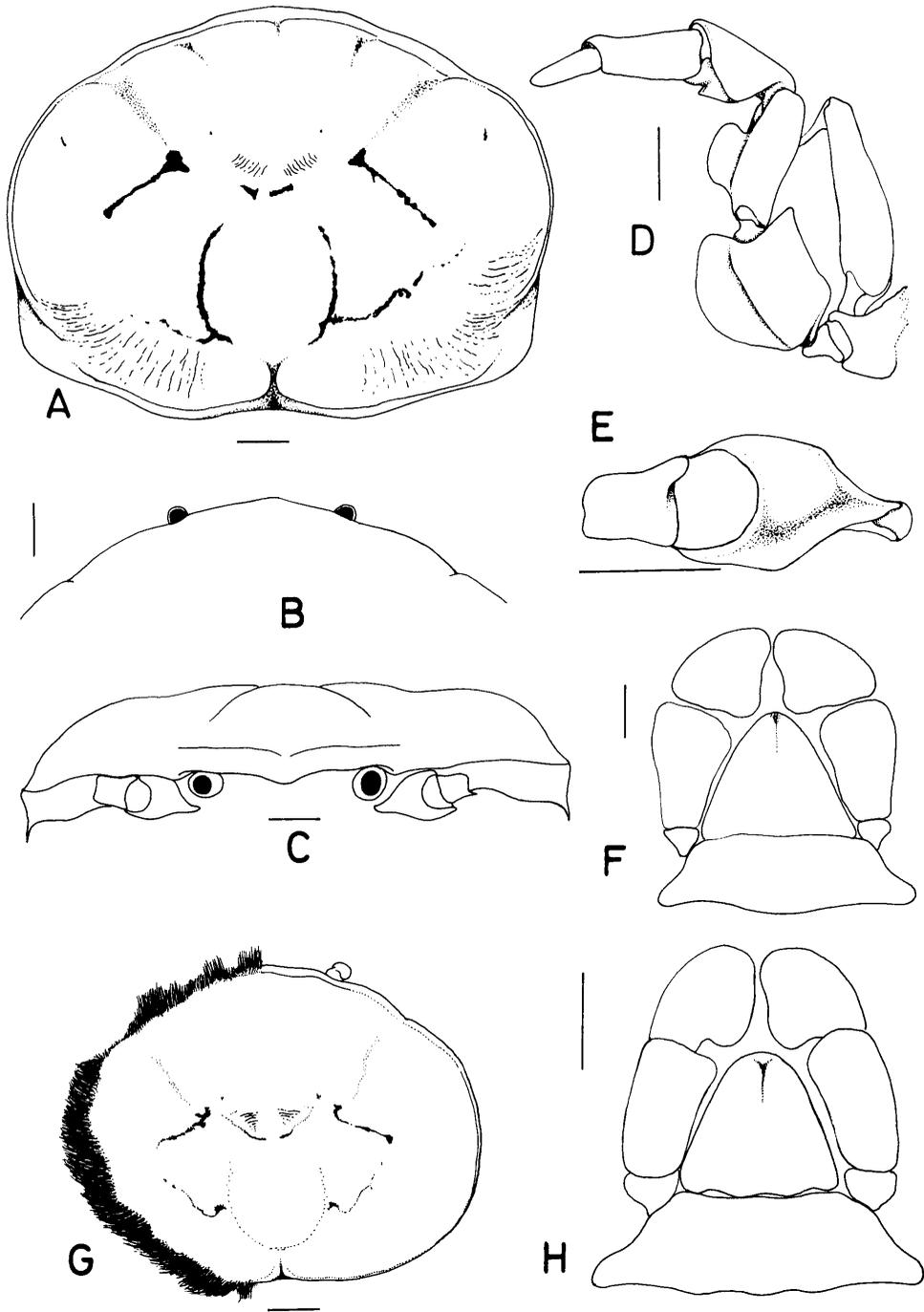


FIG. 2. *Euleniaios cometes* (Walker, 1887). A–F, female (11.2 × 8.2 mm) (ZRC 1992.10534); G, H, male (8.4 × 6.5 mm) (ZRC 1992. 10533); Changi Point, Singapore. A, Dorsal view of carapace (setae denuded); B, frontal margin (carapace slightly tilted posteriorly) (setae denuded); C, frontal view of carapace (setae denuded); D, left third maxilliped (setae denuded); E, right basal antennal segment; F, H, telson (setae denuded); G, dorsal view of carapace (carapace slightly tilted backwards, right part of frontal margin and right anterior part of anterolateral margin denuded). Scales = 1.0 mm.

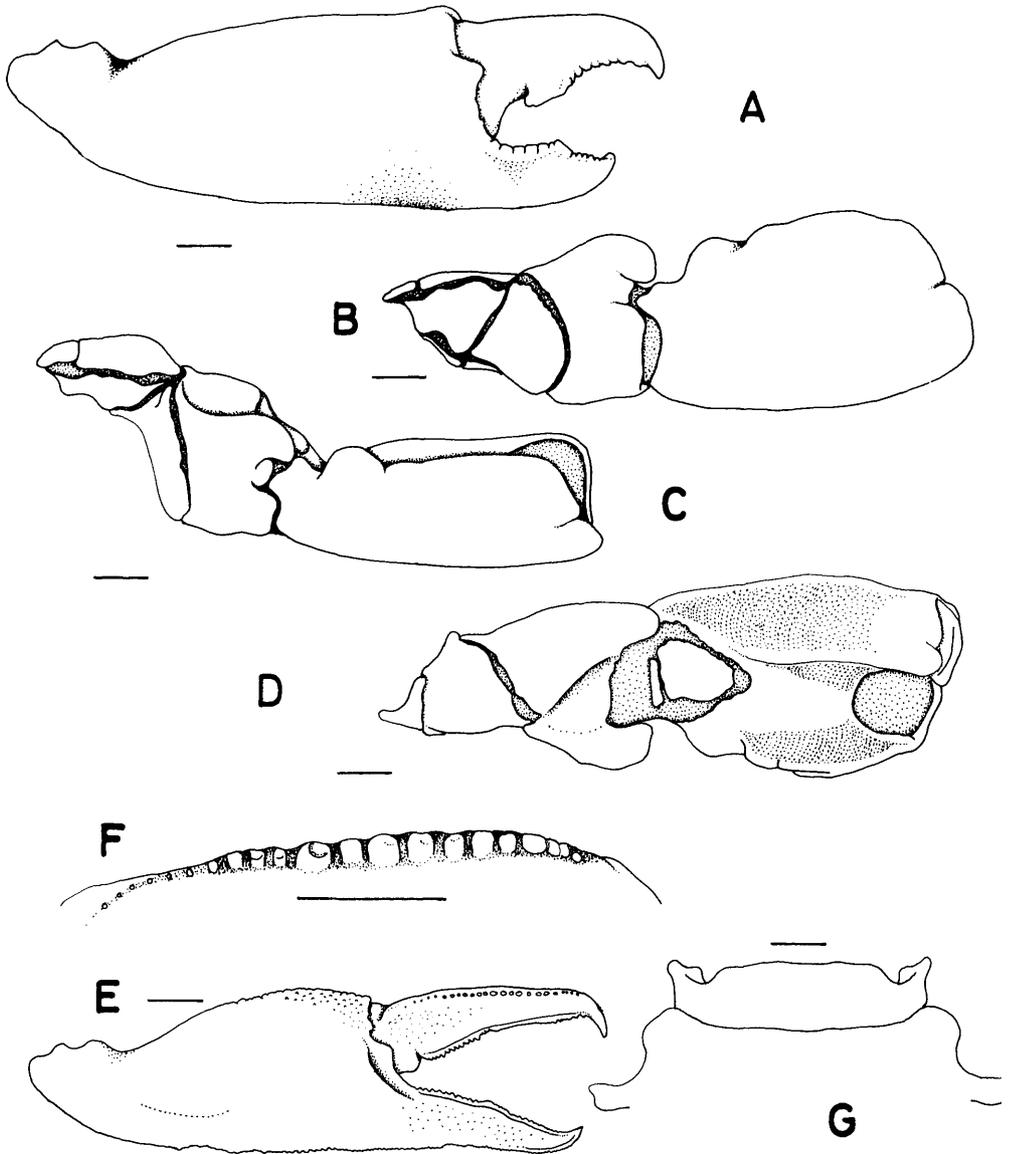


FIG. 3. *Euleniaios cometes* (Walker, 1887). A–E, chelipeds. A–E, male (8.4 × 6.5 mm) (ZRC 1992.10533); F, G, female (11.2 × 8.2 mm) (ZRC 1992.10534); Changi Point, Singapore. A, Outer surface of right (larger) chela; B, outer surface of carpus, merus and basis; C, upper marginal view of carpus, merus and basis; D, inner surface of carpus, merus and basis; E, outer surface of right (minor) chela; F, dorsal margin of dactylus, showing stridulatory-like structure; G, anterior sternal segments. Scales = 1.0 mm. (Setae denuded on all structures.)

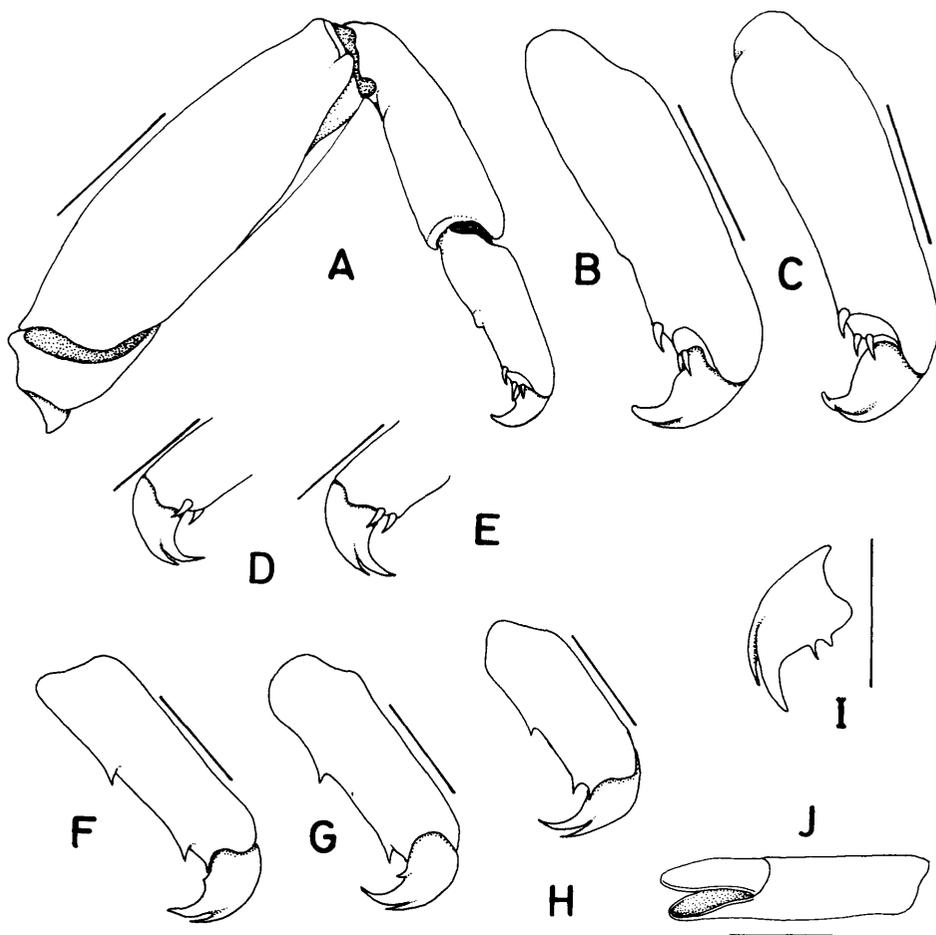


FIG. 4. *Eulenia cometes* (Walker, 1887). Ambulatory legs (outer surface views, setae denuded). A, J, male ( $8.4 \times 6.5$  mm) ZRC 1992.10533; B-E, female ( $11.2 \times 8.2$  mm) (ZRC 1992.10534); Changi Point, Singapore; F-I, female ( $9.0 \times 7.2$  mm) (ZRC 1992.10535), Pulau Semakau, Singapore. A, right first leg; B, left first propodus and dactylus; C, left third propodus and dactylus; D, right second dactylus; E, right third dactylus; F-H, first to third propodus and dactylus respectively; I, right first dactylus; J, left chela of fifth leg. Scales = 1.0 mm. (Setae denuded on all structures).

*Polyonyx cometes*, however, has so many key differences from all other congeners in *Polyonyx s.l.* (and *Aliaporcellana*) that the establishment of a separate genus for it seems warranted. Although Johnson (1958: 97) placed *P. cometes* in his '*P. sinensis*' group, he also duly noted that 'it stands rather apart from the remaining species in the extreme hairiness of the chelipeds and lateral regions of the carapace; the lack of hairs on the internal face of merus and carpus; and the better developed front' (Johnson, 1958: 115). Johnson (1967: 514) subsequently commented that although '*P. cometes* undoubtedly belongs to the *sinensis* group it is not closely related to any particular species within that group, not even to other species commensal with *Chaetopterus*. It has no close relationship with *P. sinensis* Stimpson'.

The setal pattern of *P. cometes* is perhaps the most distinctive feature of the species. The setae on the carapace are especially characteristic. Just behind the frontal,

anterolateral and anterior two-thirds of the posterolateral margins is a very faint and low ridge which marks the extent of the lateral setal covering. The seta on the posterior part extends to the dorsal surface of the carapace, covering about half of the posterior part of the branchial regions. No other *Polyonyx* species has this pattern or extent of setae on the carapace. The shape of the carapace, with the well-produced frontal and hepatic regions, also gives the species a distinctly ovoid configuration, more so than in any *Polyonyx* species which are generally more rectangular or squarish in shape. The regions in *P. cometes* are also very well defined, being clearly demarcated by the pattern of shallow and deep grooves. In contrast, the regions of *Polyonyx s.l.* are not well defined. The pattern of distinct cervical and gastric grooves also gives the species a carapace surface quite unlike any *Polyonyx*. These grooves seem to be formed by a thinning and gradual decalcification of the cuticle, and the deepest parts are almost membranous in appearance. The dactylus of the minor cheliped in both sexes possesses a very distinct row of granules adjacent to the dorsal margin (on the outer surface) which resembles a stridulatory ridge when denuded. Such a ridge of granules is not known from other *Polyonyx*. The membranous articulation (uncalcified cuticle) between the cheliped carpus, merus and propodus also seems to be more extensive in *P. cometes*. Each of the membranous articulations with the merus and propodus of *P. cometes* forms a distinctly triangular patch on the inner surface, the carpus appearing deeply cleft on each side. In the case of the carpus and merus there are two calcified plates on the membranous part. In general, *P. cometes* is also a large species, larger than any other known *Polyonyx* species, as already noted by Johnson (1958).

The first zoea of *Polyonyx cometes* are very unusual, and supports the establishment of a new genus for the species. Most striking is the form of the telson (Fig. 5I), being more proportionately elongate than that in any other known allied porcellanid first zoea, including that of two *Polyonyx* species whose larvae are known, *P. quadriungulatus* and *P. gibbesi*, fide Knight (1966) and Gore (1968), respectively. The distal part is also distinctly projected backwards to form two short sharp spines, and the two seta-like processes are present at the tips of these spines. In other porcellanid zoeae the seta-like processes are subdistal in position. Even more striking is the insertion of the setae. In *Polyonyx cometes* the setae are inserted inside the telson, with the setae projecting out from openings along the margin of the telson. In other known porcellanids the setae are inserted marginally. The other differences observed between the first zoeae of *Polyonyx cometes* and the two *Polyonyx* species are summarized in Table 1. Apart from the telson features described, other differences are believed to be significant only at the species level.

On the basis of these differences the authors propose to recognize a new genus, here named *Eulenaos*, for Walker's species. The genus is currently monotypic.

*Eulenaos* bears a very close resemblance to the genus *Raphidopus* Stimpson, 1858 (type species *Raphidopus ciliatus* Stimpson, 1858), which has three known species (Ng and Nakasone, in press). Their carapaces bear a very close resemblance in general shape, the front is trilobate, margins of the carapace (and pereopods) are densely covered with long setae, the inner margin of the ischium of the third maxilliped being auriculiform, the sub-dorso-marginal part of the cheliped dactylus bears a distinct row of granules, and the uncalcified articulatory cuticle between the cheliped carpus, merus and propodus is very extensive, forming a distinct triangular patch on each side of the carpus. *Raphidopus* differs from *Eulenaos* in that the anterolateral margin possesses a distinct cleft, and is lined with granules and/or armed with several sharp spines (cleft indistinct, margin unarmed in *Eulenaos*), outer surface of the palm is gently convex

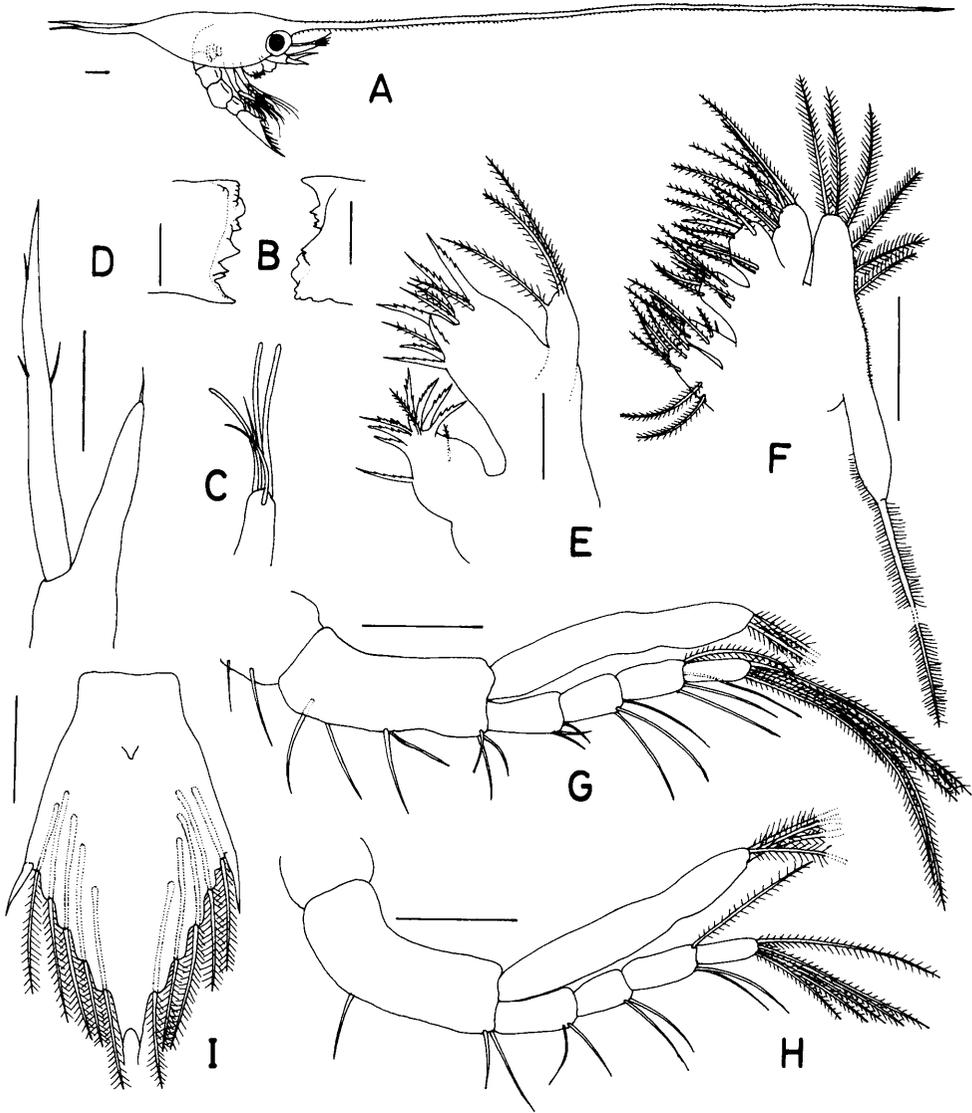


FIG. 5. *Euleniaios cometes* (Walker, 1887). First zoea. A, Lateral view of whole zoea; B, mandibles; C, antenna; D, antennule; E, maxilla; F, maxillule; G, maxilliped I; H, maxilliped II; I, telson. Scales (mm): A, D, F-H=0.1; B, C, E, I=0.05.

(almost flat in *Euleniaios*), posterior margins of the cheliped carpus and merus are not cristate (distinctly cristate in *Euleniaios*, that on the merus being well developed and partially overlapping proximal part of the cristae on the carpus in *Euleniaios*), a long and slender ambulatory dactylus, the distal part not hooked (short and hook-like in *Euleniaios*), and the shape of the anterior sternal segments (Stimpson, 1907; Miyake, 1943; Ng and Nakasone, in press). *Raphidopus ciliatus* further differs from *Euleniaios* in having the anterodorsal parts of the carapace covered with numerous short setae, the

Table 1. Differences in first zoeal morphology between *Polyonyx gibbesi*, *Polyonyx quadriungulatus* and *Euleniaios cometes*.

	<i>P. gibbesi</i>	<i>P. quadriungulatus</i>	<i>E. cometes</i>
Antennule	3 aesthetascs, 2-3 setae	3 aesthetascs, 3 setae	3 aesthetascs, 2 setae
Antenna	exopodite 2 times length of endopodite	exopodite 3 times length of endopodite	exopod 1.3 times length of endopodite
Mandible	asymmetrical, teeth simple	asymmetrical, teeth simple	asymmetrical, teeth simple
Maxillule			
endopodite	3 setae	3 setae	3 setae
coxal endite	4 spines, 6 setae	4 spines, 6 setae	6 spines, 4 setae
basal endite	6 spines, 4 setae	6 spines, 4 setae	7 spines, 2 setae
Maxilla			
endopodite	9 setae	9 setae	8 setae
coxal endite	13 processes	13 processes	13 processes
basal endite	16 processes	16 processes	16 processes
scaphognathite	1+5 setae	1+5 setae	1+6 setae
Maxilliped I			
coxopodite	2 setae	2 setae	2 setae
basipodite	1,2-3,2,3 setae	1,2,2,3 setae	1,1,2,3 setae
endopodite	3,3,3,10 setae	3,3,3,8 setae	3,3,4,6 setae
exopodite	4 natatory setae	4 natatory setae	4 natatory setae
Maxilliped II			
coxopodite	0-1 setae	no setae	no setae
basipodite	1-2,3 setae	1,2 setae	1,2 setae
endopodite	2,2,2,10 setae	2,2,2,8 setae	2,2,3,6 setae
exopodite	4 natatory setae	4 natatory setae	4 natatory setae
Pereiopods	present as buds	present as buds	present as buds
Abdomen	5 somites, each with lateral spines	5 somites, each with lateral spines	5 somites, each with lateral spines
Telson	distal median part not projecting backwards to form forked structure; 7+7 marginal processes, 2 setae on central prominence; seta-like processes submarginal	distal median part not projecting backwards to form forked structure; 7+7 marginal processes, 2 setae on central prominence; seta-like processes submarginal	distal median part distinctly projected backwards, forming forked structures; 6+6 marginal processes, no setae on dorsal surface; seta-like processes distal, on tips of spines on forked structure

Data on *P. gibbesi* from Gore (1968), *P. quadriungulatus* from Knight (1966) and *E. cometes* (present study).

entire dorsal surface appearing pileiferous (anterodorsal parts glabrous in *Euleniaios*), and the anterior margin of the carpus bearing a row of sharp spines (smooth in *Euleniaios*).

*Etymology.* The name is derived from the Greek 'eules' for worm and 'naio' for inhabitant, alluding to the type species' habit of dwelling commensally with *Chaetopterus* worms. Gender is masculine.

***Euleniaios cometes* (Walker, 1887) comb. nov.**  
(Figs 1–4)

*Polyonyx cometes* Walker, 1887: 116, pl. 9, figs 1–3; Johnson, 1958: 114; Johnson, 1963: 285, 288; Johnson, 1967: 511, pl. 1; Johnson, 1970: 36, fig. 4.  
*Porcellana (Polyonyx) euphrosyne* De Man, 1888: 221, pl. 15, figs 1–3.

*Material examined.* One male 8.4 × 6.5 mm, 1 female, 11.2 × 8.2 mm, ZRC 1992.10533, 10534, in *Chaetopterus* tube, 6 m, soft mud, off Changi Point, Singapore, leg. R. U. Gooding, 1 March 1966. One ex-ovigerous female, 9.0 × 7.2 mm, ZRC 1992.10535, in polychaete (probably *Chaetopterus*) tube, muddy substratum, c. 20 m depth, off Pulau Semakau, Singapore, leg. P. K. L. Ng and T. H. T. Tan, 27 October 1992. 100 first zoeae, ZRC 1992.10536, hatched from female (ZRC 1992.10535).

*Description of adult.* Carapace ovoid (Fig. 2A, G), domed, unevenly convex laterally and longitudinally (Fig. 2C), surfaces smooth; anterolateral and posterolateral margins strongly arcuate, not clearly separated from each other; frontal region produced forwards (Fig. 2B); posterolateral parts of carapace with dense coat of long, soft setae which obscures margins; frontal margin with setae of medium length which partially obscures margin; setae on anterolateral margin very short and rather sparse, the margin being clearly discernible; setae on posterolateral margins longer, very extensive, extending to dorsal part of branchial regions (Figs 1 and 2G); regions well defined by deep and shallow grooves (Fig. 2A); lateral and frontal margins appear subcristate, with very low submarginal crest on which setae are attached. Carapace with two short, very shallow grooves just behind orbits, cervical grooves shallow, long, reaching to edge of carapace; groove separating branchial and gastric regions deep, prominent; grooves surrounding cardiac region incomplete but deep; metagastric groove very short but deep, surface anterior of it with oblique striae. Frontal margin sharply deflexed downwards, appears almost straight from dorsal view (sometimes faintly trilobate), triangular from frontal view (Fig. 2B). Anterolateral margin entire, with broad and very shallow indentation at beginning of cervical groove, gradually curving to blend with convex posterolateral margin. Regions adjacent to posterolateral margins with low, short striae. Posterior margin of carapace with slight median cleft. Basal segment of antennae (Fig. 2E) very broad, cristate, visible from dorsal view, laterally inserted, flagellum directed forwards a short distance after the orbits. Eyes visible from dorsal view. Third maxilliped (Fig. 2D) narrow, inner margins with long stiff setae; inner margin of ischium auriculiform; merus narrow, proximal inner margin auriculiform; exopod not reaching upper edge of merus, with long flagellum.

Chelipeds (Fig. 3A–F) with dense coat of long, soft setae on outer surfaces, dorsal and ventral margins of palm and fingers, anterior and posterior margins of merus and carpus, which entirely obscure the outline of the structures. Outer surfaces and margins of palm, merus, carpus and fingers of larger cheliped smooth; lower part of

larger palm with smooth ridge. Outer and lower surfaces of merus and carpus gently convex; inner surfaces distinctly concave, appears excavated. Merus with well-developed cristate lobe on posterior margin which partially overlaps proximal crista of carpus. Posterior margin of carpus strongly cristate, proximal part with distinct auriculiform lobe, distal part of margin clefted medially. Outer surfaces of chela almost flat, inner surfaces distinctly convex. Fingers of larger chelae (Fig. 3A) with single cutting edge each, dactylus with submolariform basal tooth, remainder of cutting edge lined with denticles; pollex with broad, well-developed median triangular tooth, proximal part of the cutting edge with low blunt teeth, distal part of cutting edge with denticles; cutting edges of both fingers are laterally compressed, somewhat blade-like. Outer surfaces of smaller palm smooth on median surfaces, distal margins distinctly and finely granulated, surfaces adjacent being punctate and slightly rugose, outer surface of fingers punctate or slightly rugose, subdorsal outer margin of dactylus with row of granules which resembles stridulatory ridge. Fingers of smaller cheliped (Fig. 3E) with two cutting edges each, edges lined with numerous denticles; the two cutting edges on dactylus equal in length; outer cutting edge of pollex covers entire length of finger, inner cutting edge present only on distal part. Inner surfaces of both chelipeds very smooth, completely glabrous. Propodus of smaller chela lined with numerous denticles on lower margin; dactylus with row of submarginal granules on outer surface resembling stridulatory ridge (Fig. 3F). Uncalcified articular cuticle between carpus, merus and propodus very large, forming a distinct triangular patch on the inner surface of the carpus on each side, the lateral margins of the carpus appearing deeply clefted.

Ambulatory legs (Fig. 4A-I) short, second leg longest. Merus broad, short, margins without any spines or teeth; anterior and posterior margins (and adjacent areas) of merus, carpus and propodus densely covered with long, soft setae; outer and inner surfaces smooth, outer surface pileiferous, inner surface glabrous. Dactylus very short, strongly hooked, with one large strongly curved main spine, one minor immovable dorsal spine which is half or one-third size of main spine, ventral margin with one or two small teeth but both may sometimes be absent; no accessory spines. Ventral margin of propodus with one subdistal, one median (sometimes eroded and absent) and two distal movable, spines, the latter bracketing dactylus. Fourth leg chelate, very slender and long, normally reposing under abdomen, fingers laterally expanded, spoon-shaped, outer surfaces densely covered with long, stiff setae.

Abdomen 7-segmented (including telson) (Fig. 2F, H), broad, covering most of sternum; telson with seven elements, median plate with faint median cleft on distal margin. Male with a pair of distinct pleopods on third abdominal segment.

*Description of first zoea* (based on 10 individuals). Carapace (Fig. 5A): Typically porcellanid, carapace length *c.* 0.7 mm (without spines), with two elongate posterior spines which are about 0.6 times length of carapace, rostral spine very produced, about 4 times length of carapace; dorsal surface without setae.

Antennule (Fig. 5C): simple tapering rod with 3 aesthetascs, 2 simple setae.

Antenna (Fig. 5D): protopodite fused with endopodite, spinous process with short, simple terminal seta; elongate, tip sharp, exopodite 1.3 times length of endopodite, with 2 spinules on outer margin of distal half and one median simple seta on inner margin.

Mandibles (Fig. 5B): asymmetrical, with several large sharp, simple teeth and numerous denticles; palp absent.

Maxillule (Fig. 5E): endopodite unsegmented, with 3 plumose setae; coxal endite faintly bilobed, with 6 uniserrated spines, 4 plumose setae; basial endite with 7 uniserrate spines, 2 plumose setae.

Maxilla (Fig. 5F): endopodite unsegmented, with 8 plumose setae; proximal coxal endite with 7 processes, distal coxal endite with 6 setae; proximal basal endite with 7 processes, distal basal endite with 9 setae; scaphognathite 1 spine with 1 long apical plumose setae and 6 marginal plumose setae.

Maxilliped I (Fig. 5G): coxopodite with 2 setae; basipodite 1,1,2,3 setae (proximal to distal); endopodite 4-segmented, with 3,3,4,6 setae (proximal to distal segments); exopodite with 4 long, natatory setae.

Maxilliped II (Fig. 5H): coxopodite without setae; basipodite with 1,2 setae; endopodite 4-segmented, with 2,2,3,6 setae (proximal to distal segments); exopodite 4 long, natatory setae.

Maxilliped III: not discernible.

Pereiopods: present as buds, not protruding outside carapace.

Abdomen: 5 somites, each with distinct, sharp lateral spines, progressively larger from somites 1-5; no setae visible on dorsal surfaces.

Pleopods: absent.

Telson (Fig. 5I): elongate, about 1.8 times longer than broad; distal median part projected backwards, forming distinct forked structures which are tipped with spines, with a seta-like process on tip of each spine; lateral (first) process short, spinose; subsequent processes long, setose, 5 on each side, base of 5 + 5 long, setose processes internal, submarginal, exiting via openings on lateral margins of telson; openings for processes forming ladder-like structure; no setae on dorsal surface.

*Live colour.* The background colour of the dorsal surface of the carapace is beige-brown, although there are interspersed short, darker lateral streaks which give the animal a slightly striped appearance. The ventral surfaces are white. There are four small patches of pale blue on the carapace, two just behind the beginning of the cervical grooves, and two at the junctions between the gastric and cervical grooves. The junctions between the cardiac and intestinal grooves each have a patch of deep maroon. The intestinal regions have two large rectangular patches of white. The basal antennal segment is white. The surfaces of the cheliped are white, the fingers being brown, although the tips and cutting edges are white. The setae are light brown in colour throughout, although those on the carapace appear to be slightly darker.

*Remarks.* Walker (1887) described *Polyonyx cometes*, on the basis of one male specimen collected from somewhere in Singapore. Almost simultaneously, de Man (1888) described *Porcellana (Polyonyx) euphrosyne* from a single female from the Mergui Archipelago. Johnson (1958) argued that both species were conspecific, although he did not have specimens on hand. Johnson (1970) subsequently commented that '*P. cometes* is a very rare species which has only been collected twice, once at Singapore and once in the Mergui Archipelago' (p. 36). Johnson (1967), however, had reported two individuals obtained by Gooding from Singapore (see Material examined), and provided a detailed redescription of the species as well as corrected some ecological observations (see next section). Johnson's important 1970 paper was supposed to have been published several years earlier, but numerous problems resulted in the delayed publication of the volume containing the paper (E. R. Alfred, personal communication). As such, Johnson's paper of 1970 makes no reference to his 1967 publication.

The descriptions and figures of Walker (1887) and de Man (1888) of their specimens are so similar that there can be little doubt that both their species are conspecific. De Man's descriptions (1888) are very detailed, and confirm Johnson's contention (1958) that the Singapore specimens are almost identical with that from the Mergui

Archipelago. Although Johnson (1958: 115) reported that he could not find the types of Walker, he later (1970: 36) noted that the 'only Singapore specimen in existence is a single specimen in the dry collection of the British Museum (Natural History) [The Natural History Museum]. This bears the label 84.3 [1884.3], Singapore. Reference to the museum record books shows that the specimen was collected by Archer. It thus appears to be Walker's type specimen, which I had previously reported as being lost, though there is no entry to this effect in the museum records'. Johnson (1970: fig. 4) provided a simple sketch of Walker's type. Johnson (1967: 511, pl. 1) also discussed the type specimen, providing a photograph of the dried and pinned holotype of *P. cometes*.

The holotype male (10.0 × 8.0 mm) of *Polyonyx cometes* is in the Natural History Museum (Johnson, 1970) while the provenance of de Man's large specimen of *Porcellana euphrosyne* (13.0 × 9.5 mm) is not known. The present Singapore female (11.2 × 8.2 mm) (ZRC 1992.10534) is the largest specimen of the species known from Singapore thus far.

*Ecology.* Walker (1887) did not indicate where his specimen of *Polyonyx cometes* was collected from, or its possible host. Walker's material was obtained by Mr F. Archer from many habitats in Singapore, and included material from shallow-water dredges. For *Porcellana euphrosyne*, de Man (1888: 221) noted that 'A fine adult female specimen, without eggs, was found by Dr Anderson, living along with an Annelid in its tube. This new species is doubtless closely related to Haswell's *P. transversa* from the eastern Australian coast; and it is a remarkable fact that this species was also found in the siphons of an *Aspergillum*, so that the affinity of these two *Porcellana* is even proved by their similar habits of life'. It was probably the latter part of de Man's statement which led Johnson (1958) to incorrectly record that de Man had obtained his specimen from *Brechites* (as *Aspergillum*) (*Bivalvia*, *Brechitidae*), as has been pointed out by Sankolli (1965). Johnson (1958, 1963, 1970) subsequently suggested that *E. cometes* is a strict commensal of the bivalve, and its rarity was because of the 'difficulty of obtaining living intact specimens of *Aspergillum*' (Johnson, 1958: 115). Johnson (1970: 36) noted that he had failed to rediscover it in association with the few living specimens of that genus which I had been able to examine. Johnson (1967) corrected this observation when he obtained specimens collected by R. U. Gooding from *Chaetopterus* tubes (see Remarks). Johnson (1967: 513) noted that the 'worm was a large one with the animal 16 cm long and the tube about 70 cm long and with a maximum diameter of about 2.5 cm. At the ends, the tube was a little over 1 cm in diameter so that the crabs could presumably leave if they wanted to'. This worm specimen has been found, and is now deposited in the ZRC (No. 1992. 10666). It is still in an excellent condition. He also made some observations on their position and behaviour in the tube, and actions when subjected to more anoxic conditions.

The present study is unable to confirm the supposed commensal relationship of *P. transversus* (Haswell, 1882) from south Australia with *Brechites* (as *Aspergillum*) (Johnson, 1958: 116). Haswell (1882: 760) recorded that the species was found by Mr Alex Morton in the siphons of an *Aspergillum* but McNeill and Ward (1930: 363) noted that 'specimens [of *P. transversa*] were taken from 'U'-shaped worm tubes, occupied by a species of the polychaet *Chaetopterus*, where they were found reclining in the inflated basal portion of their sanctuaries, at a depth of about fourteen inches from the surface of the tidal flats exposed at low tide. . . . Mr M. Ward collected a series of the species for the Australian Museum in July, 1929, from similar worm tubes occurring in the mud flats at low tide on Curtis Island in Port Curtis, Queensland. He remarked that they were found in the soft mud at the extreme low tide line, or close thereto in shallow

drains and pools. In each worm tube examined a male and female crab were present. The tubes were more than one foot deep in the mud, and owing to the fragile nature of their structure, great difficulty was experienced in digging them out'.

All the three specimens of *E. cometes* examined (including Johnson's (1967) specimens) were from the tubes of *Chaetopterus variopedatus* (Renier, 1804) (Polychaeta, Chaetopteridae). The recent female (in part of a polychaete tube, probably belonging to *Chaetopterus*) was dredged from a muddy substratum. The actual worm was not collected, but the dredge managed to tear off the upper 7 cm of the parchment-like mucus-detritus tube of the worm. The crab was obtained from inside the tube. Fortunately, there was not much material dredged up in that particular haul (no molluscs, sponges etc.), and it seems very unlikely that the specimen of *E. cometes* could have come from elsewhere.

Johnson (1963: 285) had remarked that 'porcellanids have been searched for in association with *Chaetopterus* at Singapore but so far none have been found'. This suggests that *E. cometes* is either rare, or inhabits the tubes of worms from deeper sublittoral waters which are not so easily collected. Gooding's specimen was from water about 6 m deep, although it was not recorded on the labels or by Johnson (1967) how they were collected. Gooding (*in litt.*) remarked that they were probably obtained by SCUBA-diving, and the crabs were found after the entire worm was extracted and brought back to the laboratory. The recent dredged specimen was from a depth of some 20 m.

In any event, the association of *E. cometes* with *Chaetopterus* is not at all surprising. Stimpson (1907) and Shen (1936) suggested that their species, *Polyonyx sinensis* and *P. asiaticus* respectively, were from the tubes of *Chaetopterus*, although Johnson (1958: 114) correctly noted that while 'this is reasonable, it has not been proved and is largely based on analogy with *P. machrocheles*'. Stimpson (1858: 244) in describing *P. sinensis*, had noted the habitat of his species as '*In mari Sinensi, lat. bor. 23°; e fundo conchoso-arenoso*' [translation: in Chinese seas, latitude 23°N; from inside sand mollusc]. Subsequently, Stimpson (1907: 194) commented that the 'typical species of the genus, *P. macrocheles* (Gibbes), is known to be parasitic, living in the tubes of large worms. The habits of the other two species, *P. biunguiculatus* and *sinensis*, are not certainly known, but are probably similar', and he ignored his 1858 record of *P. sinensis* from a 'sand mollusc'. Shen (1936: 283) wrote that *P. asiaticus* was 'Probably living in the tube of *Chaetopterus*'. *Polyonyx asiaticus* is now regarded as a junior subjective synonym of *P. sinensis* (Johnson, 1958: 113); while *P. macrocheles* (Gibbes, 1850) is now known as *P. gibbesi* Haig, 1956, because Gibbes' species name was preoccupied.

The available evidence thus seems to indicate that *E. cometes* is commensal with *Chaetopterus* from relatively deeper waters in Singapore. Considerably more is known about the commensal relationship between *P. gibbesi* and *Chaetopterus variopedatus* (Enders, 1905; Pearse, 1913; Caine, 1975; Gray, 1961; Williams, 1984), and it seems likely that the relationship of *E. cometes* with *Chaetopterus variopedatus* is similar. Although *P. gibbesi* has been collected free-living and not with *Chaetopterus*, this does not seem to be the case for *E. cometes*, and appears to be an even stricter obligate of the worm.

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## References

- CAINE, E. A., 1975, Feeding and masticatory structures of selected Anomura (Crustacea), *Journal of Experimental Marine Biology and Ecology*, **18**, 277-301.
- ENDERS, H. E., 1905, Notes on the commensals found in the tubes of *Chaetopterus pergamentaceus*, *American Naturalist*, **39**, 457, 37-40.
- GORE, R. H., 1968, The larval development of the commensal crab *Polyonyx gibbesi* Haig, 1956 (Crustacea: Decapoda), *Biological Bulletin*, **135**, 111-129.
- GRAY, I. E., 1961, Changes in the abundance of the commensal crabs of *Chaetopterus*, *Biological Bulletin*, **120**, 353-359.
- HAIG, J., 1956, The Galatheidea (Crustacea Anomura) of the Allan Hancock Atlantic Expedition with a review of the Porcellanidae of the western North Atlantic, *Allan Hancock Atlantic Expedition Report*, **8**, 1-44, pl. 1.
- HAIG, J., 1965, The Porcellanidae (Crustacea, Anomura) of Western Australia with descriptions of four new Australian species, *Journal of the Royal Society of Western Australia*, **48**, 4, 97-118.
- HAIG, J., 1978, Contribution toward a revision of the porcellanid genus *Porcellana* (Crustacea: Decapoda: Anomura), *Proceedings of the Biological Society of Washington*, **91**, 706-714.
- HASWELL, W. A., 1882, Description of some new species of Australian Decapoda, *Proceedings of the Linnaean Society of New South Wales*, **6**, 750-763.
- JOHNSON, D. S., 1958, The Indo-West Pacific species of the genus *Polyonyx* (Crustacea, Decapoda, Porcellanidae), *Annals of Zoology, AGRA*, **2**, 8, 95-118.
- JOHNSON, D. S., 1963, Commensalism and semi-parasitism amongst decapod Crustacea in Singapore waters, in *Proceedings of the First Regional Symposium on Scientific Knowledge of Tropical Parasites*, 1962, UNESCO (University of Singapore, Singapore: UNESCO), pp. 282-288.
- JOHNSON, D. S., 1967, On some commensal decapod crustaceans from Singapore (Palaemonidae and Porcellanidae), *Journal of Zoology, London*, **153**, 499-526.
- JOHNSON, D. S., 1970, The Galatheidae (Crustacea: Decapoda) of Singapore and adjacent waters, *Bulletin of the National Museum of Singapore*, **35**, 1, 1-44.
- KNIGHT, M. D., 1966, The larval development of *Polyonyx quadriungulatus* Glassell and *Pachycheles rudis* Stimpson (Decapoda, Porcellanidae) cultured in the laboratory, *Crustaceana*, **10**, 75-97.
- MAN, J. G. DE, 1888, Report of the Podophthalmous Crustacea of the Mergui Archipelago, collected for the Trustees of the Indian Museum, Calcutta, by Dr John Anderson, F.R.S., Superintendent of the Museum, *Journal of the Linnaean Society of London, Zoology*, **22**, 1-312, pls 1-19.
- MCNEILL, F., and WARD, K., 1930, Carcinological notes. No. I, *Records of the Australian Museum*, **17**, 9, 357-383, pls 59-61.
- MIYAKE, S., 1943, Studies on the crab-shaped Anomura of Nippon and adjacent waters, *Journal of the Department of Agriculture, Kyushu Imperial University*, **7**, 3, 49-158.
- NAKASONE, Y. and MIYAKE, S., 1969, A new porcellanid crab (Anomura: Porcellanidae) from Japan (*Aliaporcellana kikuchii* gen. et sp. nov.), with description of two species of the new genus, *Publications of the Amakusa Marine Biology Laboratory*, **2**, 17-32.
- NG, P. K. L. and NAKASONE, Y., in press, On the porcellanid genera *Raphidopus* Stimpson, 1858, and *Pseudoporcellanella* Sankarankutty, 1961, with description of a new mangrove species from Singapore (Crustacea: Decapoda: Anomura), *Crustaceana*.
- † NG, P. K. L. and SASEKUMAR, A., in press, A new species of *Polyonyx* Stimpson, 1858, of the *P. sinensis* group (Crustacea: Decapoda: Anomura: Porcellanidae) commensal with a chaetopterid worm from Peninsular Malaysia, *Zoologische Mededelingen*.

- PEARSE, A. S., 1913, On the habits of the crustaceans found in *Chaetopterus* tubes at Woods Hole, *Biological Bulletin*, **24**, 2, 102-114.
- SANKOLLI, K. N., 1965, On a new species of commensal porcellanid crab, *Polyonyx loimicola* sp. nov., from India: (Crustacea, Anomura, Porcellanidae), *Journal of the Bombay Natural History Society*, **62**, 2, 285-291, pls I and II.
- SHEN, C. J., 1936, Notes on the genus *Polyonyx* (Porcellanidae) with description of a new species, *Bulletin of the Fan Memorial Institute of Biology (Zoology)*, **6** (6), 275-287.
- STIMPSON, W., 1858, Prodrumus descriptionis animalium evertibratorum quoe in Expeditione ad Oceanum Pacificum eptentrionalem a Republica Federata Missa, Cadwaladaro Ringgold et Johann Rodgers Ducibus, observavit et descripsit—Part VII, Crustacea Anomura, *Proceedings of the Academy of Natural Sciences, Philadelphia*, **10**, 225-252.
- STIMPSON, W., 1907, Report on the Crustacea (Brachyura and Anomura) collected by the North Pacific Exploring Expedition 1853-1856, *Smithsonian Miscellaneous Collections*, part of **49**, 1717, 1-240, 26 pls.
- WALKER, A. O., 1887, Notes on a collection of Crustacea from Singapore, *Journal of the Linnean Society of London, Zoology*, **20**, 107-117.
- WILLIAMS, A. B., 1984, *Shrimps, lobsters, and crabs of the Atlantic coast of the eastern United States, Maine to Florida* (Washington, DC: Smithsonian Institution Press), 550 pp.