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THE ALPHEID SHRIMP OF AUSTRALIA

Part III: The remaining alpheids, principally the genus *Alpheus*, and the family Ogyrididae

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SUMMARY

This third part of the study, based on almost 4,600 specimens, deals principally with the genus *Alpheus* Fabricius, but also included are the species of the genera *Athanopsis*, *Prionalpheus*, *Batella*, and *Metalpheus* found in Australia. We have also included the Australian species of the closely related family Ogyrididae. Since the publication of Parts I and II, we have received on loan additional collections which have contained two species of the genus *Synalpheus* which we are describing as new, one species of the genus *Athanas* and one species of the genus *Salmoneus* which are new records for Australia; these and other additional records for the species previously reported are contained in Appendix I. Another appendix gives the tabulation of the known distribution of all species known from Australian waters and a zoogeographic summary. This publication also includes the full bibliography for the three parts and a species index.

The species discussed in this paper are listed below; those that are new species or subspecies and those that are new records to Australian waters are marked by an asterisk.

Species of the genus *Alpheus*

- **Alpheus acutocarinatus* De Man
- **Alpheus acutofemoratus* De Man
- **Alpheus alcyone* De Man
- **Alpheus amirantei sizou* Banner and Banner
- **Alpheus architectus* De Man
- **Alpheus arethusa* De Man
- **Alpheus astrinx* sp. nov.
- **Alpheus australosulcatus* sp. nov.
- **Alpheus balaenodigitus* sp. nov.
- **Alpheus barbatus* Coutière
- **Alpheus bicostatus* De Man
- Alpheus bidens* (Olivier)
- **Alpheus bisincisus* De Haan
- Alpheus brevirostris* (Olivier)
- Alpheus bucephalus* Coutière
- **Alpheus bunburius* sp. nov.
- **Alpheus chiragricus* Milne-Edwards
- Alpheus collumianus* Stimpson
- **Alpheus cristatus* Coutière
- Alpheus deuteropus* Hilgendorf
- **Alpheus diadema* Dana
- Alpheus distinguendus* De Man
- **Alpheus djiboutensis* De Man
- **Alpheus dolerus* Banner
- **Alpheus edamensis* De Man

- Alpheus edwardsii* (Audouin)
 **Alpheus ehlersii* De Man
 **Alpheus euphrosyne euphrosyne* De Man
 **Alpheus euphrosyne richardsoni* Yaldwyn
 **Alpheus eulimene* De Man
 **Alpheus facetus* De Man
Alpheus frontalis Milne-Edwards
 **Alpheus georgei* sp. nov.
 **Alpheus gracilis* Heller
Alpheus gracilipes Stimpson
 **Alpheus hailstonei* Coutière
 **Alpheus heronicus* sp. nov.
 **Alpheus hippothoe* De Man
 **Alpheus hutchingsae* sp. nov.
 **Alpheus inopinatus* Holthuis and Gottlieb
 **Alpheus labis* sp. nov.
 **Alpheus leviusculus leviusculus* Dana
 **Alpheus australiensis* sp. nov.
 **Alpheus lobidens lobidens* De Haan
Alpheus lottini Guérin
Alpheus macrodactylus Ortmann
 **Alpheus maindroni* Coutière
 **Alpheus malabaricus trefzae* subspec. nov.
Alpheus malleodigitus (Bate)
Alpheus microstylus (Bate)
Alpheus miersi Coutière
 **Alpheus mitis* Dana
 **Alpheus moretensis* sp. nov.
Alpheus novaezealandiae Miers
Alpheus obesomanus Dana
 **Alpheus ovaliceps* Coutière
Alpheus pachychirus Stimpson
Alpheus pacificus Dana
 **Alpheus papillosus* sp. nov.
Alpheus paracrinitus Miers
 **Alpheus paralcione* Coutière
 **Alpheus parasocialis* sp. nov.
 **Alpheus pareuchirus imitatrix* De Man
 **Alpheus pareuchirus pareuchirus* Coutière
Alpheus parvirostris Dana
 **Alpheus polyxo* De Man
 **Alpheus pubescens* De Man
 **Alpheus rapacida* De Man
Alpheus rapax Fabricius
 **Alpheus serenei* Tiwari
Alpheus socialis Heller
 **Alpheus splendidus* Coutière
Alpheus spongiarum Coutière
 **Alpheus staphylinus* Coutière
Alpheus stephensoni Banner and Smalley
 **Alpheus strenuus cremnus* subspec. nov.
Alpheus strenuus strenuus Dana
 **Alpheus sudara* Banner and Banner
 **Alpheus sulcatus* Kingsley
 **Alpheus tasmanicus* sp. nov.

Alpheus villosus (Olivier)

**Alpheus* sp.

Genera other than *Alpheus*

Athanas polynesia Banner and Banner

**Athansopsis australis* sp. nov.

Batella parvimanus (Bate)

**Metalpheus paragracilis* Coutière

Metalpheus rostratipes (Pocock)

**Ogyrides delli* Yaldwyn

Ogyrides mjobergi (Bals)

**Prionalpheus triarticulatus* Banner and Banner

**Salmoneus sibogae* (De Man)

**Synalpheus paralaticeps* sp. nov.

**Synalpheus tijou* sp. nov.

We have placed the following species and subspecies of *Alpheus* in synonymy:

A. bisincisus malensis Coutière 1905 (= *A. bisincisus* De Haan 1850)

A. bisincisus stylirostris Coutière 1905 (= *A. bisincisus* De Haan 1850)

A. bisincisus variabilis De Man 1909 (= *A. bisincisus* De Haan 1850)

A. braschi Boone 1931 (= *A. parvirostris* Dana 1852)

A. bullatus Barnard 1955 (= *A. architectus* De Man 1897)

A. collumianus inermis Banner 1956 (= *A. collumianus* Stimpson 1861)

A. collumianus medius Banner 1956 (= *A. collumianus* Stimpson 1861)

A. collumianus probabalis Banner 1956 (= *A. collumianus* Stimpson 1861)

A. dissodontonotus Stebbing 1915 (= *A. bidens* (Olivier) 1811)

A. eurydactylus De Man 1920 (= *A. euphrosyne euphrosyne* De Man 1897)

A. gracilis alluaudi Coutière 1905 (= *A. gracilis* Heller 1861)

A. gracilis luciparensis De Man 1911 (= *A. gracilis* Heller 1861)

A. gracilis simplex Banner 1953 (= *A. gracilis* Heller 1861)

A. hailstonei assimulans De Man 1908 (= *A. hailstonei* Coutière 1905a)

A. hailstonei laetabilis De Man, 1908 (= *A. hailstonei* Coutière 1905a)

A. hailstonei paucispinata Banner 1953 (= *A. hailstonei* Coutière 1905a)

A. luciae Barnard 1946 (= *A. sulcatus* Kingsley 1878)

A. macrochirus Richters 1880 (= *A. sulcatus* Kingsley 1878)

A. malhaensis Coutière 1908 (= *A. collumianus* Stimpson 1861)

A. pareuchirus leucothea De Man 1909 (= *A. pareuchirus pareuchirus* Coutière 1905)

A. pomatoceros Banner and Banner 1966b (= *A. splendidus* Coutière 1897a)

A. praedator De Man 1908 (= *A. bidens* (Olivier) 1811)

A. sp. Forest and Guinot 1958 (= *A. inopinatus* Holthuis and Gottlieb 1958)

Crangon bucephalus var. Rathbun 1914 (= *A. bucephalus* Coutière 1905a)

We have reduced *Alpheus richardsoni* Yaldwyn 1971 and *A. langi* (Schmitt) 1926 to subspecific rank, creating new combinations *A. euphrosyne richardsoni* and *A. euphrosyne langi*. We have also reduced *A. bouvieri* Milne-Edwards 1880 to *A. leviusculus bouvieri*, and have raised *A. bouvieri hululensis* Coutière 1905a to specific rank as *A. hululensis*.

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INTRODUCTION

This, the third portion of our tripartite work on the family Alpheidae in Australian waters, was originally planned to contain only the genus *Alpheus*, but new specimens have required us to include the genera *Athanopsis*, *Prionalpheus* and *Metalpheus*; we also discovered that we forgot to include *Batella* in Part I, and have chosen to include records of two species of the related family, *Ogyrididae*. In the years since Parts I and II were written (dates of submission 1971 and 1974) new species and new records which extend the ranges of previously reported genera have been sent to us; these will be placed in Appendix I. The new collection records, recorded by our alphameric system and listed up to 1971 in the Appendix of Part I, are given in Appendix II. In Appendix III we have given the current names for those species previously reported from Australia in the literature under other generic or specific names. In Appendix IV we have given a zoogeographic summary for all Australian species. Finally in Appendix V we list the *errata* we have been able to detect in the first two parts. This final part also carries the bibliography and an index for all three parts of the study. As in Part II (p. 271) we have continued to mark unpublished distributional records with an asterisk — however, some of these will have been published by the time this paper appears.

Inasmuch as this part contains the bibliography, we have shortened our references form under synonymy to the author, date, page and relevant figures; the full reference may be found in the bibliography. Also in an effort to save printing space, we have abbreviated references except under synonymy to our own works to *B* and *B&B*; for this we ask the reader's indulgence.

In this paper, as in the parts previously published, the lengths given are total body lengths from the tip of the rostrum to the tip of the telson with the specimen laid as

straight as possible, unless "carapace length" is specified. On appendages, the lengths are from articular surfaces to articular surfaces (where the articulation is diagonal, as on the merus of the chelipeds, the maximum length at the articulation is used); the widths are measured at the maximum width, but excluding the width with any teeth or other projections. Further, in our usage spines and setae (or, at times, hairs) are articulated at their bases, while teeth, knobs and bosses are inarticulated projections of the exoskeleton.

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During 1975 the following museums graciously allowed us space in their institutions and aided us in the examination of their collections for this and related studies: the British Museum (Natural History), London, England; the Indian Museum, Calcutta, India; the Invertebrate Reference Museum, Karachi, Pakistan; the Muséum National d'Histoire Naturelle, Paris, France; the National Museum of Kenya, Nairobi, Kenya; the Rijksmuseum van Natuurlijke Historie, Leiden, The Netherlands; the University Museum of Zoology, Cambridge, England; the Universitetets Zoologiske Museum, Copenhagen, Denmark; the Zoologisch Museum, Amsterdam, The Netherlands.

As we have added five genera listed above to the nine genera given in our 1973 key (p.298), we believe it will be helpful to provide a new key to all genera of the two families this work embraces. For the previously published sections, the references are to the part number and page.

KEY TO GENERA OF ALPHEIDAE AND OGYRIDIDAE FOUND IN AUSTRALIAN WATERS

1. Eyestalks with long slender and exposed peduncles reaching to near end of antennular peduncles.Family *Ogyrididae* (p.287).
 - Corneas of eyes exposed or covered by carapace, but if peduncle exposed, never with corneas reaching to end of first antennular article. Family *Alpheidae* 2
2. (1) Corneas of eyes fully exposed in dorsal and lateral view except for partial concealment by anterior teeth of carapace 3
 - Corneas of eyes concealed in dorsal view and partially to completely concealed in lateral view by anterior extension of carapace 5
3. (2) Corneas and peduncles exposed in dorsal view, corneas somewhat

- degenerate; rostrum vestigial.*Automate* (I:299)
- Corneas alone exposed, normally developed; rostrum well-developed, reaching beyond eyes 4
4. (3) Dactylus of large chela usually carried in lateral position; rostrum long and, in lateral view, acute.*Athanas* (I:303)
- Dactylus of large chela always carried in inferior position; rostrum short and, in lateral view, rounded.*Aretopsis* (I:330)
5. (2) Large chela carried flexed with merus expanded and excavated to accommodate it 6
- Large chela carried extended, not folding back into an excavated merus. 7
6. (5) Rostrum with a ventral vertical keel; tip of telson rounded. *Athanopsis* (p. 9)
- Rostrum may carry dorsal carina but never a ventral keel; tip of telson notched*Salmoneus* (I:334)
7. (5) Fingers of large chela with serrations or teeth, never with a plunger and socket. 8
- Fingers of large chela without serrations or teeth, with a strong plunger on dactylus that fits into socket on base of propodal finger (in a few species the device is reduced to a heavy crest and a propodal groove, or absent) 11
8. (7) Rostrum completely lacking and extended front of carapace rounded in dorsal view; dactylus of large chela carried in inferior position.*Betaeus* (I:347)
- Rostrum present, of various development; dactylus of large chela carried in superior or lateral position. 9
9. (8) Fingers of chelae of second legs about one-tenth length of palm and bearing dense tuft of scaley or setiferous bristles; sixth abdominal segment lacking articulated pleura*Batella* (p. 15)
- Fingers of chelae of second legs approximately equal to length of palm, without dense setae; sixth abdominal segment with articulated pleura.. 10
10. (9) Mouthparts as normal for family, mandible with molar process and palp.*Alpheopsis* (I:336)
- Mandible without molar process and palp, incisor process greatly expanded and bearing few, but strong, teeth; other mouthparts except third maxilliped modified*Prionalpheus* (p. 12)
11. (7) Body highly compressed; carapace with knife-like mid-dorsal keel for its entire length*Racilius* (I:350)
- Body not markedly compressed; if carapace bearing keel, keel not knife-like posteriorly. 12
12. (11) With pterygostomial margin usually produced; without anal tubercles; without mastigobranchs and setobranchs.*Synalpheus* (II:271)
- With pterygostomial margin rounded, never angular; usually with anal tubercles; bearing mastigobranchs and setobranchs at least on anterior thoracic legs 13
13. (12) With normal, not protuding mouthparts; third maxilliped with trigonal, not flattened, basal article; *appendix masculina* of second pleopods of male not reaching beyond end of endopod.*Alpheus* (p. 18)

- With mouthparts enlarged, with labrum protruding and enclosed by incisor process of mandible; third maxilliped with basal article expanded and flattened; *appendix masculina* of second pleopod of male reaching beyond end of endopod. *Metalpheus* (p. 280)

Genus *Athanopsis* Coutière

Athanopsis Coutière, 1897b:301; 1899:324.

Type species: *Athanopsis platyrhynchus* Coutière

DIAGNOSIS: "Rostrum very peculiar, in the form of a vertical lamella, rounded and smooth, placed edgewise ("*de champ*" — quotation Coutière's). Without supra-ocular teeth. Orbital margin with extra-corneal tooth only distinct, located superiorly and not laterally.

"Eyes nearly invisible from above, placed as in the genus *Athanas*. Stylocerite as in *Athanas*, but wide and obtuse at its tip. Scaphocerite broad, lateral spine small carapocerite large, longer than the antennal scale, distal flagella robust.

"Chelipeds very asymmetrical (at least in the male, the female being unknown) palm of the large chela inflated, carpus very short, both of these articles folding into an excavation of the merus like that of the female of *Athanas djiboutensis*.

"All the other characters are like *Athanas* and of similar size." (Coutière, 1899:324). (Translated from the French by the authors.)

DISCUSSION: In his original description of the genus, Coutière also pointed out that the carpus of the second legs was of 5 articles, the sixth abdominal pleura were articulated, that the telson was lacking anal tubercles and that the branchial formula did not include an arthrobranch on the third maxillipeds, but did include 5 pleurobranchs.

An outstanding characteristic of this genus is the development of the distal portions of the rostrum in the flat vertical, or laterally compressed, plate that hangs below the level of the carapace anterior to the eyes; the anterior margin, when seen in lateral view, is rounded. A somewhat similar condition is found in the genus *Aretopsis* De Man (1:330); the two genera can easily be distinguished by the large chelae of the males (no females with intact chelae have ever been reported for *Athanopsis*) which are carried folded against an expanded merus in this genus but carried extended, with the dactylus in an inverted position, in *Aretopsis*.

The genus was previously known only by the type species, *A. platyrhynchus*, that Coutière described on the basis of two males from Djibouti located at the head of the Gulf of Aden. These specimens were collected under a rock partially buried in sand ("*le sable*") at the low tide level. They are the only specimens ever reported.

Athanopsis australis sp. nov.

.Fig. 1

HOLOTYPE: 16 mm female from sandy sediment. 8 m. Beaumaris, Port Phillip Bay, Victoria, 23/8/71. (VM 918, see Appendix II). AM P:30808.

DIAGNOSIS: Rostrum characterized by having tip developed as a compressed dorsoventral lamella, a continuation of a dorsal carina arising between eyes and of a ventral ridge that hangs below base of rostrum. Tip acute in dorsal view, rounded in profile, and reaching beyond end of first antennular article. In dorsal view rostral triangle

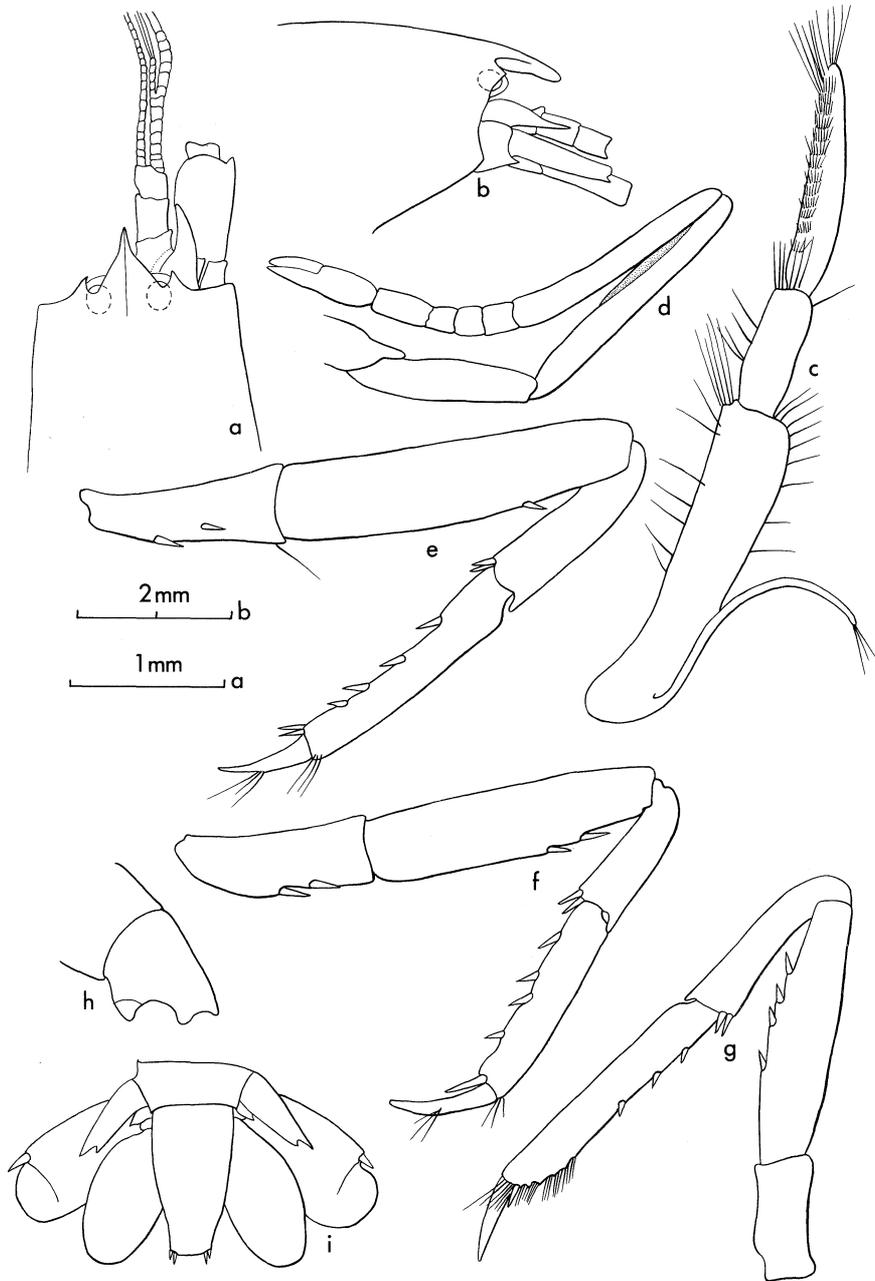


Fig. 1 *Athanopsis australis* sp. nov.

Holotype (female), **a, b**. Anterior region, dorsal and lateral view; **c**. third maxilliped, medial face; **d**. second leg; **e**. third leg; **f**. fourth leg; **g**. fifth leg; **h**. sixth abdominal segment; **i**. telson and uropods. **a, b, h, i** scale **a**; **c, d, e, f, g**. scale **b**.

almost equilateral, laterally arising from midline of eyes, but with compressed portion of rostral ridge extending beyond triangular portion; in lateral view triangular portion of rostrum is much thinner than the dorsoventral depth of lamella and joins lamella near dorsal surface. Orbital teeth small, acute, with margins more abrupt medially than laterally. Eyes with transparent portion of cornea and some of pigmented portion extending beyond anterior margin of carapace in both dorsal and lateral views.

Antennular articles short and broad, second article only slightly longer than broad and slightly longer than visible part of first; first and third article subequal. Stylocerite relatively narrow in distal portion with obtuse tip (in dorsal view), nearly reaching to end of second antennular article. Broad squame of scaphocerite reaching well beyond antennular peduncle, lateral tooth small. Carpocerite longer than scaphocerite and reaching beyond antennular peduncle by length of its third article. Basicerite bearing short subacute tooth distally.

Ratio of length of articles of third maxilliped, starting at basal article: 10:3:6. Ultimate article bearing the usual rows of setae on inner face; tip bearing a tuft of moderately long setae.

Both chelipeds are missing but bases show symmetrical development.

Ratio of carpal articles of second legs: 10:1:1:1:2; first article markedly longer than sum of four following.

Ischium of third leg 0.5 as long as merus and bearing two spines. Merus 4.2 times as long as broad, unarmed distally, but bearing at two-thirds of length an acute spine. Carpus 0.5 as long as merus, superodistal margin terminating as a subacute tooth, inferodistal margin not projected but bearing 2 short spines. Propodus 0.7 as long as merus and bearing on inferior margin 4 spines and 2 distally. Dactylus simple, 0.35 as long as propodus and bearing patch of setae on superior margin slightly distal to middle. Fourth leg similar to third but bearing 2 spines on inferior margin of merus. Ischium of fifth leg unarmed; merus with 4 spines; superodistal tooth of carpus less developed than that of third leg; propodus bearing 3 spines in proximal half and well-developed tuft of setae on distal third with tip also bearing strong spine.

Pleura of sixth abdominal segment articulated. Telson 3 times as long as broad with posterior margin broad and somewhat arcuate; dorsal surface without the usual 2 pairs of spines. Outer tooth of sympodite of uropods long, reaching almost to middle of outer branch of uropod and terminating as strong acute tooth laterally and a lesser acute tooth medially; outer branch of uropod with usual distal articulation and tooth.

DISCUSSION: While our specimen lacks the chelae, we assign it with little doubt to the genus *Athanopsis* because of the unique development of the tip of the rostrum as a distinct keel (illustrated in Coutière, 1899: figs. 17, 18). Coutière described the development of the chelae of his two males as like the development in *Athanas djiboutensis* Coutière (*op. cit.*: figs. 210, 211). We have pointed out (1960:140) that the development of the chelae in so many species of *Athanas* is correlated with both sex and maturity. Perhaps similar conditions will be found in this genus. In any case, the large chela was shown by Coutière to be heavy and carried flexed against an excavate merus.

The principal difference between *A. australis* and *A. platyrhynchus* is in the spines found on the meri of the third, fourth and fifth legs, all of which are unarmed in *A. platyrhynchus*. Other minor differences also exist: In *A. platyrhynchus* the rostral keel is deeper anteriorly than posteriorly (*op. cit.*: fig. 18) whereas in this species the keel tapers slightly towards the tip. In Coutière's species in the antennular and antennal peduncles

(*op. cit.*: fig. 135), the stylocerite is blunt and reaches only to the middle of the second antennular article and the squamous portion of the scaphocerite does not quite reach to the tip of the third antennular article, while in this species the more acute stylocerite reaches nearly to the end of the second article and the squame reaches beyond the end of the third. Coutière also described the first carpal article of the second leg as being equal to the sum of the following four, while in this species it is 1.7 times as long.

The name refers both to the existence of the species in the South Temperate Zone and to its type locality in the southernmost part of the Australian sub-continent.

The holotype will be placed in the Australian Museum.

Genus **Prionalpheus** Banner and Banner

Prionalpheus Banner and Banner, 1960b:292.

Type species: *Prionalpheus triarticulatus* Banner and Banner.

DIAGNOSIS: "General form of body, orbital hoods and appendages similar to *Alpheopsis*, but distinguished from *Alpheopsis* by the highly modified mouthparts. Mandible without palp and molar process, and with incisor process asymmetrically developed into long, sharp teeth-like processes on one side, and either somewhat similar teeth or with rounded processes on the other. First maxilla with middle lobe variously expanded, inner lobe bearing several to many strong spines, outer lobe somewhat reduced. Second maxilla reduced, with endites reduced or absent, palp present, scaphognathite reduced. First maxilliped with coxal endite probably present in all species, but joined to enlarged basal endite; endopod without articulations; exopod long and well developed, but also without articulations; epipodite reduced. Second maxilliped with endopod united with basipod, and of three or possibly four articles, with penultimate article rounded and expanded, ultimate article greatly reduced. Third maxillipeds of form normal for the family. Large chelipeds moderately heavy, symmetrical, carried extended, with simple armature on fingers, with development reminiscent of *Alpheopsis equalis* Coutière. Carpus of second leg with three to five articles. Third legs slender, with biunguiculate dactyli in all species known. Sixth abdominal segment with articulated pleura. Outer uropod with shoulder bearing a strong movable spine, and 2-5 teeth. Telson normal for the family.

"Branchial formula with 5 pleurobranchs, no arthrobranchs, and epipodites on only first and second maxilliped." (From B & B, 1971:263).

DISCUSSION: This genus, closest in most characteristics to the genus *Alpheopsis*, was separated from this genus and all others within the family by the unique development of the mouthparts. Four species have been placed in this genus to date: *P. triarticulatus* B & B, listed below and previously known only from Fiji; *P. brachytomeus* B & B known from a specimen from Fiji and one from Tahiti; *P. sulu* B & B, known from 9 specimens from the southern Philippines, and *P. fissipes* (Coutière) (previously *Alpheopsis*) known from a single specimen dredged at 50-78 fathoms in the Seychelles. The four species are separated principally on the modifications of their mouthparts and the number of articles in the carpus of the second legs; a table giving their separation is presented in our 1971 paper (B & B, 1971:263). While the first three species have been collected in shallow subtidal waters from old coral heads, nothing is known of their specific habitats nor of their living habits that would demand such strange mouthparts.

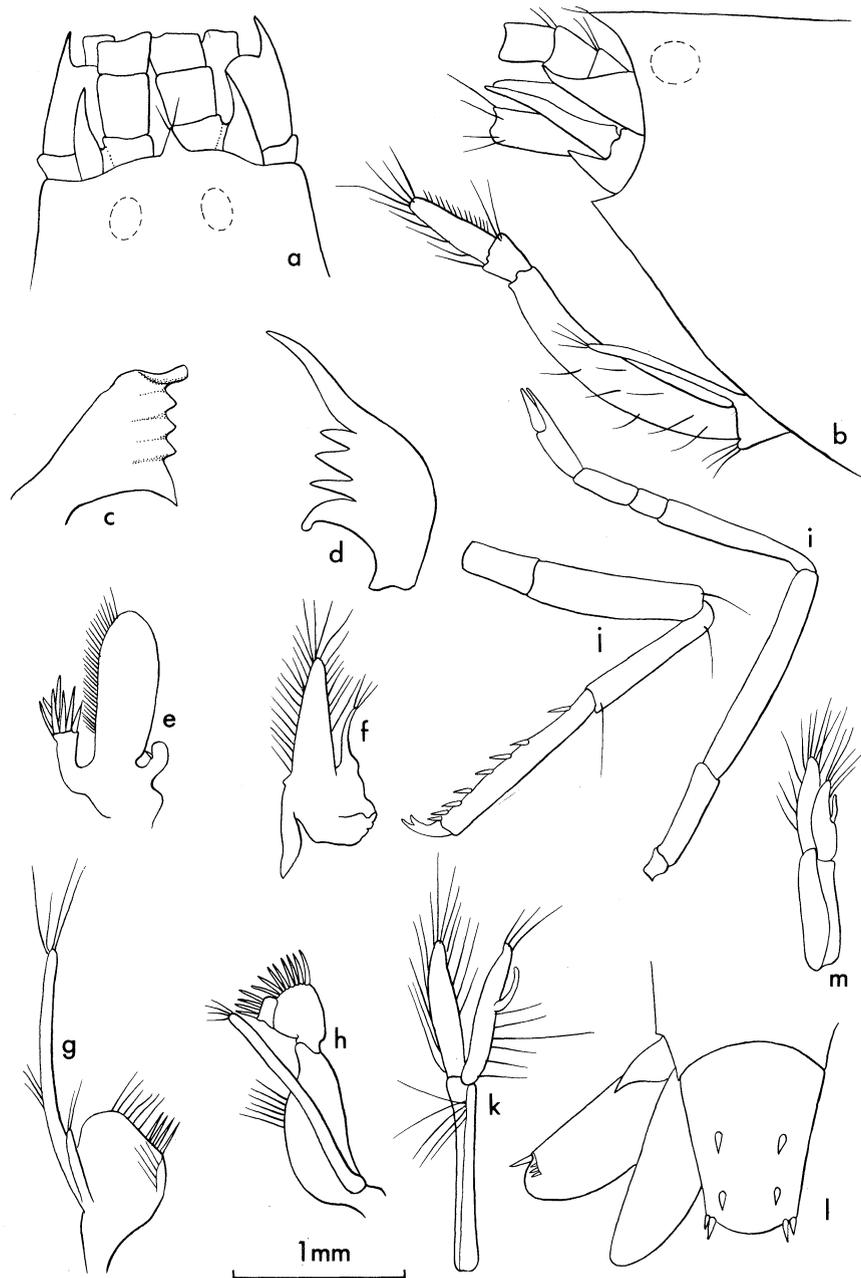


Fig. 2 *Prionalpheus triarticulatus* B&B

11 mm female from 75-LIZ 4. **a.** Anterior region, dorsal view; **b.** anterior region, lateral view with third maxilliped; **c, d.** mandibles, right and left; **e.** first maxilla; **f.** second maxilla; **g.** first maxilliped; **h.** second maxilliped; **i.** second leg; **j.** fourth leg; **k.** second pleopod of female; **l.** telson and uropods. 10 mm male from 75-LIZ 4. **m.** second pleopod of male. All figures same scale.

Prionalpheus triarticulatus Banner and Banner

Fig. 2

Prionalpheus triarticulatus Banner and Banner, 1960b:293, Fig. 1; 1971:265, Fig. 1.

SPECIMENS EXAMINED: Two specimens from 75-LIZ 4 (AM P. 28113).

DIAGNOSIS: Rostrum triangular, set off from slightly convex anterior margin of carapace, acute tip reaching to end of first antennular article, tip with two hairs usually hanging downward; without dorsal carina. Anterior carapace obscuring eyes from dorsal and lateral views and without swollen orbital hoods; without trace of ocular teeth; pterygostomial angle produced and acute.

Basal articles of antennules short and heavy, with second article broader than long; lateral tooth of stylocerite strong, with tip reaching to near end of second antennular article. Squamous portion of scaphocerite broad, reaching to end of second antennular article; lateral tooth pronounced, reaching well beyond antennular peduncles. Lateral tooth of basicerite heavy but acute, and reaching as far forward as distal end of first antennular article. Carpocerite as long as antennular peduncle. Either basal article of antennules or antenna, or sclerite at their bases on ventral side bearing a sharp acute tooth (see 1960b:Fig. 1c).

Mouthparts protrudent and conspicuous in lateral view; mandible large, expanded and flattened, curved distally. Right mandible bearing five acute teeth, posterior tooth acute, longer than middle teeth and curved (acute tip not visible in Fig. 2c; see 1960b, Fig. 1e, f); three middle teeth strong, acute and nearly equal in size. Anterior tooth of left mandible awl-shaped, almost four times length of middle teeth and fitting into almost closed groove developed by corresponding tooth of right mandible; no trace of palp or *pars molaris*. First maxilla with middle lobe greatly expanded, 2.5 times as long as broad, distally rounded and bearing a series of setae on inner margin; inner lobe short, tip truncate and bearing at its tip a cirlet of heavy setae as long as lobe. Outer lobe smaller than inner and bearing a single weak spine. Second maxilla reduced in size with total length of scaphognathite equal to length of first maxilla; endites reduced to small lobes; palp without segments and bearing only a few setae. Setiferous scaphognathite narrow with posterior lobe only two times as long as broad. First maxilliped with endite rounded, bearing a number of thin setae and four heavy setae; endopod with no apparent segmentation, bearing a few setae; exopod well-developed, epipodite partially lost in dissection. Second maxilliped apparently with only three or four articles in endopod; basal article with maximum length over twice the breadth, inner margin bearing several setae; next article distally expanded, bearing strong spines on distal margin. Ultimate article much broader than long, about half as wide as penultimate article and bearing a cluster of strong spines distally. Third maxillipeds not highly modified. Ratio of articles: 10:1.4:3.2. First article flattened, last article with a few longer setae at tip, and with medial face covered with rows of strong, short, hook-like spines.

Chelipeds lacking in both specimens. In holotype: "Ischium 0.3 length of merus; merus four times as long as broad, unarmed, bearing few scattered setae; carpus somewhat cyathiform, distally expanded to accommodate base of propodus; palm slightly shorter than fingers, 0.7 as long as broad, somewhat compressed; fingers heavy, fixed finger bearing fine serrations, dactylus with straight cutting edge, free margin armed with setiferous bristles; tips of fingers crossing." (B&B, 1960b:295). (In the related *P. sulu* B&B, chelae with bilateral symmetry and no sexual differentiation).

Carpus of second leg bearing only three articles with ratio: 10:2:4.

Third leg missing but fourth similar to third of holotype. Ischium of fourth leg inermous and 0.4 length of merus. Merus four times as long as broad, inermous. Carpus almost as long as merus, superodistal margin slightly projected, inferodistal margin rounded. Propodus a little longer than merus with six spines and a pair distally on inferior margin. Dactylus biunguiculate, inferior unguis a little shorter than superior, but nearly equal in width at base.

Second pleopods of female with long, slender protopodite, 14 times as long as broad, bearing a few long setae distally; both rami long and thin with *appendix interna* arising at about 0.6 of length of endopod and about 0.3 of that branch. Second pleopod of male shorter and heavier with protopodite three times as long as broad, *appendix interna* arising near middle of endopod; *appendix masculina* lacking.

Telson 2.2 times as long as broad distally, 1.6 times as broad proximally as distally, sides with uniform taper, tip broadly arcuate, dorsal and terminal spines small. Uropods narrow, outer uropod without distal articulation, with sub-terminal spine flanked by three smaller spines.

DISCUSSION: While the 7 mm female specimen is considerably smaller than the 10.7 mm female holotype, it and the male agree well with the Fijian specimen. The general body proportions, the proportions and armature of the appendages that were left were surprisingly the same, even to the two bristles on the tip of the rostrum, the four light spines (or heavy setae) on the inner margins of the endite of the first maxilliped, the shape and armature of the 2 ultimate articles of the second maxilliped, and the three flanking spines next to the major spine of the outer uropods. The only difference between these specimens and the holotype is in the inner lobe of the first maxilla which carried only four spines in the holotype, the terminal one being conical, almost as long as the lobe and finely setiferous, while in this specimen the lobe carries a cluster of heavy spines. While the differences in the armature of the lobe may be an indication of a specific difference that might be reflected in other parts such as the missing chela, we are loath to consider it so with both the holotype and these two specimens all being fragmentary.

The sexual differentiation of the second pleopods has not been remarked upon before. However, it may be that the lack of an *appendix masculina* in this male is a mark of sexual immaturity.

BIOLOGICAL NOTES: These specimens were collected from "solid reef rock" overgrown with algae at about 60 feet deep, which was broken up after being removed. Dr Patricia Hutchings could offer no further clues as to the shrimp's specific habitat. The holotype came from dead heads of coral found in the middle section of a fringing reef.

AUSTRALIAN DISTRIBUTION: These specimens came from off Lizard Island in the northern Great Barrier Reef.

GENERAL DISTRIBUTION: Only the holotype from Fiji was known previously.

Genus **Batella** Holthuis

Cheirothrix Bate, 1838:532 (name preoccupied)

Batella Holthuis, 1955a:92.

TYPE SPECIES: *Cheirothrix parvimanus* Bate.

DIAGNOSIS: Orbital hoods concealing eyes in dorsal and lateral but not anterior

view, with acute orbital teeth.* Median line of carapace carrying or not protuberances in the gastric region. Pterygostomial angle projecting and acute.

Antennular peduncle normal; stylocerite well-developed; outer flagellum bifurcate or simple. Basicerite with tooth; carpocerite slender; scaphocerite foliaceous with short lateral spine.

Mandible reduced, deeply bifurcate and without palp; molar process cylindrical, terminating in pyramidal projection; incisor process narrow, spatulate and densely furnished with bristles at tip. First maxilla with well-developed bilobed palp. Second maxilla with thumb-like palp and well-developed scaphognathite. First maxilliped with large oval endopod fringed with plumose setae and without articulations. Second maxilliped normal, with rudimentary epipod. Third maxilliped slender, bearing rudimentary arthrobranch and no epipod.

Large cheliped of symmetrical development (see preceding footnote) carried forward, fingers compressed with serrated teeth on proximal two-thirds of cutting surfaces. Inferior face of merus keeled.

Carpus of second leg with five articles; chela slender and tapering, about as long as carpus with fingers minute, carrying tufts of setae longer than fingers.

Posterior legs of normal form, dactyli either simple or biunguiculate; propodi armed with spines.

Abdominal pleura rounded, sixth pleura not articulated. Telson and uropods normal.

Branchial formula: five pleurobranchs, one arthrobranch, two epipodites and three exopods.

(Diagnosis adapted from Miya and Miyake, 1968b:114).

DISCUSSION: Only two specimens of this genus are known: Bate's original specimen and one reported by Miya and Miyake (1968b:116) from Japan (*B. bifurcata*); both were somewhat fragmentary but are of different species. In the examination of their specimen, Miya and Miyake discovered it lacked a palp on the mandible in addition to the unusual chelae of the second legs. Through the co-operation of Dr R. W. Ingle of the British Museum (Natural History) who re-examined the holotype, it was ascertained that the character was held in common between the two species. On the basis of their specimen and the information on Bate's, Miya and Miyake modified the generic description.

The genus is separated from all others of the family Alpheidae by the minute size of the fingers and the heavy setae on the chelae of the second legs, by a ventral keel on the merus of the chelipeds and by the lack of a mandibular palp.

Batella parvimanus (Bate)

Fig. 3a-e

Cheirothrix parvimanus Bate, 1888:533, pl.96, Fig. 2.

Batella parvimanus Holthuis, 1955a:92, Fig. 62b (after Bate).

*Dr F. A. Chace Jr of the Smithsonian Institution has kindly told us of a specimen possibly of *A. bifurcata* Miya and Miyake from the Philippines (not yet published upon). In this the orbital teeth turn somewhat upward and the eyes are fully exposed anteriorly; it also has symmetric development of the first chelipeds.

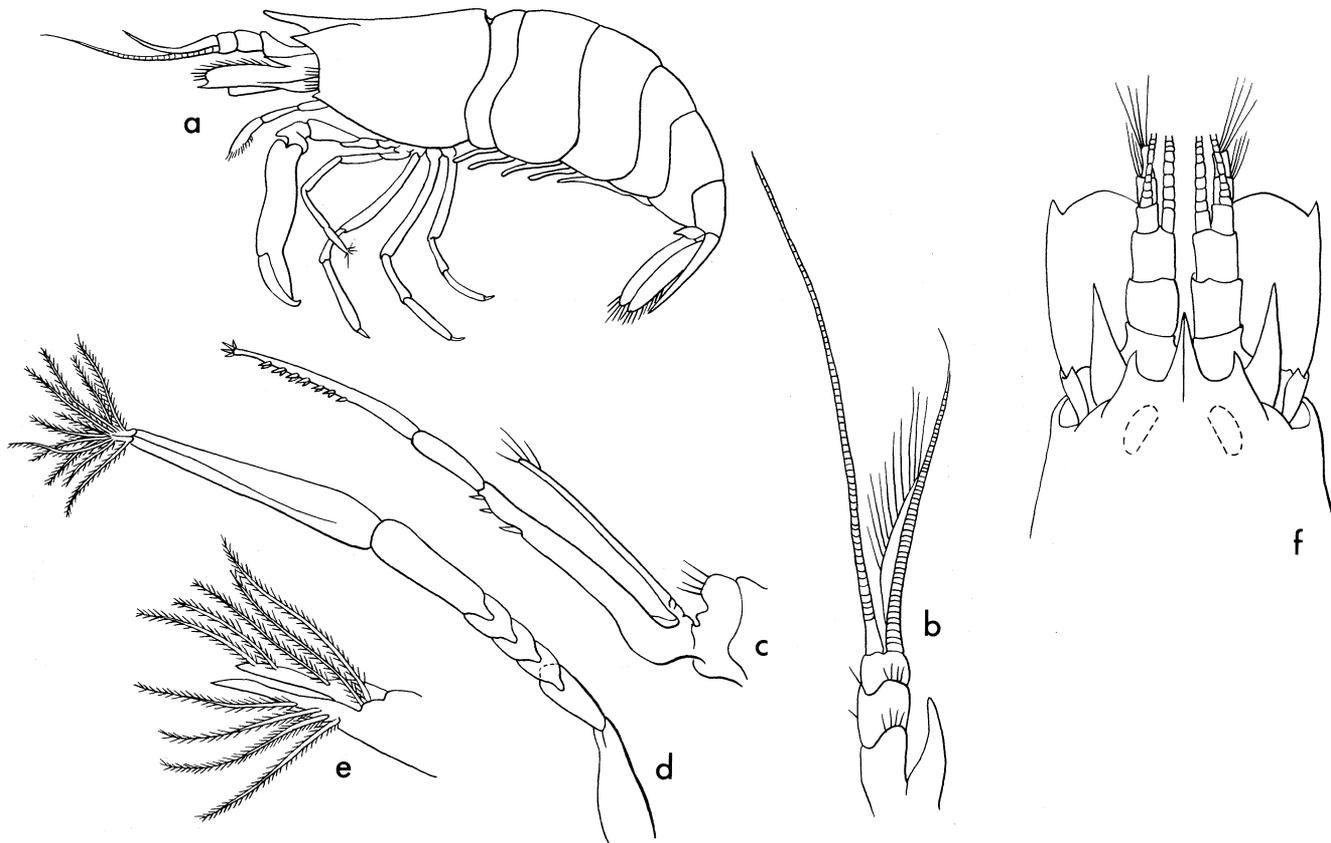


Fig. 3 *Batella parvimanus* (Bate)

a. Shrimp, lateral view; b. antennule; c. third maxilliped; d. second leg; e. distal end of second leg. (All figures after Bate) *Batella bifurcata* Miya and Miyake f. Anterior region, dorsal view. (After Miya and Miyake).

Confer: Miya and Miyake, 1968b:113.

DIAGNOSIS: Rostrum acute, reaching to end of first antennular article; acute orbital teeth nearly as long as rostrum. "Ophthalmus . . . is visible in front when viewed anteriorly." Viewed laterally, first antennular article nearly as long as second and third combined. Stylocerite acute, reaching well beyond end of first article. Outer flagellum simple, not bifurcate. Scaphocerite reaching end of antennular peduncles; squamous portion broad, lateral tooth small but acute. Carpocerite reaching to middle of third antennular article and bearing a slender flagellum about as long as entire animal. Third maxilliped with proximal article of endopod shown with strong subterminal spine and several spinules.

Only chela known slender, sub-cylindrical, five times as long as broad with fingers occupying the distal third (from plate). Fingers turned slightly inward, dactylus markedly curved at tip, overhanging propodal finger when closed. Other chela missing.

Ischium of second leg somewhat swollen in middle and tapering distally. Carpus of five articles, a little longer than merus; articles with approximate ratio of 10:6:6:6:9 (from figure). Chela is almost as long as carpus and tapers markedly distally. Dactylus and propodal finger minute, about 0.1 length of palm (from figure) and almost obscured by a distal tuft of long hairs. Bate states: "These hairs appear to be the same diameter from base to apex, but near the base and for about half their length the surface appears to consist of scales which gradually pass into minute hairs forming a closely packed fur towards the extremity."

Third leg longer and heavier than second, with no armature described or figured, merus seven times as long as broad (from plate). Dactylus simple.

Telson long, slender and tapering, similar to that of the genus *Alpheus*. Uropods are longer than telson and outer branch with articulation. (Adapted from description and figures of Bate.)

DISCUSSION: Miya and Miyake separate their species, *B. bifurcata*, on the basis of its possession of: (1) a protuberance on the carapace in the midline of the gastric region; (2) a bifurcation of the outer antennular flagellum; (3) biunguiculate dactyli on the third to fifth legs; and (4) a relatively longer rostrum and stylocerite.

Inasmuch as we had no specimen of *B. parvimanus* we are presenting a copy of Bate's original drawings (Challenger Report pl.96, Fig. 2). With the permission of Drs Miya and Miyake we are also including a dorsal view of the carapace of *B. bifurcata*.

BIOLOGICAL NOTES: Bate's specimen was 13 mm long and it was collected at eight fathoms. *B. bifurcata* was longer, 19.6 mm, and was dredged at a depth of 156 m.

AUSTRALIAN DISTRIBUTION: Bate's specimen, caught off Cape York, Qld., is the only specimen of this genus reported from Australia.

Genus *Alpheus* Fabricius

Crangon Weber, 1795:94. (Use of name suppressed; *nec Crangon* Fabricius 1798:387, 409).

Alpheus Fabricius, 1798:380, 404.

[For other synonyms see Holthuis 1955a:89]

TYPE SPECIES: *Alpheus avarus* Fabricius, 1798 [selected by Latrielle, 1810, according to Holthuis *loc. cit.*]. (See under *A. avarus*, Appendix III.)

DIAGNOSIS: Carapace continued anteriorly to form orbital hoods which completely enclose the eyes except on ventral side. Orbital hoods frequently projecting as rounded to acute teeth or ridges and usually demarked interorbitally from rostral base by shallow or marked depressions. Rostrum usually present and continued posteriorly as carina. Pterygostomial margin of carapace rounded; with cardiac notch. Orbitorostral process almost always present.

Antennules usually short, frequently with basal peduncular article and stylocerite reduced. Squame of scaphocerite at times reduced; basicerite usually bearing inferolateral tooth; carpcerite usually reaching to or beyond end of scaphocerite.

Mouthparts without enlarged labrum. *Pars incisiva* of mandible never expanded nor bearing long teeth; *pars molaris* and palp always present; subsequent mouthparts as usual for family but with distal articles of third maxilliped bearing variously bristles or spines.

Chelae of first pair always asymmetrical in form and usually in size, never carried folded against merus. Large chela of variable form in the species, from smooth and sub-cylindrical to compressed and twisted with sculpturing of palm at times deep and strong. Dactylus with "plunger", a piston-like process on opposite surface fitting into cavity on propodal pollex, usually well-developed, but at times reduced to slight confluent ridge; always with palmar and digital adhesive plaques. Large cheliped always with short, hemispherical carpus, with merus triangular in section. Small chela usually of simple form with conical fingers, but at times showing marked sexual dimorphism, at times with dactylus expanded and carrying dense setae on crests.

Carpus of second legs always with five articles of variable proportions.

Third and following legs robust, at times with merus triangular in section; armature and proportions of various articles variable; dactylus usually simple and conical, in some species biunguiculate, in others sub-spatulate. Fifth legs with "brush" distally on propodus.

Abdomen usually without lateral compression, with pleura in females larger than those of males, at times with acute projections on margins. Pleura of sixth abdominal segment not articulated. Endopod of second pleopods of males carrying an *appendix masculina* in addition to the usual *appendix interna*. Telson with posterolateral angles not projecting or acute, posterior margin arcuate and slightly projecting, neither indented nor projecting as a tooth; two pairs of dorsal spines. Anal tubercles almost always well-developed. Outer uropod almost always with distal articulation; inner uropod at times bearing short heavy spines on distal margin.

Branchial formula usually with five pleurobranchs, one arthrobranch, eight epipodites and at times a supplementary arthrobranch on third maxilliped.

DISCUSSION:

CHANGE FROM CRANGON TO ALPHEUS

For over 100 years almost all carcinologists used Fabricius' 1798 name to designate this genus (except for those who split off certain species to which they applied what are now considered to be junior synonyms, or simply misspelled the name — see Holthuis, 1955a). However, in 1904 M. J. Rathbun, the leader in carcinology in the United States,

published upon the names used in Weber's "Nomenclator entomologicus . . ." of 1795. She pointed out that both Weber and Fabricius had available to them unpublished manuscript copies of Daldorf's report on Asiatic crustaceans, and each had interpreted this manuscript in a different way. As Weber's publication had priority over that of Fabricius, she made changes in generic names in 7 cases. Concerning us here are only 2 changes in nomenclature: Weber had placed the species that Fabricius had earlier named as *Astacus malabaricus* in his new genus that he called *Crangon*. Fabricius, in his later publication, ignored Weber's work and created the genus *Alpheus* for *malabaricus* and other species, and *Crangon* for the Linnean species, *Cancer crangon*. All subsequent workers, until the Rathbun report, were either unfamiliar with Weber's work or chose to ignore it. By the principle of priority, Rathbun showed that the name *Alpheus* should be suppressed, the genus previously known as *Alpheus* should be called *Crangon*, and the commercially important genus known by the Fabrician name of *Crangon* must be given a new name, for which she chose *Crago* Lamarck.

Most Americans and some Australians followed Rathbun's lead while most Europeans ignored her changes for the next 50 years. It was the situation in which if the name *Crangon* was used in the scientific literature, one would have to know the nationality and the preferences of the author to determine if it was *Crangon*=*Alpheus* or *Crangon*=*Crago*. Finally, in 1955 the International Commission for Zoological Nomenclature, in Opinion 334, acting upon an application by L. B. Holthuis, used its plenary powers to suppress Weber's usages and to return as officially accepted the names *Alpheus* Fabricius and the family name Alpheidae. (We have not listed *Crangon* in synonymy except when a significant contribution to the knowledge of the species was made under that generic name; all citations from Australia made under *Crangon* have been listed in Appendix III.)

RELATED GENERA AND SPECIES

A number of genera were created for species once included in the genus *Alpheus*. The first major and single most important split was the creation of the genus *Synalpheus* by Bate in 1888; this genus, as redefined by Coutière (1899:334), is the second most important genus in terms of number of species within the family. It was dealt with in Part II of this study, and the characteristics for the separation of the two genera were there discussed.

Other new genera which now include members previously placed in *Alpheus*, or contain related species, are:

Pomagnathus Chace, 1937, created for a new American species, *P. corallinus* Chace;
Thunor Armstrong, 1949, created for *Alpheus rathbunae* Schmitt, an Atlantic species and once extended to include various Indo-Pacific species which were subsequently transferred back to *Alpheus* — see B&B, 1962: 162 *et seq.*
Metalpheus Coutière, 1908a, redefined by Chace, 1972 — see p. 280 for discussion.

SUBGENERIC GROUPS

Coutière (1899) divided the genus into "Groups" and later (1905a) divided one of the groups into three "Sub-Groups" which he was able to define and to which he applied the name of a characteristic species of the group, as the "Edwardsii Group". These groups were not given the name or status of subgenera, and lie beyond the International Rules of Zoological Nomenclature.

As new species that were added to the groups varied in this or that of the group

characteristic, all definitions of the groups became ambiguous. This was discussed in 1953 (B., p.47) and 1966b (B&B., p.75) — in this publication we elevated “sub-groups” to be coequal to the four original groups — and decided that while the groups could not be considered as subgenera they were of definite utility in the separation of the large number of species found within the genus. Apparently all other contemporary workers utilize these groups, some (as Crosnier and Forest, 1966) by formally dividing the species by “Group” captions, others by referring to the “Groups” in their discussions (Holthuis, 1951, Chace, 1972). We will also continue to use this aid to classification and will give a short characterization and notes before each group given below. We have followed the order of placement of the groups given by de Man. We have not been able to arrange the key so that the species within each group lie in sequence.

VARIATION IN THE GENUS *ALPHEUS*

Within this genus, as in *Synalpheus*, we find some species that are remarkably constant across the span of the Indo-Pacific realm, and others that vary markedly on the same coral reef. As with *Synalpheus*, we do not know how to handle this variability. In *A. collumianus* Stimpson for example, some 25 years ago we divided the specimens from the Marianas into three separate subspecies; in this paper we are eliminating the subspecific designations; similarly, we have found sufficient variation in *A. gracilis* Heller to believe that its three subspecies (or varieties) are not warranted. Variation is especially marked in the species in the *Obesomanus* Group that dwell as pairs in galleries under coralline algae and coral crust; fortunately with these the extent of variation can be determined by comparing the members of cohabiting pairs. On the other hand, very small characteristics in the sculpturing of the palm of the large chela such as the overhanging shoulder above the superior saddle in *A. pacificus* Dana, or its sharp prolongation in *A. chiragicus* Milne Edwards seem to be consistent throughout the entire range of the species.

Some few characteristics vary with maturity, especially the secondary sexual characteristics found in the small chela of males. Even this is not constant and recently we found we could separate *A. lobidens* de Haan into two apparently geographically separated subspecies upon whether the adult males showed the development of these sexual characteristics or not (B&B, 1975:429; see also below, p. 252). Other characteristics, especially highly modified characteristics like the hoof-shaped unguis of the third leg of *A. lottini* Guérin, may be slow in development (B, 1958:164). We are suggesting that a young rather aberrant specimen in the present collection may be the young of *A. novaezealandiae* Miers (p. 148).

With the variation that can be observed in many of the species, we have doubts as to whether some of the forms we have described below as new species or subspecies will continue to be considered as valid when greater collections are made of these and related species. We have taken the attitude that where in the related species a continuum of variation in a characteristic is seen and the differing form presents a slight to moderate extension of the continuum, it should not be described as new. On the other hand, where the extent of variation is not known in the described or related species, or where the new form shows a condition far beyond any variation previously reported, it should be described as new simply to facilitate dealing with it, as a named form, in the future literature.

NOTES ON SOME SPECIAL CHARACTERISTICS

“*Balaeniceps*” *chela*: As far as we have been able to determine, it was Coutière in

1899 who first used the word "balaeniceps" to describe the development of the small chela found in certain of the species of the genus, especially those in the Brevirostris and Edwardsii Groups. The word is obviously derived from the Latin *balaena*, the name of the baleen whales, and the Latin *caput*, head, and refers to a fringe of setae that apparently reminded Coutière of the rows of whalebone in a cetacean's mouth*. In the most extreme form, the dactylus of the small chela is broadened and somewhat excavate on the opposite face and bears a row of regularly placed stiff setae on a low ridge starting on the lateral face near the articulation and proceeding distally; towards the tip, but short of it, the setiferous crest withdraws from the margin of the fingers and crosses over the superior surface to proceed proximally to near the dactylar articulation on the medial face (see Fig. 75, e, f, g). The fringe demarks an area on the superior face that is approaching triangular. Beyond the fringe of setae the tip of the dactylus usually extends as a curved, heavy and acute tooth. This is usually a sexually dimorphic characteristic and is found in mature males, with the immature males and usually the mature females usually bearing only simple conical fingers.

Not all species, even when mature, bear this extreme condition. Instead, the completely befringed dactylus may show lesser degrees of lateral expansion down to a narrow and tapering article (*cf.* figs. 77f and 79f). To this condition we still apply the term "balaeniceps". If, however, only the medial and lateral faces of the chela bear the characteristic rows of setae, but they are not continuous over the superodistal portion, we apply the term "sub-balaeniceps" (fig. 70e). If a setiferous crest is found on only one side of the dactylus, we have not applied either term (fig. 60f). The term does not refer to a generalized setiferous condition, nor to the existence of tufts or bunches of setae (fig. 57f).

Plunger and socket of large chela: Characteristically in the genera *Racilius*, *Synalpheus*, *Alpheus* and *Metalpheus*, the dactylus of the large chela bears a somewhat cylindrical "plunger" that rests in a concavity in the fixed finger, or pollex, when closed. On the superproximal surface of the dactylus, and on the distal end of the upper palma surface, there are two "adhesive plaques", circular areas of extremely smooth chitin. The two plaques adhere when the chela is opened and, with the straining of the large muscles found in the palm, the adhesive bond is finally broken and the plunger is shot into the socket with such force as to make the characteristic clicking sound that gives the shrimp their common name, "snapping" or "pistol" shrimp. This production of sound and the use of the mechanism in the shrimp's behaviour has often been discussed in the literature (for example, Knowlton and Moulton, 1963:311, 20 figs.; Pope, 1949:326, 3 figs.; Ritzmann, 1973:459, 2 figs. According to Dr F. A. Chace Jr., judging from sketch of the chela (fig. 2a) the species discussed in Ritzman's paper "is not *Alpheus californiensis*" [personal communication].)

The characteristics of this plunger have seldom been used for specific separation within the genus. Early in our study of this genus we were struck by how the apparatus varied between species. For example, it is lacking entirely in *A. hailstonei* Coutière, and is developed as a triangular tooth without an opposing socket in the related *A. crockeri* (Armstrong). Of those that have the plunger-socket apparatus (fig. 4) there are some, like *A. pacificus* Dana that have a massive plunger, with height about half of that of maximum height of the dactylus (when seen in side view) and with its margins set off abruptly from axis of the dactylus at an angle of about 115°. In *A. lottini* the plunger is about one-third

*Dr F. A. Chace Jr. of the Smithsonian Institution has suggested in a letter to us that Coutière might not have been comparing the fringe of setae to the baleen, but rather the "triangular boss between the rows of setae on the extensor surface of a balaeniceps dactyl" to the "beak" of a whalebone whale when seen from above.

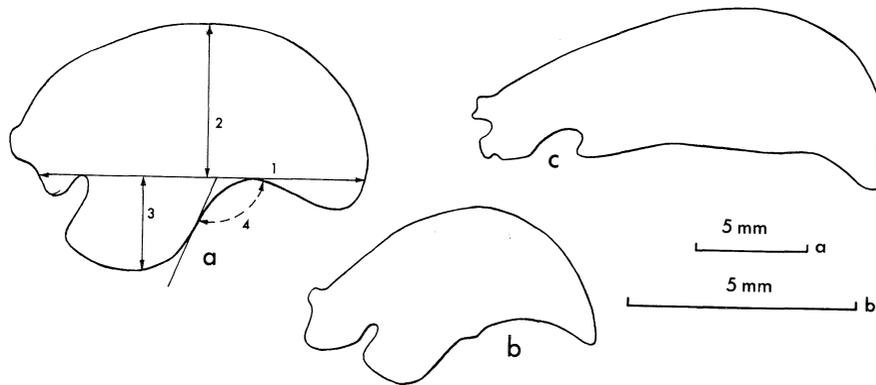


Fig. 4 Examples of dactyli of large chelae in the genus *Alpheus*
a. *A. pacificus* Dana from AM P. 13574, illustrating measurements taken: 1 axis of dactylus and total length; 2 height of dactylus; 3, height of plunger; 4, angle of plunger; **b.** *A. lottini* Guérin, from AM P. 10322; **c.** *A. distinguendus* De Man from UQ 28. c. Scale a; a, b scale b.

the height of the dactylus and the angle is about 130° . Finally, in *A. distinguendus* de Man the plunger is a low crest, usually between 0.1 and 0.2 the height of the dactylus and making an angle of about 165° to the axis of the dactylus, but with its margin gradually curving into the margin of dactylus distally (we term this condition as "confluent"). In *A. pacificus* and *A. lottini* the socket in the pollex is a definite circular hole, but in *A. distinguendus* it is an elongate groove. In all three species the proximal edge of the plunger is abrupt.

We decided to explore the validity of this characteristic for separation in the species by drawing and measuring a total of 108 specimens from *A. distinguendus* de Man, *A. chiragricus*, *A. edwardsii* (Audouin), *A. lottini*, *A. euphrosyne euphrosyne* de Man, *A. euphrosyne richardsoni* Yaldwyn and *A. pacificus* (listed in order of plunger development). We derived ratios of plunger height to dactylar height, plunger height to dactylar length and the angle of the plunger to the axis of the dactylus (fig. 4a); these ratios were studied in reference to the size and sex of the specimens.

We found that while most of the specimens were grouped there was always a spread in each characteristic; for example in 18 specimens of *A. pacificus* the ratios of plunger height to dactylar height fell between 5.0 and 5.9, but 2 were between 3.0 and 3.9. The two aberrant specimens could not be separated on size or sex differences. Regrettably we concluded that the size, shape and angle of the plunger was of systematic value only in its extremes — thus never did the condition in *A. distinguendus* overlap that of *A. pacificus*, but these were not of diagnostic value, except in a general way, between species like *A. edwardsii* and *A. lottini*. We, therefore, have had to content ourselves with the vague and unquantified description of the plunger as "low and confluent", "of moderate development" and "heavy and at a marked angle". So described, the characteristic may be of some aid.

A STUDY ON TASMANIAN ALPHEIDS

After we had completed the manuscript of this portion of the study we were asked by the University of Tasmania to be an outside reviewer for the doctoral thesis of Ms Khin U, entitled "On the biology of *Alpheus richardsoni* Yaldwyn 1971". To date the thesis, in whole or in part, has not been published, but we have Ms U's permission to cite it. She has reported four species of alpheids from Tasmanian waters: *A. richardsoni* Yaldwyn and *A. novaezealandiae* Miers, both of which we are also reporting from Tasmania (*A. richardsoni* as *A. euphrosyne richardsoni*); *A. crockeri* (Armstrong), a widespread tropical alpheid that we did not find in any of the Australian or Tasmanian collection; and a new species (to which she assigned a manuscript name). She also discussed the distribution of these four species in Tasmania. We will indicate the two species we did not find in our collections in the key only by footnote as we have not seen the specimens and the records have not been published. For *A. e. richardsoni* she has presented a detailed series of observations on its general biology based both on field notes and laboratory studies; some of these we have summarized under the subspecies (p. 239).

KEY TO THE SPECIES OF THE GENUS *ALPHEUS* IN AUSTRALIAN WATERS*

- | | | |
|--------|--|---------------------------------|
| 1. | Large chela with at most a depressed area on lower margin, never with a shoulder; where a transverse groove occurs proximal to dactylar articulation, usually the groove not U-shaped nor leading to depressed area | 2 |
| — | Large chela with definite shoulder on inferior margin proximal to base of fixed finger; superior margin bearing transverse U-shaped groove proximal to dactylar articulation that usually expands into broadened depressed areas on either face..... | 52 |
| 2. (1) | With acute teeth on anterior portions of orbital hoods or margins between hoods and rostrum..... | 3 |
| — | Neither anterior orbital hoods nor orbitorostral margins with teeth, but orbital hoods may bear anterior keels or posterior teeth | 17 |
| 3. (2) | Dactylar articulation of large chela always flanked with strong, acute tooth on lateral side, usually on medial side as well; palm always with heavy longitudinal sculpturing | 4 |
| — | Dactylar articulation of large chela without flanking acute teeth; if palm longitudinally sculptured, crests and groove not heavy | 8 |
| 4. (3) | Orbitorostral grooves short and slight, or absent..... | 5 |
| — | Orbitorostral grooves definite and extending to behind eyes | 7 |
| 5. (4) | Crest on large chela leading to medial tooth of dactylar articulation not interrupted** | <i>A. astrinx</i> (p. 35) |
| — | Crest of large chela leading to medial tooth of dactylar articulation abruptly interrupted by transverse groove | 6 |
| 6. (5) | Second antennular article 4 times as long as broad; dactylus of large chela curved and extremely compressed..... | <i>A. hailstonei</i> (p. 38) |
| — | Second antennular article about twice as long as broad; dactylus of large chela straight and moderately compressed..... | ? <i>A. staphylinus</i> (p. 41) |
| 7. (4) | Inner side of both chelae with setae so heavy as to almost obscure outlines | <i>A. deuteropus</i> (p. 42) |
| — | Inner side of both chelae with only scattered setae.... | <i>A. collumianus</i> (p. 45) |
| 8. (3) | Rostral base between eyes gradually curving into orbitorostral grooves | 9 |
| — | Rostral base between eyes abruptly set off from orbitorostral grooves, at times overhanging them..... | 14 |

* One specimen of the genus *Alpheus* has been left unnamed in this paper; A. species, possibly an immature form of *A. novaezealandiae* (see p. 148) was too incomplete to treat in this key. *A. collumianus* Stimpson varies so much in the characteristics used in dichotomy 2 that it is keyed out under both branches.

**Into this part of the dichotomy falls *A. crockeri* (Armstrong) 1941 which was reported by U from Tasmania (ms. 1977:33; see our p. 24).

9. (8) Large chela with superior surface papillose and medial face somewhat or heavily hirsute 10
 — Large chela with superior surface smooth and medial face bearing at most scattered setae 11
10. (9) Carapace densely covered with short setae; with teeth on both orbital hoods and orbitorostral margins*A. villosus* (p. 49)
 — Carapace glabrous; with teeth only on orbital hoods ...*A. architectus* (p. 55)
11. (9) Rostral carina behind eyes carrying two forward-directed teeth*A. cristatus* (p. 122)
 — Rostral carina without any trace of teeth..... 12
12. (11) Meri of both chelipeds without movable spines; orbital teeth arising from anterodorsal surface of hoods, not margins*A. splendidus* (p. 56)
 — Meri of both chelipeds armed with spines; orbital teeth arising from margin of hoods..... 13
13. (12) Large chela with slight transverse depression on superior margin; no longitudinal crest; frontal margin between orbital hoods and rostrum recessed.....*A. gracilis* (p. 60)
 — Large chela without transverse depression, with slight superior longitudinal crest; frontal margin between orbital hoods and rostrum produced into a convex prominence*A. facetus* (p. 62)
14. (8) Large chela entire, without sculpturing; dactylus of third legs with blunt, rounded tip.....*A. lottini* (p. 65)
 — Large chela with sculpturing; dactylus of third leg either simple or biunguiculate, but acute..... 15
15. (14) Large chela with only a transverse groove; dactylus of third leg simple*A. bicostatus* (p. 124)
 — Large chela with or without transverse groove, but with longitudinal grooves; dactylus of third legs biunguiculate*..... 16
16. (15) Second article of third maxilliped expanded distally into marked lobe*A. socialis* (p. 68)
 — Second article of third maxilliped only slightly expanded distally*A. parasocialis* (p. 72)
17. (2) With heavy, acute teeth flanking dactylar articulation of large chela*A. collumianus* (p. 45)
 — Without acute teeth flanking dactylar articulation of large chela 18

*Under this couplet comes *A. sp. nov.* U (ms. 1977:17; see our discussion p.24); it apparently may be distinguished from both *A. socialis* and *A. parasocialis* by the smooth rather than pustulate faces of both chelae.

THE ALPHEID SHRIMP OF AUSTRALIA

27

18. (17) Large chela rounded or at most slightly compressed in section, entire or with slight sculpturing..... 19
 — Large chela, if rounded in section, with definite grooves; otherwise, laterally compressed, with or without sculpturing..... 35
19. (18) Dactylus of large chela either tapering to tip, or heavy and rounded, but not in shape of a double-headed hammer 20
 — Dactylus of large chela in form of a rounded double-headed hammer, with depression on superior margin of palm to accommodate superior head of dactylus when flexed..... 33
20. (19) First carpal article of second legs equal in length to or longer than second 21
 — First carpal article of second legs about half as long as second article, or less..... 27
21. (20) Merus of large cheliped with heavy, acute subterminal tooth on inferior internal margin 22
 — Merus of large cheliped with or without terminal tooth on inferior margin, never with tooth located subterminally..... 23
22. (21) Fingers of small chela about twice length of palm.....*A. labis* (p. 127)
 — Fingers of small chela equal to length of palm.....*A. paracrinatus** (p. 129)
23. (21) Rostrum strong, acute..... 24
 — Rostrum absent, or very small obtuse triangle..... 26
24. (23) Frontal margin of carapace with slight flattened projection on anteromedial side of orbital hoods; superior margin of large chela with slight, ill-defined oblique depression.....*A. ehlersii* (p. 132)
 — Frontal margin of carapace not projecting; large chela without depressions 25
25. (24) Large chela about 2.3 times as long as broad; merus of third leg 3 times as long as broad; propodus of third leg bearing 10-12 spinules*A. ovaliceps* (p. 98)
 — Large chela about 3 times as long as broad; merus of third leg 5 times as long as broad, propodus of third leg bearing 6 spinules.....*A. mitis* (p. 134)
26. (23) Anterior margin of carapace extending beyond orbital hoods as rounded, shelf-like projection, without rostrum; merus of third leg without tooth.....*A. frontalis* (p. 99)
 — Anterior margin of carapace not extending beyond orbital hoods, bearing a minute rostrum in form of obtuse triangle; merus of third leg with acute tooth.....*A. pachychirus* (p. 102)

* Elsewhere in the Indo-Pacific this species is variable in many characteristics including those given in dichotomies 20 and 21.

27. (20) Anterior margin of carapace projecting beyond orbital hoods; palm of small chela somewhat bulbous..... 28
 — Anterior margin of carapace (except for rostrum) not projecting beyond orbital hoods; palm of small chela not bulbous and with at most a slight taper..... 29
28. (27) Interorbital carina a high crest; sixth abdominal tergum bearing a pair of teeth at margins of articulation of telson*A. eulimene* (p. 105)
 — Interorbital carina low; tergum of sixth abdominal segment bearing 3 teeth overhanging anterior part of telson*A. arethusa* (p. 110)
29. (27) Orbital hoods anteriorly with vertical keel; orbitorostral grooves deep and well defined.....*A. amirantei sizou* (p. 74)
 — Orbital hoods rounded anteriorly; orbitorostral grooves shallow and rounded at most 30
30. (29) Carpus of third legs with 2 or more spines 31
 — Carpus of third legs without spines 32
31. (30) Merus of third legs bearing a series of spines*A. alcyone* (p. 110)
 — Merus of third legs without spines*A. paralcione* (p. 113)
32. (30) Squame of scaphocerite vestigial; merus of third legs with regular series of long setae*A. spongiarum* (p. 116)
 — Squame of scaphocerite normal, reaching near end of antennular peduncle; merus of third legs almost glabrous*A. bucephalus* (p. 120)
- 33* (19) Tip of telson narrow, straight and flanked with heavy and long spines.....*A. obesomanus* (p. 89)
 — Tip of telson broad, arcuate and bearing light spines on posterolateral angles..... 34
34. (33) Scaphocerite not overreaching second antennular article; second carpal article less than twice as long as first*A. malleodigitus* (p. 92)
 — Scaphocerite overreaching second antennular article; second carpal article at least twice as long as first.....*A. microstylus* (p. 92)
35. (18) Large chela oval to rounded compressed in section; with sculpturing. 36
 — Large chela compressed, quadrangular in section, often with definite ridges separating the 4 faces; sculpturing variable 42
36. (35) Large chela with dense and conspicuous setae, especially on inner face; with faint to conspicuous longitudinal groove near middle of outer face 37

* The species in dichotomies 33 and 34 are extremely variable; before final determination as to species is made, refer to the discussion under the *Obesomanus* Group, (p. 87).

- Large chela bearing at most scattered setae on inner face; without longitudinal grooves near middle of outer face 39
- 37. (36) Merus of third legs with strong tooth; first carpal article of second leg about one-third length of second*A. acutofemoratus* (p. 77)
 - Merus of third legs unarmed; first carpal article of second leg approximately equal to or longer than second 38
- 38. (37) Rostrum short, reaching about middle of first antennular article, and bearing stiff, upstanding setae on margins; first carpal article of second legs slightly longer than second.....*A. sulcatus* (p. 79)
 - Rostrum reaching to near end of first antennular article and without setae on margin; first carpal article of second legs about twice length of second*A. australosulcatus* (p. 83)
- 39. (36) With conspicuous flattened teeth mesad of posterior portions of orbital hood *A. bidens* (p.136)
 - Dorsal surface of carapace not bearing teeth 40
- 40. (39) Merus of third legs with strong, somewhat subterminal tooth*A. diadema* (p. 140)
 - Merus of third legs without tooth..... 41
- 41. (40) Palm of large chela uniformly rounded-oval; transverse groove proximal to dactylar articulation rather broad, U-shaped*A. gracilipes* (p. 143)
 - Lower outer margin of palm of large chela sharp and separated from outer face by rounded longitudinal depression; transverse groove proximal to dactylar articulation narrow, V-shaped ellipses*A. novaezealandiae* (p. 145)
- 42. (35) Without transverse groove proximal to dactylar articulation of large chela 43
 - With slight to pronounced transverse groove proximal to dactylar articulation of large chela 46
- 43. (42) Large chela over six times as long as broad; mid-dorsal carina interrupted posterior to orbital hoods*A. acutocarيناتus* (p. 151)
 - Large chela at most 4.5 times as long as broad; mid-dorsal carina, if present, not interrupted..... 44
- 44. (43) Carapace not smooth but pustulate, especially anterior regions*A. stephensoni* (p. 153)
 - Carapace smooth 45
- 45. (44) Palm of small chela of male as long as broad, of female slightly longer than broad; fingers of small chela of male approaching three times length of palm*A. distinguendus* (p. 157)
 - Palm of small chela of both sexes twice as long as broad; fingers of small chela about twice length of palm.....*A. rapacida* (p. 160)

46. (42) Dactylus of third leg simple, conical 47
 — Dactylus of third leg expanded, subspatulate 49
47. (46) Rostrum short, obtusely triangular, not reaching beyond orbital hoods; fingers of small chela of both sexes with dense setae on inner face *A. barbatus* (p. 163)
 — Rostrum acute, reaching middle of first antennular article or beyond; small chela at most with only balaeniceps fringe on dactylus 48
48. (47) Carapace with light pubescence; dactylus of small chela of male with balaeniceps fringe of setae *A. pubescens* (p. 167)
 — Carapace glabrous; small chelae not sexually differentiated and with only few setae *A. miersi* (p. 168)
49. (46) Mediodistal face of palm of large chela smooth; small chela of male not balaeniceps, fingers about twice as long as palm. 50
 — Mediodistal face of palm of large chela granular; small chela of male sub-balaeniceps or balaeniceps, fingers up to 1.3 times as long as palm. 51
50. (49) Both fingers of small chela of male excavate only on medial face *A. brevirostris* (p. 170)
 — Dactylus of small chela of male arched on both margins to leave the fingers gaping when closed *A. rapax* (p. 174)
51. (49) Rostral carina continued to mid-carapace; second article of third maxilliped with only short setae; small chela of male balaeniceps *A. moretensis* (p. 177)
 — Rostral keel continued only to posterior portion of orbital hoods; second article of third maxillipeds with tuft of long setae; small chela of male sub-balaeniceps *A. djiboutensis* (p. 180)
52. (1) With projecting acute tooth on distoinferior margin of merus of third leg. 53
 — With distoinferior margin of merus of third leg at most angular 58
53. (52) With lateral tooth of basicerite reaching to level of middle of second antennular article *A. parvirostris* (p. 185)
 — With lateral tooth of basicerite not reaching to end of first antennular article 54
54. (53) Proximal shoulder of superior saddle of large chela not overhanging groove 55
 — Proximal shoulder of superior saddle of large chela overhanging groove. 56
55. (54) Second carpal article of second legs about 1.2 times length of first; rostrum slender *A. edamensis* (p. 188)
 — Second carpal article of second legs about half the length of the first; rostrum approaching an equilateral triangle *A. hutchingsae* (p. 191)
56. (54) Fingers of small chela excavate, dactylus without longitudinal crests *A. hippothoe* (p. 193)

- Fingers of small chela not excavate; medial face of dactylus with longitudinal crest, crest at times setiferous 57
- 57. (56) Crest on medial face of dactylus of small chela of male setiferous; spines on propodus of third leg in double row *A. serenei* (p. 196)
- Crest on medial face of dactylus of small chela of male not setiferous; spines on propodus of third legs in single row *A. georgei* (p. 200)
- 58. (52) Neither male nor females with balaeniceps crests of hairs on dactylus of small chela* 59
- With male only or with both sexes bearing balaeniceps crests of hair on dactylus of small chela 66
- 59. (58) With acute terminal or subterminal tooth on inferointernal margin of merus of large cheliped 60
- With inferointernal margin of merus of large cheliped unarmed 63
- 60. (59) Dactylus of third legs conical 61
- Dactylus of third legs triangular to broadened and subspatulate 62
- 61. (60) Orbitorostral margin projecting as small shelf; orbital hoods without setae; superior saddle of large chela slight and poorly defined *A. maindroni* (p. 203)
- Orbitorostral margin not projecting; anterior margin of orbital hoods bearing one conspicuous hair; superior saddle of large chela broad and definite *A. dolerus* (p. 205)
- 62. (60) Rostral triangle short, scarcely reaching beyond orbital hoods and almost as broad as long; plunger of dactylus of large chela low and gradually curving into distal margin of article *A. malabaricus trefzae* (p. 207)
- Rostral tip reaching well beyond orbital hoods and almost twice as long as broad at base; plunger of dactylus of large chela heavy and set off from distal margin of dactylus *A. macrodactylus* (p. 210)
- 63. (59) Proximal shoulder of superior saddle of large cheliped not overhanging floor of groove 64
- Proximal shoulder of superior saddle of large cheliped definitely overhanging floor of groove 65
- 64. (63) Both inferior shoulder and shoulder proximal to superior saddle low and rounded in profile *A. bunburius* (p. 213)
- Both inferior and superior shoulders heavy, abrupt and subrectangular in profile *A. tasmanicus* (p. 215)
- 65. (63) Lower shoulder on lateral face of large chela with deep rounded notch distally; plunger on dactylus very heavy and at marked angle to distal dactylar margin *A. pacificus* (p. 217)

*Three species or subspecies in this dichotomy are known only from the female and therefore will be keyed under both choices; they are *A. bunburius*, *A. heronicus* and *A. malabaricus trefzae*.

- Lower shoulder on lateral face of large chela not set off from more distal margin of pollex by notch; plunger of dactylus low and confluent with distal margin.....*A. heronicus* (p. 220)
66. (58) Both males and females with balaeniceps or sub-balaeniceps dactylus on small chela 67
- Males only with balaeniceps dactylus on small chela..... 71
67. (66) Shoulder proximal to superior saddle of large chela low and rounded 68
- Shoulder proximal to superior saddle abrupt and at times overhanging floor of groove..... 69
68. (67) Merus of both chelipeds without a distal tooth; plunger of dactylus of large chela heavy and at marked angle to distal margin.
.....*A. australiensis* (p. 256)
- Merus of both chelipeds bearing a distal tooth on inferointernal margin; plunger of dactylus low and confluent with distal margin. (Note: female alone known but male presumed to have a balaeniceps dactylus.)
.....*A. balaenodigitus* (p. 223)
69. (67) Proximal shoulder of superior saddle of small chela of both sexes abrupt, at right angles or overhanging floor of groove; plunger of dactylus of large chela low and confluent with distal margin
.....*A. pareuchirus imitatrix* (p. 278)
- Proximal shoulder of superior saddle of small chela of both sexes low and rounded; plunger of dactylus of large chela heavy and set off at marked angle from distal margin..... 70
70. (69) Inferior margin of small chela of both sexes almost straight, without trace of shoulder.....*A. strenuus strenuus* (p. 225)
- Inferior margin of small chela of both sexes with marked but low shoulder*A. strenuus cremnus* (p. 229)
71. (66) Proximal shoulder of superior saddle of large chela rounded to abrupt, not overhanging groove 72
- Proximal shoulder of superior saddle of large chela rounded to acute and overhanging floor of groove 79
72. (71) Dactylus of third leg somewhat flattened to definitely subspatulate 73
- Dactylus of third leg simple and conical 76
73. (72) Propodus and dactylus of third leg bearing setae on lateral face; plunger of dactylus of large chela heavy and at marked angle to distal margin . 74
- Propodus of third leg with setae only on margins, dactylus glabrous; plunger of dactylus of large chela low and confluent with distal margin 75
74. (73) Squamous portion of scaphocerite broad and reaching near end of lateral tooth; small chela of mature males with superior saddle
.....*A. euphrosyne euphrosyne* (p. 232)
- Squamous portion of scaphocerite narrow, not reaching near end of

- lateral tooth; small chela of mature males without trace of superior saddle.....*A. euphrosyne richardsoni* (p. 235)
75. (73) Rostrum reaching only slightly beyond margins of orbital hoods; merus of large chela unarmed; dactylus of third leg subspatulate*A. malabaricus trefzae* (p. 207)
- Rostrum reaching well beyond margins of orbital hoods; merus of large chela with small sub-terminal tooth; dactylus of third legs trigonal with expanded and flattened inferior surface.....*A. bunburius* (p. 213)
76. (72) Inner face of small chela of male with heavy setae in distal half or on fingers alone..... 77
- Inner face of small chela of male with only scattered setae (except for the balaeniceps fringe) 78
77. (76) Small chela of male with heavy sculpturing; setae scattered on distal half of inner face of male and female small chelae*A. inopinatus** (p. 241)
- Palm of small chela of male rounded, without sculpturing; dense setae only on inner face of fingers of male small chela*A. sudara* (p. 243)
78. (76) Superior saddle of large chela extending into lateral face as narrow U-shaped groove; mature males with little sculpturing on palm of small chela*A. leviusculus leviusculus*(p. 246)
- Superior saddle of large chela extending into a well-marked triangular depression; small chela of mature males with heavy sculpturing*A. lobidens lobidens* (p. 252)
79. (71) Inferior shoulder on outer face of large chela projecting into an acute subacute tooth..... 80
- Inferior shoulder on outer face of large chela rounded 83
80. (79) Inferior shoulder of outer face of large chela bearing numerous small papillae.....*A. papillosus* (p. 260)
- Inferior shoulder of outer face of large chela smooth 81
81. (80) Rostrum and rostral triangle on carapace flattened dorsally, sharply demarked and overhanging orbitorostral grooves*A. bisincisus* (p. 263)
- Rostrum and rostral triangle rounded dorsally and curving into orbitorostral grooves 82
82. (81) Proximal shoulder of superior saddle and inferior shoulder of outer face of large chela projecting as acute teeth; rostrum narrow, and awl-shaped.....*A. chiragricus* (p. 267)
- Proximal shoulder of superior saddle and inferior shoulder projecting as rounded teeth; rostrum broader, triangular. (Note: this species shows a marked variation in sculpturing of large chela — see fig. 83 l, m, n.)*A. edwardsii* (p. 270)
83. (79) Dactylus of third leg biunguiculate.....*A. polyxo* (p. 274)

*Species no longer considered valid — see footnote, (p. 241).

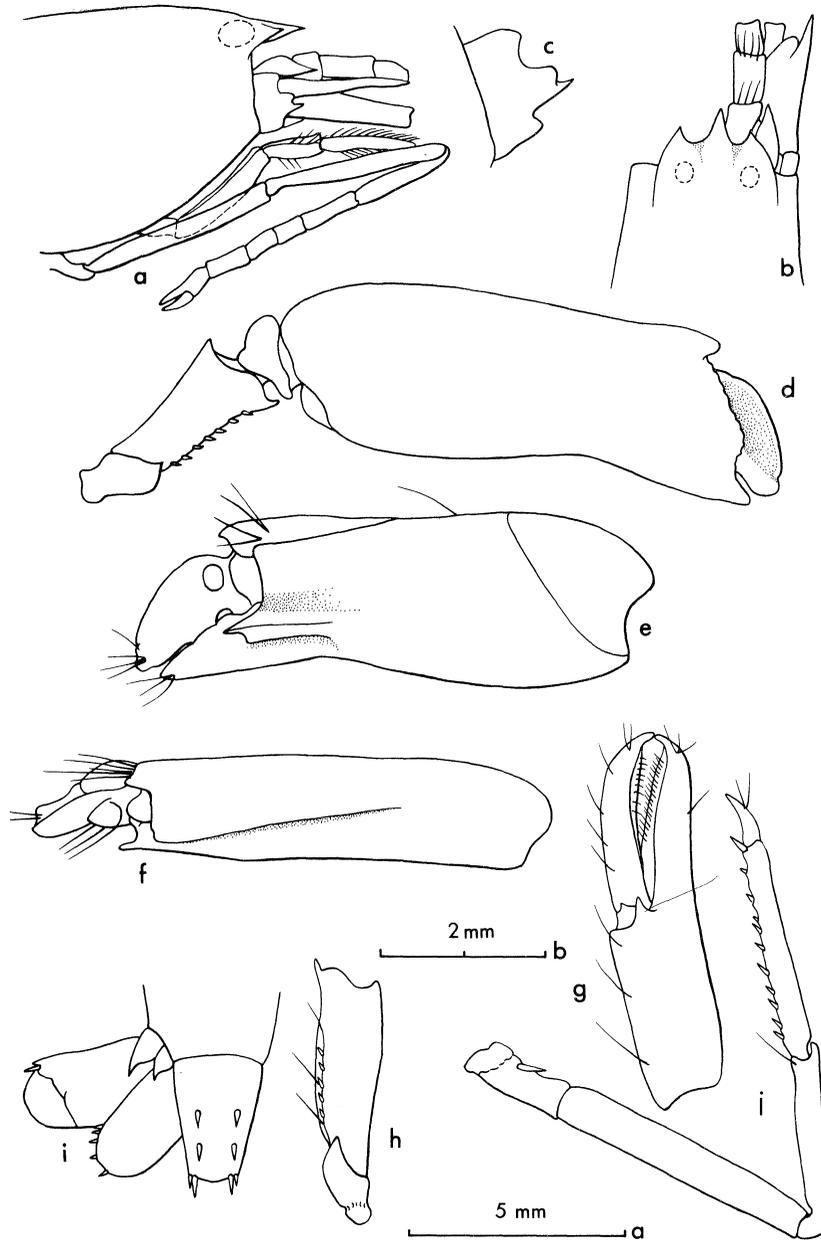


Fig. 5 *Alpheus astrinx* sp. nov.

Holotype (female). **a, b**. Anterior region, lateral and dorsal view; **c**. basicerite, enlarged; **d**. large cheliped, medial face; **e**. large chela, lateral face; **f**. large chela, superior face; **g, h**. small chela, lateral face and merus, medial face; **i**. telson and uropods. 40 mm female paratype; **j**. Third leg. **a, b, d, e, f, g, h, i** scale a; **c** scale b.

- Dactylus of third leg simple 84
- 84. (83) Meri of both chelipeds unarmed; inner face of small chela and carpus of third leg with many long setae (only female known)*A. heronicus* (p. 220)
- Meri of both chelipeds armed with teeth; no conspicuous setae on small chela, except for balaeniceps fringe on finger of male, nor on carpus of third leg except at tip*A. pareuchirus pareuchirus* (p. 276)

MACROCHELES GROUP

Always with orbital teeth. Palm of large chela compressed, somewhat twisted, with 3 heavy longitudinal ridges and grooves, at times interrupted, terminating distally in (1) a heavy tooth above dactylar articulation, (2) the adhesive plaque, (3) a usually heavy tooth below the dactylar articulation; dactylus frequently high and thin, at times with bulbous tip. Small chela never balaeniceps. Third leg with or without meral tooth; dactylus biunguiculate or simple.

Many of the species of this group are only known from dredgings in deeper waters; the ones occurring intertidally or subtidally seem to be characteristic of clean habitats associated with growing coral.

***Alpheus astrinx* sp. nov.**

Fig. 5

HOLOTYPE: 28 mm female from Garden Island, near Perth, W.A. 100 yds. offshore. Coll. R. Dawson and Marine Group, 25/11/61. In coral. (WM 265-65)

PARATYPES: 2 females and 2 males reaching to 43 mm in length collected from same locality as type (most without legs attached).

DIAGNOSIS: Rostrum acute, a little longer than broad at base, reaching to near end of first antennular article, rounded dorsally and separated from anterior portions of orbital hoods by only slight rounded concavities. At level of corneas carapace rounded with orbital hoods and rostral base confluent, not demarked. Orbital teeth acute, directed forward, one-third as long as rostrum, with medial margins joining base of rostrum as a continuous curve. Antennules stout; visible part of first antennular article slightly shorter than second article which is 1.5 times as long as broad; third antennular article 0.6 as long as second. Stylocerite acute, reaching to end of first antennular article. Squamous portion of scaphocerite narrow, not reaching to end of antennular peduncle, lateral margin straight, lateral tooth strong, reaching past end of antennular peduncle. Carpocerite stout, reaching to end of antennular peduncle. Lower margin of basicerite with acute tooth; adjacent to tooth is a rounded projection which blends gradually into distal margin.

Ratio of articles of third maxilliped: 10:4:7.

Large chela compressed, 3 times as long as broad with fingers one-quarter of total length. Proximal superior margin of palm curving laterally to form rounded ridge terminating in palmar adhesive plaque; distal portion of ridge demarked superiorly by flattened area, inferiorly by rounded groove. Superior flattened area with distal ridge on medial margin terminating in strong tooth flanking dactylar articulation. Distal portion of outer face with third longitudinal rounded ridge that terminates as lateral tooth flanking dactylar articulation; below this ridge is a rounded but deep depression. Dactylus bulbous and truncate at tip, medial face somewhat concave; plunger low, but fitting into well-defined open-ended groove on pollex. Merus twice as long as broad, superodistal

margin slightly projecting; inferoventral margin bearing several small spines and an acute tooth distally.

Small chela of female 4 times as long as broad with fingers as long as palm. Palm bearing an acute tooth on either side of articulation of dactylus. Superior margin of dactylus rounded; cutting edges of fingers bearing row of short stiff setae. Merus similar to that of large chela but slender, 3.5 times as long as broad. Small chela of male unknown.

Carpal articles of second leg with ratio: 10:5.4:3.3:3.3:4.0.

Ischium of third leg armed with spine. Merus inermous, 7 times as long as broad. Carpus 0.6 as long as merus, superodistal margin projected as a rounded tooth, inferodistal margin bearing one strong seta. Propodus 0.8 as long as merus, bearing on inferior margin 11 spines and a pair distally. Dactylus simple with slight notch on dorsal surface from which springs 2 short stiff setae. (This is a description from a third leg of a 43 mm paratype; the holotype had only the second leg).

Telson 2.6 times as long as posterior margin is broad; tip slightly arcuate; inner spine of posterolateral pair twice as long as outer. Anterior pair of dorsal spines placed anterior to middle.

DISCUSSION: The crests and grooves of the large chela plainly place this species in the *Macrocheles* Group. This species is related to the group of species in the *Macrocheles* Group that have no distoventral tooth on the merus of the third leg. These include: *A. waltervadi* Kensley, *A. seurati* Coutière, *A. albatrossae* (Banner), *A. oahuensis* (Banner), *A. hailstonei* Coutière, *A. lanceostylus* Banner, *A. staphylinus* Coutière and *A. crockeri* (Armstrong). It can be separated from the first seven species by the lack of a transverse groove on the superomedial crest of the large chela. It can be further separated from *A. waltervadi*, *A. seurati* and *A. oahuensis*, all of which have a biunguiculate dactylus on the third leg. *A. hailstonei* usually carries a biunguiculate dactylus on the third leg, but this may be simple. *A. astrinx* is remarkably close to *A. crockeri*, but the form of the dactylus of the large chela is entirely different. In *A. astrinx* the dactylus is only a little compressed and lacks a strong superior keel while in *A. crockeri* the middle section of the dactylus is highly compressed, knifelike with a sharp superior keel. The tip of the dactylus in the present species curves inward only slightly, but in *A. crockeri* the tip is broadly flared and extremely twisted. The cutting margin in *A. astrinx* bears a small but definite plunger or crest that fits into a concavity on the pollex in the typical *Alpheus* fashion, but in *A. crockeri* the plunger is developed as a heavy acute tooth which closes close to, but not against, a more rounded tooth on the basal portion of the outer face of the pollex (see Banner, 1953:19d, as *Crangon tuthilli*) and the pollex carries no socket or groove for its accommodation.

A. crockeri is a widespread species, not uncommon in the central Pacific where it reaches to Hawaii; in the western Pacific it is known from the Gulf of Thailand as well as the Indian Ocean side of the Malayo-Thai peninsula. Crosnier and Forest (1965b:603) have reported it from the tropical Atlantic. However, it has never been reported from Australia, so *A. astrinx* may represent a stock in Australian waters derived from the more widespread *A. crockeri*.

The name is taken from the Greek *a*, without, and *strinx* meaning furrow, channel or groove and refers to the fact that the large chela lacks the transverse groove found in related species. The holotype and paratypes will be placed in the Western Australian Museum.

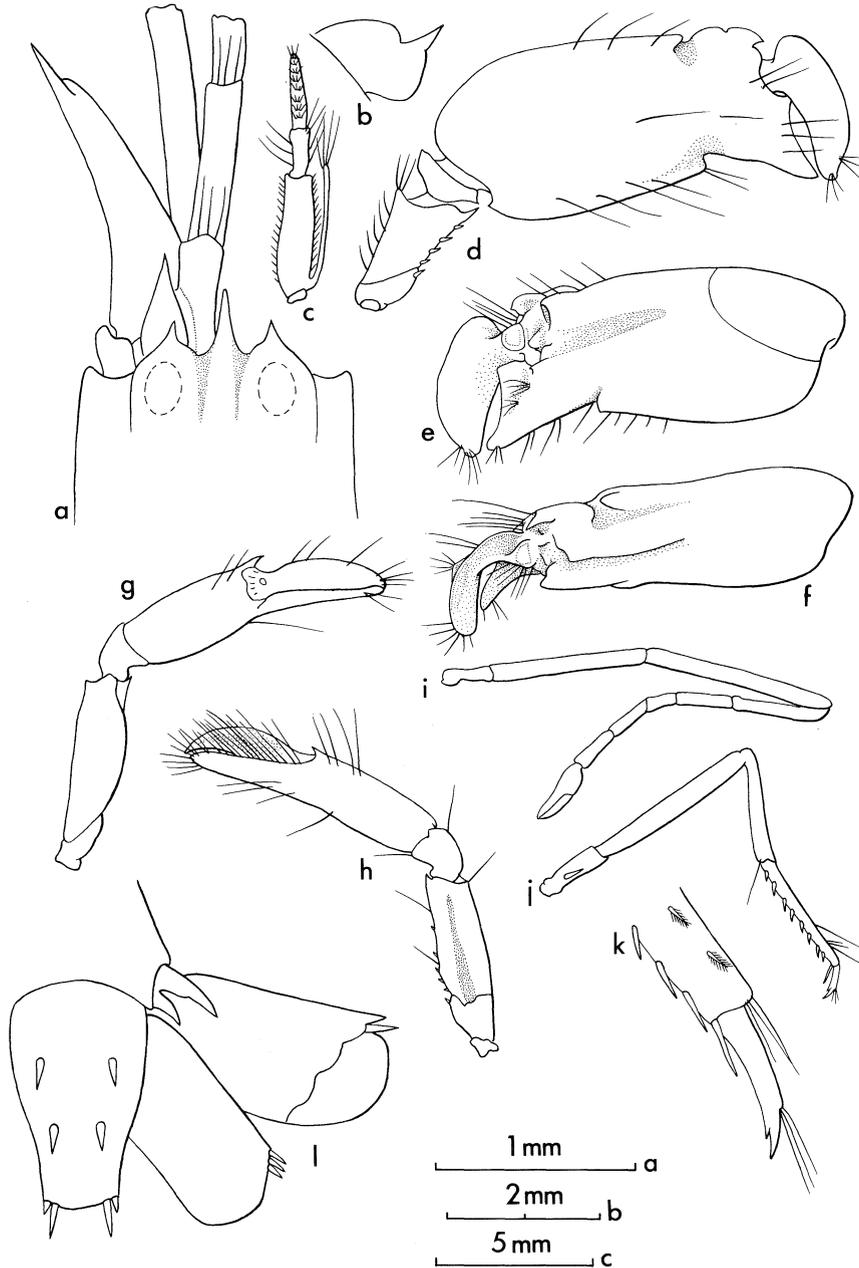


Fig. 6 *Alpheus hailstonei* Coutière
 25 mm male from WM 184-65. **a.** Anterior region, dorsal view; **b.** basicerite; **c.** third maxilliped, medial face; **d.** large cheliped, medial face; **e, f.** large chela, lateral and superior face; **g, h.** small cheliped, lateral and medial face; **i.** second leg; **j, k.** third leg and dactylus enlarged; **l.** telson and uropods. **d, e, f, g, h, i, j** scale **a**; **a, b, c,** 1 scale **b**; **k** scale **c**.

Alpheus hailstonei Coutière

Fig. 6

Alpheus hailstonei Coutière, 1905a:879, pl. 74, fig. 18.*Alpheus hailstonei laetabilis* De Man, 1908:98; 1911:333, fig. 64d.*Alpheus hailstonei assimulans* De Man, 1908:99; 1911:331, fig. 64-64c. Miya, 1974:116, pl. 18.*Crangon hailstonei paucispinata* Banner, 1953:51, fig. 16.

SPECIMENS EXAMINED: 1 specimen from AM G. 2190; 1, AMP. 7224; 3, AM P. 7377; 1, AM P. 7557; 1 AM P. 9448; 1, WM 45-65; 1 WM 63-65; 2, WM 64-65; 1, WM 69-65; 4, WM 71-65; 3, WM 90-65; 11, WM 94-65; 2, WM 132-65a; 1, WM 145-65; 14, WM 184-65; 2, WM 213-65; 2, WM 246-65; 2, WM 255-65; 5, WM 270-65; 2, WM 4985.

DIAGNOSIS: Rostrum acute, 1.5 times as long as broad at its base, reaching to middle of visible part of first antennular article. Visible part of antennular article 0.8 as long as second article, second article 4 times as long as broad, third article 0.4 as long as second. Stylocerite acute, reaching near end of first antennular article. Scaphocerite with lateral margin concave, squamous portion very narrow, reaching short of middle of third antennular article; lateral tooth reaching to end of third article. Carpocerite slender, 8 times as long as broad, reaching well past end of antennular peduncle. Basicerite with strong tooth on inferolateral margin.

Large chela 2.4 times as long as broad with fingers occupying distal 0.25; dactylar articulation displaced laterally to proximal portion of chela. Proximal superior margin of palm continued as rounded ridge leading to palmar adhesive plaque, separated from distal superior ridge by flattened area broadly rounded with slight depression in middle. Superomedial ridge terminating distally in strong tooth at dactylar articulation, demarked proximally by transverse groove that extends a slight distance on to medial face; shoulder proximal to groove overhanging groove. Ridge to plaque demarked on inferior side by shallow rounded groove reaching to mid-palm. Ridge of lower margin of groove flattened and terminating in rather small but acute tooth flanking dactylar articulation. Inferior margin of palm bearing strong, rounded shoulder proximal to broad depression at level of superior transverse groove. Dactylus extremely compressed, curved with tip expanded especially on medial face; tip bearing patches of setae. Cutting edge of dactylus knife-like, somewhat curved and without trace of plunger. Cutting edge of pollex similar, but more concave and bearing proximally an angular tooth. Merus 1.5 times as long as broad superior margin projected in a rounded tooth bearing on its margins several short setae. Inferointernal margin bearing several small spines and an acute tooth distally. Ischium bearing one spine distally on inferior margin.

Small chela not sexually dimorphic, 4.5 times as long as broad, fingers and palm almost equal. Palm bearing distally an acute tooth on either side of articulation of dactylus. Dactylus displaced somewhat laterally. Superior and lateral surfaces rounded, glabrous. Medial face concave its entire length and with many setae. Tips cross when closed leaving no gape between fingers. Merus 3 times as long as broad, inferointernal margin bearing several small spines and an acute tooth distally.

Articles of third maxilliped with ratio 10:4.4:6.5.

Carpal articles of second leg with ratio: 10:5.6:3.1:4.7:4.7.

Ischium of third leg with spine. Merus inermous, 8 times as long as broad. Carpus 0.6 as long as merus, superodistal margin projected as an obtuse tooth. Propodus 0.7 as long as merus, bearing on its inferior margin 9 pairs of spines and a pair distally; medial

surface, near superior margin of all three walking legs, bearing distally 2 or 3 setiferous bristles. Dactylus slender, 0.2 times as long as propodus, usually biunguiculate with inferior unguis small and acute; superior margin bearing tufts of setae.

Telson 2.6 times as long as posterior margin is broad. Inner spine of posterolateral pair over twice as long as outer, anterior pair of dorsal spines placed well anterior to middle.

DISCUSSION: Since Coutière's original description of *A. hailstonei* from the Maldives, De Man named two new varieties and Banner, raising De Man's names to subspecific rank, described a third (citations above). Banner also presented a table of 31 characteristics, some of which would serve to separate the subspecies and some to separate the species from related species. Miya (1974:118) chose from the earlier table those characteristics he believed could be used to separate the nominal subspecies, but he cautioned that "the validity of each subspecies might be questionable . . ."

In his descriptions De Man emphasized the proportions of the chelae and third legs, ratio of the carpal articles of the second legs, the armature of the merus and ischium of both chelipeds and the biunguiculation of the dactylus of the third legs. As the differences in the proportions were close and the number of intact specimens available to De Man was small, Miya chose to ignore these characteristics as reliable for use in separations; to this we agree. This left the number of spines on the merus and ischium of the chelipeds and the biunguiculation of the dactylus of the third leg.

None of the specimens in the present or in the Hawaiian collection had spines on the superior margin of the ischium or merus of either cheliped, but on the merus of the large cheliped there would be frequently one or more setae in positions comparable to the locations where the spines were found. All the Australian specimens carried 3-8 spines of variable size on the inferior margin of the meri of the large and small chelipeds. The inferior margin of the ischium of the large cheliped carried one to two spines, the small cheliped carried none. In as much as in other species such armature varies considerably, often with setae substituting for spines, and the number of spines or patches of setae also varies, we believe that this characteristic is unreliable.

Remaining then is the biunguiculation of the dactylus. Here, too, the inferior unguis, never large, varies in size. At our request Dr J. Forest of the Museum National d'Histoire Naturelle of Paris kindly re-examined the 4 specimens that Coutière had marked "Type" and found all had "*un minuscule ongle*" (Coutière had not shown or mentioned the secondary unguis). Dr Forest stated that in other specimens it was not possible to distinguish the secondary unguis from a strong swelling. In the Australian specimens the size of the secondary unguis was variable although always small, and in one 17 mm specimen the extra unguis was lacking. In view of the variability here, and in view of the variability in other species (*A. gracilis* Heller, p.60 below and *A. diadema* Dana, Banner, 1959:142, fig. 7), we believe that this criterion cannot be relied upon for the separation of the subspecies. Therefore we return all to the nominate species without distinctions.

It should be noted in passing that as these specimens are always dredged, each person working upon the species has reported that many, if not most, of the specimens available were in only fragmentary condition. Possibly the lack of sufficient intact specimens has prevented earlier workers and ourselves from discovering the extent of variation within the species.

BIOLOGICAL NOTES: This species is a deep water form and has been collected from 25 metres to 536 metres. The colour is unknown. Our specimens ranged in size up to 30 mm.

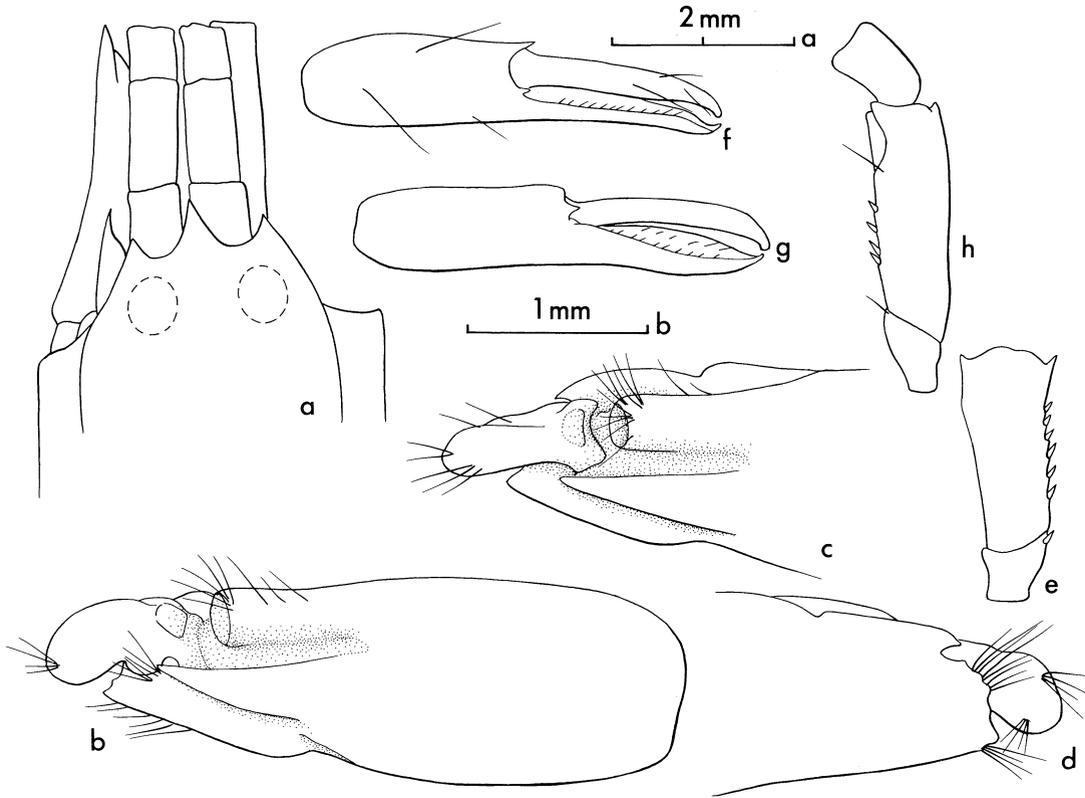


Fig. 7 (?) *Alpheus staphylinus* Coutière
 14 mm specimen from AM 305. **a.** Anterior region, dorsal view; **b, c, d.** large chela, lateral face; distal region of superolateral face; distal region, inferior face; **e.** merus, large cheliped, medial face; **f, g.** small chela, superolateral and lateral face; **h.** merus, small cheliped, medial face. **b, c, d, e, f, g, h** scale a; **a** scale b.

AUSTRALIAN DISTRIBUTION: In Western Australia we have specimens from Cape Naturaliste to Bluff Pt.; in eastern Australia from off Cooktown Qld. to Cape Green N.S.W. We also have one specimen from Victoria.

GENERAL DISTRIBUTION: This species has been reported, either as the nominate form or its subspecies, from the Maldives, Amirantei, Seychelles, Indonesia, Japan and Hawaii.

(?)*Alpheus staphylinus* Coutière

Fig. 7

Alpheus staphylinus Coutière, 1908a:204; 1921:418, pl. 62, fig. 13.

Alpheus crockeri Miya, 1974, pl. 21. (Nec Armstrong, 1941.)

SPECIMEN EXAMINED: 1 specimen from AM 305 (AM P. 28114).

DIAGNOSIS: Rostrum triangular, a little longer than broad at base, reaching to last quarter of visible part of first antennular article. Anterior carapace dorsally rounded, without trace of orbitorostral grooves, orbital teeth half as long as rostrum.

Second antennular article 1.5 times as long as visible part of first and nearly twice as long as broad, third article 0.5 as long as second. Stylocerite reaching as far forwards as rostrum. Lateral margin of scaphocerite almost straight, lateral tooth strong, reaching to end of antennular peduncle, squamous portion reaching only to last quarter of third antennular article. Carpcerite a little longer than antennular peduncle. Lateral tooth of basicerite strong.

Large chela three times as long as broad with dactylus less than 0.3 as long as entire chela. Crest leading to superolaterally placed adhesive plaque heavy and rounded, arising from proximal portion of superior margin of palm and curving laterally to plaque. Superomedial crest separated from plaque crest by shallow flattened area and terminating in strong tooth at medial margin of dactylar articulation; crest interrupted proximally and re-arising as low, short crest, rounded in profile. Heavy crest on lateral face proximally flattened and demarked from plaque crest by deep groove; terminating in acute tooth with rounded tip lying on lateral side of dactylar articulation; inferior side of crest demarked by deep flattened area. Rounded concavity on inferior margin of palm somewhat proximal to fingers. Dactylus heavy, somewhat compressed, with rounded tip closing across end of pollex; plunger developed as a conical outstanding tooth with rounded apex, socket round and complete. Merus 2.5 times as long as broad, superior margin terminates distally in a rounded tooth, inferointernal margin bearing several small spines and terminating distally in an acute tooth.

Small chela 5.4 times as long as broad, palm and fingers equal. Palm without sculpturing and terminated both medially and laterally proximal to dactylus in an acute tooth. Opposing margins of fingers bearing a row of short stiff setae. Merus similar to that of large chela.

DISCUSSION: This sole specimen is fragmentary: the body and the appendages appear as if they had been soaked in a chemical (such as a household bleach or sodium hydroxide) that ate away most of the flesh and softened the exoskeleton. Most of the legs were already gone and the soft body was badly distorted when we first examined the specimen. In the process of examination the small chela was lost and the dactyl was broken off the large chela.

From the parts that are intact, we can see no differences between this specimen and

the species Coutière described as *A. staphylinus* from the Chagos Archipelago, the type of which we have examined at the Muséum National d' Histoire Naturelle of Paris. The orbital hoods and the relationship of the antennular and antennal peduncles are the same; both the large and small chelae are similar, but the interruption of the ridge leading to the medial articular tooth of the large chela which we show in fig. 7c is not shown in Coutière's figure 12a — that is merely because of rotation for it appears in the holotype. This specimen is also related to *A. crockeri* (Armstrong) and *A. astrinx* (described above), but can be separated from them by lack of modification of the plunger of the dactylus of the large chela; to *A. albatrossae* (Banner), but from it this species differs by having a relatively heavier and second antennular article; and to *A. oahuensis* (Banner), but that species differs by having the fingers of the small chela straight and heavy, not curved and simple.

Dr Miya reported some specimens from the Ryukyus as *A. crockeri* (Armstrong) (*loc. cit.*). From his description and figure we suspected that the specimens might be *A. staphylinus*. We sent specimens of *A. staphylinus* from our Philippine collections to him and he compared them to his specimens from the Ryukyus and confirmed our tentative diagnosis; he has requested that we indicate the correction of his identification in this paper (personal communication).

AUSTRALIAN DISTRIBUTION: The sole specimen was collected from Murray Island, Torres Straits, in 1907.

GENERAL DISTRIBUTION: This species is known only from the Chagos Archipelago in the central Indian Ocean; it may also occur in Japan. We have specimens in our collections from the Philippines.

***Alpheus deuteropus* Hilgendorf**

Fig. 8

Alpheus deuteropus Hilgendorf, 1878:834, pl. 4, figs. 8-10; Coutière, 1899:215, figs. 254, 255; Banner and Banner, 1966b:80, fig. 26; Tiwari, 1963:281, fig. 6.

Crangon deuteropus Banner, 1953:70, fig. 22.

Previous Australian records: O'Loughlin, 1969:36. Houtman Abrolhos, W.A.

SPECIMENS EXAMINED: 1 specimen from AC C-54; 1, AM 467 (AM P. 27410); 3, BAU 15; 3, BAU 17; 5, BAU 30; 2, BAU 31; 7, BAU 47; 1, BAU 55.

DIAGNOSIS: Rostrum acute, curved abruptly upward toward tip, tip reaching to middle of visible portion of first antennular article; rostral carina pronounced, rounded dorsally, and continuing to base of eyes. Orbital hoods inflated, with acute teeth about as long as rostrum. Medial margins of orbital hoods expanded and shelflike. Orbitorostral grooves moderately deep.

Second article of antennular peduncle slender, three times as long as broad, 1.5 times as long as visible portion of first and about twice as long as third article. Antennular peduncles hirsute. Lateral spine of stylocerite reaching to distal third of first antennular article. Outer margin of scaphocerite markedly concave, lateral tooth strong, reaching to end of antennular peduncle, squamous portion narrow, reaching only to end of second antennular article. Carpocerite as long as antennular peduncle. Basicerite bearing strong lateral tooth and adjacent shorter acute tooth.

Large and small chelae so densely hirsute on inner faces and superior margins of outer faces that their form is obscured; hirsute surfaces heavily papillose. Large chela

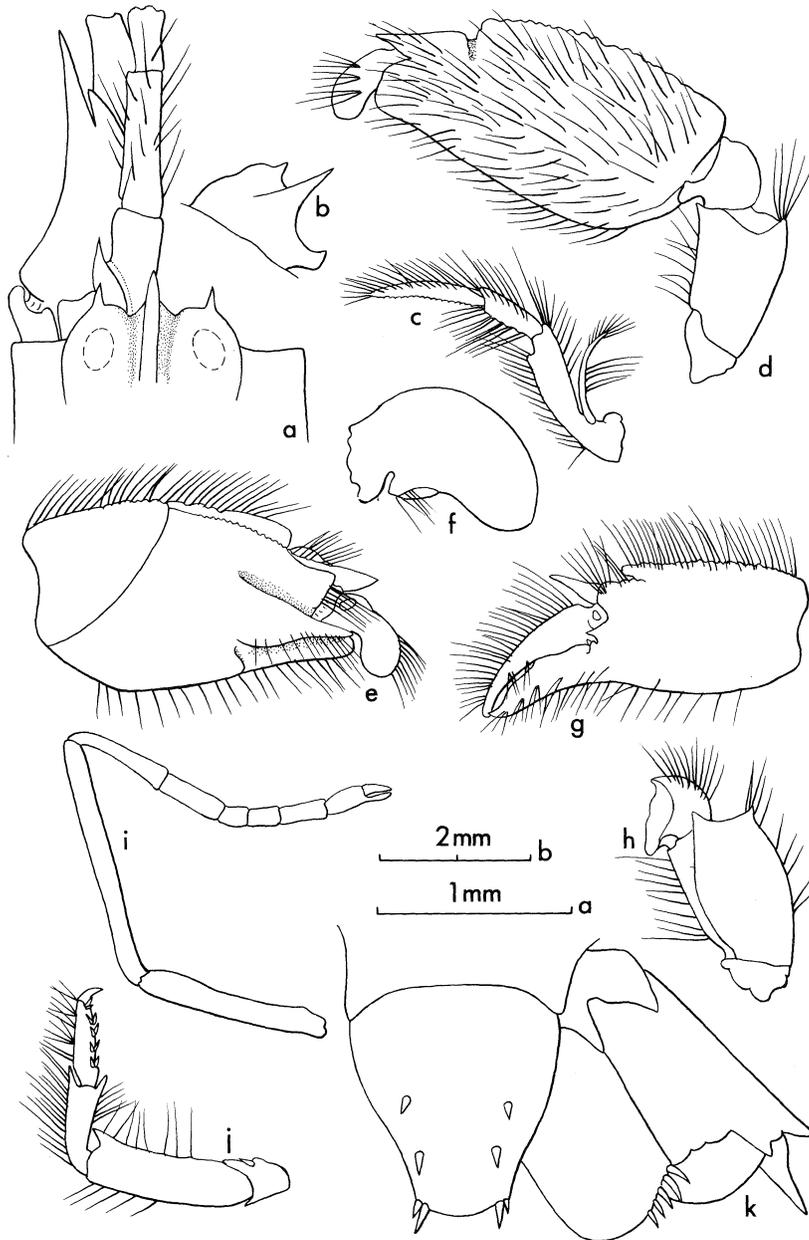


Fig. 8 *Alpheus deuteropus* Hilgendorf
 25 mm male from BAU 15. **a.** Anterior region, dorsal view; **b.** basicerite; **c.** third maxilliped; **d.** large cheliped, medial face (dense layer of hairs not fully indicated); **e, f.** large chela and detail of dactylus, lateral face; **g, h.** small chela and merus, lateral face; **i.** second leg; **j.** third leg; **k.** telson and uropods. **c, d, e, g, h, i, j** scale **a**; **a, b, f, k** scale **b**.

strongly compressed, ovate in shape and about twice as long as high. Fingers approximately 0.2 as long as entire chela. Superior longitudinal crest rounded and bounded on either side by grooves; groove on lateral face extending to distal third of palm. Superior groove reaching to *linea impressa* with papillose superior margin of serrulate appearance. Superior margin interrupted by a deep transverse groove proximal to dactylar articulation. Dactylar articulation flanked by two heavy and acute teeth; superior being a continuation of superior margin, lateral arising below lateral groove; both reaching almost to end of shortened pollex. Inferior margin of chela rounded, much less hirsute than superior margin and bearing small shoulder opposite transverse groove. Tip of pollex truncate; cavity for plunger with "slot" in distal margin. Dactylus rotated somewhat laterally, with bulbous tip overhanging pollex; plunger short. Merus 1.5 times as long as broad, inferoventral margin projecting as slight acute tooth, superodistal margin forming a triangular projection; inferoventral margins not projected.

Small chela 0.8 as long as large chela, ovate, fingers over 0.5 as long as palm. Dactylar articulation flanked by acute teeth, with medial prominent and lateral tooth small. Superior margin of palm bearing a transverse groove near dactylar articulation with proximal margin overhanging groove. Merus similar to that of large chela.

Third maxilliped densely hirsute. Ratio of articles: 10:4:8. Last article 6.6 times as long as broad, tapering distally.

Ratio of carpal articles of second legs: 10:6:2:2:4.

Ischium of third leg with spine. Merus 3.5 times as long as broad, with strong acute tooth distally and numerous hairs on superior and inferior margins. Carpus 0.5 as long as merus, both margins terminating in strong acute teeth. Propodus as long as carpus, bearing on inferior margin four pairs of small spines and a pair distally. Dactylus simple, curved.

Telson stout, anterior margin 2.2 times as wide as posterior margin. Lateral margins anteriorly convex, posteriorly concave. Anterior pair of dorsal spines at 0.5 of length. Distolateral margins of inner uropods bearing five strong spines.

DISCUSSION: Our specimens showed the same variation in characters as those discussed by Banner (1953:72) for 50 specimens from Hawaii. 1. The rostrum varied from slightly shorter to slightly longer than the orbital teeth. 2. The frontal margin of the carapace between the orbital teeth varied from almost straight to definitely arcuate. 3. The length of the stylocerite and relative lengths of scaphocerite, carapocerite and antennular peduncle varied. Usually the scaphocerite reached to somewhat past the middle of the third antennular article. 4. The second carpal article of the second legs varied from 0.55 to 0.85 times the length of the first article, usually being about 0.6-0.7 its length. The distal articles appeared to bear a more fixed relationship to the length of the second article than to the length of the first article. 5. The number of spines on the propodus of the third legs varied from four to seven pairs.

BIOLOGICAL NOTES: This species characteristically is found in fissures in massive heads of living coral. The following forms have been reported as hosts: *Astreopora myriophthalma* (Lamarck), *Porites lobata* Dana (B&B, 1964:88); *Porites spp.*, *Acropora sp.* (B&B, 1966b:82); *Porites evermanni* Verrill, *Montipora verrucosa* (Lamarck), and *Pavona varians* Verrill (Vaughan, 1973:37 et seq.). It may continue to live in fissures persisting in heads after the coral has died and it has been found in dead bases of living coral heads. The species has been found from the low intertidal to depths of 35 m (Vaughan, *op. cit.*) but this was the limit of depth of his observations.

Vaughan (*op. cit.*) made an extensive study of *A. deuteropus*, its fissures, distribution and behaviour in Hawaii. He found that the fissures inhabited were from 0.3-0.9 cm wide and up to 25 cm long and that the longer fissures had the greater depths (*circa* 3 cm). Off the deeper parts of the U-shaped crevice were the burrows, rounded *cul-de-sacs* reaching deeper into the head and exactly fitting the shrimp that would retire there when disturbed, lying with its hairy chela effectively blocking the entrance. Vaughan found that 85 percent of the fissures he studied contained a cohabiting pair, each with its separate burrow; a few crevices less than 5 cm long had only one inhabitant and one burrow; in two cases he found in longer fissures two berried females with a male and in one other longer fissure he found two pairs living.

While Vaughan could not prove that the shrimp actually excavated the crevice-burrow unit, he could show that the fissure was not pre-existing in the growth form of the coral, that the groove was not made by any other known biological agent, and that it might be possible for the shrimp to inhibit the growth of coral and possibly excavate the coral with its large chela. He made sections through the coral head at the site of the groove and was able to count up to five annual growth rings to the sides of the groove; whether that meant that the shrimp had been in position for five years or whether it had actively burrowed through five years growth his studies did not show.

He found the rim of the groove to bear a band of small hydroids of various families embedded in a mass of filamentous alga dominated by the red alga, *Spermothamnion* that extended 2 cm from the lip. He speculated that the hydroids might with their nematocysts protect the inhabitants of the groove and might also eat the shrimp larvae when released. He was able to show that when the shrimp were removed from their dwellings and given fragments of the algal mat under laboratory conditions they would graze on the mat. He found the same algae in the gut contents of the shrimp freshly removed from their burrows, so the shrimp use the mat as a standing food crop. (All information from Vaughan summarised with his permission.)

It is noteworthy that when we were collecting in Indonesian waters in 1975 we found many massive heads of coral with grooves that appeared to be superficially similar to those made by *A. deuteropus*, but in almost all cases they were inhabited by *A. acutofemoratus* Dana (full collections not yet studied and will be reported in a future paper).

We have no colour observations on the Australian specimens, but in Hawaii the species has pink eyes, surrounded by a circlet of broken red lines and the body and appendages are largely transparent with a sprinkling of small red chromatophores; the gut shows through the carapace as brown, and the inner face and the tips of the fingers of the chelae are brownish. The embryos in maturing eggs are brown with black eyes.

The specimens ranged from 8 to 30 mm in length.

Australian distribution: One specimen was found in the Houtman Abrolhos in Western Australia, the remainder were found from off Port Douglas, Qld. to as far south as Heron Island in the Capricorn Group.

General distribution: South and East Africa, Maldive Archipelago; Thailand, Vietnam; Japan, Marianas; Marshall Islands; Samoa; Line Islands and Hawaii.

***Alpheus collumianus* Stimpson**

Fig. 9

Alpheus collumianus Stimpson, 1861:30; Banner, 1953:67, fig. 21.

Alpheus collumianus probabilis Banner, 1956:338, fig. 10.

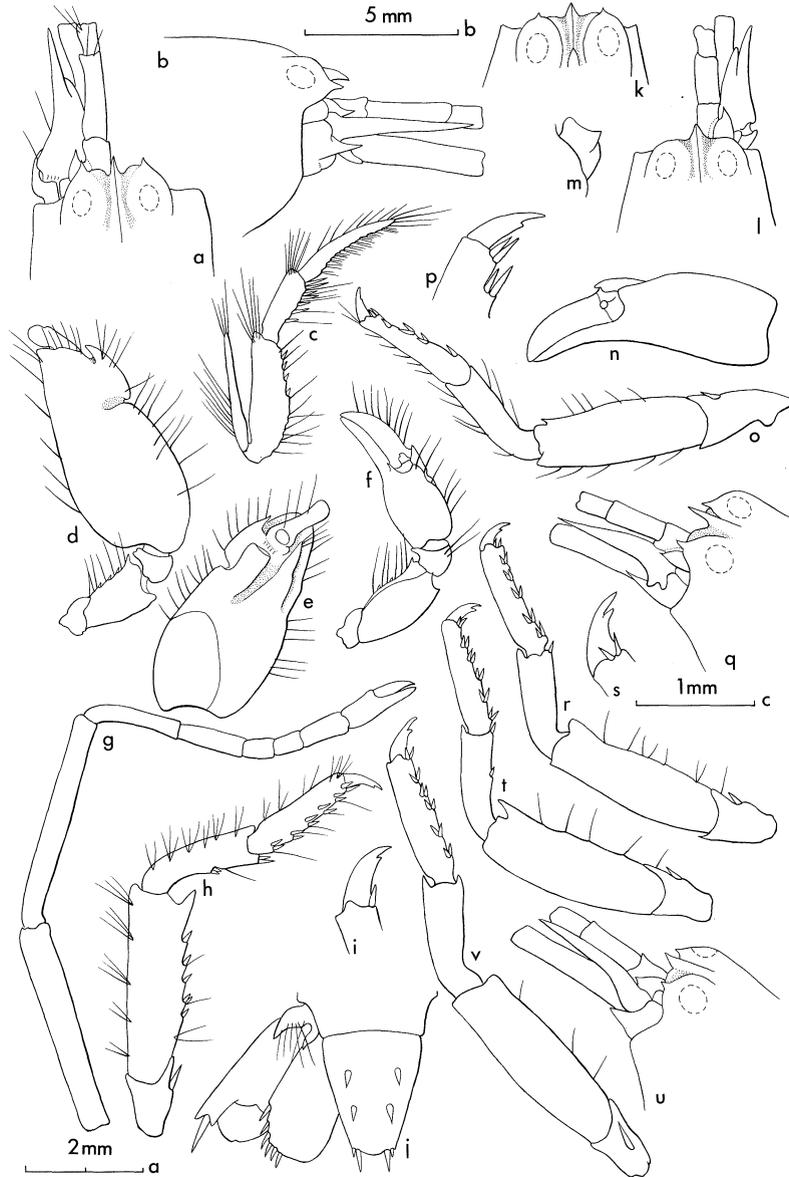


Fig. 9 *Alpheus collumianus* Stimpson

18 mm male from BAU 21. **a, b.** Anterior region, dorsal and lateral view; **c.** third maxilliped; **d.** large cheliped, medial face; **e.** large chela, superolateral face; **f.** small cheliped, lateral face; **g.** second leg; **h, i.** third leg and enlarged dactylus; **j.** telson and uropods. Cohabiting pair from BAU 21; **k.** Anterior region of 15 mm female; **l.** anterior region of 15 mm male; **m.** basiscerite of male; **n.** small chela of male, medial face; **o, p.** third leg and enlarged dactylus of male. 18 mm female from BAU 32; **q.** Anterior region, superolateral view; **r, s.** third leg and enlarged dactylus. 15 mm male from BAU 32; **t.** Third leg. 18 mm female from BAU 47. **u.** Anterior region, lateral view; **v.** third leg. **a, b, c, g, h, j, k, l, m** scale a; **d, e, f** scale b; **i, n, o, p, q, r, s, t, u, v** scale c.

Alpheus collumianus medius Banner, 1956:340, fig. 11.

Alpheus collumianus inermis Banner, 1956:342, fig. 12.

Alpheus malhaensis Coutière, 1908a:205; 1921:419, pl. 62, fig. 14.

Previous Australian record: Coutière, 1900:414. Murray Is., Torres Straits.

SPECIMENS EXAMINED: 1 specimen each from AC 18, 29, 35, 57, 68, 74; 1, AC C-59; 4, AM 74 (AM P. 27470); 2, AM 98 (AM P. 27781); 10, AM 109 (AM P. 27508); 3, AM 305 (AM P. 27776); 1, BAU 11; 2, BAU 15; 2, BAU 18; 5, BAU 21; 5, BAU 29; 4, BAU 30; 3, BAU 31; 5, BAU 32; 12, BAU 33; 4, BAU 47; 2, BAU 48; 1, BAU 55: 2, 75 LIZ-7 (AM P. 27903); 1, 75 LIZ-C (AM P. 27904); 1, 75 LIZ-H (AM P. 27905); 2, 75 LIZ-I (AM P. 27906); 2, 75 LIZ-Q (AM P. 27907); 2, 75 LIZ-R (AM P. 28144); 3, 75 LIZ-T (AM P. 28143); 1, 75 LIZ-U (AM P. 27908); 2, 75 LIZ-V (AM P. 27909).

DIAGNOSIS: Rostrum acute, short, reaching to near middle of visible part of first antennular article, a little longer than wide at base. Rostral carina strong, narrowly rounded, extending posteriorly to behind eyes. Orbital hoods inflated, rounded. Orbital margin varying from lacking teeth to having teeth almost as long as rostrum. Margin of carapace of specimens without orbital teeth tapering gradually into rostrum; those specimens with orbital teeth have area between teeth and rostral base flattened with margin convex and separated from base of rostrum by rounded notch. Orbitorostral grooves deep but rounded, extending to posterior portion of orbital hoods.

Second antennular article 2.7 times longer than third and usually 2 or more times as long as visible part of first, and 2-3.5 times as long as broad. Stylocerite varying from having only a slight distal tooth to having a well-developed tooth reaching almost to end of first antennular article. Scaphocerite with strong lateral tooth reaching to end of antennular article, squamous portion narrow, reduced, much shorter than lateral tooth and reaching near end of second antennular article. Carpcerite reaching to or beyond end of antennular peduncle. Tooth on basicerite varying from a strong tooth that reaches to end of first antennular article to being a rounded to slightly acute angle (figs. 9b, m, u).

First and third article of third maxilliped nearly equal in length, second article 0.6 as long as first. Inferior margins of both the first and second articles bearing a few short spines as well as fine setae.

Large chela heavy, compressed, nearly 1.3 times as long as broad. Palm marked distally by three crests, a strong superior crest terminating distally in acute tooth flanking superior side of dactylar articulation, a rounded crest terminating in adhesive plaque, a lateral flattened ridge terminating in strong lateral tooth at dactylar articulation. Superior crest arising proximally from narrow transverse saddle that reaches about 0.4 width of medial face. Plaque crest merging with superior margin of palm and demarked from superior and lateral crests by deep but rounded grooves. Lateral crest with inferior groove shallow. Inferior shoulder slight and rounded. Dactylus truncate, twisted laterally, and tip slightly overhanging end of pollex. Merus 1.5 times as long as broad; inferior margin bearing 3 short spines and terminating distally in a strong acute tooth.

Small chela about 3.0 times as long as broad with fingers and palm very nearly equal. Superior margin bearing a slight transverse groove at about middle of palm. Superior margin proximal to groove flattened and bordered on medial side by a slight shoulder. Superior margin distal to transverse groove terminating in strong

acute tooth at articulation of dactylus, similar to that of large chela. Palm also bearing acute tooth lateral to dactylar articulation. Medial face of chela moderately hirsute, lateral face glabrous. Merus 2.1 times as long as broad. Inferoventral margin bearing fine setae and a few small spines and terminating distally in a small acute tooth. Small cheliped of female similar to that of male but more slender.

Carpal articles of second leg with ratio: 10:7:3:3:5.

Ischium of third leg with spine. Merus 3.2-3.7 times as long as broad. Inferoventral margin bearing at times 4-5 strong spines and at times bearing no spines but only setae; distally varying from heavy acute tooth to rounded (see figs. 9h, o, r, t, v). Carpus 0.5 as long as merus, inferior margin may be smooth or may bear one to several spines, distal margins usually projected or bearing one or 2 spines. Propodus 0.6 as long as merus, bearing on inferior margin 5 pairs of spines and a pair distally. Dactylus 0.3 as long as propodus, biunguiculate with inferior unguis represented variously from a slight angle to a strong unguis 0.25 as long as superior unguis.

Telson 3.0 times as long as broad at posterior end. Distal portion of inner uropod beset with spines.

DISCUSSION: In the collections from the Marianas reported by the junior author in 1956 there seemed to be three forms of this species represented, differing chiefly in the development of the orbital teeth, orbitorostral front, the tooth of the stylocerite, the tooth of the basicerite, in the armature of the merus and carpus of the third legs and finally in the secondary unguis of the dactylus. These were described tentatively as separate subspecies, *A. c. probabilis* (name selected as the subspecies most likely to be similar to Stimpson's lost holotype) being consistently with heavy and numerous spines and teeth; *A. c. inermis* being almost devoid of this armature, and *A. c. medius* being somewhat intermediate between the two. In the 28 specimens then reported these characteristics seemed to sort themselves out with distinct breaks between the variability of one subspecies and the others. Although the inadequate field notes available could not substantiate the point, it was suggested that perhaps the three forms were ecologically isolated.

In one subsequent publication we reported the two subspecies present in a single collection, probably a cohabiting pair (from the Societies, B&B, 1967:264). This threw some doubt on the validity of the subspecific separation. However, in 1968 (p. 279) we reviewed 93 separate collections of the species then available to us and found "only 11 collections had the 2 subspecies represented, and none had all three."

In the present Australian collection each of the three morphological distinctions occurred, but often with "independent assortment", so that while the sets of characteristics usually went together as originally described, some were found in which these characteristics were mixed, for example, without the meral spines of the third legs (characteristic of *A. c. inermis*), but with the orbital teeth (characteristic of *A. c. probabilis*). They were not found to be ecologically separated as originally presumed, for example, in BAU 33, in one collection of 12 specimens from coral heads in one narrow zone all three subspecies occurred. Finally we discovered that the shrimp themselves do not recognize our distinctions, for as in the Society Islands, we found *A. c. inermis* and *A. c. medius* to make up a cohabiting pair (BAU 21). We found a similar confusion of characteristics in 58 specimens we collected from the southern Philippines. We regretfully conclude that if nature itself does not recognize our fine distinctions, perhaps we too should give up the subspecies

separations in this species.

However, it is still interesting to note that apparent geographical or ecological separation still appears. Thus, all of the 7 specimens from the Houtman Abrolhos lacked spines and terminal tooth on the merus of the third leg.

We have examined Coutière's holotype for *A. malhaensis* from Saya de Malha at the Muséum National d'Histoire Naturelle of Paris and find it no different than the form previously recognized as *A. c. medius*. Coutière had figured the dactylus of the third leg as simple (fig. 14c), but upon close examination was found to carry a small secondary unguis. We place this species in synonymy.

BIOLOGICAL NOTES: This species is common on reef flats; it has also been dredged as deep as 24-41 fathoms (Banner, 1953:70). Those Australian specimens for which we have collection records all came from dead coral heads in water up to 10 ft deep. Two cohabiting pairs from Arlington Reef (BAU 21, the mismatched pair cited above, the other of the form of *A. c. probabilis*) were noted to be bright red in life. This colour was also reported in a pair from the Societies (*loc. cit.*). However, specimens collected from the Houtman Abrolhos (AC 57, 68, 74) were reported as being "yellow-brown with darker brown spots". One specimen from BAU 33 appeared to be living commensally with a brittle star *Ophiothrix (Placophiothrix) sp.* (identified by Dr Dennis Devaney of the Bishop Museum, Honolulu). Our largest specimen was 20 mm long.

AUSTRALIAN DISTRIBUTION: We have specimens from western Australia from Houtman Abrolhos; in northern Australia from Murray Island in the Torres Straits and on the east coast from Lizard Island in northern Queensland south to Heron Island in the Capricorn Group.

GENERAL DISTRIBUTION: This species has been collected from the Red Sea and Madagascar to Japan and across the central Pacific to Hawaii and the Societies.

SULCATUS GROUP
(=Macrochirus Group)

Often with orbital teeth; at times with rostral base flattened and demarked from orbitorostral grooves. Large chela usually with light to heavy longitudinal grooves, usually without transverse grooves, never markedly compressed; dactylus normal. Small chela never balaeniceps. Third legs with or without meral tooth; dactylus biunguiculate or simple.

Most species appear to occur in dead or living coral, but some are found under coral heads and the range of some extends beyond the range of coral. The name has been changed from Macrochirus Group to Sulcatus Group as *A. macrochirus* Richters has been found to be a synonym of *A. sulcatus* Kingsley.

***Alpheus villosus* (Olivier)**

Fig. 10

Palaemon villosus Olivier, 1811:664.

Palaemon diversimanus Olivier, 1811:663.

Alpheus villosus Milne-Edwards, 1837:354. Coutière, 1898f:204; 1899; fig. 47, 48, 126, 148, 266, 319, 320, 383.

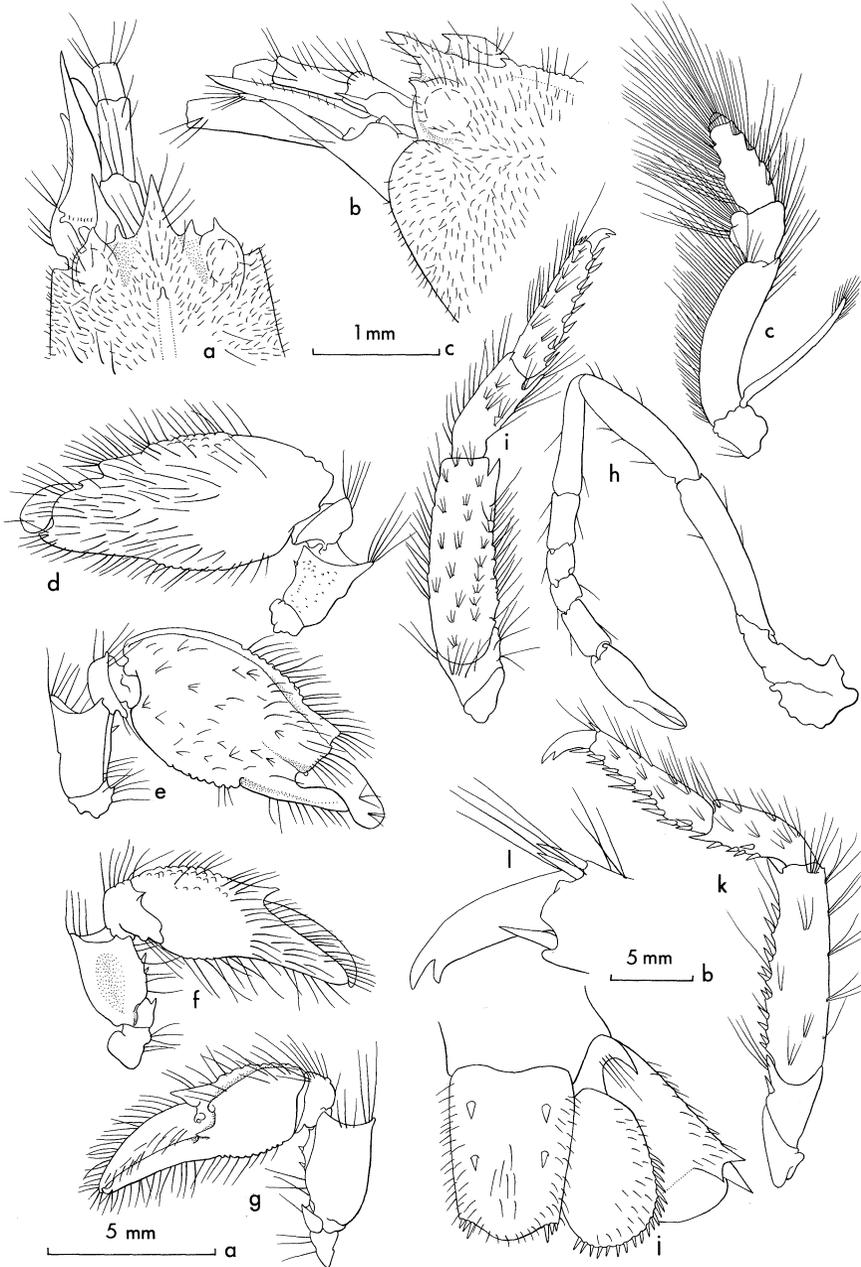


Fig. 10 *Alpheus villosus* (Olivier)

40 mm male from WM 296-65. **a, b.** Anterior region, dorsal and lateral view; **c.** third maxilliped; **d, e.** large cheliped, medial and lateral face; **f, g.** small cheliped, medial and lateral face; **h.** second leg; **i.** third leg; **j.** telson and uropods. 38 mm male from WM 247-65. **k, l.** Third leg and enlarged dactylus. **a, b, c, h, i, j, k** scale a; **d, e, f, g** scale b; **1,** scale c.

Paralpheus diversimanus Bate, 1888:568, pl. 102.

Previous Australian records:

- Haswell, 1882b:187. Southern Australia.
- Miers, 1884:290. N.E. Australia.
- Ortmann, 1894:14. Thursday Is., Torres Straits.
- Coutière, 1898f:206. (discussion of type)
- Nobili, 1899:233. Beagle Bay, Dampier Land.
- Sayce, 1902:155. Port Phillip, Victoria.
- Balss, 1921:9. Cape Jaubert, W.A.
- Hale, 1927a:46, fig. 37. S. Australia (as *Crangon villosus*).
- Hale, 1927b:307. Baeres Pt., Kangaroo Is., S. Australia [as *C. villosus*].
- Hale, 1941:265. S. Australia [as *C. villosus*].

SPECIMENS EXAMINED: 1 specimen from AC 40; 5, AM 15 (AM P. 27798); 1, AM 18 (AM P. 27785); 3, AM 21 (AM P. 27793); 2, AM 34 (AM P. 27822); 1, AM 122 (AM P. 28145); 1, AM 128 (AM P. 27823); 3, AM 139 (AM P. 27820); 2, AM 224 (AM P. 27819); 1, AM 248 (AM P. 27829); 2, AM 303 (AM P. 28146); 2, AM 308 (AM P. 27784); 4, AM 382 (AM P. 27834); 1, AM E. 4496; 4, AM E. 4497; 1, AM G. 614; 1, AM P. 2055; 1, AM P. 2344; 2, AM P. 2768; 6, AM P. 3014; 8, AM P. 3956; 1, AM P. 8702; 1, AM P. 9422; 1, AM P. 13583; 4, AM P. 14959; 5, AM P. 27884; 12, AM P. 27885; 1, BAU 28; 2, SM C-501; 2, SM C-502; 1, SM C-504; 4, SM C-505; 1, SM C-514; 1, SM C-1074; 1, TM G1461; 1, TM G1511; 1, TM G1528; 1, VM 1; 4, VM 10; 13, VM 11; 2, VM 17; 1, VM 18; 2, VM 22; 1, VM 30; 1, VM 33; 1, VM 25S; 2, VM 33S; 2, VM 41N; 1, WM 38-65; 3, WM 85-65; 1, WM 105-65; 1, WM 187-65; 2, WM 212-65; 2, WM 226-65; 2, WM 247-65; 1, WM 274-65; 1, WM 293-65; 6, WM 296-65; 1, WM 301-65; 1, WM 298-65; 1, WM 6052; 1, WM 8752; 1, WM 9982; 1, WM 10468; 1, WM 10570; 1, WM 108-60; 1, WM 11100/1; 1, WM 115-33.

DIAGNOSIS: Entire body hispid with short stiff setae interspersed with scattered long setae, all arising from small bosses. Rostrum acute, 1.8 times as long as broad at base, slanted upward and reaching end of first antennular article; carina sharp, carrying acute, forward-directed tooth at level of posterior margin of eyes, and continued posteriorly as sharp ridge to mid-carapace. Orbital hoods inflated, each with acute tooth overhanging anterior margin of hood. One small triangular tooth on orbitorostral margin between orbital hoods and base of rostrum. Eyes never brown to black, at times appearing chalky or ranging from a light yellow to a dark red in alcohol.

Second antennular article about 2 times as long as broad and 1.3 times length of first and almost twice length of third article; all articles with scattered long setae. Stylocerite with prominent lateral tooth reaching beyond end of first antennular article. Scaphocerite with lateral margin concave, lateral tooth reaching beyond end of antennular peduncle, almost to end of carapocerite; squamous portion narrow, reaching middle of third antennular article. Carapocerite reaching more than half length of third antennular article past that article. Basicerite with lateral tooth heavy, cylindrical and reaching to end of second antennular article; inferior to major tooth lies a minute but acute tooth (not seen from angle of fig. 10b).

Third maxilliped stout, third article 2.2 times as long as broad. Medial surface of all articles bearing long hairs with those of second and third articles long, thick and brushlike.

Large chela compressed, 2.2 times as long as broad with fingers occupying the distal 0.2. All surfaces of chela bearing small tubercles, lateral face with short bristles, but medial face with thickly set stiff setae that sweep forward. Medial face without grooves.

Superior face with obliquely directed longitudinal groove extending from carpal to dactylar articulation. Lateral margin of groove smooth, medial serrate. Lateral face with smooth broad groove arising mid palm and extending to dactylar articulation. Near inferolateral margin is a moderately deep longitudinal groove that extends from inferior shoulder nearly to distal portion of pollex. Dactylar articulation flanked by acute teeth on either margin. Tip of dactylus truncate, overhanging end of pollex. Inferior margin of ischium with three spines. Merus 2 times as long as broad, surface covered with bosses carrying hairs. Inferoventral margin bearing two or three spines, distally bearing a small acute tooth. Superior margin projected into a broad rounded tooth and bearing a tuft of setae.

Small chela not sexually dimorphic, 2.7 times as long as broad, fingers and palm nearly equal. Dactylar articulation flanked by teeth, with medial tooth longer and curved upward. Superior margin bearing groove directed obliquely toward lateral face similar to that of large chela. Merus similar to that of large chela.

Carpal articles of second leg with ratio: 10:5:2:2:5. Chela as long as last three articles.

Ischium of third leg armed with spine. Merus 2.7 times as long as broad, inferior margin bearing about seven patches of short stiff setae, or alternatively with definite spines, and terminating distally in a strong acute tooth. Superior margin terminates in a patch of moderately long stiff setae. Carpus 0.6 as long as merus, inferior margin bears two to three patches of setae or spines similar to those on merus and terminating in acute tooth; superior margin projected but rounded. Propodus a little longer than carpus, with inferior margin bearing six pairs of spines and a pair distally. Superior margin beset with a series of patches of long stiff setae with a spine distally. Dactylus biunguiculate, inferior unguis two-thirds as long as superior.

Telson 1.7 times as long as broad, anterior margin 1.3 times as wide as posterior. Anterior pair of dorsal spines placed anterior to middle. Lateral margin of inner uropod bearing a row of spines.

DISCUSSION: Olivier in 1811 described among other species collected by Perron (or Péron) two species that are now believed to be identical. One was named *Palaemon villosus* from the "mer des Indies" but bearing the label in the vial of "Port du Roi Georges", presumably King George Sound at Albany, W.A., and the other was named *P. diversimanus* from "Nouvelle Hollande". The specimens of "*P. diversimanus*" evidently have been lost, and the exact locality of collection cannot be ascertained as Péron accompanied Nicolas Baudon, who in 1800-1804 explored and mapped the south and west coasts of Australia from near Sydney around to Melville Island. In his terse descriptions, Olivier did not contrast the characteristics or otherwise distinguish between the two named forms.

In 1837 Milne-Edwards re-described *A. villosus* and stated (p. 354) that *A. diversimanus* "ne me parait pas devoir être distingué spécifiquement de l'*Alphée velu* . . ." But he did state that *A. diversimanus* had a little more abundant hairs which were a little stiffer. Others accepted this synonymy until Bate (1888) revived the specific name *diversimanus* and created it for a new genus, *Paralpheus*; his specimen came from off Cape York. In 1898f Coutière re-examined the specimens of Bate and decided that his *Paralpheus diversimanus* was actually *Alpheus villosus*. In his 1899 Thesis Coutière provided some excellent figures of the species (see above). Since that date the name has stood except for that interim when the name *Crangon* was substituted for *Alpheus*.

This species shows variation on a number of characteristics. In preservation and

possibly in life there is a variation noted above in the eye colour. The rostrum may reach considerably short of the end of the first antennular article to somewhat beyond; the carinal tooth at the level of the posterior margin of the eyes may vary from a slight protuberance to a large acute tooth.

The lengths relative to the antennular articles of the carpopocerite itself and the large tooth of the basicerite both vary. The ratio of lengths of the first two carpal articles of the second legs ranges from 10:5 to 10:8. In Bate's figure (pl. 102, fig. v) he showed two spines on the distal portion of the outer uropod; two of our specimens were similarly armed, but all other specimens had but a single tooth. Other minor differences in proportions were seen.

However, the armature of the merus and carpus of the third legs can be used to separate the species into two distinct forms. One form, mostly from south temperate waters, carries tufts of setae on the inferior borders of these articles; the other, always from tropical waters, carries distinct spines in place of the setae (contrast figs. 10i and 10k). Between the two forms we have found no intermediates, such as thicker setae or finer spines approaching setae. This difference has not been noted by earlier workers. Coutière, in his figure of the third leg (1899; fig. 319) showed spines on the type specimens, but our examination of the same specimen (Olivier's, from Port du Roi Georges) showed these were not spines but setae. Bate's specimen of "*diversimanus*" (pl. 102, fig. 1) was shown to have spines as would be expected from its tropical location, but Coutière (1898f) in his re-examination of the specimen did not remark on the difference.

We were initially inclined to consider the form bearing the spinose articles as a distinct and geographically separated sub-species. The northern form did not extend beyond the Torres Straits (about 11°S) in the east nor beyond Exmouth Gulf (about 22°S) in the west, while the southern form did not reach further north than 37°S in the east nor 32°S in the west save for one specimen from Houtman Abrolhos (at about 28°43'S). However, after we had made the decision two additional specimens were received that upset this geographical separation: the specimen from SM C505, from "Northern Territory" noted above, and one specimen from the Sulu Archipelago, Philippines (WM 216-65), neither of which have the spines on the third legs characteristic of the other tropical specimens. We therefore are deferring the separation of the species into geographical or ecological sub-species until further studies are made.

Two other minor mistakes have appeared in the literature. Bate described the dactylus of the third leg as being "single pointed"; this was corrected by Coutière in his re-description. Coutière (1899, fig. 383) did not show the row of small spines on the margins of the inner uropod, but our re-examination of the holotype showed these were present and they were found on all other specimens we have examined.

BIOLOGICAL NOTES: This species has been reported to reach 67 mm in length. It has been dredged as deep as 24 fathoms and taken from corals collected intertidally. The specimens for which the habitat was noted in the collection data, were recorded from cryptic locations; the sole specimen we ourselves collected was from deep within a head of coral. It is probable that the lack of normal pigmentation of the eyes is associated with this dimly lit or lightless habitat.

The colour notes on the northern and southern forms show similar colouration. The specimen we collected from the Torres Straits region was lemon yellow with stellate red chromatophores, with red and white striped antennules and antennae and red eyes. The colour notes on a specimen supplied by the Fisheries and Wildlife Department of Victoria (VM 33S) from Western Port stated "All over pale light orange, spotted with red stellate

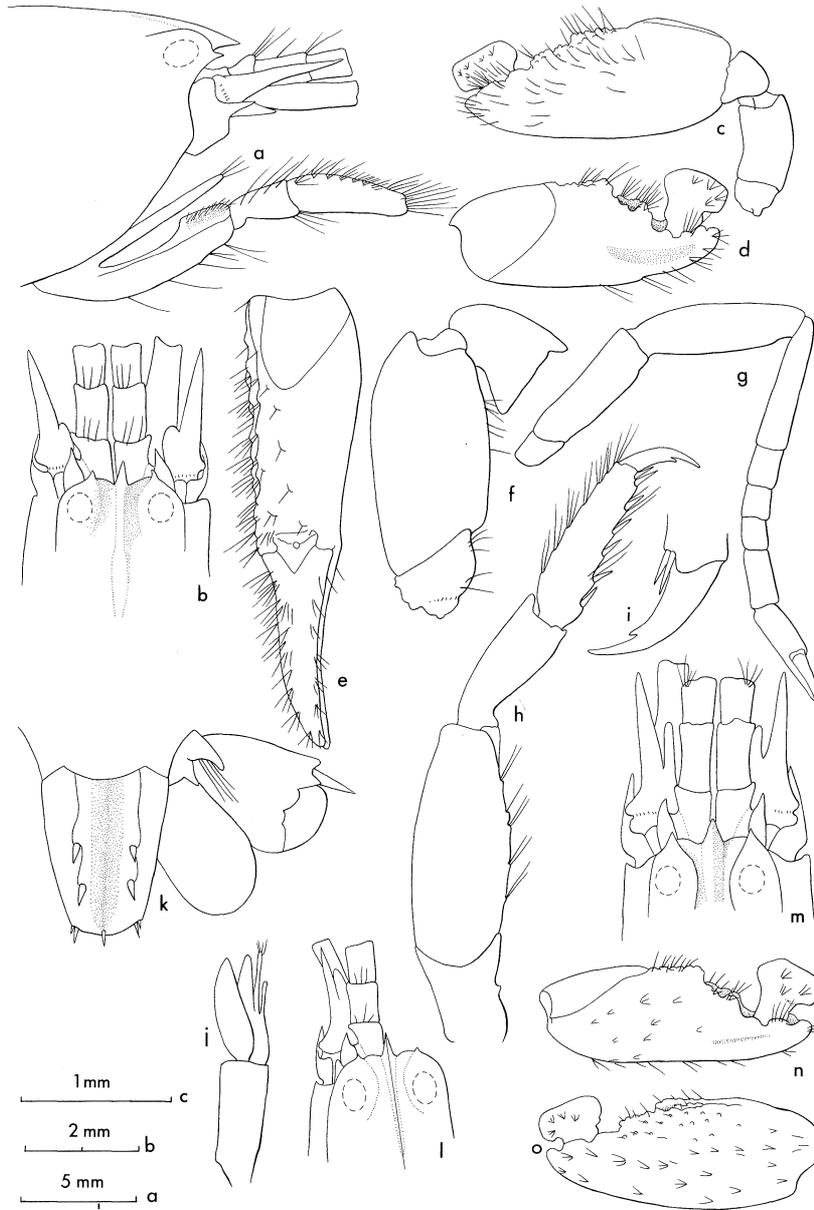


Fig. 11 *Alpheus architectus* De Man

24 mm female from US 123599. **a, b.** Anterior region lateral and dorsal view; **c.** large cheliped, medial face; **d.** large chela, lateral face; **e.** small chela, superior face; **f.** merus of small cheliped, medial face; **g.** second leg; **h, i.** third leg and dactylus enlarged; **j.** second pleopod, male; **k.** telson and uropods. 15 mm female from AM 185. **l.** Anterior region, dorsal view. 24 mm syntype of *Alpheus bullatus* Barnard. **m.** Anterior region, dorsal view; **n.** large chela, lateral face; **o.** large chela, medial face. **c, d, n, o** scale a; **a, b, e, f, g, h, j, k, l, m** scale b; **i,** scale c.

chromatophores. Medial face of large chela bright orange, eggs orange. Dorsal spines of telson and posterior lateral spines orange". Similar colours were reported by Hale (1927a:46) and for the specimen from Houtman Abrolhos (AC 40).

AUSTRALIAN DISTRIBUTION: "Southern form" from Twofold Bay, N.S.W., south and west to Perth, W.A. (with extensions noted above); "Northern form" from Exmouth Gulf east to Torres Straits.

GENERAL DISTRIBUTION: South Africa; Mascarene Islands; Sulu Sea, Philippines (reported above).

Alpheus architectus De Man

Fig. 11

Alpheus architectus De Man, 1897:726, fig. 60.

Alpheus bullatus Barnard, 1955:45, fig. 22.

SPECIMENS EXAMINED: 1 specimen from AM 185 (AM P. 28115); 3, US 123599.

DIAGNOSIS: Rostrum 2 times as long as wide at base, tip reaching past middle of visible part of first antennular article. Carina sharp and high to behind eyes then broadening and becoming rounded, finally constricting again and merging with carapace near middle. Orbital hoods bearing short acute teeth. Orbitorostral margin arcuate, set off from margins of rostrum by curved notch. Orbitorostral grooves moderate, rounded.

Second antennular article 1.5 times as long as broad and sub-equal in length to visible part of first and third articles; distal margins of first two articles bearing a few stiff setae. Stylocerite acute, not reaching end of first antennular articles. Scaphocerite with heavy lateral tooth reaching near end of antennular peduncles, squamous portion usually rudimentary, but if developed, narrow, not reaching further than middle of third antennular article.

Large chela moderately compressed with a hammer-shaped dactylus. Chela 2.4 times as long as broad with fingers occupying distal 0.2. Superior surface of chela developed as flattened shelf immediately behind dactylar articulation (to accommodate end of dactylus when flexed); proximal to this is a low rounded ridge extending to *linea impressa*. Superodistal portion of medial face carrying large bosses from which spring single and groups of stiff bristles; bosses giving way to small punctae on middle and lower portions of face. Lateral face almost glabrous, but with deep "V"-shaped groove originating near *linea impressa* half-way up on palm and continuing to slightly beyond dactylar articulation. Adhesive plaques large. Dactylus extending well beyond short pollex; pollex and sides of dactylus near tip bearing tufts of short stiff bristles.

Small chela 2.7 times as long as broad, 0.75 as long as large chela. Lateral face smooth with some pustules near superior surface. Superior surface developed as slight rounded shoulder running from *linea impressa* to dactylar articulation and carrying tufts of short setae set in depressions. Superomedial area bearing scattered pustules with patches of short bristles. Upper portion of lateral face bearing a few patches of short setae. Pollex carrying knife-like cutting edge on medial side, meeting low angular ridge on dactylus; tips curved and crossing. Merus 1.8 times as long as wide, distal margins without teeth.

Ratio of carpal articles of second leg: 10:8:3:3:6.

Third leg robust. Ischium without spine, merus inermous, 2.7 times as long as broad, bearing patches of setae on inferior margin. Carpus 0.6 as long as merus with upper and

lower distal angles extended as blunt teeth. Propodus 0.8 as long as merus, lower margin carrying five heavy spines and a pair distally. Dactylus biunguiculate, lower unguis one-sixth of upper, both ungui similarly curved.

Telson 2.2 times as long as wide at posterior margin. Dorsal spines carried on two high rounded longitudinal ridges with broad depression at midline and flat along edges. First pair of dorsal spines placed anterior to middle. At times posterior margin of telson with one or two spines near middle, in addition to usual posterolateral pairs.

DISCUSSION: In addition to the three specimens listed above, we have a large series from Madagascar that were concurrently studied. Our specimens are in agreement with the two specimens that De Man originally described from Atjeh. In the only Australian male the *appendix masculina* of the second pleopod was much longer than the *appendix interna* (fig. 11j) and as long as the endopodite; the male specimens from Madagascar were of similar development. In most species of the genus *Alpheus*, except some in the Crinitus Group, the *appendix masculina* is only a little longer than the *appendix interna* and not nearly as long as the endopodite; this condition was not remarked upon by De Man. In the genus *Metalpheus* and in the Atlantic genus *Thunor* the greater development of the *appendix masculina* is considered to be of generic importance.

Through the courtesy of Dr B. F. Kensley of the South African Museum we were able to examine a male syntype of *Alpheus bullatus* Barnard which we compared to the specimens from Australia and from Madagascar. We have figured the large chela and anterior region of the carapace of the syntype. The orbitorostral margins, figured by Barnard as concave, we found to be convexly arcuate. It had the long *appendix masculina* like the others in our study collection. We could find no major differences between this specimen and others in the collection, so we do not hesitate to place *A. bullatus* in synonymy to *A. architectus*.

BIOLOGICAL NOTES: These specimens were found intertidally under corals. The specimens from Madagascar were collected from eel grass beds. Moulton, who collected the specimens from Wistari Reef (US 123599), noted that they were "dark red in life, prominent white markings on large chela". The largest specimen was 32 mm in length.

AUSTRALIAN DISTRIBUTION: The specimens came from northern New South Wales and Heron Island in the Capricorn Group.

GENERAL DISTRIBUTION: De Man's specimens came from Atjeh; Barnard's from South Africa; we will report on the Madagascar specimens in a later paper; there are no other records.

***Alpheus splendidus* Coutière**

Fig. 12

Alpheus splendidus Coutière, 1897a:235. De Man, 1924:41, fig. 14; 1929:23, pl. 3, fig. 8. Crosnier and Forest, 1965a:361, fig. 4 (*passim*).

Alpheus pomatoceros Banner and Banner, 1966b:93, fig. 32.

SPECIMENS EXAMINED: 1 specimen from BAU 32.

DIAGNOSIS: Rostrum acute, 2 times as long as broad at base, reaching to just past end of first antennular article. Rostrum with rounded carina that extends posteriorly to behind base of eyes. Orbitorostral grooves rounded, moderately deep. Anterior margins of orbital hoods evenly rounded and extended as flattened prominences, orbitorostral

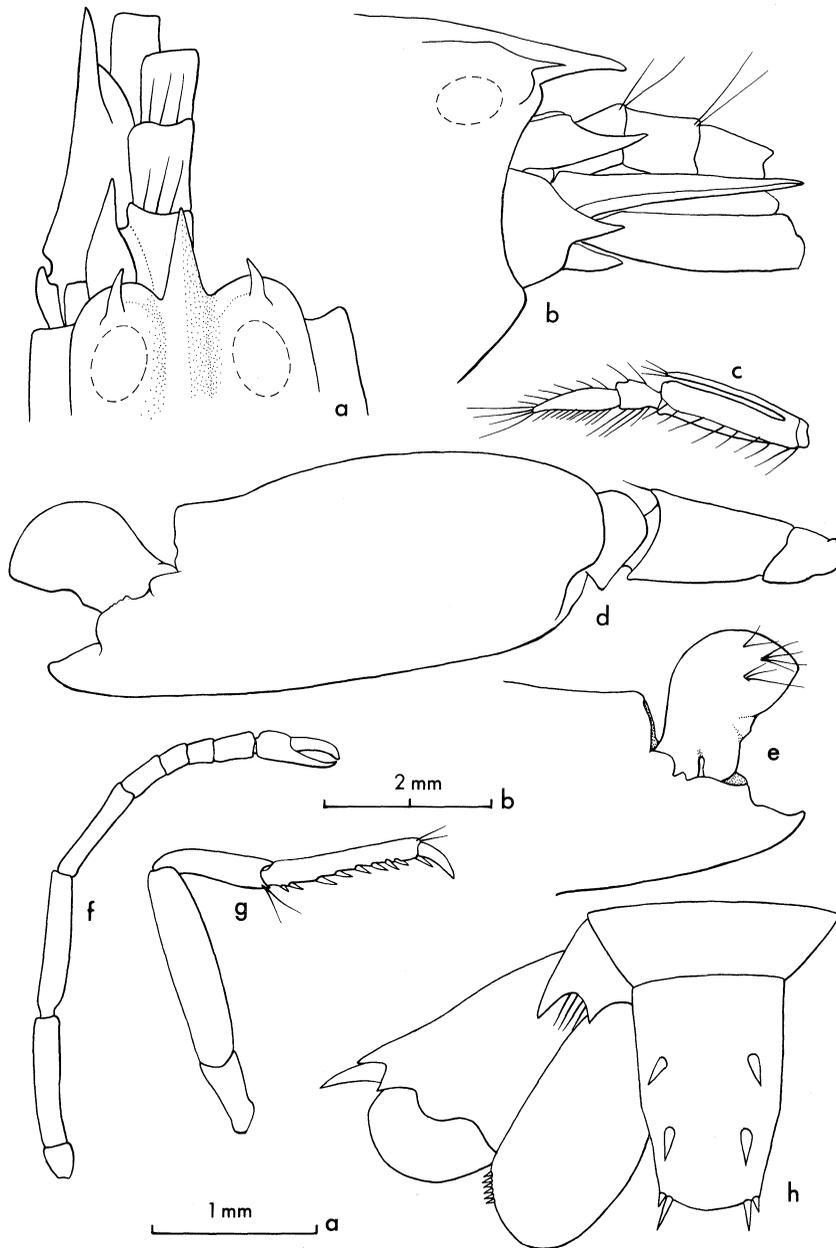


Fig. 12 *Alpheus splendidus* Coutière
 14 mm specimen from BAU 32. **a, b**. Anterior region, dorsal and lateral view; **c**. third maxilliped; **d, e**. large cheliped, medial face and distal region, lateral face; **f**. second leg; **g**. third leg; **h**. telson and uropods. **a, b, c, h** scale **a**; **d, e, f, g** scale **b**.

margin concave. Short acute orbital teeth arising from upper curvature of hoods, not from margins, and curved somewhat medially.

Visible portion of first antennular article a little longer than either of two following; second article 1.2 times as long as wide and as long as third. Stylocerite acute, reaching slightly past end of first article. Scaphocerite with lateral margin slightly concave, lateral tooth reaching almost length of third antennular article past that article, squamous portion reaching just past end of antennular peduncle. Carpocerite longer than squame. Spine of basicerite broad at base, tip reaching near end of rostrum.

Large chela moderately compressed, 2.7 times as long as broad with fingers occupying distal 0.27. Superior margin bearing a narrow, shallow longitudinal groove that extends from proximal third to near articulation of dactylus. Dactylus truncate at tip, plunger prominent. Merus 1.8 times as long as broad, inferoventral margin terminating in acute tooth, superior margin with strong rounded projection distally. Small chela not sexually dimorphic, 4.3 times as long as broad with fingers slightly longer than palm; tips of fingers hooked and crossing. Palm bearing medially at articulation of dactylus an acute tooth, no tooth on distolateral margin. Merus 1.4 times as long as broad. Inferodistal margin terminating in small acute tooth, superior margin in a prominent tooth and inferoexternal margin rounded.

Carpal articles of second leg with ratio: 10:4:3:3:4.

Ischium of third leg unarmed, merus 5 times as long as broad, unarmed. Carpus slender, 0.5 as long as merus with distal margins slightly projected. Propodus 0.7 as long as merus and bearing on its inferior margin 8 spines and a pair distally. Dactylus simple, 0.25 as long as propodus.

Telson 2.3 times as long as broad at posterior end. Inner spine of posterolateral pair 2 times as long as outer.

DISCUSSION: In 1966 we described from the Gulf of Thailand what we believed to be a new but closely related species to *A. splendidus* which we named *A. pomatoceros*. We separated the two species on the basis of the large chela; in as much as Coutière had given only a sketchy description of the chela and no figures, we used the redescription and figure of De Man (1929) of a specimen from the Malacca Straits. In 1965 Crosnier and Forest published a drawing of the anterior body region and the large chela of the holotype, the latter being quite different than that of De Man. Dr Forest of the Muséum National d'Histoire Naturelle of Paris agreed to compare the holotype with 2 specimens we had collected in the Philippines that were identical to our Australian specimen; he could find no important differences. We have also re-examined our specimens from Thailand and find that they belong to *A. splendidus* as now described. They have the slight longitudinal groove on the superior surface of the large chela, a characteristic found in *A. splendidus* which we had failed to note in the original description. On the basis of these comparisons, we are assured that the specimens from Australia, the Philippines and the Gulf of Thailand are all *A. splendidus* and we are placing *A. pomatoceros* into synonymy.

We have also had the opportunity to re-examine De Man's specimen from the Malacca Straits through the kindness of the Zoologisch Museum in Amsterdam. We found that its characteristics except for the chela were those of *A. splendidus*, but that the chela, loose in the jar, appeared to be that of *A. parvirostris* Dana. We are therefore presuming that De Man's record of the species from Indonesian waters is correct, but that his drawing of the chela was in error.

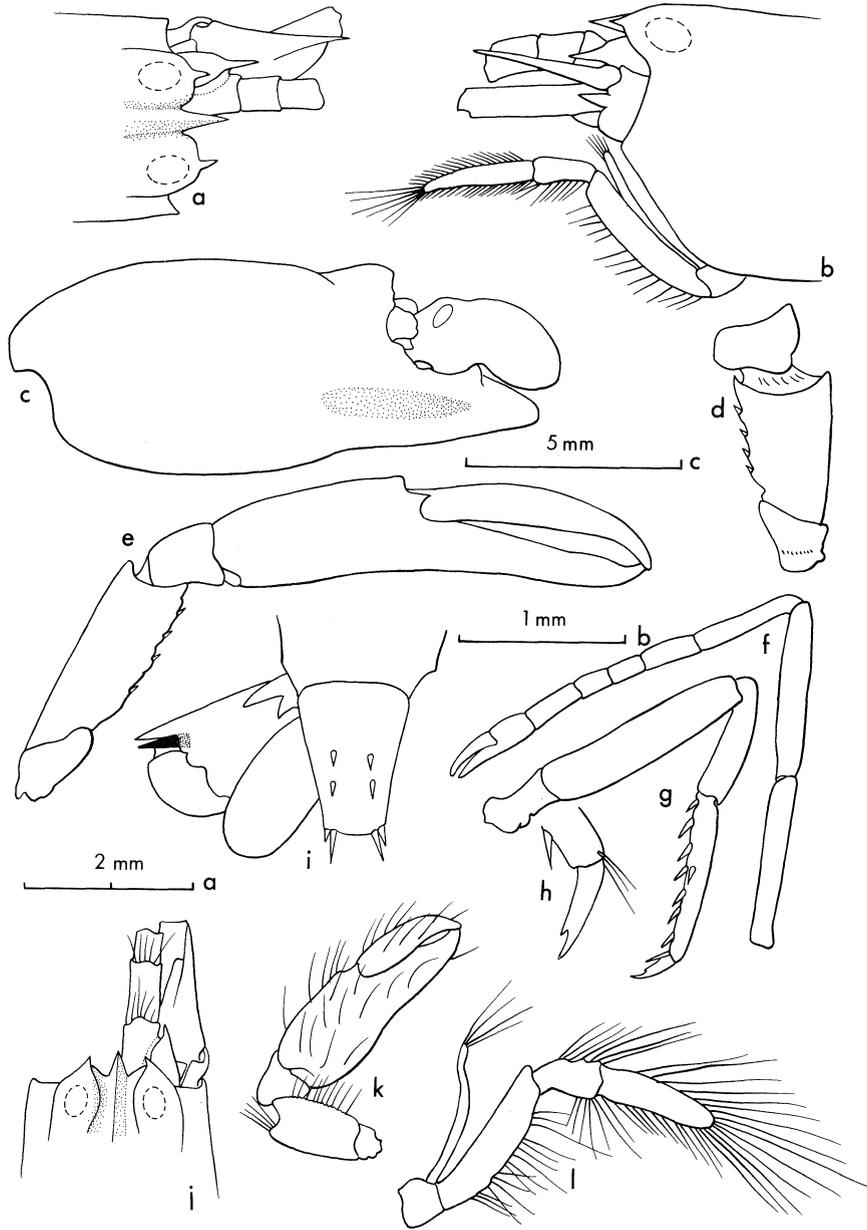


Fig. 13 *Alpheus gracilis* Heller

16 mm female from BAU 33. **a, b.** Anterior region, dorsal and lateral view; **c.** large chela, lateral face; **d.** Merus of large cheliped, medial face; **e.** small cheliped, medial face; **f.** second leg; **g, h.** third leg and enlarged dactylus; **i.** telson and uropods. 15 mm female from BAU 29. **j.** Anterior region, dorsal view; **k.** small cheliped, medial face; **l.** third maxilliped. **a, b, c, d, e, f, g, i, j** scale a; **h, k** scale b; **l** scale c.

BIOLOGICAL NOTES: This species has been collected only intertidally. Coutière's colour remarks in his original description are as follows: ". . . *une étroite bande jaune vif du rostre au telson, bordée de deux bandes brunes; le reste du corps rougeâtre, sauf deux étroites lignes blanches contiguës aux bandes brunes; pinces orange clair*". The Australian specimen is only 20 mm in length, but we have some specimens from Hong Kong that are 50 mm.

AUSTRALIAN DISTRIBUTION: Our one specimen came from Opal Reef on the Great Barrier Reef near Port Douglas.

GENERAL DISTRIBUTION: Red Sea, Seychelles, Indonesia, Malaysia, Thailand, Philippines and Hong Kong.

***Alpheus gracilis* Heller**

Fig. 13

Alpheus gracilis Heller, 1861:271, pl. 3, fig. 19, 20. De Man, 1897: 733, fig. 60g, h (*passim in texto*). Tiwari, 1963:283, fig. 7.

Alpheus gracilis Alluaudi Coutière, 1905a:882.

Alpheus gracilis luciparensis De Man, 1911:337, fig. 66.

Alpheus gracilis gracilis Banner and Banner, 1968:280.

Crangon gracilis simplex Banner, 1953:75, fig. 25.

Alpheus gracilis simplex Banner and Banner, 1966b:97, fig. 34; 1968:280.

? *Alpheus gracilis* Stebbing, 1919:123, pl. 20. Barnard, 1950:742.

SPECIMENS EXAMINED: 1 specimen from BAU 29; 1, BAU 33; 1, JG 6-73.

DIAGNOSIS: Rostrum acute, rounded dorsally, without carina; tip reaching past middle of visible part of first antennular article. Orbital hoods with narrow acute teeth well demarked from curvature of hoods; tips reaching past middle of rostrum. Orbitorostral margin deeply incised but rounded; orbitorostral grooves shallow and rounded. Antennular peduncles with second antennular article about 0.7 as long as visible part of first and only slightly longer than broad. Stylocerite large with lateral spine reaching to middle of second antennular article. Scaphocerite with strong lateral spine reaching beyond, and squamous portion subequal to, antennular peduncle. Carpocerite as long as lateral tooth of scaphocerite. Lateral tooth of basicerite prominent, as long as rostrum.

Large chela compressed, 2.5 times as long as broad, with fingers occupying distal 0.3. Superior margin bearing shallow rounded transverse depression proximal to dactylus; below this depression the inferior margin showing a slight constriction. Inferior third of lateral face bears shallow longitudinal depression that extends proximally from near middle of pollex to level of constriction on inferior margin. Dactylus not carinate, tip rounded; plunger of moderate development. Merus 1.5 times as long as broad, superodistal margin slightly projecting but rounded, inferointernal margin bearing 4 spines and a small acute tooth distally.

Small chela not sexually dimorphic, 4.6 times as long as broad; fingers a little longer than palm. Palm bearing tooth at dactylar articulation. Merus similar to that of large chela.

Ratio of articles of third maxilliped: 10:3:4. Second article 2 times as long as distal margin is wide. Distal tip with small brush of hairs.

Ratio of carpal articles of second leg: 10:4:3:3:4.

Ischium and merus of third leg unarmed; merus 4 times as long as broad. Carpus 0.6 as long as merus, superodistal margin projecting as a rounded tooth. Propodus 0.7 as long as merus, bearing on inferior margin 8 spines with a pair distally. Dactylus slender, 0.3 as long as propodus, in one specimen (BAU 33) bearing a small secondary unguis (fig. 13g, h) and another (JG 6-73) bearing a swelling on inferior surface at corresponding site.

Telson 2.5 times as long as posterior margin is broad. Anterior dorsal spines anterior to middle. Inner spines of posterolateral pair with length about equal to half breadth of posterior margin. External spine (not tooth) of outer uropod black.

DISCUSSION: While we have only 2 specimens clearly of this species from Australia (BAU 33, JG 6-73) we wish to review the "varieties" and subspecies of this species that have appeared in the literature. Heller's original type came from the Red Sea; De Man found his description defective and redescribed it in 1911. In 1905 Coutière described a variety *alluaudi* from the Seychelles and Maldives which was distinguished from Heller's species only by the lack of a secondary unguis on the dactylus of the third leg. In 1911 De Man also described the variety *luciparensis* from Indonesia which was separated from Heller's holotype by subtle differences in proportions. In 1953 the junior author described also as a variety (but subsequently used the name as a subspecies) a form from Hawaii under the name *simplex* that was separated from *A. gracilis gracilis* by the rostral carina, orbitorostral grooves, lack of tooth on the merus of the large cheliped, and with *A. g. alluaudi*, the lack of a secondary unguis on the dactylus of the third leg. He also pointed out that the variations found in the Hawaiian form would invalidate the criteria used by De Man for the separation of his variety (if, of course, populations from the Red Sea and Indonesia showed variation parallel to that in Hawaii).

In addition to the Australian specimens, we have studied the following specimens available to us in our various collections: 23 specimens from the Red Sea; 42 specimens from Thailand; 23 specimens from the southern Philippines; 8 specimens from Christmas Island (of the Line Islands, Pacific Ocean); 25 specimens from Maui, Hawaiian islands.

In these collections we found:

1. That while most specimens had deep orbitorostral grooves, those from Hawaii and Thailand appeared to be more shallow. However, in all groups there was variation and the impressions were subjective and could not be quantified. We also found that all groups of specimens, except those from Christmas Island, showed considerable variation in the relative length of the rostrum to the orbital teeth, but with the rostrum markedly longer than the teeth. In all 8 specimens from Christmas Island the rostrum was short, equal or subequal to the lengths of the teeth.

2. In all specimens examined there was a projection at the dactylar articulation of the small chela, but in groups from all localities this varied from a low obtuse tooth to a strong acute tooth as shown in figs. 13 e, k. The length-breadth ratio of the small chela varied from 3.5 to 4.5, a variation that could not be correlated with size, sex or locality.

3. All specimens from Thailand had no indication of a secondary unguis on the dactylus of the third leg (it should be noted that Tiwari figures a specimen from nearby Vietnam with a secondary unguis). Specimens from Hawaii had either a uniformly tapering dactylus or carried a swelling at the point where the secondary unguis would be expected; in one, however, the swelling was larger and definitely made an obtuse angle. In the small number of specimens from Christmas Island we found the condition varying from a slight rounded swelling through an angular projection to a strong definite tooth. Of the 23 specimens from the Philippines 3 had no secondary unguis, 4 had a slight

swelling, and the rest had a definite but small secondary unguis. All specimens from the Red Sea had strong and acute secondary ungui.

We conclude, therefore, that this species shows a tendency to develop morphologically separated geographic races or subspecies, but that this tendency is not definite enough to warrant the use of subspecific names, and we recognize only the nominate species.

The third specimen that we have listed as this species, a 15 mm female from BAU 29, is somewhat doubtful, for it differs from the other specimens we include in our review by a number of characteristics: the stylocerite only reaches to near end of first antennular article instead to the middle of the second; the blade of the scaphocerite is narrower; the third article of the third maxilliped is 3.5 instead of 7.0 times as long as broad, has a broader and more rounded tip and its tip bears setae longer than the article rather than markedly shorter; the merus of the chelipeds have the spines of the inferoventral margin replaced by setae and lack the terminal tooth; the small chela is somewhat heavier, 3.0 times as long as broad (but *A. gracilis* from the Red Sea run from 3.5 to 4.5 times as long as broad). It may have a different habitat, for it was collected from the rubble-strewn windward reef flat of Rudder Reef (off Port Douglas) where at times there is heavy direct surf action, while all *A. gracilis* we have been able to document did not occur in areas where the waves actually break. We consider the differences in the third maxilliped the most important. However, considering the variation in *A. gracilis*, and considering that there was only one somewhat defective specimen of this form, we are tentatively placing it under this species. We are illustrating this form in figure 13. Should additional specimens be collected and show constant characteristics, its separation should be reconsidered.

We agree with Barnard (1950:741) that both Stebbing's previous report of *A. gracilis* from South Africa and his own report of defective specimens that were possibly of this species are not firm enough to warrant extending the range of *A. gracilis* to include that area.

BIOLOGICAL NOTES: Coutière reported some colour notes on specimens from Djibouti (1898i:197). " . . . *gris rougeâtre, cette coloration étant disposée par bandes sur le corps et en macules irrégulières sur les pinces*". Our specimens from Maui, Hawaii also have the reddish bands from near the middle of the carapace to the posterior end of the abdomen. We feel it is likely that this reddish brown banding is typical of *A. gracilis*. Most of the specimens we have seen have the external spine of the uropod coloured brown to black. This species has been collected inter- to subtidally and grows to a length of 35 mm.

AUSTRALIAN DISTRIBUTION: Two of our specimens came from off Port Douglas, Qld. and the other from Stradbroke Island, near Brisbane, Qld.

GENERAL DISTRIBUTION: This species has been recorded from many localities from the Red Sea and possibly South Africa, through the Indian Ocean and central Pacific to Hawaii and the Society Islands. We would expect to find it at least in the Ryukyus and possibly in southern Japan.

***Alpheus facetus* De Man**

Fig. 14

Alpheus facetus De Man, 1908:100; 1911:340, fig. 67. Tiwari, 1963:288, fig. 9. Banner and Banner, 1966b:96, fig. 33.

SPECIMENS EXAMINED: 1 specimen each from AC 19, 28, 42, 58, 67, 81; 1, AM 21 (AM

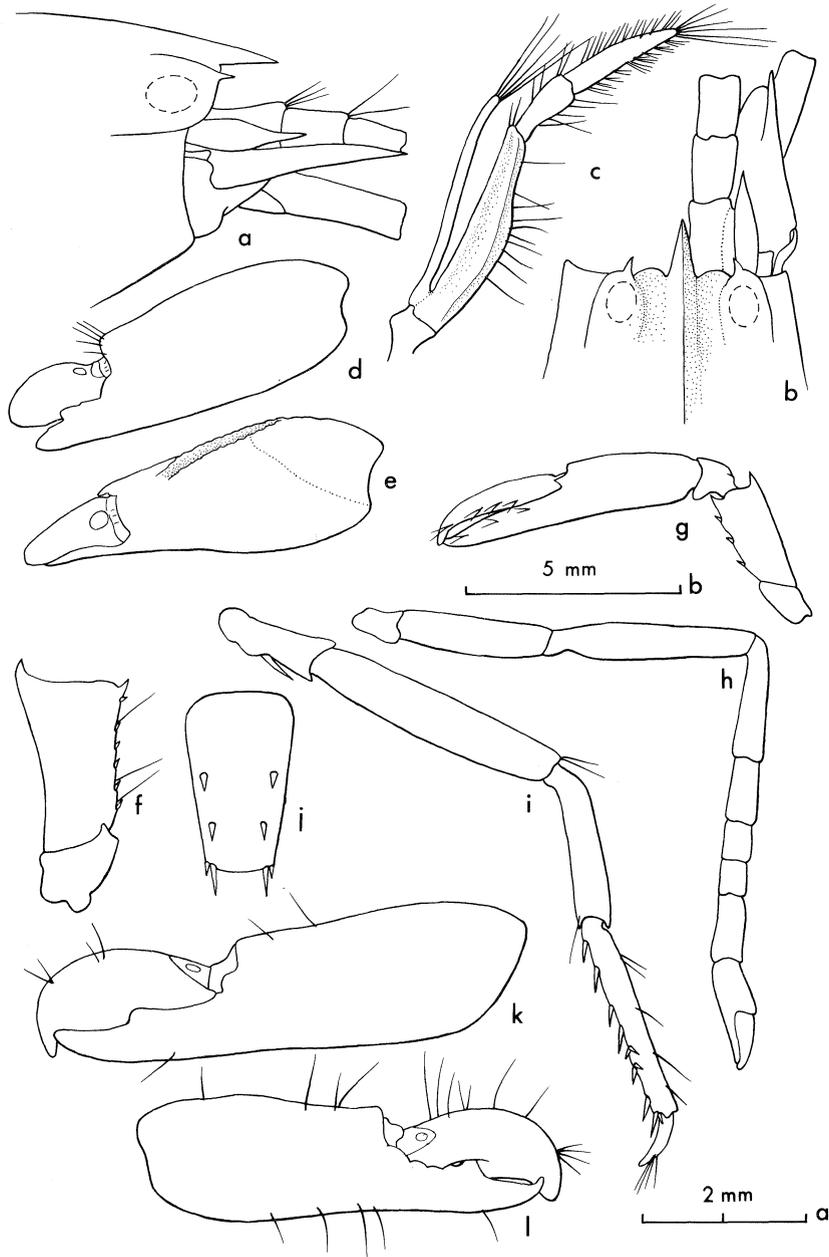


Fig. 14 *Alpheus facetus* De Man
 15 mm male from BAU 56. a, b. Anterior region, lateral and dorsal view; c. third maxilliped; d, e. large chela lateral and superolateral face; f. merus of large cheliped, medial face; g. small cheliped, medial face; h. second leg; i. third leg; j. telson. 24 mm male from BAU 27. k. Large chela, lateral face. 22 mm male from BAU 28. l. Large chela, lateral face. a, b, c, f, h, i, j scale a; d, e, g, k, l scale b.

P. 27792); 1, AM 28 (AM P. 27551); 1, AM 33 (AM P. 27812); 1, AM 207 (AM P. 27563); 2, AM 283 (AM P. 27330); 1, AM 349 (AM P. 28147); 6, AM P. 2580; 1, AM P. 5314; 1, AM P. 6351; 1, AM P. 10534; 1, AM P. 27409; 1, AM P. 27569; 2, BAU 4; 2, BAU 10; 2, BAU 16; 1, BAU 21; 6, BAU 25; 8, BAU 27; 2, BAU 28; 1, BAU 32, 2, BAU 43; 4, BAU 44; 3, BAU 56; 2, JG 22-73; 1, MM 414; 1, WM 210-65; 2, WM 221-65.

DIAGNOSIS: Rostrum acute, 2 times as long as broad at base, reaching to end of first antennular article, with blunt carina that broadens slightly posteriorly and extends to near middle of carapace. Orbitorostral grooves broad and shallow, eye hoods only moderately inflated. Anterior margins of orbital hoods bearing teeth, 0.3 as long as rostrum and directed slightly inwards. Anterior margin between orbital teeth and rostrum with flattened prominences. Antennular articles nearly equal in length; second article 1.4 times as long as broad. Stylocerite with acute tip reaching to middle of second antennular article. Scaphocerite with lateral margins straight, lateral tooth extending slightly beyond antennules, squamous portion reaching to last quarter of third antennular article. Carpcerite reaching well past antennules, slightly longer than tooth of scaphocerite. Tooth on inferior margin of basicerite acute, broad at base and reaching to level of tip of rostrum.

Ratio of articles of third maxilliped: 10:3:5. Tip of third article bearing a tuft of long hairs.

Large chela slightly compressed, varying from 2.4 to 3.6 times as long as broad, with fingers varying from 0.4 to 0.6 times length of palm. Superior margin bearing 2 longitudinal ridges with a depression between which begin near proximal fifth and extend obliquely, to near distal fifth of palm where they disappear. This groove is often faint and at times missing entirely. Inferior margin rounded without notches or grooves. Merus 1.8 times as long as broad, superior margin bearing distally a broad acute tooth, inferointernal margin bearing from 4-6 small spines and a small acute tooth distally.

Small chela not sexually dimorphic, 4.6 times as long as broad with fingers and palm equal. Palm bearing slightly medially an acute tooth at dactylar articulation. Merus 2.3 times as long as broad, similar in armature to large chela.

Ratio of carpal articles of second leg: 10:5:3:3:5.

Ischium of third leg with spine. Merus 5 times as long as broad, unarmed.

Carpus 0.6 as long as merus, distal angles slightly projecting. Propodus 0.8 as long as merus, bearing on its inferior margin 9 spines with a pair distally. Dactylus 0.23 as long as propodus, simple.

Telson 2.7 time as as long as posterior margin is broad, first pair of dorsal spines placed just anterior to middle, inner spine of posterolateral pair long and slender, length almost half length of posterior portion.

DISCUSSION: The specimens exhibited some variation. The rostrum varied from shorter than to slightly longer than, the first antennular article. The palm of the large chela varied from 1.4 to 2.3 times longer than the fingers with the majority of specimens having the palm over 2 times longer than the fingers. There were only 3 specimens in which the fingers were unusually long and we have figured 2 (fig. 9k, 1). The dactylus of all the specimens, except those with the longer fingers, was truncate. Since the three specimens with the longer fingers resembled the other specimens in the collection almost exactly we considered this a variation. The specimen from BAU 27 came from a collection of seven of normal proportions from the same location. In a collection of 25 specimens of this species we made in the Philippines there was also one specimen in

which the palm was 1.5 times longer than the fingers. The first two articles of the second legs in our specimens varied from 10:5.5 to 10:4.7.

BIOLOGICAL NOTES: This species has been collected from intertidal to depths of 30 metres, but most specimens have come from dead coral heads collected in 6 metres or less depths.

A specimen from Hayman Island (BAU 43) was reported as having "two longitudinal brown bands separated mid-dorsally by a pinkish tan band. Chelae more or less a continuation of the brown band. Tail fan dark at base, then with a light band adjacent to this, and the tail terminated in a dark green band". Yaldwyn has supplied similar colour notes for a specimen from the Gulf of Carpentaria (AM 28). Our largest specimen was 28 mm in length.

AUSTRALIAN DISTRIBUTION: We have specimens from Western Australia from near Perth north to Yampi Sound. In northern Australia from Darwin, the Gulf of Carpentaria and Thursday Island; in eastern Australia from off Port Douglas south to near Sydney, N.S.W.

GENERAL DISTRIBUTION: Viet Nam; Thailand; Indonesia; Philippines.

***Alpheus lottini* Guérin**

Fig. 15

Alpheus Lottini Guérin, 1829:pl. 3, fig. 3.

Alpheus Lottinii Guérin, 1838:38. Kingsley, 1882:113.

Alpheus lottini Holthuis, 1958:22; 1961:168. Tiwari, 1963:285, fig. 8. Banner and Banner, 1966b:91, fig. 31.

Alpheus ventrosus Milne-Edwards, 1837:352.

Alpheus laevis Randall, 1839:141.

Alpheus Thetis Miers, 1874:5, pl. 4, fig. 7 (=A. *Thetis* White, a *nomen nudum*) (New Holland).

Crangon latipes Banner, 1953:82, fig. 27 (juvenile form).

Crangon ventrosa Banner, 1953:83, fig. 28

Previous Australian records:

Heller, 1865:107. Sydney (as *A. laevis*).

Haswell, 1882b:191. Sydney (as *A. laevis*).

Coutière, 1900:413. Murray Is. (as *A. ventrosus*).

Patton, 1966:282. Queensland (as *A. ventrosus*).

McNeill, 1968:15. N. Queensland (as *A. ventrosus*).

SPECIMENS EXAMINED: 1 specimen from AC 15; 1, AC 17; 1, AC 61; 1, AC 62; 1, AH 5; 1, AM 29 (AM P. 27299); 4, AM 58 (AM P. 27300); 4, AM 74 (AM P. 27502); 1, AM 83 (AM P. 27301); 2, AM 99 (AM P. 27770); 14, AM 123 (AM P. 27302); 4, AM 147 (AM P. 27303); 2, AM 171 (AM P. 27503); 1, AM 174 (AM P. 27525); 1, AM 186 (AM P. 27304); 2, AM 238 (AM P. 27305); 2, AM 268 (AM P. 28103); 1, AM 275 (AM P. 27405); 9, AM 283 (AM P. 27306); 3, AM 294 (AM P. 27307); 3, AM 305 (AM P. 27773); 1, AM 341 (AM P. 27332); 4, AM 342 (AM P. 27333); 1, AM 400 (AM P. 27334); 1, AM G. 3283; 3, AM P. 2578; 1, AM P. 6862; 1, AM P. 7309; 3, AM P. 7422; 1, AM P. 7454; 6, AM P. 7524; 1, AM P. 7981; 1, AM P. 8026; 3, AM P.

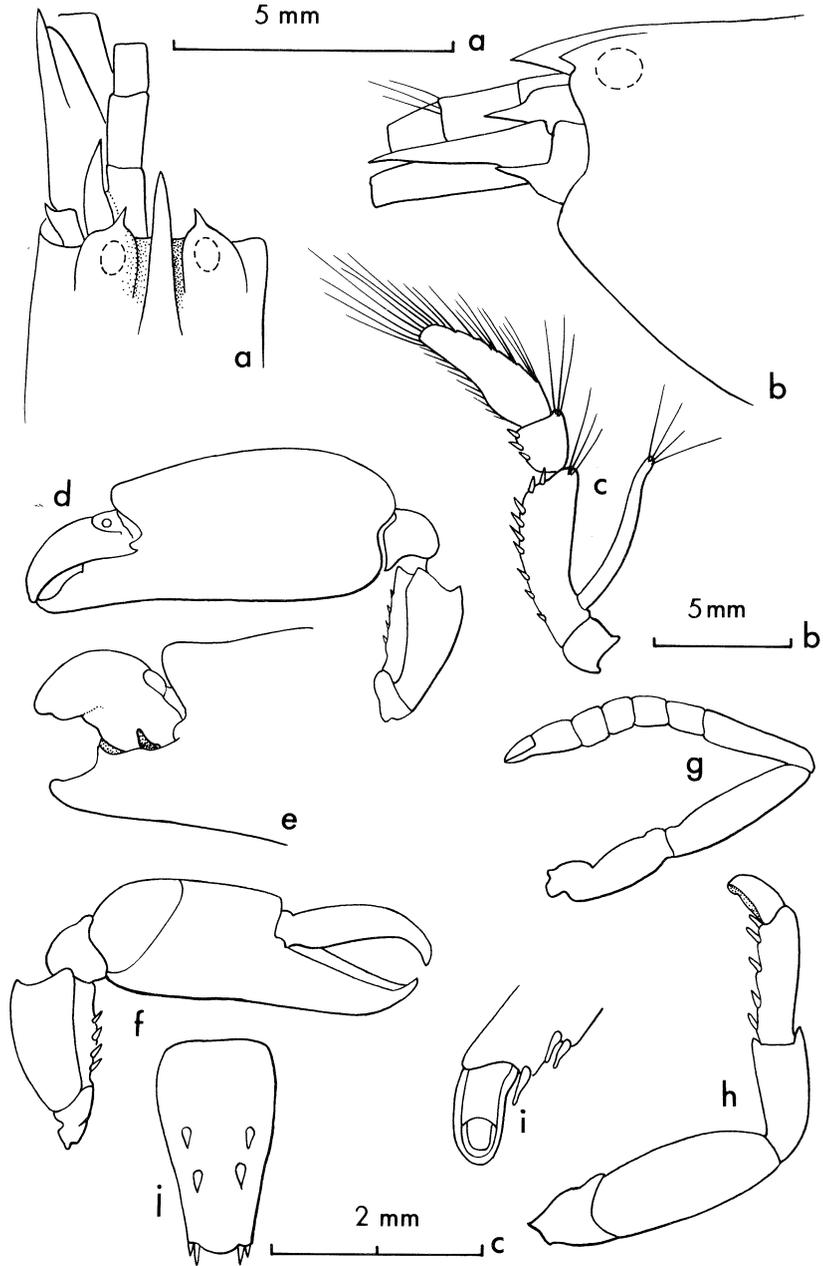


Fig. 15 *Alpheus lottini* Guérin
 29 mm male from AMP 8026. a, b. Anterior region, dorsal and lateral view; c. third maxilliped; d, e. large cheliped and enlarged distal region; f. small cheliped, lateral face; g. second leg; h, i. third leg and enlarged dactylus, inferior face; j. telson. a, b, c, e, g, h, j scale a; d, f scale b; i scale c.

8567; 3, AM P. 10322; 2, AM P. 11401; 1, AM P. 13547; 1, AM P. 13573; 1, BAU 3; 1, BAU 4; 1, BAU 15; 1, BAU 16; 1, BAU 24; 1, BAU 27; 1, BAU 32; 2, BAU 38; 4, BAU 44; 2, BAU 47; 3, BAU 48; 1, BAU 52; 1, BAU 57; 1, JC 23; 2, MM 111; 1, MM 263; 1, MM 421; 2, QM W. 999; 2, VM 2; 1, WM 23-65; 1, WM 118-65; 2, 75 LIZ-S (AM P. 27918).

DIAGNOSIS: Rostrum slender, acute, reaching to end of first article of antennular peduncle. Rostral base broadened, flattened, not carinate dorsally, separated from carapace by deep and narrow sulci on each side. Orbital hoods rounded laterally, bearing acute teeth on more medial portion of hood, teeth directed slightly inward. Antennular peduncle slender, with second article variable but usually 1.7 times as long as broad, only slightly longer than visible portion of first or third. Stylocerite reaching to middle of second antennular article. Scaphocerite long with narrow squamous portion reaching just beyond end of antennular peduncle and with lateral tooth reaching well past end. Carpocerite subequal to length of scaphocerite. Lateral spine of basicerite acute, equal to or exceeding length of stylocerite.

Third maxilliped stout, articles with a ratio: 10:3:8. Inferior margin of both first and second article bearing spines, superior margins bearing coarse setae distally.

Large chela compressed, margins rounded, without grooves or crests, 2.5 times as long as broad. Dactylus not strongly arcuate, in males 0.3 length of entire chela with tip acute and hooked; in females dactylus rounded at tip, only 0.2 length of entire chela. Merus with both superior and inferointernal angles rounded, although projecting; inferointernal margin with about 5 spines.

Small chela almost as long as large chela but more slender, varying from 2.5 to 3.0 times as long as broad; fingers about equal in length to palm. Dactylus strongly curved at tip, crossing fixed finger when closed. Inner margin of cutting face of fixed finger with distinct lamellar ridge along entire length. Merus similar to that of large cheliped.

Ratio of carpal articles of second leg: 10:6:6:6:5; last four articles almost as broad as long.

Ischium of third legs inermous. Merus inermous, over 3 times as long as wide. Carpus with both margins continued as heavy projections. Propodus with 5-7 spines, with broadened, flattened tips. Dactylus heavy, blunt, laterally compressed, with thick longitudinal ridge on inferior face continuing around blunt tip as a curving ridge, the blunt tip thus carrying a ridge of hard chitin similar in form to a horse's hoof; portion of dactylus surrounded by ridge of soft flexible chitin.

Telson 3.3 times as long as broad at posterior end. First pair of dorsal spines placed just anterior to middle. Inner pair of posterior spines nearly same size as dorsal spines.

DISCUSSION: This well-known species has been figured and described many times and has been known by 4 names. Coutière in 1899 (p. 12) placed *A. laevis* into synonymy to *A. ventrosus*; Holthuis in 1958 (p. 12) reviewed the synonymy and accepted Kingsley's (1882:113) decision that *A. ventrosus* was a junior synonym of *A. lottini* Guérin. Holthuis (1957, 1961) also discussed the dates of publication of Guérin's plate bearing the name *Lottini* (in his 1838 description he spelled it *Lottinii*). The junior author also created a synonym, *Crangon latipes*, based on a juvenile specimen markedly different from the adult (1953:82); this was corrected in a subsequent paper (1958:165). Finally we have reported that the largely unused name *A. thetis* White is a synonym of *A. lottini* (B&B, 1977:282).

This species is most easily recognized and the most surely identified in its adult form in the whole genus by the unique development of the dactyls of the walking legs; smaller

specimens found in symbiosis with living pocilloporid corals which do not have this development should be carefully compared to the description of the juvenile form (*loc. cit.*) and with the other symbiont of the same corals, *Synalpheus charon* (Heller) (B&B, 1975:369).

BIOLOGICAL NOTES: This species is an obligate symbiont, living exclusively in living heads of the members of the Pocilloporidae, especially *Pocillopora meandrina* var. *nobilis* Verrill, *P. ligulata* Dana, large colonies of *P. damicornis* (Linnaeus) (= *P. cespitosa* Dana) and some of the species of the genus *Seriatopora* (the last reported by Patton, 1966). This species, together with crabs of the genus *Trapezia*, is found in various parts of the branching colonies, but retire deeply between the branches when disturbed. Also in the same heads, but apparently confined to the unbranched base is the smaller *Synalpheus charon* (Heller). All three symbionts are of similar colour, a mottled bright orange-red ground color with a dark red mottling. *A. lottini* also may bear a mid-longitudinal stripe of deep red that may appear almost black.

In most of the Australian collections the exact depth at which the specimens were collected was not often clearly indicated, but as the host corals cannot survive much intertidal exposure, most must have been subtidal, and extending down to the depth limits of the host. The specimens range in size up to 38 mm.

AUSTRALIAN DISTRIBUTION: We have a few specimens from western Australia from near Perth to the Dampier Archipelago. In North Australia we have specimens from Darwin and the Torres Straits, but the majority of specimens range from Princess Charlotte Bay in north Queensland to Sydney. We also have 4 specimens from Lord Howe Island. There were no specimens from South Australia or Tasmania in our collections.

GENERAL DISTRIBUTION: This species is one of the most widespread species of the Indo-Pacific appearing, it would seem, wherever the host corals appear, from the head of the Red Sea to east and South Africa, through the Indian and Pacific Oceans, and even extending beyond the Eastern Pacific Barrier to the mouth of the Gulf of California. It would be expected to occur in the Ryukyus and Southern Japan as the genus *Pocillopora* appears there, but it has not yet been so reported.

***Alpheus socialis* Heller**

Fig. 16

Alpheus socialis Heller, 1865:106, pl. 10, fig. 1. Thomson, 1903:436, pl. 27, figs. 6-12.

Alpheus doto White, 1847:75. (*nomen nudum*).

Previous Australian records

Haswell, 1882b:190. Sydney.

Sayce, 1902:155. Port Phillip, Victoria.

SPECIMENS EXAMINED: 1 specimen from AM 32 (AM P. 27872); 4, AM 49 (AM P. 27867); 1, AM 76 (AM P. 27845); 7, AM 93 (AM P. 27890); 6, AM 122 (AM P. 27873); 1, AM 150 (AM P. 27843); 2, AM 192 (AM P. 27846); 2, AM 214 (AM P. 27933); 1 AM 220 (AM P. 27866); 1, AM 233 (AM P. 27844); 1, AM 289 (AM P. 27847); 2, AM 383 (AM P. 27876); 1, AM 388 (AM P. 27868); 1, AM 395 (AM P. 27848); 1, AM 398 (AM P. 27849); 2, AM P. 3072; 1, AM P. 5029; 1, AM P. 5711; 1, AM P. 6309; 2, AM P. 6526; 3, AM P. 6912; 1, AM P. 8438; 3, AM P. 10092; 1, AM P. 10114; 15, AM P. 11734; 1, AM P. 13546; 1, AM P. 13560; 4, AM P. 13580; 1, AM P. 27874; 2, AM P. 27877.

DIAGNOSIS: As this species is so like *A. parasocialis* sp. nov., described and figured

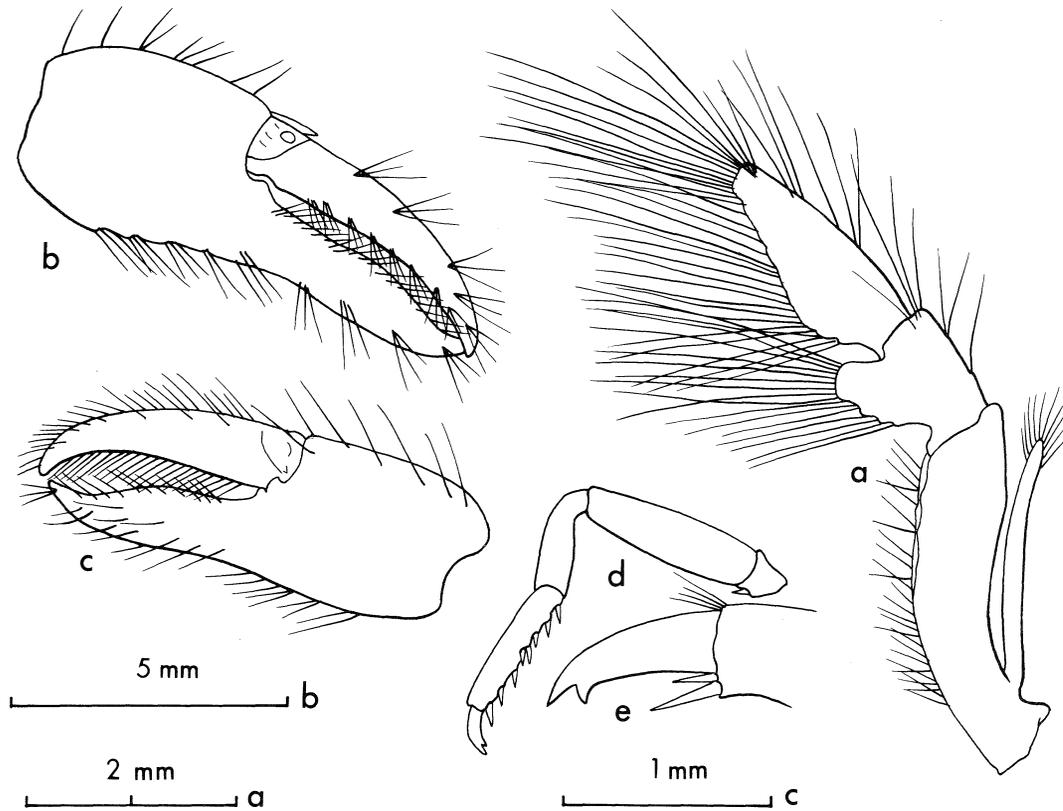


Fig. 16 *Alpheus socialis* Heller
 25 mm male from AM 388. a. Third maxilliped; b, c. small chela, lateral and medial face; d, e. third leg
 and enlarged dactylus. a scale a; b, c, d scale b; e scale c.

below a new full description and figures are not given. Figure 16 illustrates the characteristic features of *A. socialis*.

DISCUSSION: The separation of this species from *A. sulcatus* Kingsley and those related to it in Australian waters is given on Table 1 (p. 86). It is most closely related to *A. parasocialis* B&B and the separation of these 2 species is discussed on p. 73.

Heller did not designate a holotype and give its locality, but instead designated a syntypic series from New Zealand and Australia ("Fundort: Auckland, Sydney"). The species was completely redescribed by Thomson (1903:436, figs. 6-12) using specimens from New Zealand. As neither author mentioned the unique lobe on the second article of the third maxillipeds, and as *A. socialis* and *A. parasocialis* may coexist in the Sydney area, we were undecided as to which species should bear the name given by Heller. We were unable to find Heller's type material, but we reasoned that if only one of two species occurs in New Zealand it is likely that one would be the true *A. socialis*. Dr John Yaldwyn of the National Museum at Wellington compared specimens from Australia that we sent him with those from New Zealand, and in turn sent us some New Zealand specimens for our study. Dr Yaldwyn found that only the form with the lobe on the third maxilliped and other characteristics of this species occurs in New Zealand, so we are designating this form as *A. socialis*.

It is worthy to note that White's *A. doto*, a *nomen nudum* that he reported from Sir C. Hardy's Island from the northern portion of the Great Barrier Reef (approximately 11°56'S:143°29'E) is plainly this species for, in spite of its desiccated condition, it shows the characteristic lobe on the third maxilliped (B&B 1977:282). We are unable to account for this extreme extension of the range of a species that has otherwise been limited to temperate waters in Australia; we suggest the label may be in error.

BIOLOGICAL NOTES: The majority of specimens in these collections were obtained intertidally. However, Yaldwyn sent us a well preserved specimen from off the southern part of South Island, New Zealand that was collected from 60 fathoms.

Yaldwyn supplied the following colour notes for a specimen collected from Long Reef (AM 192). "A small green specimen with a 'W' mark on big hand and had the following general coloration in life: overall colour pale green, incipient darker green band posteriorly on each abdominal segment. Large hand with broad green 'W' on white background". Yaldwyn also reported to us in a personal communication that in a collection of 6 fresh specimens that were collected in 18 fathoms of water off Cape Colville, in the Auckland area, he had found the same distinctive 'W' on the upper face of the large chela. However, all other specimens he had seen from New Zealand had a completely different colour pattern on the large chela. ". . . both hands are orange to purple with a series of large scattered white spots on their upper faces". Yaldwyn sent us several specimens with the latter colour pattern and we compared them with a preserved specimen from Long Reef and were able to detect no morphological differences. We can only assume that the color pattern in *A. socialis* is not a reliable character for identification. Specimens range in size up to 35 mm.

AUSTRALIAN DISTRIBUTION: All of our specimens of *A. socialis* came from the coast of New South Wales, largely from the Sydney area with 9 additional specimens coming from Lord Howe Island. This species appears to be restricted to these areas; it overlaps with *A. parasocialis* only in New South Wales.

GENERAL DISTRIBUTION: Only Australia, Lord Howe Island and New Zealand.

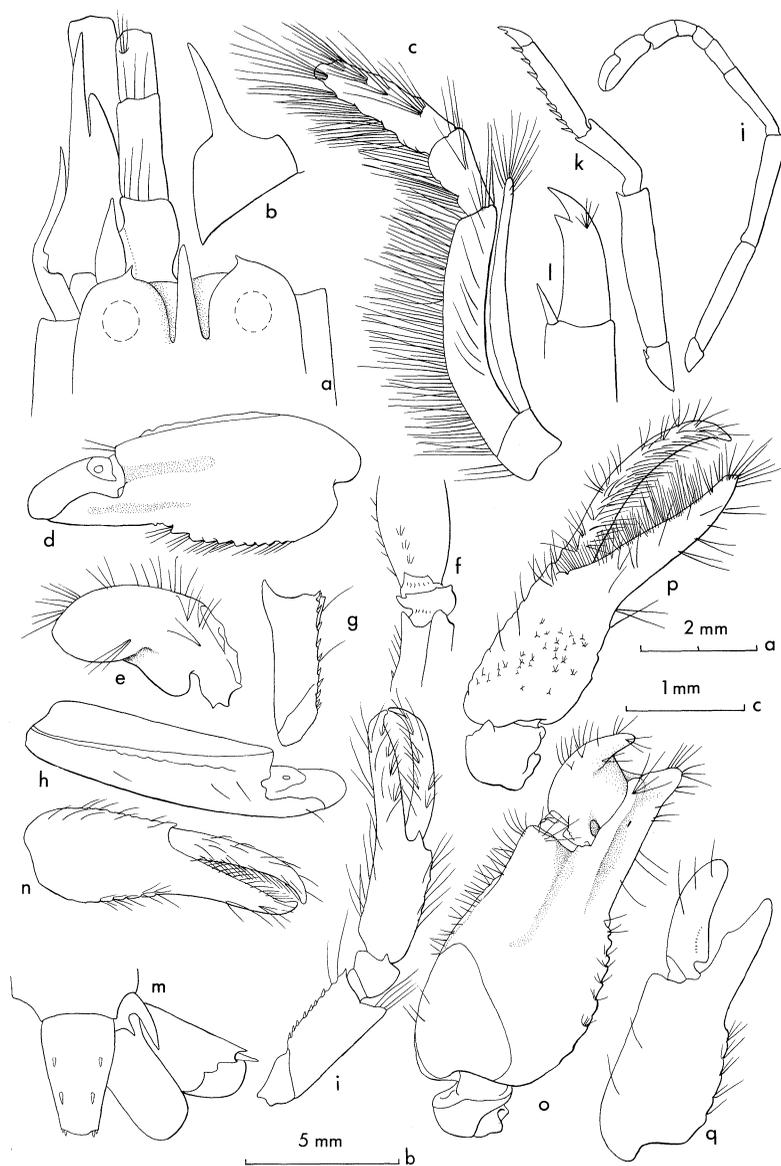


Fig. 17 *Alpheus parasocialis* sp. nov.

Holotype (female). **a.** Anterior region, dorsal view; **b.** basicerite, inferolateral face; **c.** third maxilliped; **d, e.** large chela and dactylus, lateral face; **f.** carpus of large cheliped, inferior face; **g.** merus of large cheliped, medial face; **h.** large chela, superior face; **i.** small cheliped, medial face; **j.** second leg; **k, l.** third leg and dactylus enlarged; **m.** telson and uropods. Allotype (male). **n.** Small chela, medial face. 28 mm male from WM 143-65; **o.** Large chela, lateral face; **p.** small chela, medial face. 30 mm female from WM 182-65. **q.** Large chela, lateral face. **a, b, c, e** scale **a**; **d, f, g, h, i, j, k, m, n, o, p, q** scale **b**; **l**, scale **c**.

Alpheus parasocialis* sp. nov.

Fig. 17

HOLOTYPE: 34 mm female from Palm Beach, Rockingham, W.A. Collected by P. Barrett-Lennard from jetty piles, 1959. (WM 288-65).

ALLOTYPE: 32 mm male specimen from same locality as holotype.

PARATYPES: 2 specimens from AC C-1; 2, AC C-29; 1, AC C-50; 1, AC 41; 1, AC 52; 1, AC 65; 1, AC 76; 1, AC 77; 2, AM 75 (AM P. 27249); 1, AM 182 (AM P. 27250); 2, AM 229 (AM P. 27251); 5, AM E. 5679; 4, AM P. 2329; 1, AM P. 12427; 1, AM P. 13578; 1, AM P. 27256; 10, AM P. 27257; 1, AM P. 27258; 3, AM P. 27259; 1, AM P. 27260; 1, AM P. 27261; 1, AM P. 27936; 1, BAU 3; 3, BAU 4; 1 specimen each from CS. 33, 34, 35, 36; 2, MM 204; 3, QV1971-10-6; 1, SM 2; 1, TM G1482; 1, TM G1509; 1, TM G1510; 2, TM G1538; 1, VM 21; 1, VM 22; 1, WM 23-65; 2, WM 29-65; 2 WM 38-65; 1, WM 42-65; 4, WM 58-65; 3, WM 87-65; 4, WM 95-65; 1, WM 97-65; 1, WM 103-65; 1, WM 108-65; 1, WM 109-65; 1, WM 111-65; 2, WM 112-65; 1, WM 113-65; 6, WM 117-65; 1, WM 120-65; 2, WM 121-65; 1, WM 130-65; 1, WM 135-65; 2, WM 143-65; 1, WM 159-65; 2, WM 182-65; 1, WM 198-65; 1, WM 200-65; 1, WM 201-65; 2, WM 202-65; 1, WM 203-65; 1, WM 228-65; 1, WM 240-65; 1, WM 248-65; 1, WM 257-65; 3 WM 266-65; 1, WM 267-65; 1, WM 269-65; 4, WM 288-65; 4, WM 153/173-31; 3, WM 4985; 1, WM 10011; 2, WM 10381; 1, WM 10467; 5, WM 10571/72; 1, WM 11100/1; 3, WM 251/78-32.

DIAGNOSIS: Rostrum acute, about 3 times as long as broad at its base, reaching variously from first quarter to near end of visible part of first antennular article, without rostral carina. Orbits moderately inflated, orbitorostral grooves deep, recessed under rostrum from anterior margin to base of rostrum. Middle of anterior border of eye hoods bearing short acute teeth that turn medially. Orbitorostral border convex. Visible part of first and third antennular article subequal; second article 1.4 times longer than third article and 2.4 times as long as broad. Stylocerite reaching to end of first antennular article. Outer margin of scaphocerite concave in proximal section, lateral tooth strong and reaching to end of antennular peduncle, squamous portion reduced in breadth and only slightly longer than second antennular article. Carpocerite slightly longer than scaphocerite. Inferior margin of basicerite bearing strong tooth reaching to middle of second antennular article.

Articles of third maxilliped with ratio: 10:2.5:7. Inferior face of all 3 articles bearing profuse long sweeping hairs, tip with a brush of long hairs. Second article with only slight distal broadening, third article with slight taper.

Large chela 2.5 times as long as broad with fingers occupying distal 0.3. Tip of dactylus usually heavily rounded, but at times subacute. Superior margin bearing a longitudinal groove extending from proximal portion of palm and disappearing near dactylar articulation. Medial side of groove with bosses bearing sprinkling of hairs. Outer face of palm with 2 shallow grooves, the superior arising mid-palm and extending to dactylar articulation, the inferior arising near a slight "notch" in inferior margin and continuing on pollex to distal margin of socket. Inferior margin bearing a series of bosses carrying short stiff setae. Plunger of dactylus essentially cylindrical in section with tip truncate at an angle and connected on medial side to distal bulbous portion of dactylus by

*While we are aware that the prefix *para* is Greek and the root *socialis* is Latin, and that the combination of Greek and Latin into a single name is not recommended by the International Commission, we are making the combination deliberately to show what we think is a close relationship, and such relationship cannot be simply expressed in Latin. We have a similar combination for the same reason in *Synalpheus paralaticeps* (p. 291). We also point out that similar combinations have been used in the past, as in *M. paragracilis*.

thin ridge; socket distally with narrow but deep "v"-shaped incision to accommodate ridge. Carpus cup-shaped, 0.4 as long as merus, bearing just proximal to inferior margin of chela a small acute tooth, at times of minimal development. Merus twice as long as broad with distosuperior margin projecting as subacute tooth; inferior margin bearing 7-8 small spines and a small acute tooth distally. Ischium bearing 3 spines on inferior margin similar to those of merus.

Small chela with slight sexual dimorphism, varying from 3.0 to 3.6 times as long as broad, with that of female usually more slender than that of male. Fingers and palm nearly equal. Palm bearing an acute tooth over dactylar articulation. Inferior and superior margin bearing bosses similar to those of large chela. Finger hirsute, at times with hair so dense as to obscure cutting surface on medial face. Merus similar to that of large chela, but distosuperior margin is not projected.

Ratio of carpal articles of second leg: 10:5:2:2:4.

Ischium of third leg bearing small spine. Merus 4.6 times as long as broad, usually with inferior margin projecting as small acute tooth. Carpus 0.5 as long as merus, both distal margins projecting. Propodus 0.7 as long as merus, bearing on inferior margin 7 spines and a pair distally. Dactylus 0.3 as long as propodus, biunguiculate.

Telson 3.2 times as long as posterior margin is broad. Anterior pair of dorsal spines placed anterior to middle. Posterolateral spines the same size as dorsal spines. Articulation on outer uropod scalloped.

DISCUSSION: This species is plainly closely related to *A. sulcatus* Kingsley and to other species so related; the separation of these is given in Table 1. Its closeness to *A. socialis* Heller is most great, and it can be separated by only four characteristics, three of which may be variable. The most reliable and important is the form of the distal articles of the third maxilliped. In *A. parasocialis* the second article is only slightly expanded distally and the third has a slight taper from the base to the tip. In *A. socialis* the development of these articles is unique, with the second bearing a massive, diagonally-truncate lobe, and the third article expanding broadly in the initial third and distally tapering rapidly to a narrow tip; both the lobe and the inferior side and tip of the third article bears many setae about as long as third article. In addition the carpus of the large chela bears a tooth on the inferodistal margin that is lacking in *A. socialis*, the small chela of the male and female varies from 2.4-3.0 times as long as broad in this species and bears a meral tooth like the large cheliped while in *A. socialis* it is stouter, 3.0-4.0 times as long as broad, and lacks the distal tooth.

We believe this species, as it is more generalized and more broadly spread (with the exception of the New Zealand range of *A. socialis*) to be the form from which *A. socialis* was derived. If our hypothesis about *A. parasocialis* being derived from *A. sulcatus* is correct (see discussion under that species) it is notable that this species, having adapted to the cold Australian waters, has re-entered warmer waters both in eastern and western Australia where its range overlaps that of *A. sulcatus*. Its range also overlaps with *A. socialis* in New South Wales and extends on either side of *A. australosulcatus* sp. nov., known only from Tasmania.

Of the 130 specimens in our collection, 60 complete specimens were carefully studied for variation. It was found that the third maxilliped was at times much more hirsute on the inferior margin than at other times. The distal tip of the dactylus of the large chela varied from heavily rounded (fig. 17d) to a definite but rounded tooth. The small chela varied from 3.0-3.8 times as long as broad and usually that of the female was more slender. The merus of the third leg varied from 4.2 to 4.6 times as long as broad and the

distal tooth varied from a small acute tooth to a sharp angle and in 14 of the specimens the tooth was entirely lacking.

One specimen from Lancelin Is., W.A. (WM 143-65) and one from Tasmania (TM G1538), both males, differ from the usual *A. parasocialis* in the form of their chelae. On the large chela the palm is normal for the species, but the dactylus is acute at its tip and the plunger is massively developed, and instead of being cylindrical with a thin distal ridge, tapers only slightly distally from maximum diameter to broadly rounded edge. When the article is viewed from the superior aspect, the distal portion of plunger is seen to make a heavy shoulder on the medial side of the article. Correspondingly the narrow distal incision of the socket is here a broad and deep "U"-shaped depression to accommodate the heavy distal extension. In the small chela the fingers were much more hirsute than is usual and appear almost sub-balaeniceps (fig. 17p) but did not have the orderly rows of setae as in *A. australosulcatus*, and the constriction on the inferior margin opposite the articulation of the dactylus was more pronounced than is usual. However, the rest of the characteristics were like those of the holotype and the Tasmanian male was in the same collection as a normal female. We therefore suggest that these differences may be an extreme variation. In one specimen from Houtman Abrolhos (WM 185-65) the plunger of the dactylus of the large chela was only of minimal development (fig. 17q) and the fingers were nearly 0.8 as long as the palm instead of 0.4 as in the typical specimen. The rest of the specimen was usual. This may be due to a regenerating large chela.

BIOLOGICAL NOTES: Most of these specimens have been collected intertidally, but a few came from as deep as 16 fathoms. One specimen was reported from a sponge. The following colour notes were supplied by James and Davempport for 2 specimens from Houtman Abrolhos (AC C-1) "Transparent body. Orange chela with red tips. Red to orange on each abdominal segment. Orange to red carapace". Our largest specimen was 35 mm.

AUSTRALIAN DISTRIBUTION: The species ranges from Moreton Bay south and west along the entire southern coast of Australia, including Tasmania, and northward on the western coast to Shark Bay. No specimens came from the coast of Victoria, but it certainly should be expected to occur there.

DISTRIBUTION OF TYPE MATERIAL: The holotype and allotype will be returned to the Western Australian Museum and the paratypes to their respective museums.

***Alpheus amirantei sizou* Banner and Banner**

Fig. 18

Alpheus amirantei sizou Banner and Banner, 1967:265.

Crangon amirantei Banner, 1953:87, fig. 29.

Confer: *Alpheus amirantei* Coutière, 1908a:15, 1921:421, pl. 63, fig. 16.

SPECIMEN EXAMINED: 1 specimen from AM 109 (AM P. 27507).

DIAGNOSIS: Rostral carina high, sharp and narrow between eyes, abruptly curving ventrally to short free portion of rostrum; tip of rostrum reaching to end of first third of visible part of first antennular article, posteriorly carina reaching only to posterior end of orbital hoods. Orbital hoods inflated, projecting anteriorly into round vertical keel. Orbitorostral margin almost straight, orbitorostral grooves flattened. Carapace inflated over antennular bases, leaving groove between bases

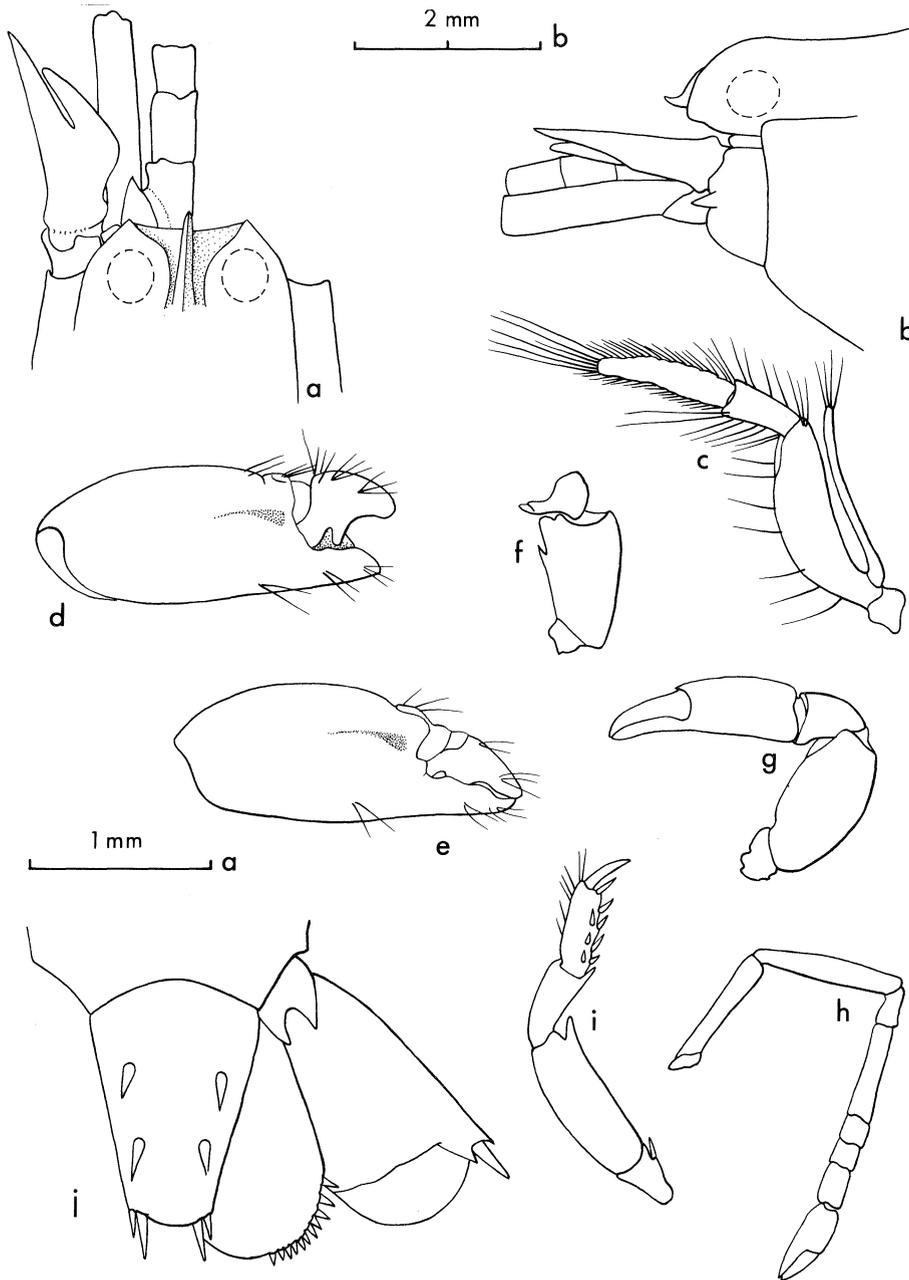


Fig. 18 *Alpheus mirantei sizou* B&B
 11 mm female from AM 109. **a, b.** Anterior region, dorsal and lateral view; **c.** third maxilliped; **d, e.** large chela, lateral and superolateral faces; **f.** merus, large cheliped, lateral face; **g.** small cheliped, lateral face; **h.** second leg; **i.** third leg; **j.** telson and uropods. **a, b, c, j** scale **a**; **d, e, f, g, h, i** scale **b**.

and orbital hoods. Visible part of first antennular article as long as second; second 1.4 times as long as broad; third article 0.7 length of second. Stylocerite acute, tip not reaching end of first antennular article. Outer margin of scaphocerite slightly concave, lateral tooth reaching well beyond antennular peduncle, squamous portion narrow and reaching to end of antennular peduncle. Carpocerite reaching almost length of third article past that article. Lateral tooth of basicerite moderately developed, acute.

Large chela sub-cylindrical, 2.4 times as long as broad with fingers occupying distal third. Dactylus heavy with rounded tip. Palm bearing small, poorly defined transverse groove proximal to dactylus, and a small but at times V-shaped longitudinal groove on lateral face running from near middle of palm to near palmar adhesive plaque. Inferior margin entirely without constriction or grooves. Merus 1.8 times as long as broad, superodistal margin rounded, inferointernal margin usually bearing sub-terminally small acute tooth.

Small chela of female three times as long as broad with fingers slightly shorter than palm. Merus two times as long as broad, broadest in middle, without teeth on inferodistal margins. Male chela similar, but larger in proportion to specimen.

Carpal articles of second leg with ratio: 10:22:6:6:10.

Third leg stout, ischium with strong spine. Merus 2.8 times as long as broad, bearing distally a strong sub-terminal tooth. Carpus 0.5 as long as merus with inferodistal margin terminating in a strong acute tooth and superodistal margin terminating in a rounded tooth. Propodus 0.6 as long as merus, inferior margin bearing about 10 spines in two irregular rows. Dactylus simple, strong and slightly curved, 0.2 as long as merus.

Telson three times as long as posterior margin is broad, first pair of dorsal spines placed anterior to middle; inner spines of posterior pair twice as long as outer. Inner uropod with numerous strong spines on distolateral curve.

DISCUSSION: It should be noted that when the dactylus of the large chela is fully flexed (as in fig. 18d) it appears hammer-shaped, but when seen fully closed (as in fig. 18e) it appears to be more or less "normal" with a closure along the length of the pollex, not with its bulbous tip closing over end of the pollex as is found in "true" hammer-shaped dactyli (as in the *Obesomanus* Group).

We separated *A. amirantei sizou* from the central Pacific from the nominate *A. amirantei* of the central Indian Ocean by a series of characteristics; this small Australian specimen clearly is of the central Pacific form and shows all of the characteristics that were used in the separation. However, since the original description we have found greater variation than that originally reported in specimens from the Pacific and may wish to review the separation should we have available a larger series showing comparable variation from Indonesia and the Indian Ocean.

BIOLOGICAL NOTES: In the central Pacific this species has been collected exclusively in the intertidal and the shallow sub-tidal zones; this specimen was taken from "coral washings" at Herald Cay in the same depth zone (J. C. Yaldwyn, personal communication).

AUSTRALIAN DISTRIBUTION: Our sole specimen was collected in the Herald Group, Coral Sea.

GENERAL DISTRIBUTION: Marshall Islands; Tonga; Line Islands; Tahiti; Rarotonga (not previously reported). The nominate species is known only from the Seychelles and the Maldives.

***Alpheus acutofemoratus* Dana**

Fig. 19

Alpheus acutofemoratus Dana, 1852:550, pl. 35, fig. 2. De Man, 1902:888, pl. 27, fig. 63. Banner and Banner, 1966b:87, fig. 29.

Alpheus parabrevipes Coutière, 1898c:151.

Nec Alpheus acutofemoratus Bate, 1888:545, pl. 97, fig. 2. [Cape York]. (=?).

SPECIMENS EXAMINED: 2 specimens from BAU 24; 1, BAU 27; 3, BAU 28; 11, BAU 55.

DIAGNOSIS: Rostrum small, triangular, slightly depressed between orbital hoods, with broad, rounded carina broadening posterior to base of hoods and merging with carapace. Rostrum reaching middle of visible part of first antennular article. Orbitorostral margin concave lateral to base of rostrum, orbital margin convex. Visible part of first antennular article and third article sub-equal; third article 0.7 length of second; second 1.8 times as long as broad. Stylocerite acute, not reaching quite to end of first antennular article. Lateral margin of scaphocerite strongly concave, with strong lateral tooth reaching well past end of antennular peduncle, squamous portion narrow, reaching slightly beyond end of antennular peduncles. Carapocerite as long as lateral tooth of scaphocerite. Tooth in inferior margin of basicerite prominent, but shorter than stylocerite.

Ratio of articles of third maxilliped: 10:4:7. Last two articles bearing only moderately dense hairs, tip bearing a brush of long fine hair.

Large cheliped massive, cylindrical, 2.2 times as long as broad with fingers occupying the distal 0.3. Male chela slightly more massive than that of female. Medial, superior and upper lateral faces of palm and dactylus covered by a mat of fine, extremely long setae, each arising from a small pustule. Lateral face lightly punctate, inferior margin with grooves and bearing sparsely set fine setae. Superior margin of chela with narrow transverse groove proximal to dactylus, obliquely placed and continuing onto lateral face where it ends abruptly in the distal end of a narrow longitudinal groove on the lateral face. Groove on lateral face continues proximally to *linea impressa*. Longitudinal groove on lateral face forms a small pocket just opposite termination of superior groove. Tip of dactylus of large chela usually truncate, but at times terminating in a small sub-acute tooth. Merus 1.5 times as long as broad, with an acute tooth sub-terminally on inferoventral margin.

Small chela 3.1 times as long as broad, palm 2.6 times longer than fingers. Inner face of palm bearing long fine setae similar to those of large chela. Carpus cup-shaped, 0.3 times as long as palm, bearing on its distal margin just proximal to superior margin of palm a strong acute tooth. Merus two times as long as broad, superior margin slightly projected as rounded tooth, inferoventral margin terminating in an acute tooth.

Carpal articles of second leg with ratio: 10:30:6:6:10.

Third leg stout. Ischium with acute spine. Merus three times as long as broad with strong acute tooth on distoventral angle. Carpus almost half as long as merus,

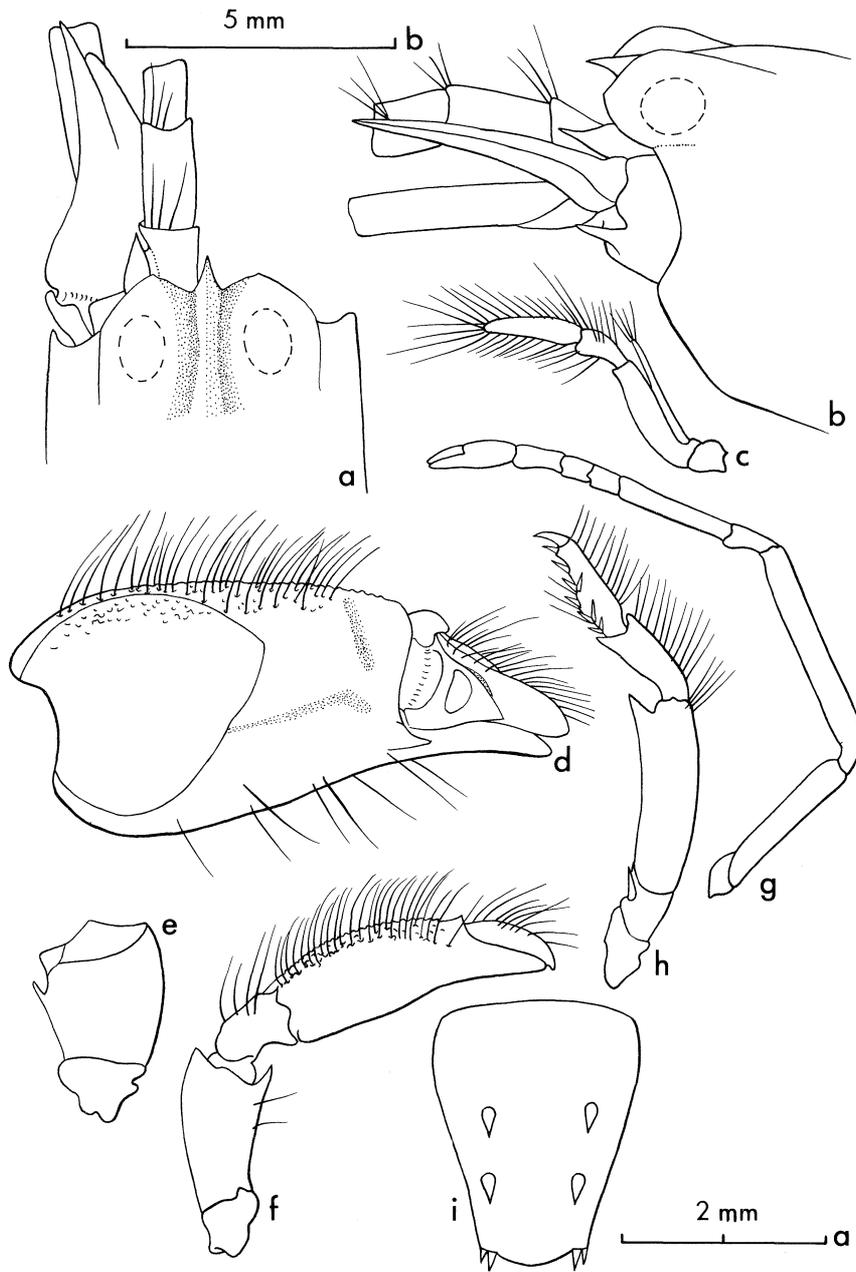


Fig. 19 *Alpehus acutofemoratus* Dana
 20 mm male from BAU 55. **a, b.** Anterior region, dorsal and lateral view; **c.** third maxilliped; **d.** large chela, superolateral face; **e.** merus of large cheliped, meidal face; **f.** small cheliped, medial face; **g.** second leg; **h.** third leg; **i.** telson. **a, b, i** scale **a**; **c, d, e, f, g, h** scale **b**.

distosuperior margin terminating in rounded tooth and distoinferior margin in an acute tooth. Propodus more than half as long as merus, bearing on its inferior margin 8-10 spines and a pair distally. Dactylus 0.4 as long as propodus, simple.

Telson 2.3 times as long as posterior margin is broad, first pair of heavy dorsal spines placed anterior to middle. Inner pair of posterolateral spines almost as large as dorsal spines.

DISCUSSION: Bate's specimen from Arrou Island, north of Cape York, certainly cannot be *A. acutofemoratus* since the first carpal article of the second leg is longer than the second instead of "second more than twice as long as first" (Dana, *loc. cit.*). Also in Bate's specimen (fig. 2, *loc. cit.*) the merus of the third leg is much more slender than in Dana's and it lacks the tooth at the distal end of the merus and carpus found in *A. acutofemoratus*. Finally the sculpturing of the large chela as shown by Bate (fig. 2b) is like that found in the Edwardsii Group and quite unlike that of the Sulcatus Group. Unfortunately, Bate's specimen is missing from the Challenger collection at the British Museum (Natural History) and probably is lost, and from his figures and description we cannot identify it further.

We have compared our specimens particularly with the long description and excellent figures of De Man (1902), and find they are in agreement except the lateral tooth of the basicerite in De Man's specimen is a little more prominent than in our specimens.

BIOLOGICAL NOTES: We have collected this species in Australia from heads of coral from water not deeper than 10 ft. It is apparently an intertidal species. In Indonesia we found this species living in fissures in coral similar to those made by *Alpheus deuteropus* Hilgendorf (see p. 42). Our largest specimen was 22 mm long.

AUSTRALIAN DISTRIBUTION: Torres Straits; Green Island, near Cairns; Heron Island in the Capricorn Group.

GENERAL DISTRIBUTION: Indonesia; Thailand; Philippines; Marshall Islands; Samoa.

***Alpheus sulcatus* Kingsley**

Fig. 20

Alpheus sulcatus Kingsley, 1878:193. Crosnier and Forest, 1966:237, fig. 9a-d.

Alpheus macrochirus Richters, 1880:164, pl. 17, figs. 31-33. De Man, 1902:863. Crosnier and Forest, 1965a:356, figs. 1, 2.

?*Alpheus californiensis* Holmes, 1900:186, pl. 2, fig. 42, pl. 3, figs. 43-44 (according to Crosnier and Forest, 1966).

Nec Alpheus macrochirus De Man, 1888a:519 (=A. *ehlersii* De Man).

Alpheus luciae Barnard, 1946:389; 1950:755, figs. 143 j-m.

SPECIMENS EXAMINED: 1 specimen from AC-S2; 1, AM 8 (AM P. 27831); 1, AM 27 (AM P. 27841); 1, AM 69 (AM P. 27842); 1, AM 71 (AM P. 27438); 2, AM 98 (AM P. 27782); 1, AM 129 (AM P. 27559); 1, AM 134 (AM P. 27825); 1, AM 238 (AM P. 27366); 2, AM 275 (AM P. 27402); 1, AM 282 (AM P. 27403); 2, AM 290 (AM P. 27363); 1, AM 299 (AM P. 27404); 2, AM 316 (AM P. 27364); 1, AM 328 (AM P. 27365); 1, AM P. 8566; 1, JC 24; 1, QM W 1296; 2, US 123593; 1, US 123594; 4, US 123595; 2, US 123596; 1, US 123597; 5, US 123598; 3, US

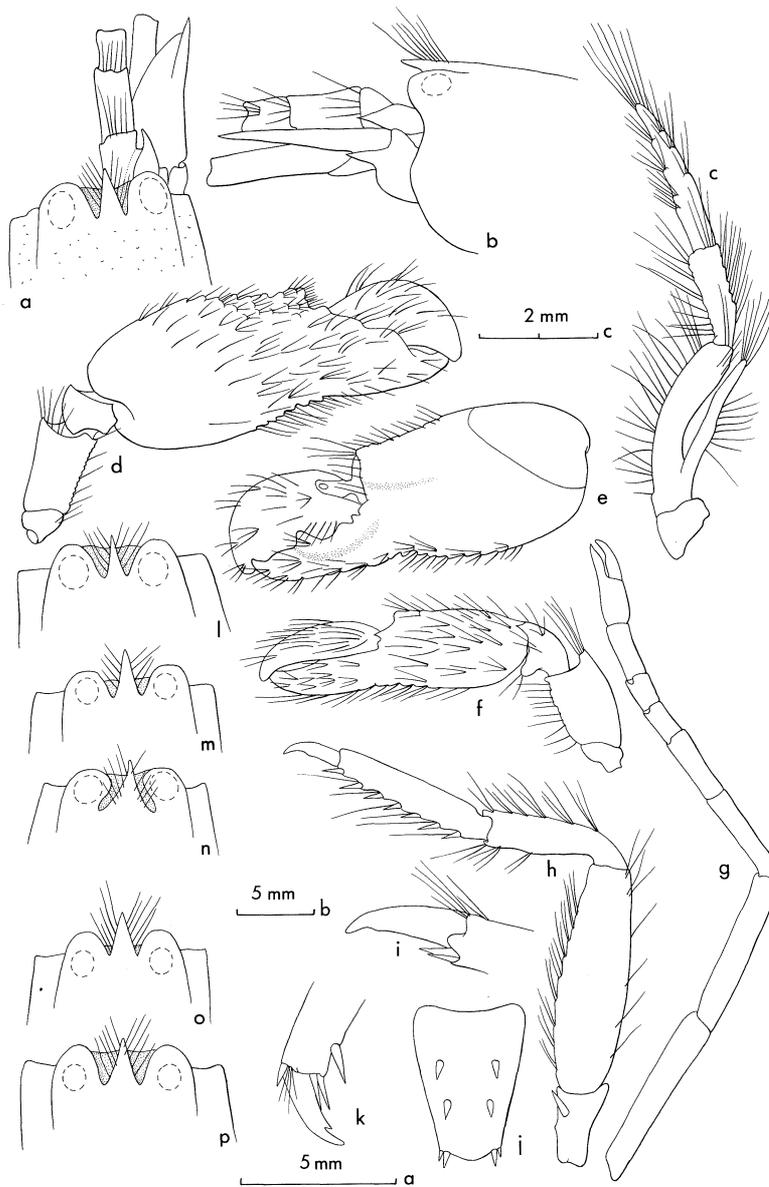


Fig. 20 *Alpheus sulcatus* Kingsley

50 mm male from WM 101-65. **a, b.** Anterior region, dorsal and lateral view; **c.** third maxilliped; **d.** large cheliped, medial face; **e.** large chela, lateral face; **f.** small cheliped, medial face; **g.** second leg; **h, i.** third leg and enlarged dactylus; **j.** telson. 35 mm male from JC 24. **k.** Dactylus, third leg. Anterior region of carapace from: **l.** 40 mm male from WM 139-65; **m.** 48 mm female from AM 275; **n.** 35 mm female from US 123598; **o.** 40 mm male from AM 290; **p.** 35 mm male from WM 210-65. **a, b, c, g, h, j, l, m, n, o, p** scale a; **d, e, f** scale b; **i, k** scale c.

123599; 2, VM 16; 1, VM 20; 1, WM 41-65; 2, 73-65; 1, WM 101-65; 1, WM 132-65b; 1, WM 139-65; 1, WM 173-65; 1, WM 174-65; 2, WM 210-65; 3, WM 238-65; 11, WM 287-65.

DIAGNOSIS: Rostrum varying from 0.8-1.9 times as long as wide at base. Sides of rostrum bearing moderately long stiff setae. Orbitorostral grooves deep, slightly recessed under margins of rostrum, and sharply cut off from orbital hoods. Orbital hoods slightly inflated, anterior margin rounded, without teeth. Visible part of first and third antennular article nearly equal. Second antennular article 1.5 times as long as third article and two times as long as broad. Stylocerite acute, reaching slightly past end of first antennular article. Outer margin of scaphocerite almost straight, lateral tooth reaching well past squamous portion; squamous portion as long as antennules, lateral tooth as long as carpuccerite.

Ratio of articles of third maxilliped: 10:5:8. Inferior margin bearing long setae; third article bearing setae in tufts rather than rows, tip with tuft of setae two-thirds as long as article.

Large chela compressed, 2.6 times as long as broad, with fingers heavy and occupying distal third. Lateral face glabrous except along margins and bearing longitudinal groove arising near middle of palm and running to dactylar articulation; groove at mid-length may be shallow or a deep "V". Superior margin of palm with low rounded ridge arising near carpal articulation distally curving slightly to terminate above palmar adhesive plaque. Medial face with longitudinal groove similar to that of lateral face, but usually less deep; face bearing many long heavy setae in patches, those near distal portion of superior ridge arising from heavy bosses, those on other portions of face from slight indentations. Lower margin with slight constriction opposite dactylar articulation and carrying on the distal half or two-thirds of margin and lower portions of each face similar long setae, at times on bosses. Dense row of short setiferous bristles on median edge of palmar adhesive plaque. Both fingers with patches of setae, some long, some short. Dactylus heavy, distally rounded and reaching beyond pollex; plunger very heavy and curved. Merus 1.7 times as long as broad, inferoventral margin irregular and bearing short setae; superodistal angle not produced but bearing long setae. Carpus without tooth on inferodistal margin.

Small chela not sexually dimorphic, three times as long as broad with fingers slightly longer than palm. Medial side of dactylar articulation bearing sub-acute tooth. Palm in general with ridge, bosses and setae of large chela, but not as highly developed; longitudinal grooves of both faces lacking. Fingers also hirsute, at times heavily so on medial faces. Merus 1.8 times as long as broad; inferoventral margin irregularly serrate with scattered short setae; superodistal margin with long setae. Carpus with obtuse tooth projecting above superior margin of palm.

Carpal articles of second leg 10:(7-9):3:3:4.

Ischium of third leg armed with a spine. Merus 3.5 times as long as broad, without teeth, but with inferior margin bearing patches of setae. Carpus 0.6 as long as merus; superodistal margin projecting as heavy rounded tooth, inferior margin slightly projecting. Propodus 0.7 as long as merus, bearing on its inferior margin six spines, each associated with a long setae, and a pair distally. Dactylus 0.3 as long as propodus, varying from uniformly conical to bearing a definite secondary unguis (as in fig. 20k); most specimens with a thickening only at site of secondary unguis (as in fig. 20i).

Telson 2.5 times as long as posterior margin is broad. First pair of dorsal spines placed anterior to middle. Spine on outer uropod not dark.

DISCUSSION: This species was formerly known in the Indo-Pacific as *A. macrochirus* Richters (1880) although it was known to be related to *A. sulcatus* Kingsley (1878) from the Atlantic and the western coasts of America. Crosnier and Forest, using specimens from the Gulf of Guinea discussed what they believed to be three differences between the two species. We have examined our 51 specimens from Australia, 26 specimens from the Indian Ocean and 26 specimens from the southern Philippines in reference to these points of difference and have found all were variable in each of the three groups of specimens we studied. Specifically we found:

1. Crosnier and Forest believed that the orbitorostral grooves in *A. sulcatus* were broader and extended only to the posterior margin of the eyes, while in *A. macrochirus* they were narrower and extended posterior to the base of the eyes. We found that the width of the grooves was a function of the breadth of the rostrum, and that the rostrum varied from less long than broad at its base to over twice as long as broad. However, in almost all specimens in these collections the length of the grooves were more like *A. sulcatus* than the condition attributed to *A. macrochirus*.

2. Crosnier and Forest reported that the fingers of the large chela were relatively broader and longer when compared to the palm in *A. sulcatus* than in *A. macrochirus*. In 25 measured specimens from Australia we found the ratio of palm height to finger height varied from 1.2-1.8 times, and the palm varied from 1.8-2.6 times the length of the fingers. This variation extends beyond the differences given by the two authors.

3. Crosnier and Forest believed that the dactylus of the third leg was simple in *A. sulcatus* and biunguiculate in *A. macrochirus*. The specimens we examined varied from having a uniform taper from base to tip, through having a swelling of various sizes along the inferior margin, to having a definite, but variable, secondary unguis.

After this study we told Dr Forest of our conclusions and asked that he compare selected specimens from Australia, the Philippines and East Africa from our collections with his specimens from West Africa. He did and concurred with us that *A. sulcatus* is a species of possibly discontinuous circumtropical distribution.

The placement of *A. macrochirus* in synonymy will necessitate changing the name of the sub-generic group to the Sulcatus Group.

Barnard (1946:389) described a new species, *A. luciae*, from St Lucia Bay, Zululand, which he suggested was very close to *A. macrochirus*; in 1950 (fig. 143) he figured this species. Through the courtesy of Dr B. F. Kensley, of the South African Museum, we were able to examine the holotype and compared it to specimens in our collections. None of our specimens had as deep a constriction on the inferior border of the large chela opposite the articulation of the dactylus as figured by Barnard (fig. 143m), but the holotype was less constricted than figured. Barnard stated that all dactyli of the thoracic legs were simple, but upon close examination we found that the dactyli did have a slight swelling on the inferior surface similar to those of many of our specimens (see fig. 20i). Finally, Barnard believed that his specimen was a male, but he stated that the second pleopod did not have an *appendix masculina*. However, Kensley (1970:118, fig. 13) re-examined the type and found the second pleopod did have an *appendix masculina* which we were also able to confirm. In view of the variations we have found for this species, we can find no specific differences between the forms and are placing it, too, in synonymy to *A. sulcatus*.

Crosnier and Forest (*loc. cit.*) have suggested that Holmes' species *A. californiensis* may also be a synonym. We must leave this question to those working with American alpheidids.

A. sulcatus, common in tropical Australian waters and penetrating to temperate waters on the west coast only to Shark Bay, has reached Grafton, N.S.W., and the waters off Victoria in the south-east. However, if one uses the following criteria there would appear to be three separate but closely-allied temperate water species:

1. A flattened triangular rostrum whose margins overhang the orbitorostral grooves;
2. Large chela of similar general configuration, with longitudinal grooves on the palm and a tendency to be hirsute;
3. Small chela of similar general configuration (but not showing any great specialisation), and also with a tendency to be hirsute;
4. A tendency to have a biunguiculate dactylus on the third leg.

Sharing these characteristics with *A. sulcatus* are *A. australosulcatus* sp. nov., *A. parasocialis* sp. nov., and *A. socialis* Heller. Each is differentiated from *A. sulcatus* and from each other by rather firm characteristics that have not been observed to overlap, and which are presented in Table 1, p. 86.

We suggest that in the successful adaptation from a restricted tropical ecological niche to the changed ecosystems in the colder waters, different new niches were found, resulting in the morphological differences listed in the table. As the morphological differences are maintained in spite of ranges that overlap or come close to overlapping in all four species, they must represent distinct stocks with genetic separation, or true species, not sub-species.

BIOLOGICAL NOTES: This species has been collected under rocks intertidally and from corals taken from shallow water. It has been dredged from as deep as 13 fathoms. Moulton (1967:7) reported a possible commensal relationship at Heron Island. "Four pairs of shrimp were collected and each pair was hovering over one of the worms (*Eurythoe complanata*) beneath a coral bommie on Heron Island Reef". Yaldwyn has supplied the following colour notes for two specimens from One Tree Island (AM316): "Uniform dark green with mottling on hands". We have specimens up to 58 mm in length.

AUSTRALIAN DISTRIBUTION: On the west coast from Rottnest near Perth to Cape Leveque, the east coast from the Coral Sea to near Sydney, N.S.W. Three specimens came from Victoria.

GENERAL DISTRIBUTION: As *A. sulcatus* the species has been reported in the eastern Pacific from the Galapagos Islands to Panama and Peru (and possibly California), and from the eastern Atlantic off Africa. In the Indo-Pacific it has been reported, mostly as *A. macrochirus*, from east and south Africa across to the Society Islands. We have specimens in our collections from the Red Sea. Strangely, it has not been reported from Japan, Hawaii or the Caribbean.

***Alpheus australosulcatus* sp. nov.**

Fig. 21

HOLOTYPE (AND ONLY SPECIMEN): 65 mm female from North Head, Flinders, Victoria (*sic*). Collected by F. E. Grant 30/12/00. Dredged. (AM P. 13551).

DESCRIPTION: Rostrum flat, triangular, 1.3 times as long as broad at base, reaching

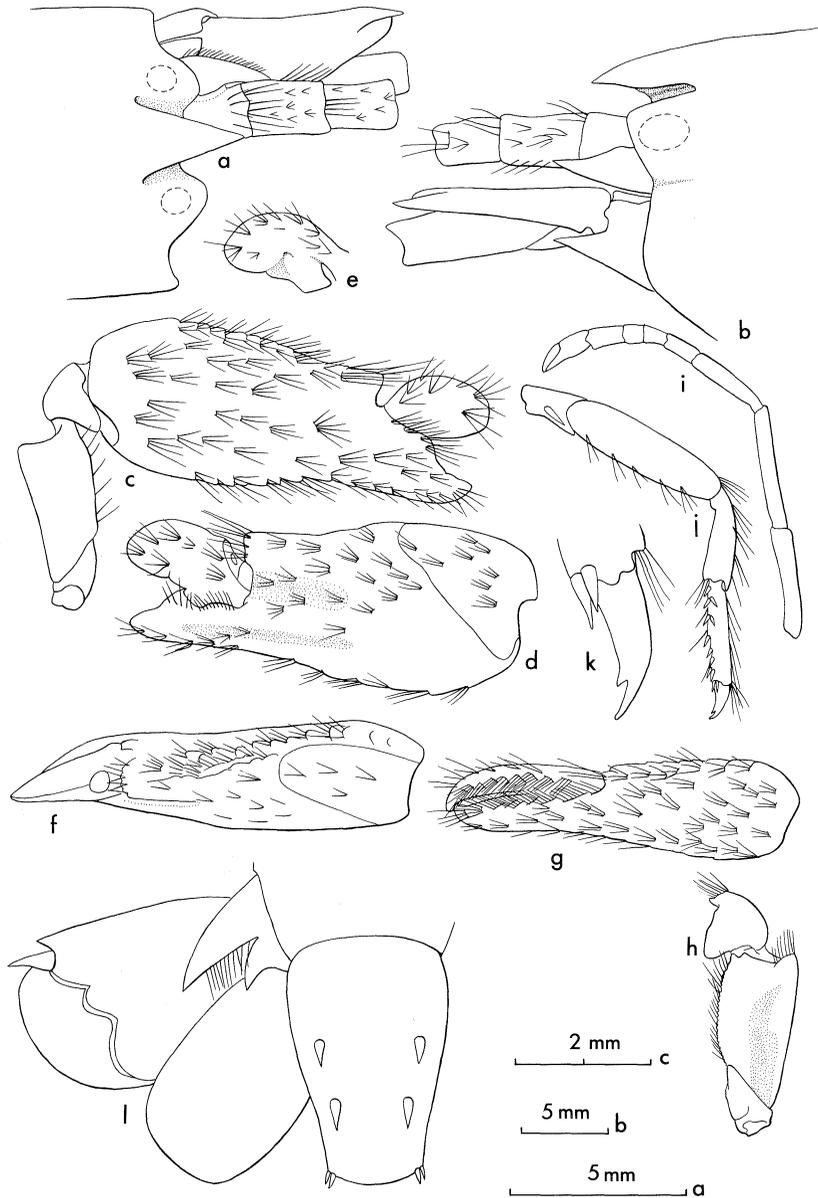


Fig. 21 *Alpheus australosulcatus* sp. nov.

Holotype (female). **a, b.** Anterior region, dorsal and lateral view; **c.** large cheliped, medial face; **d, e.** large chela and dactylus lateral face; **f.** large chela, superior face; **g, h.** small chela and merus, medial face; **i.** second leg; **j, k.** third leg and enlarged dactylus; **l.** telson and uropods. **a, b, k** scale **a**; **c, d, e, f, g, h, i, l** scale **b**; **j** scale **c**.

to end of first antennular article. Orbitorostral grooves deep, recessed under rounded lateral margins of rostrum. Orbital hoods not inflated, not bearing teeth on orbitorostral margin but projected into arcuate prominences. Orbitorostral margin of carapace deeply concave towards base of rostrum. Antennular articles nearly equal, second article 1.4 times as long as broad; distal margins of first and second article bearing many forward-directed setae. Stylocerite acute, reaching near middle of second antennular article. Outer margin of scaphocerite nearly straight, lateral tooth reaching well beyond antennular article, tip directed inward, squamous portion narrow, a little shorter than lateral tooth. Carpocerite stout, sub-equal in length to tooth of scaphocerite. Basicerite with tooth on inferior margin broad at base and reaching almost as far forward as stylocerite.

Third maxilliped similar to that of *A. sulcatus*, reaching well beyond antennules. Ratio of articles: 10:1.4:0.7.

Large chela compressed, 2.5 times as long as broad, fingers occupying distal 0.2. All surfaces of chela, including fingers, bearing patches of stiff setae arising from the distal edges of slits in the integument, often arranged in more or less lineal series; patches of setae on superior margin emerging from bosses, outer face bearing two rounded and shallow longitudinal grooves, the inferior arising below socket on pollex and extending to middle of palm, the superior, broader and shallower than inferior, arising proximal to dactylar articulation and terminating distal to inferior groove. Tip of dactylus heavily rounded, tip of pollex acute. Merus 2 times as long as broad, distal margins not projecting. Tooth on inferodistal margin of carpus not projecting.

Small chela 3.4 times as long as broad, finger a little shorter than palm. All surfaces of palm with setae in patches similar to that of large chela. Patches of setae on lateral face of minimal development. Medial and lateral side of both fingers near oppositional faces carrying short stiff setae arranged in oblique combs which cross to make regular intermeshing brushes. Superodistal margin of carpus bearing prominent sub-acute tooth.

Carpal articles of second leg with ratio: 10:4:3:3:4.

Ischium of third leg bearing spine. Merus inermous, four times as long as broad, bearing along inferior margin several tufts of setae. Carpus 0.5 as long as merus, superodistal margin slightly projected. Propodus 0.6 as long as merus, bearing on its inferior margin 10 spines with a pair distally. Dactylus 0.3 as long as propodus, biunguiculate with small inferior tooth.

Telson three times as long as posterior margin is broad, anterior pair of dorsal spines placed anterior to midline. Articulation of outer uropod with scalloped pattern.

DISCUSSION: This species is plainly within the *Sulcatus* Group, and is remarkably close to *A. sulcatus* itself. Its separation from *A. sulcatus* and those species we believe to be related to *A. sulcatus* in temperate Australian waters is given in Table 1; in summary, this species differs from *A. sulcatus* in the form of the rostrum and its lack of setae, the length of the scaphocerite and the brushes placed in series on the fingers of the small chela. It is the condition of the small chela upon which we place the greatest reliance.

As indicated under the discussion of *A. sulcatus* above, this sole specimen was collected not too far away from the three specimens of *A. sulcatus* taken in waters off Victoria, and *A. parasocialis* B&B, also related, has been taken in New South Wales, Tasmania and South Australia, so the ranges of these species overlap. Only *A. socialis* of the group does not penetrate so far south.

TABLE 1
Differences between *A. sulcatus* and its southern Australian derivatives

| | I <i>A. sulcatus</i> Kingsley | II <i>A. australosulcatus</i> B&B | III <i>A. parasocialis</i> B&B | IV <i>A. socialis</i> Heller |
|--|--|---|---|--|
| Rostrum | Broad triangle cut off from orbital grooves but usually not overhanging; with setae on margins | Broad triangle overhanging grooves, without setae | Narrow triangle, overhanging grooves; without setae | Same as III |
| Orbital hoods | Without teeth | Same as I | With small teeth | Same as III |
| Stylocerite | To near end of 1 ap.* | To middle of 2 ap. | Same as I | Same as I |
| Squame | To near end of 3 ap. | Same as I | To near end of 2 ap. | Same as III |
| Tooth on inferior margin of basicerite | Heavy, to first quarter of 2 ap. | Heavy, to middle of 2 ap. | Slender, past middle of 2 ap. | Same as III |
| Third maxilliped second article | Margins parallel | Same as I | Slight distal broadening | Inferodistal margin projecting as heavy lobe |
| third article | With marked distal taper | Same as I | With slight distal taper | With strong taper |
| Large chela | Moderately setiferous | Heavily setiferous | Slightly setiferous | Same as III |
| Carpus, large cheliped | Distally inermous | Same as I | With inferodistal tooth | Same as I |
| Fingers, small chela | With light, random setae | With heavy setae in brush | With light setae | With setae in row |
| Third leg, merus dactylus | Unarmed From simple to biunguiculate | Unarmed Biunguiculate | Usually with distal tooth Biunguiculate | Unarmed Biunguiculate |

* 1, 2, 3 ap. = first to third articles of antennular peduncles.

The name indicates that we believe this to be a southern form of *A. sulcatus*. The holotype will be deposited in the Australian Museum.

BIOLOGICAL NOTES: All of the data we have is that listed above from the label in the vial. It is noteworthy that in all of the collections from New South Wales and Victoria no further specimens have been found.

Obesomanus Group

Rostrum reduced, at times lacking. Species with a tendency to develop elongate antennular peduncles, tooth on stylocerite reduced or lacking, reduced scaphocerite and carpocerite. Large chela usually proximally rounded, tapering distally with moderate to slight longitudinal grooves; dactylus of the form of a single to double-headed hammer, closing over end of pollex (*A. perplexus* Banner only with marked longitudinal grooves like those found in *Macrocheles* Group). Small chela never balaeniceps. Second legs at times extremely long and of asymmetrical development. Third legs variable but usually not heavily armed. Outer uropods may lack articulation. Telson variable, at times narrow at tip, may lack anal tubercles. At times with strong sexual dimorphism.

Some, and perhaps most, species live in protected galleries in the crust of coralline algae.

DISCUSSION: We reviewed the *Obesomanus* Group in 1966a (p. 162), and of the 18 previously reported species or unnamed forms, we accepted 10, one of which was new, and placed eight in synonymy. In Australia we have found only two species, *A. obesomanus* Dana and *A. malleodigitus* (Bate); *A. microstylus* (Bate) must be included, however, as its type locality is the Torres Straits. In our collections consisting of a total of 186 specimens of these three species from the central Pacific we found considerable variation in characteristics previously used for the separation of these species which we analysed in detail in our 1966 study; we found the variations repeated in our Thai collections (1966b:99). As similar variations were noted in the Australian collections, we here summarise the findings for an aid to Australian workers:

ROSTRUM AND ORBITAL HOODS: The rostrum is small and variable and it may be lacking; orbitorostral margin may be straight or somewhat indented towards rostral base.

ANTENNULAR PEDUNCLES: The second article in *A. malleodigitus* ranges from 1.3 to 4.9 times the length of the first article, and from 2.5 to 6.7 times as long as broad; the ranges of the other two species are less broad, but are largely overlapped by the range of *A. malleodigitus*. The presence of a tooth on the stylocerite is variable, at least in *A. microstylus*.

ANTENNAL PEDUNCLES: The relative lengths of the lateral tooth and squame of the scaphocerite and the carpocerite are variable, but still offer one of the sure points to differentiate between the three species. In *A. malleodigitus* the tooth of the scaphocerite ranges in length, reaching from the beginning to the end of the second antennular article, and the carpocerite to about its middle, while in *A. obesomanus* and *A. microstylus* both articles reach to near the end of the third article. The latter two species may be distinguished, however, by the squamous portion which reaches only near to the middle of the second article in *A. obesomanus* (as well as *A. malleodigitus*), and to near the end of the third article in *A. microstylus*. In other words, the scaphocerite and carpocerite are normal in *A. microstylus*, the squame alone is reduced in *A. obesomanus*, and both the scaphocerite and carpocerite are reduced in *A. malleodigitus*.

LARGE CHELA: As this is largely made of relatively soft chitin, grooves and ridges may

appear, or normally occurring ones may be intensified, as artifacts arising out of preservation.

SMALL CHELA: The range of variation of the ratios between palm and finger length in *A. malleodigitus* is from 2.4 to 3.7, and completely overlaps the ranges found in the other two species. There is no sexual differentiation.

SECOND LEGS: The second article ranges from about 1.0 to 2.0 times the length of the first in *A. malleodigitus* and from 2.0 to 4.6 times the length in *A. obesomanus*; the few specimens we had of *A. microstylus* ranged from 1.9 to 3.3.

THIRD LEGS: In *A. malleodigitus* the length/breadth ratios of the merus and carpus, with both ranging from about three to seven times as long as broad, almost completely overlap the ranges of the other two species.

TELSON: Here *A. obesomanus* had the greatest range of length to breadth at the tip, with ratios running from 2.5 to 7.0, encompassing the ranges of the other two species; however, usually the tip of the telson in *A. obesomanus* is narrow and straight with the inner spines of the posterolateral pair long, heavy and located close to middle, while in the other two species it is broader, somewhat convex and with spines of more normal size and position.

The three species live in similar habitats, as we described from Thai waters (B&B, 1966b:101): "[They live] in branching galleries under coralline encrusting algae on heads of dead coral, usually in regions of wave action. The galleries communicate to the surrounding water by a series of uniform and often regularly placed holes or ports, each too small to permit the egress of the shrimp. In each set of galleries lives a single pair of shrimp, and each set is separated from the galleries of neighbouring pairs. Of the pair within the burrow, the female is usually the larger and softer, with smaller chelae. No differences in habitat could be detected for the three species; indeed, on the western beaches of Phuket, all three species were taken from galleries on a single coral head." However, Dr A. J. Bruce, of the Heron Island laboratory, has collected some *A. obesomanus* from living coral of the genus *Acropora* where they occur in deep burrows, and "I have also seen them in small fossa in other corals, usually only in pairs." (Personal communication).

Of the 27 collections that we personally made of the two species along the Great Barrier Reef complex from Thursday Island to Heron Island, 10 contained both species, 12 contained *A. malleodigitus* alone, and five contained *A. obesomanus* alone. Unlike the central Pacific and Thai collections where the two species were collected in roughly equal numbers, in the Australian collections were over 200 specimens of *A. obesomanus* and only 32 of *A. malleodigitus*. In our earlier collections *A. microstylus* was by far the most uncommon and in Australia is only known from Bate's type as mentioned above.

Coutière, in giving biological notes from his observations at Djibouti (1898i:198) remarked on *A. malleodigitus* that it was found always in galleries in the "croûte" of the reef that had been previously dug by burrowing annelids or molluscs, that the male sat in the entrance to the burrow to protect it. He also stated: "Un détail assez singulier est la présence dans leur retraite d'un paquet d'Ulves vertes, vraisemblablement apporté par l'animal, soit comme une réserve alimentaire, soit pour utiliser le dégagement d'oxygène dont l'Ulves est le siège et qui s'y continue encore quelque temps après qu'elle a été soustraite aux radiations lumineuses". Except for the presence of the species in galleries, his other observations we have not been able to confirm. Both species are, as Coutière described for *A. malleodigitus*, of sulphur yellow colour, with the ovary green through the transparent carapace in the female.

We should add that we still have doubts about the separation of these three species. In the large number we have examined the separation of them on morphological characteristics seems certain in spite of their wide variations, and in co-habiting pairs that we have separately bottled we have never had any examples of two different species living together. On the other hand, they do occupy what appear to be identical galleries in the same habitat and in the same ecological zones, and presumably their ways of life are also identical. It is seldom that two distinct species of apparently similar ecological requirements can continue to co-exist in the same habitats. It should be noted, however, that *A. obesomanus* has not been collected west of the Torres Straits, but that *A. malleodigitus* extends to Dampier Archipelago in Western Australia.

We are also rather surprised that more species of the *Obesomanus* Group have not been found in Australian waters; while the other species are never common in our previous collections from coral reefs, they do appear. Should other species be found in Australia, we refer the worker to the key in our publication (1966a:173). We also caution future workers about the difference in opinion on the validity of the genus *Thunor*, for while we placed it into synonymy in the 1966 study, Chace in 1972 (p. 105) revived the generic name for the Caribbean species *T. rathbunae* (Schmitt).

In the following three species we describe only the most abundant *A. obesomanus*, for except for small differences (listed above) the three species are essentially the same; we illustrate these differences in Figure 22.

***Alpheus obesomanus* Dana**

Fig. 22a-l

Alpheus obesomanus Dana, 1852:547, pl. 34, fig. 7. Boone, 1935:135, pl. 35. Banner and Banner, 1966a:168, figs. 8-18; 1966b:101, fig. 35.

Alpheus lutini Coutière, 1905a:885, fig. 24.

Alpheus species #2. Banner, 1956:351, fig. 15.

Nec Alpheus obesomanus Pocock, 1890:520 (= *A. cristulifrons* Rathbun according to Schmitt, 1924:65).

Previous Australian record: Miers, 1884:287. Port Molle, Qld.

SPECIMENS EXAMINED: 1 specimen from AM 52 (AM P. 27513); 1, AM 74 (AM P. 27500); 2, AM 109 (AM P. 27510); 2, AM 174 (AM P. 27524); 3, AM 196 (AM P. 27323); 1, AM 238 (AM P. 27324); 1, AM P. 13584; 2, BAU 14; 2, BAU 15; 15, BAU 17; 2, BAU 18; 1, BAU 20; 20, BAU 21; 6, BAU 23; 6, BAU 25; 2, BAU 27; 39, BAU 30; 16, BAU 31; 58, BAU 32; 10, BAU 33; 2, BAU 37; 3, BAU 43; 4, BAU 47; 4, BAU 48; 2, BAU 50; 9, BAU 52; 9, BAU 55; 8, BAU 57; 6, BAU 58; 2, 75 LIZ-8 (AM P. 27910); 3, 75 LIZ-O (AM P. 27915); 3, 75 LIZ-Q (AM P. 28148); 2, 75 LIZ-R (AM P. 27917); 5, 75 LIZ-S (AM P. 27911); 3, 75 LIZ-V (AM P. 27912).

DIAGNOSIS: Rostrum short, triangular, at times vestigial, never reaching beyond first quarter of visible part of first antennular article. Rostral carina slight, continued posteriorly to base of eyes. Orbital hoods slightly inflated, forming shallow orbitorostral grooves, frontal margin gradually rounded.

Second antennular article varying from 1.5-3.0 times as long as wide. Visible part of first antennular article and third article sub-equal in length, about 0.3-0.7 times as long as second. Stylocerite without tooth, reaching only to middle of visible part of first antennular article. Scaphocerite with strong lateral tooth which reaches to near end of

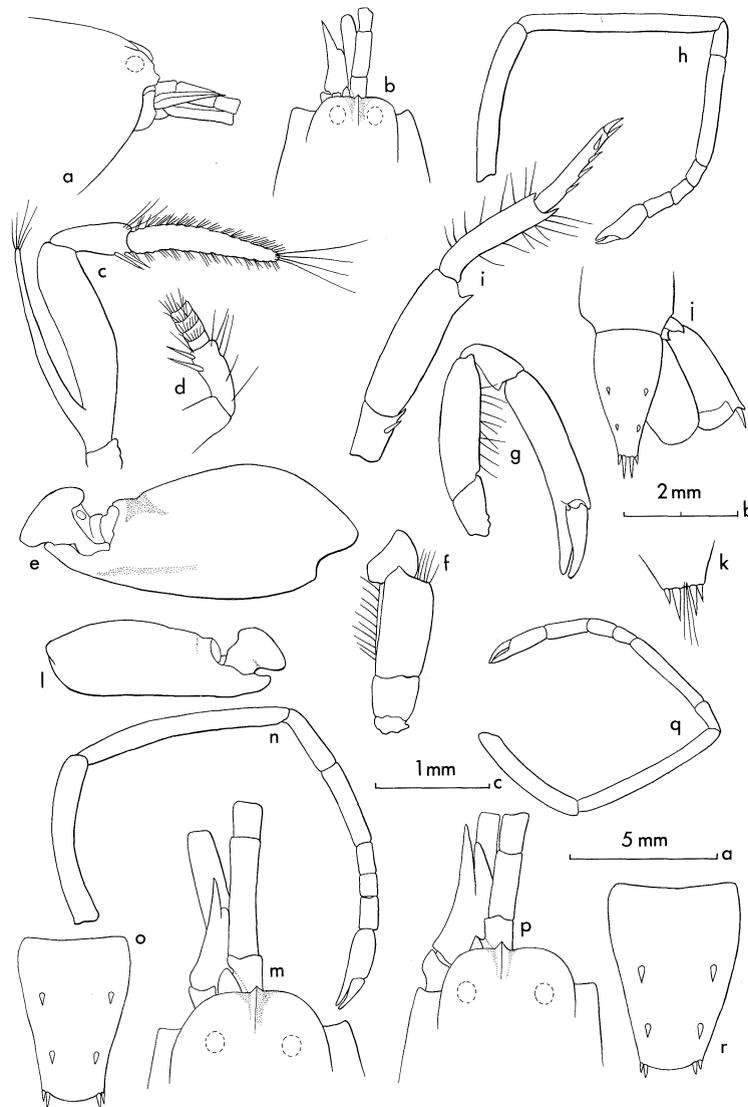


Fig. 22 Species of the *Obesomanus* Group

Alpheus obesomanus Dana, 17 mm male from BAU 17. **a, b.** Anterior region, lateral and dorsal view; **c, d.** third maxilliped, lateral face and detail of second article, medial face; **e, f.** large chela and merus, lateral face; **g.** small cheliped, lateral face; **h.** second leg; **i.** third leg; **j, k.** telson and uropods and detail of posterior end of telson. 15 mm male from BAU 33. **l.** Aberrant large chela. *Alpheus malleodigitus* (Bate) 21 mm male from BAU 20. **m.** Anterior region dorsal view; **n.** second leg; **o.** telson. *Alpheus microstylus* (Bate) 25 mm male from the Red Sea. **p.** Anterior region, dorsal view; **q.** second leg; **r.** telson. **c, d, h, i, k** scale **a**; **a, b, e, f, g, j, l, n, o, p, r** scale **b**; **m, q** scale **c**.

antennular peduncle, squamous portion reduced, reaching to near middle of second antennular article, and usually without setae but at times bearing short fine hairs. Carpopodite slender, usually as long as antennular peduncle; basipodite without lateral tooth.

Articles of third maxilliped with ratio: 10:3:6. Distal end of internal margin of second article bearing one or two stiff setae and fine hairs; superodistal margin bearing strong setae, but not as heavy as those on the inferior margin. Lateral margins of third article bearing a series of patches of short setae, with a brush of long hairs distally.

Large chela oval in section proximally, tapering towards fingers. Dactylus in form of double-headed hammer with both heads heavy and rounded; dactylus closing over and beyond short, and somewhat excavated, pollex. Pollex bearing tufts of short, stiff bristles on either side. Dactylar articulation broad, dactylar and palmar adhesive plaques large; palmar plaque surrounded by heavy ridge of chitin around circumference except on inferior portion. Palm always with marked depression proximal to articulation to accommodate head of dactylus when flexed. Depression extending proximally a short distance on superior margin, into a variable depression on medial face, and terminating laterally near adhesive plaque. Lateral face of palm with rounded depression below dactylar articulation, extending distally to middle of pollex, proximally a similar distance. Inferodistal surface of palm and pollex somewhat flattened. Merus without teeth, twice as long as broad.

Small chela without sexual differences, varying from about 3.5 to 5.0 times as long as broad, palm cylindrical without sculpture, and from about 2.5 to 4.0 times length of fingers. Merus of variable proportions, unarmed.

Second legs asymmetrical in length in both sexes, with the longer about 1.5 times the length of shorter, and with meral length of longer approximating length of carapace. Ratio of carpal articles of both legs variable, centering on 10:30:7:7:13, but with the second article varying from about 2.0 to 4.5 times length of first.

Ischium of third leg with spine. Merus 3.6 times as long as broad with strong tooth on distal end of inferior margin. Carpus without spines, but bearing hairs on its inferior and superior margin; inferodistal margin with a strong acute tooth; superodistal margin also with acute tooth, but much smaller than inferior. Propodus a little shorter than carpus and bearing on inferior margin four spines and a pair distally. Dactylus simple, 0.2 as long as propodus.

Telson slender, 2.5 to 7.0 times as long as posterior margin is broad. Posterior margin straight, posterolateral pairs of spines not as near corner as usual, but with medial pair usually heavy and closer to midline. Dorsal spines extremely small and some may be lacking.

DISCUSSION: The variability of this species and its separation from related species is discussed under the *Obesomanus* Group.

Not previously remarked upon in the literature are the heavy setae on the inferodistal margin of the second article of the third maxilliped; these are also found in *A. malleodigitus* and *A. microstylus*.

We have figured the large chela (fig. 221) of a specimen from Opal Reef (BAU 33) in which the superior "head" of the dactylus was somewhat reduced and the sculpturing on the chela was limited to a slight depression immediately behind the dactylar articulation; one of similar development was found in the Philippine collections. We regard this as an extension of the variation already discussed in our 1966a study.

AUSTRALIAN DISTRIBUTION: Specimens in the present collections are limited to the area from the Torres Straits to the Capricorn Group.

GENERAL DISTRIBUTION: From the Red Sea and Madagascar to the Society Islands, including Japan. It has not been reported from Hawaii.

Alpheus malleodigitus (Bate)

Fig. 22m-o

Betaeus malleodigitus Bate, 1888:565, pl. 101, fig. 5.

Alpheus malleodigitus De Man, 1902:866. Banner and Banner, 1966a: 162 *et seq.*, figs. 8-18; 1966b:103, fig. 35.

Alpheus malleodigitus var. *gracilicarpus* De Man, 1909a:99.

Alpheus phyrgianus Coutière, 1905a:886, fig. 25.

Alpheus persicus Nobili, 1906a:33.

Previous Australian records: Coutière, 1900:413. Murray Is., Torres Straits. McNeill, 1968:15. N. Queensland.

SPECIMENS EXAMINED: 2 specimens from AM 170 (AM P. 27526); 1, AM 305 (AM P. 27779); 2, BAU 15; 2, BAU 20; 2, BAU 21; 2, BAU 23; 4, BAU 27; 1, BAU 29; 2, BAU 30; 2, BAU 32; 1, BAU 44; 4, BAU 47; 1, BAU 48; 1, BAU 52; 1, BAU 53; 1, BAU 54; 1, BAU 56; 1, WM 26-65; 1, WM 70-65; 1, WM 247-65; 1, 75 LIZ-R (AM P. 27916).

DISCUSSION: This species is variable but is very similar in appearance to *A. obesomanus* Dana and *A. microstylus* (Bate); variation and separation of the three species is discussed above. We noted that in a pair of specimens we collected from Opal Reef, the female was an "off pinkish-red" and the male was tan.

We have examined the holotype at the British Museum (Natural History) and find it agrees with the specimens we have been identifying under this name.

AUSTRALIAN DISTRIBUTION: We have specimens in Western Australia from the Dampier Archipelago to Cockatoo Island in Yampi Sound; in the north from the Torres Straits; and on the east coast from off Cooktown to Heron Island in the Capricorn Group.

GENERAL DISTRIBUTION: The Red Sea; Indonesia and Japan and across the Pacific to the Society Islands. It has not been reported from Hawaii.

Alpheus microstylus (Bate)

Fig. 22p-r

Betaeus microstylus Bate, 1888:566, pl. 101, fig. 6.

Alpheus microstylus Coutière, 1905a:884, fig. 23. Banner and Banner, 1966b:105, fig. 35.

Alpheus obesomanus De Man, 1888a:520; 1902:867 (*nec* Dana, 1852).

Alpheus malleodigitus Coutière, 1899:223, 316, figs. 270-272, 400 (*nec* *A. malleodigitus* (Bate)).

Alpheus microstylus var. De Man, 1911:345, fig. 68.

Previous Australian records: Bate, (*loc. cit.*). Cape York, Qld.

DISCUSSION: As in the case of *A. malleodigitus* (Bate), this species is so similar to *A. obesomanus* Dana that we are using that species as a generalised description, and have pointed out its variation and differences from the other two species in the introduction to the Obesomanus Group. We have examined Bate's type at the British Museum (Natural History) and found it lacking all thoracic legs except for one, possibly the third. However, its anterior region with appendages and its telson confirm our identification of this species reported from previous collections. The drawings in Figure 22p, q, r were made from a specimen from the Red Sea.

AUSTRALIAN DISTRIBUTION: The only specimen known is Bate's from Cape York.

GENERAL DISTRIBUTION: This species has been reported from the Red Sea, Madagascar, Seychelles, Maldives and Laccadives, the Indian Ocean coast of the Malayo-Thai peninsula, Indonesia, Vietnam, the Marianas and Samoa. It has not been found in the eastern archipelagoes of the Pacific.

CRINITUS GROUP

Orbital teeth lacking; rostrum often reduced, at times absent. Large chela rounded in section, without grooves or ridges. Small chela of male often balaniceps. Third legs with merus usually armed, dactylus simple or biunguiculate.

Many species of this group live in algal tubes or in sponges; other species may have similar cryptic habitats, but these have not been noted.

SPECIES FOUND IN FABRICATED TUBES

Five species of the Crinitus Group have been reported as occurring in tubes — at times branching and with embayments or chambers — which they have constructed for themselves of filamentous algae and other materials (see B&B, 1968:284-286). These are: *A. bucephalus* Coutière, which may use pure algae, or algae with sponges and other materials; *A. brevipes* Stimpson, which has been found in a tube of red filamentous alga; *A. clypeatus* Coutière, which prefers a tube of red filamentous alga (*Acrochaetium*) but may use other reds, browns and blue-greens as well (Bowers, 1970:77); *A. pachychirus* Stimpson and *A. frontalis* Milne-Edwards, which in the field seem to confine their tube-dwelling activities largely to filamentous blue-green algae such as *Microcoleus* spp. (note: the names of the blue-greens referred to in the older literature are in question since the publication of Drouet (1968) which revised most of the names applied in the group). *A. brevipes* and *A. clypeatus* are not known to occur in Australian waters.

The only species known to be an obligate tube-builder is *A. frontalis* which makes massive and conspicuous tubes, up to 40 cm long and 15-20 mm in diameter (Fishelson, 1966:98). It is likely that *A. pachychirus* and *A. clypeatus* also always dwell in tubes, but as these tubes are smaller and found between fronds of dead racemous coral where they are disrupted when the coral head is broken up, the shrimp often appear in the rubble as if they were living freely in the head. The two less specialized species (see below), *A. bucephalus* and *A. brevipes*, both relatively small, have been reported as tube dwellers only once in the literature (B&B *loc. cit.*).

The five species are similar in general form and are variable in many characteristics (see B&B *loc. cit.*, and for *A. brevipes* and *A. clypeatus*, Banner, 1953:103, 107). In many characteristics the species overlap — thus the rostral fronts cannot be used to separate *A. brevipes*, *A. clypeatus* and *A. pachychirus*, and the

TABLE 2
Separation of the tube dwelling species of the Cinitus group

| Characteristic | <i>A. brevipes</i> | <i>A. bucephalus</i> | <i>A. clypeatus</i> | <i>A. pachychirus</i> | <i>A. frontalis</i> |
|--|--|--|---|---|---|
| Front of carapace | Somewhat truncate, with slight rostral projection | Indented with definite rostrum | From slightly indented to truncate, slight projection | Similar to <i>A. clypeatus</i> | Markedly projecting, rounded truncate, with slight rostral projection. |
| Third article of third maxillipeds | Or normal shape, tapering, with slight short setae | Similar to <i>A. brevipes</i> | Slightly broadened with long setae in moderate numbers | Markedly broadened with heavy growth of long setae | Extremely broadened with heaviest growth of long setae. |
| Tooth on merus of large cheliped | Absent | Usually present | Usually present | Absent | Absent |
| Small chela sexually dimorphic | No | Yes | Yes | Yes | Yes |
| Dactylus, small chela, male | Conical, 2-3 times as long as broad; setae scattered | Subspatulate, 2.5 times as long as broad; margins lined with setiferous bristles | Subspatulate, 2 times as long as broad; margins like <i>A. bucephalus</i> | Subspatulate, 1.5 times as long as broad; margins like <i>A. bucephalus</i> | Subspatulate, 2 times as long as broad; margins like <i>A. bucephalus</i> |
| Ratio of first two articles of second legs | 10:14-21 | 10:20-30 | 10:9-13 | 10:5-7 | 10:3-5 |
| Tooth on merus, third legs | Present | Present | Present | Present | Absent |

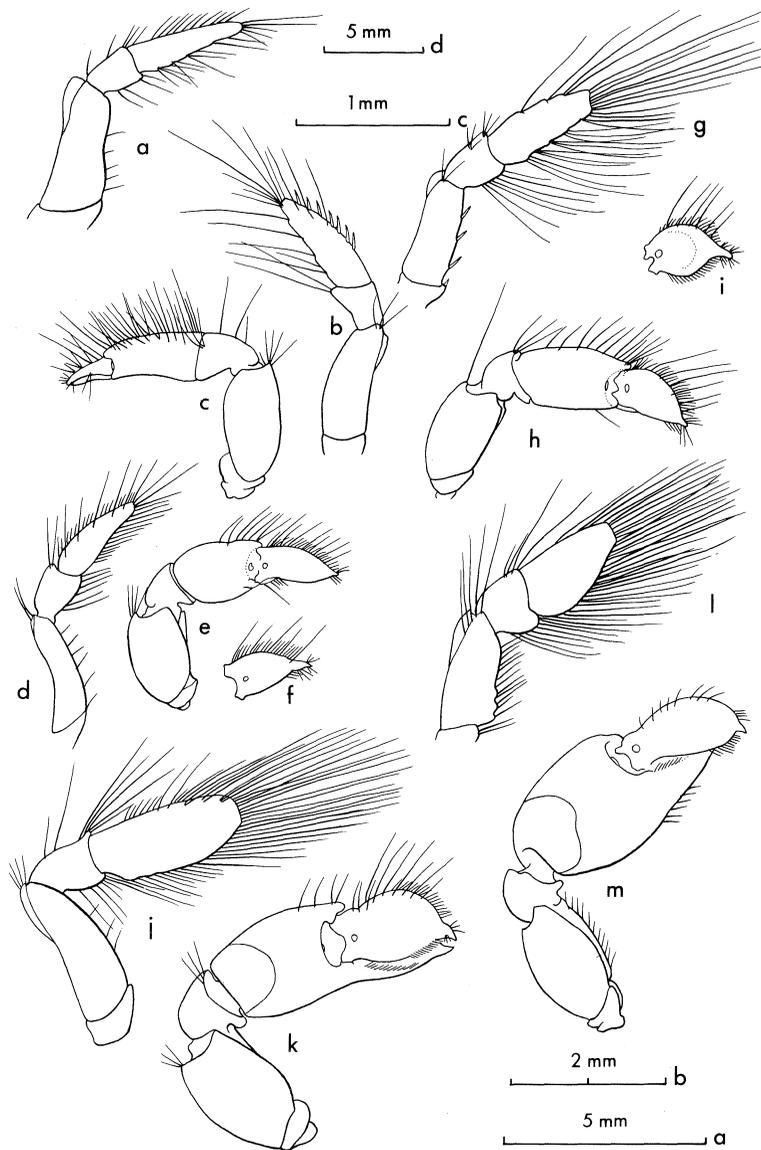


Fig. 23. Tube-dwelling species of the Crinitus Group, third maxillipeds and small chelae in lateral aspect (measurements indicate carapace lengths). *Alpheus brevipes* Dana 4.0 mm female and 3.2 mm male from City of Refuge, Hawaii: **a**. Third maxilliped, female; **b**. third maxilliped, male; **c**. small cheliped, lateral view, male. *Alpheus bucephalus* Coutière, 5 mm male from BAU 28: **d**. Third maxilliped; **e**, **f**. small cheliped; dactylus held flat. *Alpheus clypeatus* Coutière 5 mm male from Makena, Hawaii: **g**. Third maxilliped; **h**, **i**. small cheliped; dactylus held flat. *Alpheus pachychirus* Stimpson. 6.5 mm male from AM P. 7521: **j**. Third maxilliped; **k**. small cheliped; dactylus held flat. *Alpheus frontalis* Milne-Edwards. 12 mm male from AM P. 13572: **l**. Third maxilliped; **m**. small cheliped, lateral view (see also fig. 25 d-j). e, f, h, i, k, l scale a; c, d, g, j scale b; a, b scale c; m scale d.

ratio of the first two carpal articles of the second legs probably would present a continuum if enough specimens were measured from *A. bucephalus* which may have a ratio of 10:30 to *A. frontalis* with a ratio of 10:4. In this last characteristic, however, the frequency curve would have 5 modes and only the fringes of the individual curves would overlap.

The separation of the species is given in Table 2 and the important small chelae of the males and the third maxillipeds, not previously contrasted in the literature, are shown in Figure 23. The species appear to show a progressive adaptation for tube dwelling especially in these chelae and maxillipeds, from *A. brevipes* with "usual" small chelae and maxillipeds to *A. frontalis* with highly hirsute maxillipeds and fingers of the chelae. Other features may also reflect modification for tube dwelling — for example, the rounded rostral front, so conspicuous in *A. frontalis*, but to a degree developed in all species except *A. bucephalus*, may be an adaptation for the avoidance of entanglement in the algal filaments.

Tube building activities have been described by Cowles for *A. pachychirus* in the Philippines (1913:121), by Fishelson for *A. frontalis* in the Red Sea (*loc. cit.*) and by Bowers for *A. clypeatus* in Hawaii (1970:74). (We do not know why Fishelson believed that Cowles worked on *A. frontalis* rather than *A. pachychirus* as he reported, for we have collected *A. pachychirus* in tubes of bluegreen alga from the Philippines). It is only rarely that the shrimp do not occur in cohabiting heterosexual pairs in the tubes, and probably never as homosexual pairs or trios (see Bowers on agonistic behaviour). The tubes establish for the pair a discrete territory that is easily defensible (Bowers) and the alga of their walls is eaten (Fishelson, Bowers) although they may use other food as well (Fishelson). Bowers found that five of the seven species of algae used by *A. clypeatus* for tube building are eaten by herbivorous fishes, and that the most common building material, *Acrochaetium*, is an important part of the diet of fishes of the genus *Zebrasoma*. No one has remarked that the most common building material of *A. pachychirus* and *A. frontalis* (*Plectonema wollesi* of Cowles and *Oscillaria* of Fishelson, *Lyngbya majuscula* and *L. sordida* of B&B, all possibly now *Microcoleus spp.*) may be highly toxic to many animals (see for example Moikeha and Chu, 1971:8) and may therefore confer protection from predation to the tube dwellers. Fishelson has remarked that the tubes constitute a microhabitat containing "numerous unicellular algae as well as various ciliates, foraminifera, nauplii and adult micro-crustaceans." When it was slit either the male or both members of the pair would repair it. Fishelson implied (by lack of other designation) that the large chela was used to pull the tube together while the maxillipeds were used to "seal it by rapid sewing motions"; both Cowles and Bowers found the shrimp used the slender flexible second pair of chelae to interlace the filaments of algae from one side to the other. All three authors observed the shrimp form new tubes from loose algal fragments, but only Bowers gives details of how the first fragments are interwoven, again by the second legs, into the initial mat. Fishelson believed that the tubes are more than interwoven "but are also held together in various spots by a sticky substance which seems to be produced by the inhabiting shrimp." Cowles believed the tubes were attached to the underside of rocks by mere entanglement.

Aside from Fishelson's remarks on the use of the third maxillipeds to "sew" the split tubes as quoted above, no one has remarked on the function of the highly modified small chela and setiferous maxillipeds.

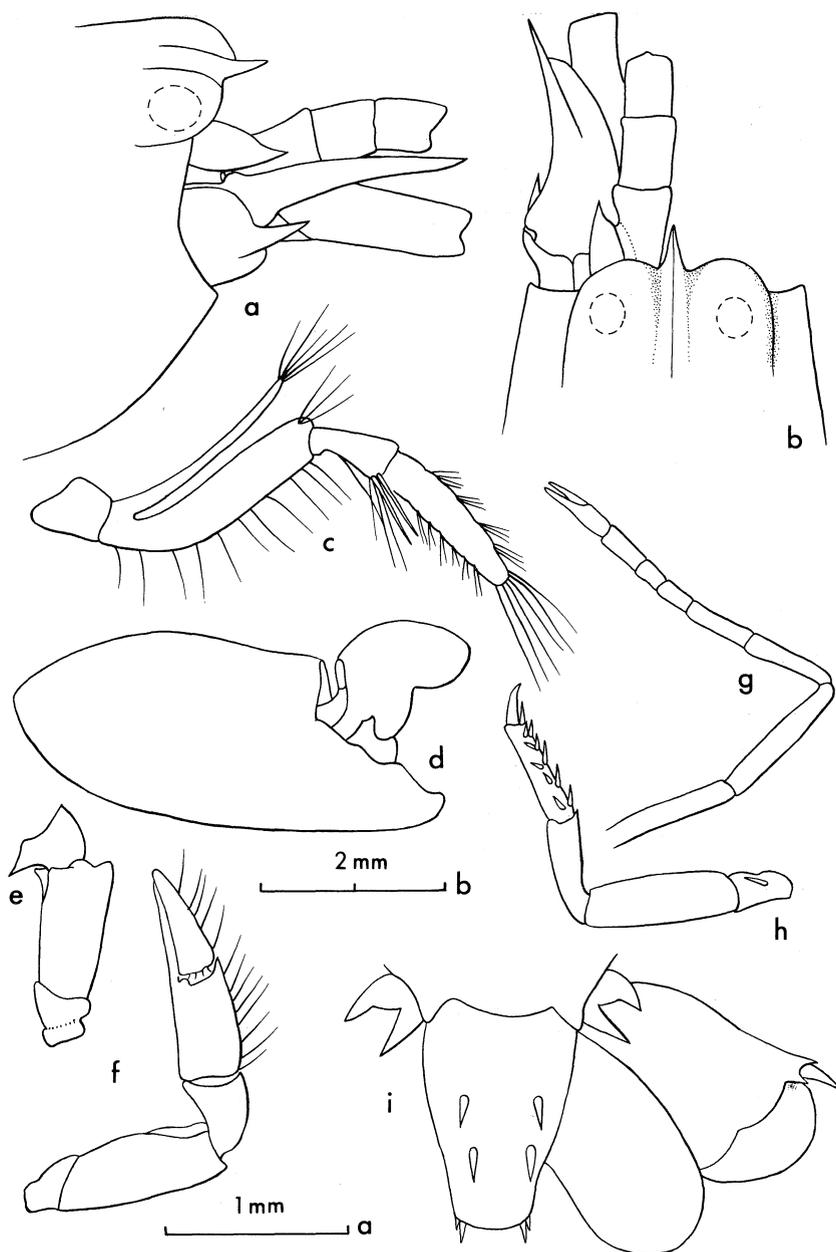


Fig. 24 *Alpheus ovaliceps* Coutière
 15 mm female from BAU 29. **a, b.** Anterior region, lateral and dorsal view; **c.** third maxilliped; **d, e.** large cheliped, chela, lateral face and merus, medial face; **f.** small cheliped, lateral face; **g.** second leg; **h.** third leg; **i.** telson and uropods. **a, b, c, i** scale **a**; **d, e, f, g, h** scale **b**.

Alpheus ovaliceps Coutière

Fig. 24

Alpheus ovaliceps Coutière, 1905a:888, pl. 77, fig. 27. Banner, 1956:356, fig. 18. Banner and Banner, 1967:275.

SPECIMENS EXAMINED: 3 specimens from BAU 29.

DIAGNOSIS: Rostrum acute, reaching to middle of visible part of first antennular article, with rounded carina extending posteriorly to behind level of eyes. Orbitorostral gooves only moderately deep. Anterior margin of orbital hoods rounded and curving posteriorly towards base of rostrum. Antennular articles nearly equal, second antennular article 1.4 times as long as broad. Stylocerite acute, not reaching end of first antennular article. Outer margin of scaphocerite concave, lateral tooth extending nearly to length of third article past that article; squamous portion narrow, reaching to end of third antennular article. Carpocerite as long as tip of lateral tooth of scaphocerite. Tooth on basicerite strong and reaching beyond stylocerite.

Articles of third maxilliped with ratio of 10:4:7. Third article 4.6 times as long as broad near base. Tip of third article bearing a brush of long hairs, medial face bearing usual rows of setae. Distal end of inferior margin of second article bearing 2 long heavy bristles and a few long setae.

Large chela cylindrical, 2.4 times as long as broad with fingers occupying the distal third. Dactylus heavy with distal tip obtuse, slightly overhanging pollex when closed. Merus 2.2 times as long as broad, distal margin not projected. Small cheliped not sexually dimorphic. Chela rounded in section, 3 times as long as broad with fingers and palm nearly equal. Superior portion of inner face of palm somewhat hirsute.

Carpal articles of second leg with ratio: 10:8:4:4:5.

Ischium of third leg with a spine. Merus broadened in middle without inferodistal tooth, 3 times as long as broad. Carpus 0.7 as long as merus, superodistal margin projecting but rounded, inferodistal margin with acute tooth. Propodus 0.7 as long as merus, bearing on its inferior margin 5 pairs of spines and a pair distally. Dactylus simple, 0.4 as long as propodus.

Pleura of first abdominal somite of male rounded at tip.

Telson 2 times as long as posterior margin is broad. Inner spine of posterolateral pair 2 times as long as outer spine. Articulation of outer uropod broadly scalloped.

DISCUSSION: We have previously remarked upon consistent differences between the "Pacific form" of this species (*loc. cit.*) and the specimen from Minikoi originally described by Coutière. These include in the Minikoi holotype the tapering of the palm towards the dactylar articulation, and a slight transverse groove proximal to the articulation in the large chela, and a dark brown spine on the uropod in Coutière's specimen. Further it has not been previously remarked upon that in the holotype the palmar adhesive plaque is set at an angle to the axis of the palm, permitting the heavy dactylus to be raised to an angle greater than 90°. In contrast, all Pacific specimens we have seen have the palm of the large chela without a taper towards the dactylus and without a transverse groove proximal to the dactylus. They also have the adhesive plaque set at about 90° to the axis of the palm and a slightly more slender dactylus, and all bear a colourless spine on the outer uropod. The 3

specimens from Australia, as well as several specimens from the southern Philippines, agree with the other specimens from the Pacific. All Pacific specimens have the two heavy bristles on the second article of the maxilliped as was described and figured by Coutière. We are now approaching the opinion that the "Pacific form" should be separated from the Indian Ocean form described by Coutière either at the specific or subspecific level, but we have again decided to defer the separation to see if we have additional specimens from the Indian Ocean in the unstudied collection we now have available.

BIOLOGICAL NOTES: Coutière's specimens from Minikoi and Chagos were dredged, but the other specimens in our collections were from dead coral heads from water not over 15 feet deep. The Australian specimens came from a rubble covered reef flat. The largest specimen we have seen was 20 mm long.

AUSTRALIAN DISTRIBUTION: Our 3 specimens came from Rudder Reef off Port Douglas, Qld.

GENERAL DISTRIBUTION: Minikoi Atoll, Chagos, Philippines, Mariana, Marshall, Phoenix, Tonga, Samoa and Society islands.

Alpheus frontalis Milne-Edwards

Figs. 23 l,m; 25

Alpheus frontalis H. Milne-Edwards, 1837:356*. Ortmann, 1890:488. Tiwari, 1963:294, fig. 15. Fishelson, 1966:98, figs. 1-3. Miya, 1974:135, pl. 23, figs. D-G.

Alpheus latifrons A. Milne-Edwards, 1873:87. De Man, 1888a:521, pl. 22, fig. 4; 1890:119, pl. 6, fig. 15.

Betaeus utricola Richters, 1880:164, pl. 17, fig. 34, 35.

Alpheus frontalis Zehntner, 1894:200. [Partim]

Previous Australian records:

White, 1847:75. Torres Straits.

Haswell, 1882b:188. Australia. [Translation of original description.]

Coutière, 1900:414. Murray Is., Torres Straits.

McNeill, 1968:16. North Queensland.

SPECIMENS EXAMINED: 1 specimen from AM 74 (AM P. 27498); 1, AM 94 (AM P. 27468); 1, AM 142 (AM P. 27469); 2, AM 425 (AM P. 27772); 2, AM 432 (AM P. 27331); 2, AM P. 4303; 4, AM P. 7440; 1, AM P. 13554; 8, AM P. 13572; 1, AM P. 27783; 1, WM 204-65.

DIAGNOSIS: Anterior margin of carapace extending between orbits as a shelf-like projection, vaulted in profile carrying rounded dorsal carina extending to base of eyes. Eyehoods inflated, forming moderately deep orbitorostral grooves. At least half of first antennular article covered by anterior projection, visible section one-third as long as second; second article almost 3 times as long as broad; third article 0.5 as long as second. Lateral margins of second and third articles armed with a fringe of short setiferous bristles. Stylocerite rounded, without tooth and reaching only to middle of first

*Several early authors attributed the original description of *A. frontalis* to Thomas Say. However, Holthuis' compilation of the carcinological works of Thomas Say (1969) leaves little doubt that Say never mentioned *A. frontalis* in any of his works on Crustacea, the last of which was published in 1818. Dr F. A. Chace Jr. (personal communication) has pointed out to us that the error arose from Milne-Edwards himself (*loc. cit.*). Milne-Edwards misplaced his footnote 2, attributing authorship to Say, from *A. minus* where it belongs to his own *A. frontalis* listed immediately below.

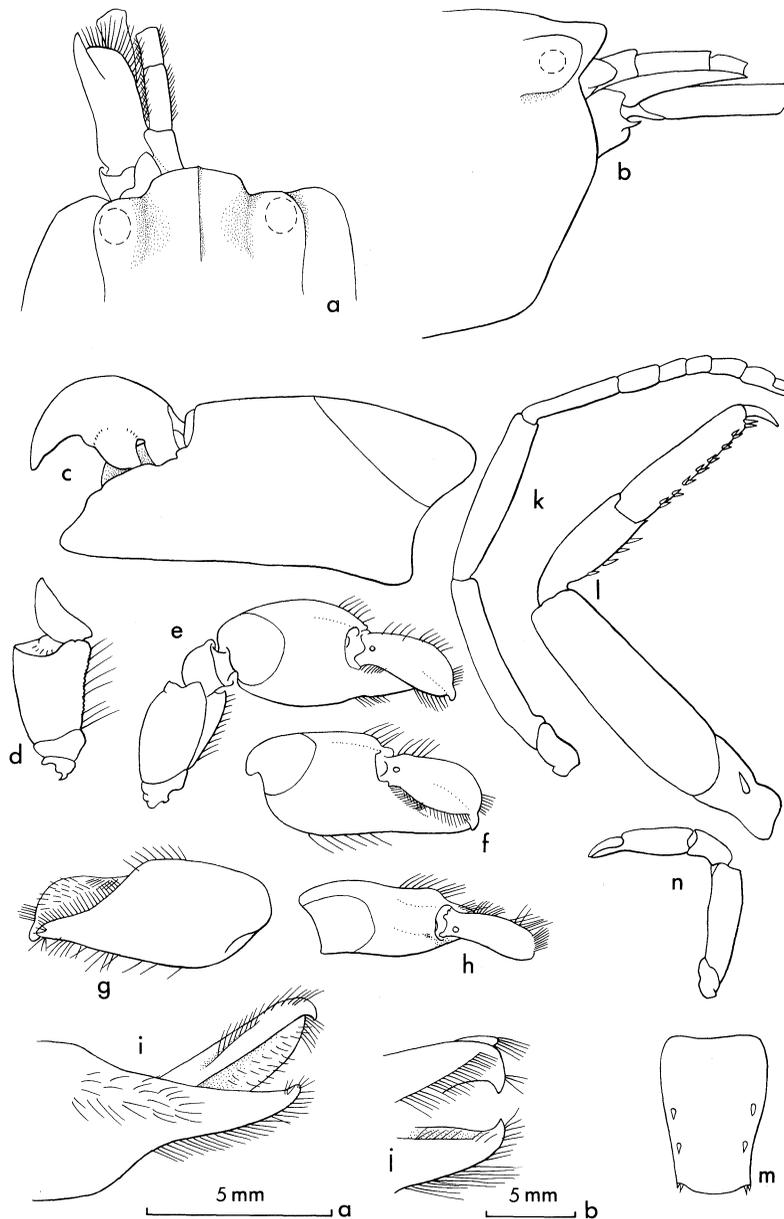


Fig. 25 *Alpheus frontalis* Milne-Edwards
 37 mm male from AM P. 13572. **a, b.** Anterior region, dorsal and lateral view; **c, d.** large chela, lateral face, and merus, medial face; **e.** small cheliped, lateral view, merus held flat; **f.** small chela, lateral face, held flat; **g, h.** small chela medial and superior face; **i.** small chela, inferior face; **j.** small chela, inferolateral face; **k.** second leg; **l.** third leg; **m.** telson. 45 mm female from AM 432. **n.** Small cheliped, lateral face. **a, b, i, j, k, l, m** scale a; **c, d, e, f, g, h, n** scale b.

antennular article. Lateral tooth of scaphocerite strong, tip curved slightly medially and reaching to end of antennular peduncle; squamous portion broad, reaching past middle of third antennular article. Carpocerite reaching length of third article past that article. Inferior margin of basicerite with a small acute tooth.

Third maxillipeds stout, ratio of articles: 10:4:7. Second article broader than long, with large setiferous lobe on inferior margin. Third article 1.7 times as long as broad, compressed and acutely triangular in section with inferior margin knife-like and superior margin somewhat thicker; long setae on both margins, with most equal to article in length; setae more dense on inferior margin.

Large chela massive, subcylindrical, without grooves, 2.3 times as long as broad, fingers occupying the distal 0.3. Plunger of dactylus long, tip of dactylus strongly curved and extending slightly beyond pollex when closed. Entire surface of chela covered with minute papillae. Merus nearly as long as broad, superodistal margin not projected. Inferointernal margin with fine irregular teeth and bearing long fine setae; distal angles not projecting.

Small chelipeds sexually dimorphic. Small chela of males about 0.6 as long as large chela, stout, almost 2.4 times as broad, with fingers approximately equal in length to palm. Palm compressed, margins rounded with slight rounded longitudinal depressions on either side of low, rounded crest leading to palmar adhesive plaque, and similar shallow depression on lateral face of base of pollex; palm with only scattered setae. Articular hinge of dactylus set at 45° to vertical axis of palm, closing on pollex from superolateral angle; dactylus broadly expanded, almost petal-like with slight superior ridge distally that terminates in strong, sharply curved terminal tooth; tooth continued on opposite face of dactylus as a heavy "V"-shaped ridge; tip of tooth with sharp shearing edge that slides past comparable edge on terminal tooth of pollex. Rounded margin of dactylus on either side of terminal tooth with dense row of setiferous bristles; other bristles along margins and scattered softer setae on flattened opposite face superior to ridge. Pollex slightly expanded proximally, tapering to curved terminal tooth, with groove on opposite face to accommodate ridge of dactylus; inferior margin near palm with numerous long setae; inner margin with row of setiferous bristles of moderate length and with row of shorter setae on proximal portion of lateral margin. Palm and dactylus with adhesive plaques.

Merus similar to that of large cheliped. Small chela of female unmodified, less than half length of chela of male of corresponding size, with palm cylindrical, 3.7 times as long as broad, fingers slender and tapering; fingers about half length of palm. Merus 3.3 times as long as broad, slightly longer than chela and almost 3 times as long as carpus.

Carpal articles of second leg with ratio: 10:4:2:2:3.

Ischium of third leg with spine. Merus unarmed, 3.5 times as long as broad. Carpus 0.4 as long as merus, terminating inferiorly in acute, superiorly in obtuse tooth. Propodus 0.5 as long as merus and bearing on its inferior margin 7 pairs of spines and a pair distally. Dactylus simple, curved.

Posterior margin of first abdominal pleura of male rounded, but more narrow than in female.

Telson 2.3 times as long as posterior margin is wide. Spines on dorsal surface small, anterior pair placed at middle. Outer spine of posterior pair very small. Articulation of outer uropod straight, not scalloped.

DISCUSSION: The shape of the anterior margin of the carapace is variable in this

species. It is sometimes shorter than in the specimen figured, sometimes slightly emarginate and the sharpness of the carina is also variable. De Man (1911:fig. 79, 79a, b) adequately illustrates this variation. In immature males in this collection the small chelae have only a minimal development of sexual dimorphic characters, a condition already remarked upon (B&B, 1968:286). The usual development of the anterior region of the carapace in spite of its variation makes this species easy to separate from all other species. The 10 mm female from Ambon mentioned by Zehntner (1894:200) was not *A. frontalis* as the first article of the second leg is a third the length of the second article, a condition never approached by this species.

BIOLOGICAL NOTES: For the tube dwelling habits of *A. frontalis* see discussion under the Crinitus Group. As this species appears to be an obligatory commensal in tubes of algae, we suggest that the label of one of Miya's specimens (1974:138) which stated that it was found as a commensal with *Tridacna crocea* was in error.

There appears to be some variation in the colour patterns. Bruce (1975:24, fig. 4) published a beautiful colour photo of a specimen from Mombasa, Kenya which was dark purple and violet and sprinkled with pale lavender and white spots. In a personal communication he stated that this species is ". . . quite common here on Heron Island (Australia) and the colour pattern is still essentially the same, possibly slightly paler only". This is similar to the colour pattern reported by Miya (1974:137) for specimens from the Ryukyus. Fishelson reports his specimens from the Red Sea have ". . . pale transparent bodies, and the only blackish spots are the eyes and stomach. On both sides along the dorsum, there are two rows of white spots on each tergite. The chelae are marbled . . ." However, we cited (1968:286) a report from Dr Cadet Hand that specimens of *A. frontalis* from Kapingamarangi in the Caroline Islands were "purple with a red tail and had blue spots on their bodies". Our specimens from the Philippines were pale brown.

This species ranges in depth from the immediate subtidal to appreciable depths, 130 m according to Miya (1974:138), and from a dredge haul from 20-80 fathoms according to Coutière (1921:425). We have specimens up to 45 mm in length.

AUSTRALIAN DISTRIBUTION: In western Australia we have a specimen from Northwest Cape, in eastern Australia we have specimens from the Torres Straits and along the Great Barrier Reef from the Coral Sea to Heron Island.

GENERAL DISTRIBUTION: This species ranges across the Indo-Pacific from East Africa to the Society Islands. It does not occur in Hawaii.

***Alpheus pachychirus* Stimpson**

Figs 23 j, k; 26

Alpheus pachychirus Stimpson, 1861:30. De Man, 1890:116, pl. 6, fig. 14. Ortmann, 1890:487, pl. 36, figs. 17 a-k. Cowles, 1913: 121, figs. 1, 2.

Previous Australian records:

Coutière, 1900:414. Murray Is., Torres Straits.

SPECIMENS EXAMINED: 1 specimen from AM 74 (AM P. 27501); 1, AM 305 (AM P. 27780); 2, AM P. 7521; 2 AM P. 13568; 2, BAU 31.

DIAGNOSIS: Frontal margin projecting and broadly convex across front from orbital hood to orbital hood, with only a trace of orbitorostral concavity and only a slight obtuse triangle for rostrum. Rostrum bearing low, but distinct, carina reaching posterior to eyes. Orbital hoods inflated, orbitorostral area almost flat.

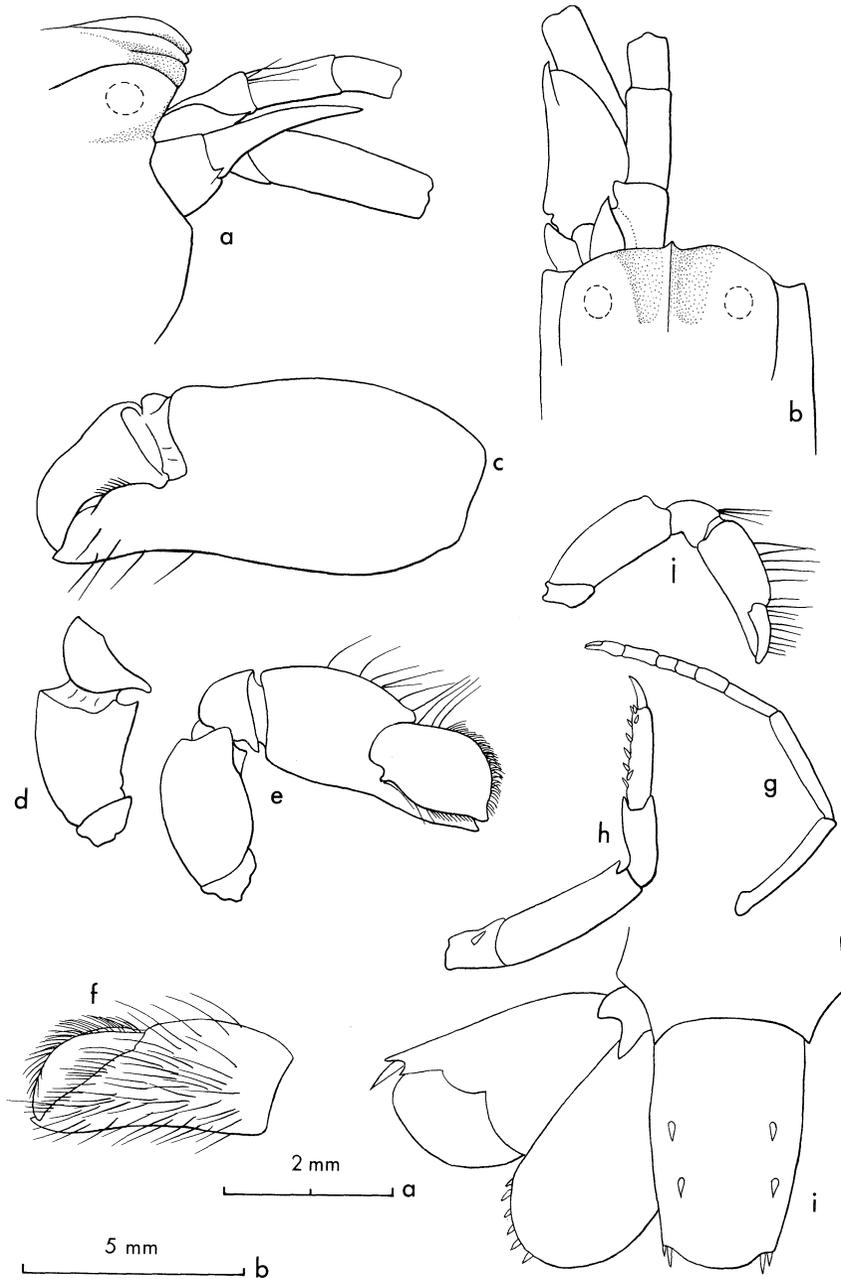


Fig. 26 *Alpheus pachychirus* Stimpson

20 mm male from AM P. 7521. **a, b.** Anterior region, lateral and dorsal view; **c, d.** large cheliped, lateral face and merus, medial face; **e.** small chela, lateral face; **f.** small chela, medial face; **g.** second leg; **h.** third leg; **i.** telson and uropods. 20 mm female from AMP. 7521. **j.** Small cheliped, lateral face. a, b, i scale a; c, d, e, f, g, h, j scale b.

Antennular peduncle with visible part of first antennular article 0.7 as long as second which is 2.3 times as long as broad. Third article 0.4 as long as second. Stylocerite acute, short, not reaching end of first antennular article. Outer margin of scaphocerite nearly straight, lateral tooth curved inward at tip and reaching middle of third antennular article. Squamous portion broad, a little shorter than lateral tooth. Carpocerite reaching well beyond antennular peduncle. Basicerite with small acute lateral tooth.

Third maxilliped stout; second article 1.4 times as long as broad and 0.3 as long as third article. Third article 2.4 times as long as broad, flattened and paddle-shaped. Margins of both second and third articles bearing numerous long bristles with a patch of longer bristles distally.

Large chela cylindrical, 2.3 times as long as broad; dactylus, which is directed slightly laterally, 0.3 total length of chela. Chela of female 0.7 length of that of male of comparable size. Dactylus obtuse, but not truncate distally. Merus 1.5 times as long as wide distally, inferointernal margins without spines, but distally armed with a small acute tooth.

Small chela sexually dimorphic. In the male dactylus opening lateral to axis of palm, 1.5 times as long as broad, spatulate with opposite face concave and with ridge ending in strong, curved and acute distal tooth (compare to figs. 25 e-j for *A. frontalis*); margins bearing dense setiferous bristles. Inferior portions of distal palm and proximal pollex bearing numerous long setae. Merus 1.5 times as long as broad, without teeth distally. Small chela of female 2.7 times as long as broad with fingers 0.6 as long as palm. Inner face near superior margin bearing fine setae. Merus similar to that of male.

Carpal articles of second leg with a ratio: 10:6:4:3:6.

Ischium of third leg with spine. Merus 3.3 times as long as broad with small acute tooth on inferodistal margin. Carpus 0.5 as long as merus; inferodistal margin projected as acute tooth; superodistal margin projected slightly as rounded tooth. Propodus 0.6 as long as merus, bearing 7 spines on its inferior margin and a pair distally. Dactylus simple, 0.3 as long as propodus. Fourth leg without meral tooth.

First abdominal pleura in male acute, but not hooked.

Telson 2.2 times as long as posterior margin is broad. Anterior margin only 1.3 times wider than posterior. Outer margin of inner uropod bearing 6 spines near posterior section. Articulation of outer uropod scalloped.

DISCUSSION: The separation of this species from closely related forms is given in Table 2. Of the species occurring in Australia, it is closest to *A. frontalis* Milne-Edwards, but from that species it can be separated easily by the nature of the frontal margin of the carapace; it is even closer to *A. clypeatus* Coutière which has not been reported in Australia, and from that species it can best be separated by the shape and the setae of the last article of the third maxilliped. It should be noted that in young males the spatulate condition of the dactylus of the small chela may not be developed.

Fishelson (1966) and Miya (1974) state that they believe the species reported by Cowles (1913) from the Philippines as *A. pachychirus* was *A. frontalis*; this assumption probably was based on the fact that *A. frontalis* was known to make felted or woven tubes of blue-green alga and that habit was unknown for *A. pachychirus* except for Cowles's report. However, we found one pair of *A. pachychirus* in Australia and 6 specimens (some unpaired) in the Philippines all living in such tubes. Therefore, unless other evidence can be offered, we will accept Cowles's determination.

BIOLOGICAL NOTES: This species, which we believe to be largely an obligate

dweller in algal tubes, is discussed with other tube dwellers on p. 94. The species has been found from the lower intertidal to depths of 36 m. from which it was dredged. It reaches the length of 25 mm.

AUSTRALIAN DISTRIBUTION: In northern Australia a specimen was collected from the Torres Straits; in the eastern coast the species ranges from the Coral Sea to off Cooktown and Pt. Douglas, Qld.

GENERAL DISTRIBUTION: Red Sea; Coetivy, Seychelles; Indonesia; Philippines; Ryukyus; Caroline, Marshall, Rotuma, Wake, Palmyra, Tahiti islands.

***Alpheus eulimene* De Man**

Fig. 27

Alpheus eulimene De Man, 1909a:101; 1911:364, fig. 76. Banner, 1956:356. Miya, 1974:146, pl. 27.

SPECIMENS EXAMINED: 1 specimen from AM 305 (AM P. 27777); 2, BAU 29; 2, BAU 30; 1, BAU 31; 2, BAU 42; 2, BAU 48; 1, BAU 55; 1, WM 4985.

DIAGNOSIS: Anterior portion of carapace projecting in front of orbital hoods with portion near rostrum straight in dorsal view and then laterally curving abruptly to meet orbital hoods in their middle. Rostrum broadly triangular and short, scarcely reaching one-fifth length of visible portion of first antennular article; rostral carina extending posteriorly variously from one-third to one-half length of carapace, broadening posteriorly. Second antennular article 1.6 times as long as broad and 1.5 times as long as visible part of first and third articles. Stylocerite acute, not reaching end of first antennular article. Scaphocerite with outer margin concave, squamous portion reduced but protrudent and rounded, reaching to middle of second antennular article, bearing short setae. Carpocerite slender, reaching almost the length of third article past that article. Basicerite without a lateral tooth.

Ratio of articles of third maxilliped: 10:3:7. Inferior margin of first article bearing irregular and usually rounded teeth, inferior margin of second article bearing many setae, particularly distally; third article with tip bearing brush of hairs.

Large chela 2.5 times as long as broad with fingers occupying the distal 0.3. Palm gradually broadening distally, but with abrupt reduction in diameter before dactylar articulation, giving a slight "humped" appearance. Tip of dactylus truncate, overhanging pollex. Merus 1.4 times as long as broad, superior margin not projected, inferointernal margin bearing strong subterminal tooth. Large chela of male much larger than that of female (in one cohabiting pair of equal size (BAU 29), the female chela was 0.6 the length of the male chela).

Small cheliped not sexually dimorphic. Chela 3 times as long as broad, palm broader proximal to midsection, appearing somewhat bulbous from superior aspect. Finger 1.2 times length of palm, rotated to palm so as to open in mediolateral plane, slender and curved laterally; opposing faces varying from nearly flat to markedly concave, with opposing margins serrulate and bearing short setae. Carpus cup-shaped 0.2 as long as chela. Merus 2 times as long as broad, bearing on inferointernal margin an acute terminal tooth.

Carpal articles of second leg with ratio: 10:18:3:3:7.

Ischium of third leg unarmed. Merus 4.0 times as long as broad bearing distally on

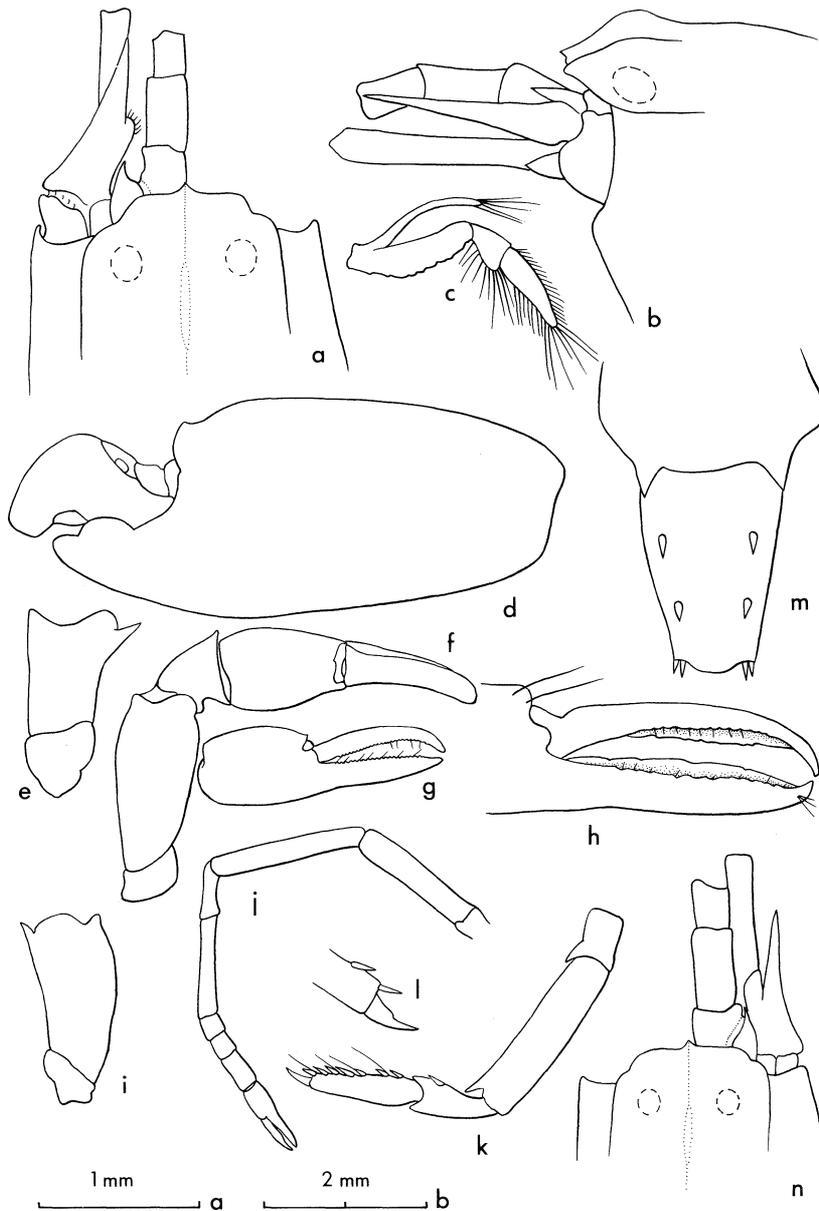


Fig. 27 *Alpheus eulimene* De Man

12 mm male from BAU 29. **a, b.** Anterior region, dorsal and lateral view; **c.** third maxilliped; **d, e.** large chela, lateral face and merus, medial face; **f.** small cheliped, lateral view; **g, h.** small chela, inferior view; distal region enlarged; **i.** merus small chela, medial face; **j.** second leg; **k, l.** third leg and enlarged dactylus; **m.** telson. 15 mm female from BAU 48. **n.** Anterior region, dorsal view. **a, b, h, l, m, n** scale **a**; **c, d, e, f, g, i, j, k** scale **b**.

the inferior margin a strong acute tooth. Carpus 0.4 as long as merus, distal margins projected, superior projection rounded, inferior projection acute; inferior margin unarmed or bearing one or two spines. Propodus 0.5 as long as merus, bearing on its inferior margin 6 spines and a pair distally; spines interspersed with a few long setae. Dactylus varying from simple to bearing a small acute secondary unguis. Merus of fourth legs unarmed.

Pleura of first abdominal segment of male hooked and acute. Sixth abdominal somite with strong teeth above lateral margins of telson but without tooth in middle. Telson 2.5 times as long as broad; anterior pair of dorsal spines placed just anterior to middle. Inner uropod with spines on distal margin.

DISCUSSION: Four species and one variety within the Crinitus Group are closely related and are known from a very few specimens. They are (in order of date or page priority):

Alpheus styliceps Coutière, 1905a:889, pl. 78, fig. 28 from the Maldives and Laccadives also from the Marshall Islands (B&B 1968:282).

Alpheus stanleyi Coutière, 1908a:207 (repeated with figures, 1921:423, pl. 63, fig. 18) from Amirante, and by Johnson (1962a:52) from the Singapore region.

Alpheus arethusa De Man, 1909a:100 (and 1911:352, fig. 72), known only from Indonesia.

Alpheus eulimene De Man, 1909a (and 1911) (*loc. cit.*), originally reported from Indonesia and subsequently from the Marianas (Banner, 1956:356) and Japan (Miya, 1974:146, pl. 27).

Alpheus stanleyi var. *dearmatus* De Man, 1910b:287 (and 1911:367, fig. 78), 3 specimens from Indonesia and 11 in our collection from the Philippines (see below).

The species and the one variety are separated by slight differences in characteristics that have been found to be variable in other members of the Crinitus Group and the separation, especially of *A. eulimene* and *A. styliceps*, has been questioned (Banner, 1956 and Miya, 1974). As the ranges of the four species could easily include at least Northern Australian waters, we are presenting a table of characteristics which may be used to separate them, if indeed they are distinct (Table 3).

The principal difference between the two nominal forms of *A. stanleyi* and the three other species lies in the small chelae, with a cylindrical palm and straight fingers that are laterally expanded, with the pollex excavate in the two forms of *A. stanleyi* and with a bulbous palm and narrow curved fingers in the other three. The chelae are not sexually dimorphic.

All the specimens we have from Australia save one (see *A. arethusa* De Man) fit the description of *A. eulimene* the best. However, the following variations were found in the small sample of 12 specimens:

1. The squame varied from nearly vestigial, as depicted in fig. 27a, to reaching almost to end of second antennular article.
2. In the carpus of the second leg the ratios of the first two articles varied from 10:12 to 10:18.
3. In the third leg all meri were armed with an acute distal tooth; 4 specimens had no spines on the carpus while 8 had one or two spines, and the dactylus was either simple or had a small secondary unguis.
4. On the fourth legs, none of the meri had teeth and none of the carpi had spines.

The final decision on the validity of the separation of the three nominal species, *A. styliceps*, *A. arethusa* and *A. eulimene*, will have to be reserved until more specimens, preferably over a greater geographic range, are studied. However, at present we have

TABLE 3
Characteristics of the species of the *Alpheus styliceps* complex

| Characteristic | <i>A. styliceps</i> Coutière | <i>A. stanleyi</i> Coutière | <i>A. arethusa</i> De Man | <i>A. eulimene</i> De Man |
|--|---|--------------------------------------|---------------------------|------------------------------|
| Length of rostrum to 1 aa ¹ | Two-thirds | Middle | First third, minute | First third, minute |
| Anterior margin of carapace | Projecting, but flowing into rostrum as concave curve | Same as <i>A. styliceps</i> | Projecting, almost convex | Projecting and transverse |
| Stylocerite to 1 aa | Reaching end | Past middle or near end ² | To about half | Near end |
| Scaphocerite: | | | | |
| Lateral spine to 3 aa | Past end | Middle | Past end | Past end |
| Squame to 2 and 3 aa | 0.5 of 2 aa | 0.7 of 2 aa | End 2 aa | From 0.2 to near end of 2 aa |
| Capocerite to 3 aa | Well past | Scarcely past | Well past | Well past |
| Small chela: | | | | |
| Palm, viewed above | Bulbous | Sides parallel | Bulbous | Bulbous |
| Fingers | Narrow, curved inward | Broadened, straight | Narrow, curved inward | Narrow, curved inward |
| Second leg: | | | | |
| Ratio, first 2 carpal articles | 10:13 | 10:7 | 10:16 | 10:12-10:18 |
| Third leg: | | | | |
| Merus length: breadth | 3.0 | 5.0 | 4.0 | 4.0 |
| Carpal spines | None | None | 1 | 0-2 |
| Dactylus | Simple | Simple | Biunguiculate | Simple to biunguiculate |
| Fourth leg: | | | | |
| Distal margin of merus | Tooth | Tooth | Rounded | Rounded |
| Carpal spines | (Not mentioned) | (Not mentioned) | 1-2 | None |
| Pleura, abdominal segments of males | (Not mentioned) | (Not mentioned) | 1-4 hooked, last acute | 1 hooked, subsequent rounded |

1. 1, 2, 3 aa — first, second or third antennular article.

2. cf. fig. 18, 18', Coutière, 1921.

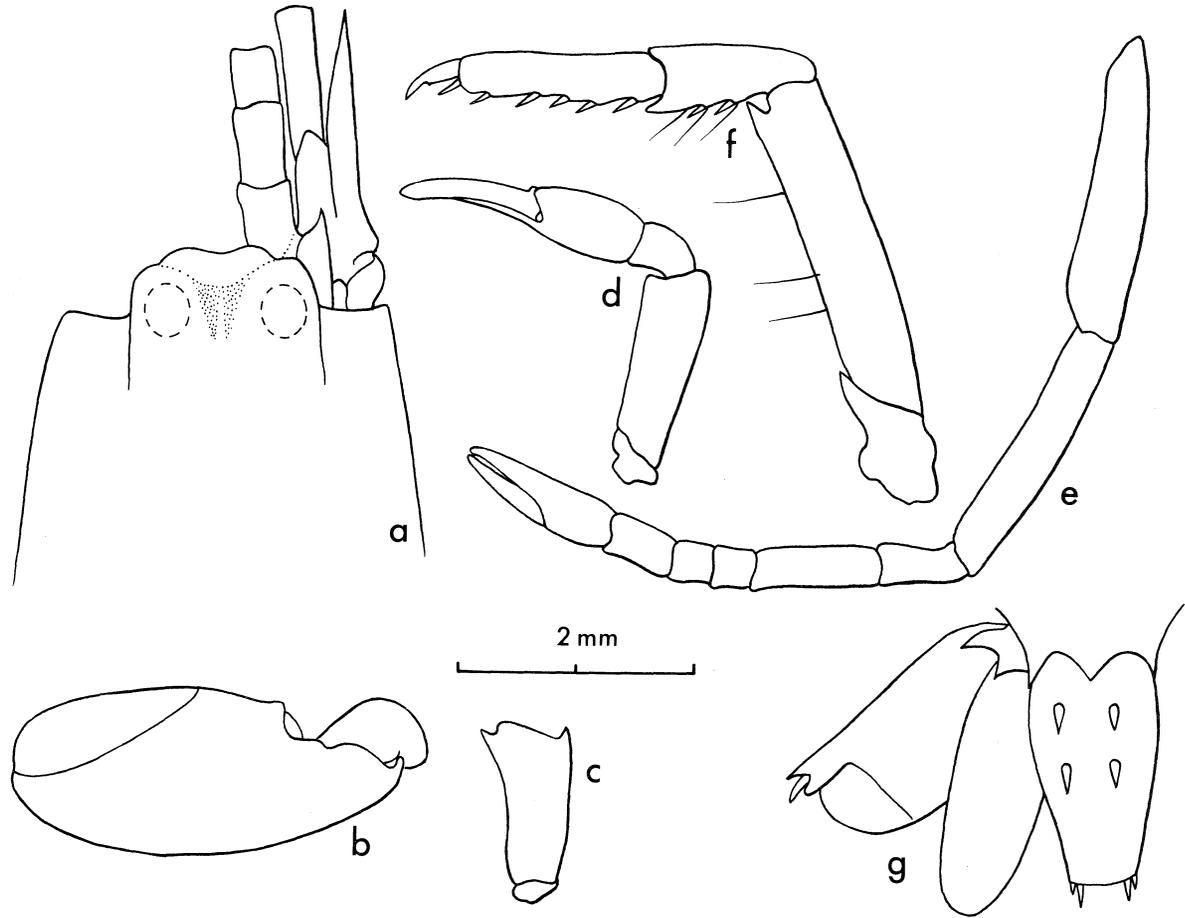


Fig. 28 (?) *Alpheus arethusa* De Man
 9 mm female from BAU 53. **a.** Anterior region, dorsal view; **b, c.** large chela, lateral face and merus, medial face; **d.** small cheliped, lateral face; **e.** second leg; **f.** third leg; **g.** telson and uropods. All figures same scale.

doubts that they do indeed represent distinct species. We have reconsidered the 11 Philippine specimens that we originally thought to be *A. stanleyi* var. *dearmatus* and have decided that the different form described by De Man is more likely to be a variety than a subspecies by modern rules. This change will be published in our Philippine paper which may possibly appear before this longer study.

BIOLOGICAL NOTES: De Man's specimens were collected from 83 metres, but our specimens have been collected from dead corals in water not over 15ft. deep. Two of the specimens came from sponges. It is a small species, our largest specimen being only 14 mm.

AUSTRALIAN DISTRIBUTION: On the west coast of Australia we have one specimen from off Geraldton; in the north, a specimen from the Torres Straits and on the east coast specimens from off Port Douglas in northern Queensland to Heron Island in the Capricorn Group.

GENERAL DISTRIBUTION: Maldives, Indonesia, Philippines, Japan, Marianas.

(?) ***Alpheus arethusa*** De Man

Fig. 28

Alpheus arethusa De Man, 1909a:101; 1911:352, fig. 72.

SPECIMEN EXAMINED: 1 specimen from BAU 53.

DISCUSSION: A single 9 mm female specimen from Heron Island in the available collections lies within the limits of variation of the small collection of *A. eulimene* from Australia except for 3 characteristics: First, the anterior margin of the carapace is shallowly concave where the rostrum should be; recalling the variation previously reported for *A. clypeatus* Coutière from Hawaii (Banner, 1953) we attach no great significance to this. Second, the palm of the small chela is less bulbous than in *A. eulimene*, but this may be due to the small size or to the sex of the specimen. Third, the median posterior margin of the sixth abdominal tergum projects over the telson as a large and definite tooth, a characteristic not found in any of the specimens of *A. eulimene* we have seen. It is for this reason that we have assigned the specimen to this species, but with doubt. As the hooked condition of the abdominal pleura is found only in males, we did not have that corroboration for our identification.

For the separation of this nominal species from the others in the *A. styliceps* complex, see Table 3, p. 108.

BIOLOGICAL NOTES: De Man's specimens were taken from the "reef" and ours was taken from a head of dead coral taken from the reef flat. The species may be small as our specimen was only 9 mm and De Man's 2 specimens were 10 mm.

AUSTRALIAN DISTRIBUTION: Our specimen came from Heron Island in the Capricorn Group.

GENERAL DISTRIBUTION: This is the first time this species has been reported since De Man's original specimens from Timor, Indonesia.

Alpheus alcyone De Man

Fig. 29

Alpheus alcyone De Man, 1902:870, pl. 27, fig. 61. Nobili, 1906c:32. De Man, 1911:351 (charact. emend.). Banner, 1966b:107, fig. 36. Miya, 1974:144, pl. 26.

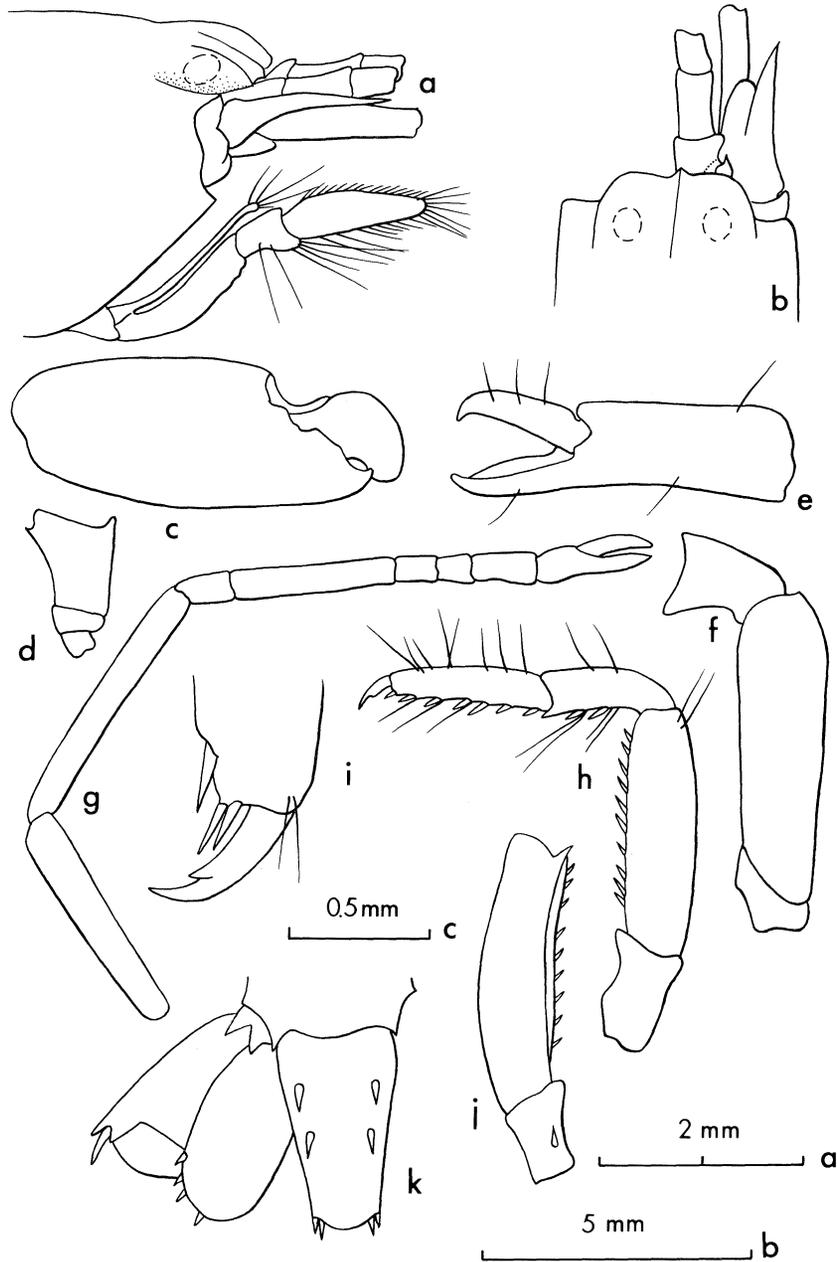


Fig. 29 *Alpheus alcyone* De Man
 14 mm male from BAU 55. **a, b.** Anterior region, lateral and dorsal view; **c, d.** large cheliped, chela, lateral face and merus, medial face; **e, f.** small cheliped and merus, lateral face; **g.** second leg; **h, i.** third leg and enlarged dactylus, medial face; **j.** merus third leg, lateral face; **k.** telson and uropods. a, b, e, f, g, h, j, k scale a; c, d scale b; i scale c.

Alpheus aculeipes Coutière, 1905a:892, pl. 79. fig. 31.

Alpheus crinitus Bate, 1888:548, pl. 98, fig. 2. Zehntner, 1894:206 (Nec Dana, 1852).

SPECIMENS EXAMINED: 2 specimens from AM 283 (AM P. 27329); 1, AM 298 (AM P. 27769) 2, AM 305 (AM P. 27775); 1, AM 329 (AM P. 27400); 1, BAU 25; 1, BAU 30; 3, BAU 31; 1, BAU 43; 2, BAU 44; 2, BAU 53; 7, BAU 55; 8, BAU 56; 1, BAU 57; 1, JC 30; 1, WM 91-65; 4, WM 183-65; 3, 75 LIZ-1 (AM P. 27897).

DIAGNOSIS: Rostrum small, triangular, hardly exceeding the orbital margin, rostral carina rounded reaching to base of orbits. Anterior margin of carapace slightly concave lateral to rostrum. Visible part of first antennular article and third article subequal, second article 1.5 times longer than third article and 1.6 times as long as broad. Stylocerite with tip acute, small, not reaching end of first antennular article. Scaphocerite with lateral margin concave, lateral tooth reaching to end of antennular peduncle, squamous portion narrow, reaching to end of second antennular article. Carpocerite reaching well beyond end of antennular peduncle. Basicerite without lateral tooth.

Ratio of articles of third maxilliped: 10:4:10. Second article only a little longer than distal section is wide, distoinferior margin bearing a batch of fine setae. Third article 3.5 times as long as broad, broadened in the middle and bearing a tuft of fine setae at tip.

Large chela cylindrical, 2.4 times as broad as long with fingers occupying the distal 0.3. Tip of dactylus truncate, overhanging pollex. Merus a little longer than broad, superodistal margin terminates in a subacute tooth, inferointernal margin in a small acute tooth.

Small chela not sexually dimorphic. Chela 4 times as long as broad, palm 1.7 times longer than fingers. Carpus cup-shaped, almost half as long as palm. Merus 3.4 times as long as broad, not projecting distally.

Ratio of carpal articles of second leg: 10:28:7:7:11.

Ischium of third legs with a small spine. Merus 3.3 times as long as broad; inferoexternal margin terminating in an acute tooth; inferointernal margin bearing 3-12 small spines and no tooth distally. Carpus 0.5 as long as merus bearing on inferior margin 1-4 spines. Distosuperior margin not projected, distoinferior margin terminating in acute tooth. Propodus 0.7 as long as merus, bearing on its inferior margin 6 spines and a pair distally; superior margin bearing long fine setae. Dactylus biunguiculate, 0.2 as long as propodus.

Pleura of first abdominal somite of male hooked.

Telson 2.8 times as long as broad, posterior pair of dorsal spines placed just posterior to middle. Inner uropod with only a few spines on outer distal margin. Articulation of outer uropod straight, not scalloped.

DISCUSSION: While we have not seen De Man's type specimens, these specimens from Australia agree well with his descriptions (1902, 1911) and with the other specimens we have placed under this species in previous studies. We have noted that the second article of the carpus of the second leg varies from 2 to 3 times the length of first, that the number of spines on the merus, carpus and propodus of the third leg is variable (with one specimen carrying only 3 spines on the merus and 1 on the carpus), and that the secondary unguis of these legs varies from a slight shoulder to a pronounced tooth.

De Man's original description of this species was defective and Coutière (1905a) described *A. aculeipes* on differences between his specimens and De Man's original

description. In 1911 De Man reported on the re-examination of his 4 "type specimens" and corrected his earlier errors; this removed the differences and *A. aculeipes* was placed in synonymy.

In the meantime, Nobili (1906b:257) had described a variety, *triphopus* (later spelled *tryphopus* in 1907:355) under *A. aculeipes* from the Tuamotus. On the basis of his at times somewhat ambiguous descriptions, this form may represent a geographical subspecies of *A. alcyone* or, more likely, a separate species which was De Man's 1911 opinion. We examined Nobili's type in the Muséum National d'Histoire Naturelle of Paris and found it to be somewhat desiccated and with only the detached large cheliped of all its pereopods. As this form was not represented in our collection from the nearby Cook and Society Islands, we defer judgement on its validity as a species until more specimens from the Tuamotus are examined to determine their range of variation.

BIOLOGICAL NOTES: This species has been collected in waters up to 71 fathoms. Although our collections have been made from heads of dead coral that we broke up we feel that these specimens, like so many other members of the Crinitus Group may have been dwelling in sponges. Yaldwyn has supplied the following colour notes for a specimen from One Tree Island (AM 329) "Body, limbs and eggs orange, internal organs green, gut in abdomen white". The largest specimen was 18 mm long.

AUSTRALIAN DISTRIBUTION: In western Australia we have specimens from Carnarvon and Exmouth Gulf; in northern Australia from the Torres Straits, and in eastern Australia from Lizard Island south to the Capricorn Group.

GENERAL DISTRIBUTION: Red Sea, East Africa, Persian Gulf, Maldives, Ceylon, Malaysia, Thailand, Indonesia, Philippines, Japan, Marshall, Caroline, Fiji, Tonga and Samoa Islands.

***Alpheus paralcyone* Coutière**

Fig. 30

Alpheus paralcyone Coutière, 1905a:895, pl. 80, fig. 34. Miya, 1974:139, pl. 24.

Crangon paralcyone Banner, 1953:99, fig. 34.

Crangon laysani Edmondson, 1925:17, fig. 3.

Crangon bucephalus Edmondson, 1925:14 [PARTIM].

SPECIMENS EXAMINED: 1 specimen from BAU 10; 2, BAU 15; 2, BAU 17; 1, BAU 31; 2, BAU 33; 6, BAU 43; 2, BAU 55; 1, MM 181; 1, WM 290-65; 1, 75 LIZ-H (AM P. 27914).

DIAGNOSIS: Rostrum short but discrete, a broad triangle extending only slightly beyond anterior margin; with definite, but low rostral carina extending to base of orbital hoods. Orbital hoods slightly inflated, area between orbital hoods and rostral carina flat. Orbitorostral margin slightly concave. Pterygostomial angle projecting but obtuse. Visible part of first and third article of antennular peduncle subequal, second article 1.5 times longer than third and 2 times as long as broad. Stylocerite short, acute, and not reaching end of first antennular article. Scaphocerite with outer margin slightly concave, lateral tooth strong, reaching to near end of third antennular article. Carpocerite reaching more than length of third article past that article. Inferior margin of basicerite with strong acute tooth.

Ratios of articles of third maxilliped 10:3:6. Second article as long as wide in distal part with inferodistal margin bearing many long setae. Third article 2.5 times as long as

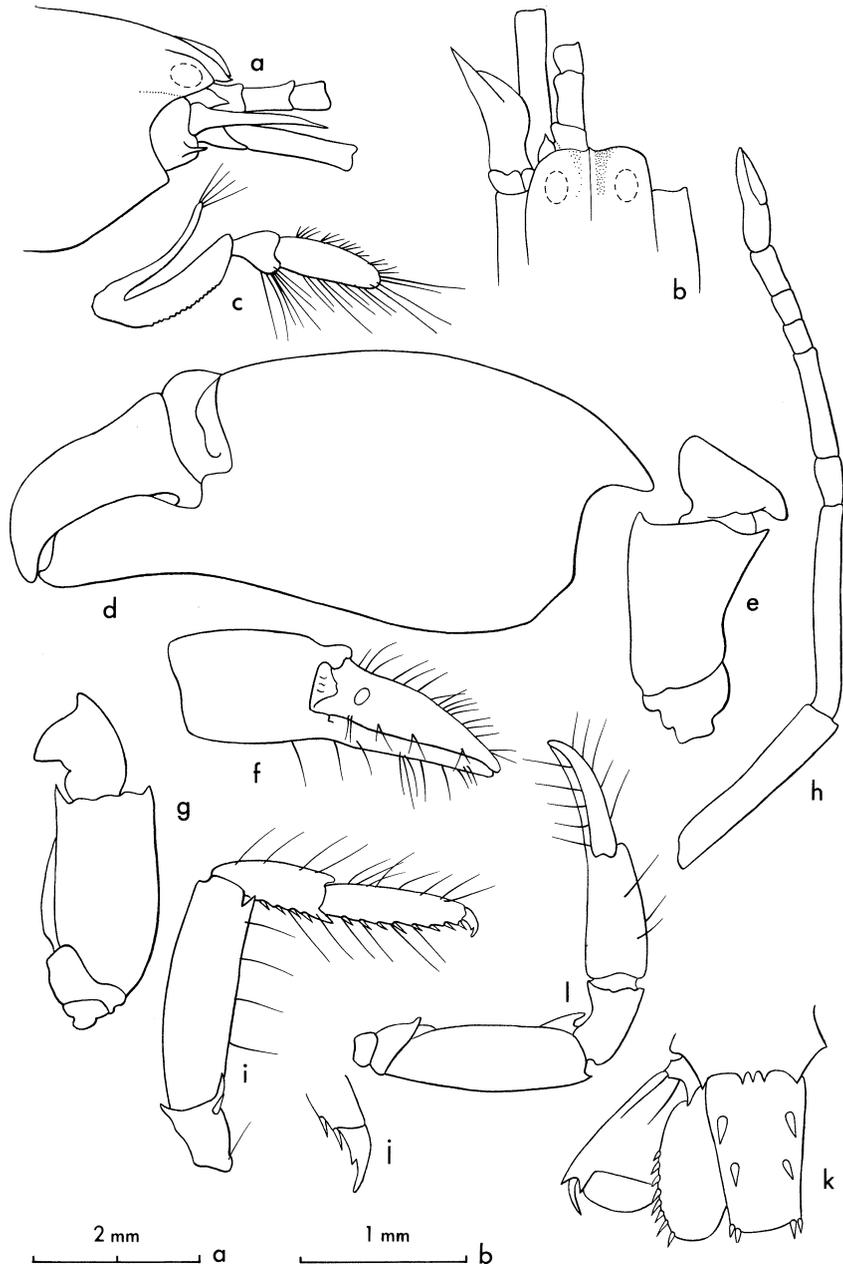


Fig. 30 *Alpheus paralcione* Coutière

14 mm male from BAU 43. **a, b.** Anterior region, lateral and dorsal view; **c.** third maxilliped; **d, e.** large cheliped, chela, lateral face and merus, medial face; **f, g.** small cheliped, chela, lateral face and merus, medial face; **h.** second leg; **i, j.** third leg and enlarged dactylus; **k.** telson and uropods. 10 mm female from BAU 43. **l.** Small cheliped, lateral face. **a, b, c, d, e, f, g, h, i, k, l** scale **a**; **j,** scale **b**.

wide, medial face with batches of short stiff setae interspersed on inferior margin with long setae, tip with several long setae.

Large chela cylindrical, 2.3 times as long as broad with fingers occupying distal 0.3. Distal section of chela twisted slightly laterally. Dactylus not carinate, curved, tapering but rounded at tip. Merus 1.3 times as long as broad, superodistal margin with subacute tooth, inferointernal margin with acute distal tooth.

Small chela sexually dimorphic. Male chela 3 times as long as broad, with fingers a little longer than palm. Palm cylindrical with small obtuse projection medial to dactylar articulation. Dactylus slightly broadened from articulation to well past middle at which point it tapers gradually to tip. Both margins of fingers bearing scattered setae. Merus 2 times as long as broad, superior margin projected as small acute tooth; inferointernal margin with a strong acute tooth distally. Female chela more slender, 4 times as long as broad, fingers and palm equal. Palm slightly compressed, bearing distomedially a small obtuse tooth. Dactylus not broadened, tapering gradually to tip. Carpus 0.6 as long as palm. Merus 3 times as long as palm, superior margin projecting as a small acute tooth, inferointernal margin bearing prominent tooth.

Ratio of carpal articles of second leg: 10:23:6:6:10.

Ischium of third leg with spine. Merus 3.5 times as long as broad, bearing an acute tooth distally on inferior margin. Carpus 0.5 as long as merus and bearing on its inferior margin 1-4 small spines; both distal angles projecting, superior rounded, inferior acute. Propodus 0.6 as long as merus, bearing on its inferior margin 7 spines and a pair distally. Dactylus biunguiculate with secondary unguis varying from an acute angle to one-third length of superior unguis. Merus of fourth legs also armed, carpus with but one or two spines.

Pleura of first abdominal somite of male acute. Middle of posterior margin of sixth abdominal tergum bearing 3-4 small acute teeth.

Telson 2.0 times as long as broad. Inner uropod bearing several short spines on outer margin near posterior section. Spine at distal articulation on outer uropod strong, and curved strongly towards midline; articulation straight.

DISCUSSION: The Australian specimens agree very well with Coutière's original description (holotype is missing) except most of our specimens had more than two teeth on the posterior margin of the sixth abdominal somite. Banner (1953:99, fig. 34) described and figured specimens of this species from Hawaii. On the basis of a large collection he found the following characters variable:

1. The length of the second antennular article varied from 1.4 to 2.0 times the length of the visible portion of the first.
2. The tip of the stylocerite reached from markedly shorter than the first antennular article to equal to it.
3. The relative lengths of the antennular peduncle, carpocerite and scaphocerite showed considerable variation.
4. The second carpal article of the second leg varied from 2 to 4 times as long as the first.
5. The number of spines on the carpus of the third leg varied from 1 to 5.

This species also varies in the number of teeth above the articulation of the telson, with Miya (1974) reporting from 2 to 7 on specimens from Japan, De Man (1911) reporting none to several in Indonesian specimens, and Banner (1953) reporting none at all from Hawaii.

BIOLOGICAL NOTES: This species has been collected from dead coral heads in the immediate subtidal to as deep as 90 fathoms west of Carnarvon in Western Australia. Banner (1953) reported on several deep water collections made by the *Albatross* near Hawaii. Johnson (1962b:283) reported this species as very common in the beach sponges of Singapore. It is a small species attaining a maximum length of 15 mm.

AUSTRALIAN DISTRIBUTION: Off Carnarvon, W.A.: in northern Australia from the Torres Straits; off Queensland from Lizard Island south to Heron Island in the Capricorn Group.

GENERAL DISTRIBUTION: Maldives, Seychelles, Ceylon, Indonesia, Singapore, Thailand, Philippines, Japan, and across the central Pacific to Hawaii.

***Alpheus spongiarum* Coutière**

Fig. 31

Alpheus spongiarum Coutière, 1897a:236. Miya, 1974:148, pl. 28.

Alpheus paraculeipes Coutière 1905a:894, pl. 80, fig. 32. Pearson, 1905:84; 1911:356. Green, 1972:67.

Previous Australian Records:

Coutière 1900:413. Torres Straits.

Green, 1972:67. Houtman Abrolhos.

SPECIMENS EXAMINED: 1 specimen from AC S. 2; 1, AM 247 (AM P. 27535); 1, BAU 21; 4, BAU 33; 2, BAU 42; 1, BAU 43; 1, BAU 44; 3, BAU 55; 1, BAU 56; 1, WM 81-65; 1, WM 91-65; 1, WM 114-65; 1, WM 144-65; 1, WM 226-65; 1, WM 264-65; 4, WM 279-65; 5, 75 LIZ-1 (AM P. 27895).

DIAGNOSIS: Rostrum of moderate size, triangular, with rostral crest reaching to base of eyes. Orbitorostral grooves shallow and rounded, orbitorostral margin almost straight. First and third antennular articles almost equal in length, second article twice as long as broad and almost twice length of visible portion of first article; stylocerite with acute tip not reaching to end of first article. Outer margin of scaphocerite slightly concave, squamous portion vestigial, reaching only to end of first quarter of second antennular article. Lateral tooth reaching to middle of third antennular article. Carapocerite reaching slightly more than half the length of the third article past that article.

Third maxilliped similar to *A. paralcione* (p. 113).

Large chela cylindrical, 2.2 times as long as broad with fingers occupying the distal 0.3. Tips of dactylus obtuse. Merus 2 times as long as broad, superior margin projecting, acute, inferoexternal margin bearing small acute tooth distally.

Small chela not sexually dimorphic, cylindrical, 3.4 times as long as broad with fingers 0.7 as long as palm. Carpus 0.6 as long as palm. Merus 0.75 as long as chela, 2.5 times as long as broad, with inferoexternal margin bearing small, acute, tooth.

Carpal articles of second legs with ratio: 10:20:3:3:9.

Ischium of third leg unarmed. Merus 4.3 times as long as broad, triangular in section; inferoexternal margins bearing 10-12 long fine setae with an acute tooth distally but no spines; inferoexternal margin bearing numerous short setae. Carpus 0.5 as long as merus with both margins projecting as blunt teeth and bearing setae and often 1 or 2 spines on inferior margin and a row of patches of short setae medial to this. Propodus 0.7 as long as merus and bearing on its inferior margin 8 spines directed distally with the tip often

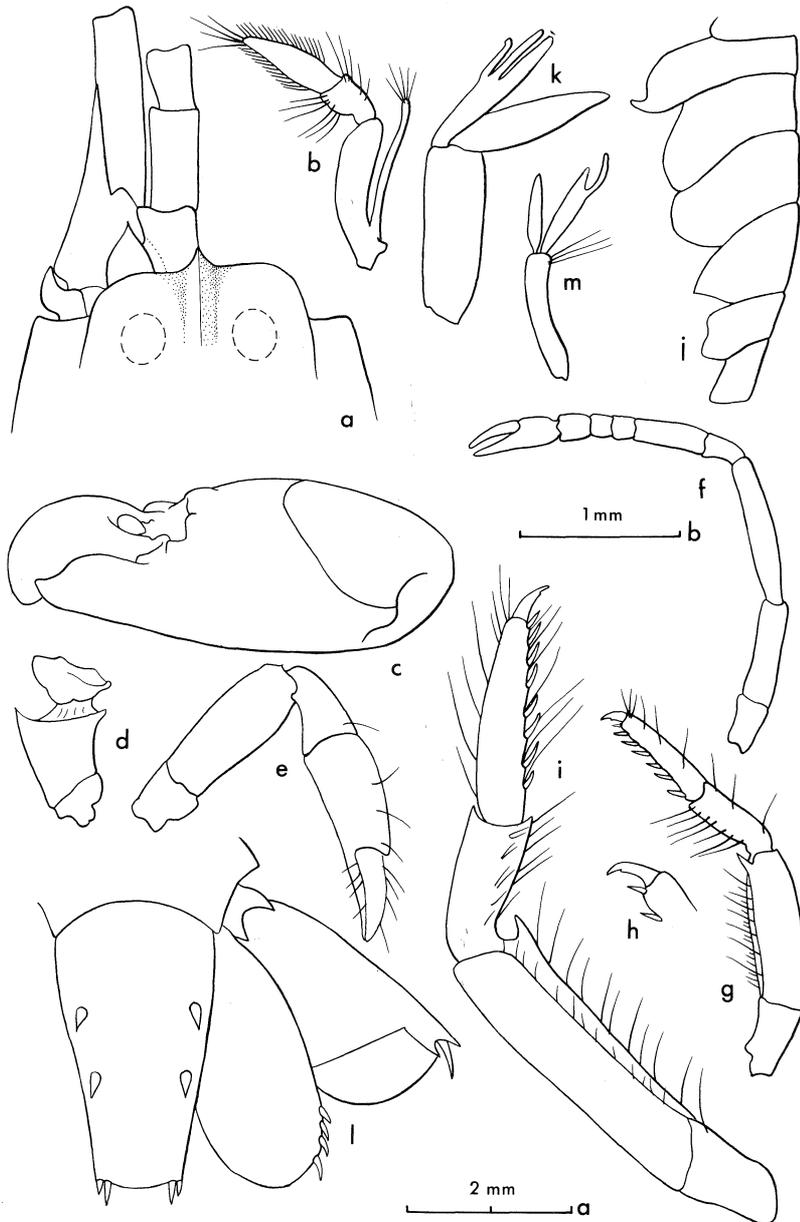


Fig. 31 *Alpheus spongiarum* Coutière

12 mm male from BAU 44. **a.** Anterior region, dorsal view; **b.** third maxilliped; **c, d.** large cheliped, chela, lateral face and merus, medial face; **e.** small cheliped, lateral face; **f.** second leg; **g, h.** third leg and enlarged dactylus lateral face; **i.** third leg, enlarged, medial face; **j.** abdomen, lateral face; **k.** second pleopod; **l.** telson and uropods. 10 mm female from BAU 55. **m.** Second pleopod. **b, c, d, e, f, g** scale **a**; **a, h, i, j, k, l, m** scale **b**.

turned towards the axis of the propodus, spines interspersed with long hairs. Dactylus usually biunguiculate with secondary unguis small.

Appendix masculina in second pleopod of male arising near middle of endopod and extending slightly past endopod. *Appendix interna* in female arising in distal third of endopod, curving inward and extending well past endopod.

First abdominal pleura of male hooked.

Telson 3.2 times as long as posterior margin is broad. Anterior pair of dorsal spines placed just anterior to middle. Posterolateral margin of inner uropod armed with a few curved spines. Articulation of outer uropod not scalloped.

DISCUSSION: Coutière (1905a) described *A. paraculeipes* as closely related to his earlier species, *A. spongiarum*, from which it differed only in the characteristics of the third leg; he illustrated the third legs of the two species in figures 32f and 33.

De Man (1911:364) suggested that the two nominal species were "varieties of one and the same species." Miya (1974:150) studied 7 specimens from Japan and concluded that his specimens were also intermediate between the two and placed *A. paraculeipes* in synonymy to *A. spongiarum*. With 26 specimens in the Australian collections we made a detailed study of all characteristics used by Coutière for the differentiation between the species, and found all were variable, but that the Australian specimens were mostly closer to the form described as *A. spongiarum*. Thus, the dactylus usually carried a secondary unguis which varied from a definite tooth to a minor angular projection; only in 3 specimens was the secondary unguis entirely lacking as Coutière had reported for *A. paraculeipes*.

We have remarked before upon the variation that is found in other species of alpheids that are symbiotic, especially those found hidden in spongocoels. (See for example, the discussion under *Synalpheus lophodactylus* Coutière in B&B 1975:352) and we would expect that the slight differences listed by Coutière would be within these limits of variation. While we have not bridged all of the differences in the present collection, we still accept Miya's designation of *A. paraculeipes* as a synonym.

We have re-examined the specimen from the Houtman Abrolhos that Green (1972) reported that we had identified for him with reservations as *A. paraculeipes* and found it to be within the range of variation for *A. spongiarum*.

BIOLOGICAL NOTES: There is little doubt that this species lives entirely in sponges. Johnson (1962b:283) reported it living in the beach sponge *Suberites inconstans*. A "cotype" of this species at the University Museum of Zoology, Cambridge (England) had a note in the bottle indicating it was commensal with the sponge, *Hippospongia reticulata*. It has been found from the intertidal to as deep as 23 fathoms. Coutière reported that his original specimen from Djibouti was: "*Incolore, sauf une bande rouge cerise clair sur le thorax et sur les 2e and 3e anneaux de l'abdomen. Bout des pinces violet foncé passant au rouge sur la paume.*" Miya reported that the chelipeds on the specimens from Japan were dark to light red and all of the abdominal segments were banded with red. It is not a large species, our largest specimen being 18 mm.

AUSTRALIAN DISTRIBUTION: We have specimens from western Australia from Cockburn Sound, near Perth, to Dampier Archipelago and Cape Jaubert. In the north it has been collected in Torres Straits and Gulf of Carpentaria. In eastern Australia it was collected from Lizard Island, Qld, south to Heron Island in the Capricorn Group.

GENERAL DISTRIBUTION: Djibouti, Gulf of Aden, Maldives and Laccadives, Ceylon, Singapore, Indonesia, Japan.



Fig. 32 *Alpheus bucephalus* Coutière

17 mm male from BAU 20. **a**, **b**. Anterior region, dorsal and lateral view; **c**, **d**. large cheliped, chela, lateral face and merus, medial face; **e**, **f**. small chela, and merus, lateral face; **g**. second leg; **h**. third leg; **i**. telson and uropods. 19 mm female from BAU 20. **j**. Small cheliped, lateral face. 16 mm male from BAU 20. **k**. Distal end, large chela, medial face. All drawings same scale.

***Alpheus bucephalus* Coutière**

Figs. 23 d-f; 32

Alpheus bucephalus Coutière. 1905a:890, pl. 78, fig. 29. Banner and Banner, 1966b:110, fig. 38.

Alpheus consobrinus De Man, 1908:101; 1911:360, fig. 75.

Alpheus crinitus Coutière, 1900:413. (Nec Dana, 1852).

Crangon bucephalus Edmondson, 1925:14. (Partim =*A. paralcycone* Coutière).

Crangon bucephalus var. Rathbun, 1914:654.

Confer: Banner, 1957:201.

Previous Australian Records:

Coutière, 1900:413. Torres Straits (as *A. crinitus* Dana).

Rathbun, 1914:654. Monte Bello Island.

Balss, 1921:9. Cape Jaubert.

SPECIMENS EXAMINED: 5 specimens from AM 123 (AM P. 27325); 1, AM 238 (AM P. 27326); 1, AM 332 (AM P. 27401); 1, AM 460 (AM P. 27788); 1, BAU 10; 2, BAU 11; 4, BAU 16; 18, BAU 20; 2, BAU 21; 4, BAU 23; 9, BAU 24; 5, BAU 25; 23, BAU 27; 10, BAU 28; 14, BAU 29; 1, BAU 30; 2, BAU 33; 1, BAU 41; 3, BAU 42; 3, BAU 43; 1, BAU 44; 2, BAU 50; 6, BAU 52; 5, BAU 55; 2, BAU 56; 4, JC 3.

DIAGNOSIS: Rostrum short, reaching to middle of visible part of first antennular article, tip curved upwards, anterior margin lateral to rostrum concave; dorsal carina high and thin ending abruptly at base of eyes. Orbital hoods inflated, projecting anteriorly as rounded vertical keel. Orbitorostral grooves broad and shallow, projecting anteriorly as flattened, rounded extensions of frontal margin.

Second article of antennular peduncle 2 times as long as wide and a little less than 2 times as long as visible part of first and third article. Stylocerite short with acute tooth not reaching end of first antennular article. Scaphocerite with outer margin slightly concave and with strong lateral tooth that reaches well beyond antennular peduncle, squamous portion narrow, reaching almost to end of antennular peduncle. Basicerite usually without lateral tooth.

Large chela sub-cylindrical, 2.2 times as long as wide with fingers occupying distal 0.3. Medial face moderately hirsute, lateral face glabrous. Dactylus heavy, varying from projecting at tip and crossing pollex when closed, to truncate and not crossing pollex. Merus stout, with outer face a little longer than broad. Superior margin slightly projected in a rounded tooth, inferoventral margin usually with subterminal tooth varying from rounded to broadly acute.

Small chelipeds usually sexually dimorphic. Typical chela of male stout, 2.6 times as long as broad with fingers and palm almost equal. Dactylus balaeniceps, fringe of hair more dense on medial margin with proximal broadening continuing for 0.8 of length then constricting; tip rounded and meeting, not overhanging, propodal tooth. Small chela of female slender, 3.4 times as long as broad, palm 1.3 times longer than dactylus and tapering from carpus to tip; fingers never balaeniceps. Carpus cup-shaped, 0.7 as long as palm. Merus 2.3 times as long as broad, inferoventral margin often bearing acute tooth distally.

Carpal articles of second leg with ratio: 10:20-30:6:6:10.

Ischium of third leg bearing spine. Merus 3.5 times as long as broad; inferior margin terminating in strong, acute tooth. Carpus almost half as long as merus, distoinferior margin terminating in an acute tooth similar to that of merus, distosuperior margin terminating in rounded projection. Propodus 0.6 as long as merus armed with 5 pairs of spines on the inferior margin and a pair distally. Dactylus simple, curved at tip.

Pleura of first abdominal somite of male not hooked.

Telson 2.2 times as long as posterior margin is broad, 1.4 times as broad anteriorly as posteriorly, anterior spines of dorsal pair placed well anterior to middle and posterior spines just posterior to middle. Posterior margin of telson with several small spines. Inner uropod bearing spines on lateral and distal margin.

DISCUSSION: The variability in this species was discussed by Banner (1957:201). The Australian specimens show the same variability. The basicerite is only occasionally armed; the distal end of the inferointernal margin of the merus of the large chela varies from a rounded tooth to a large acute tooth; the small chela is usually sexually dimorphic, but in some males the dactylus of the small chela is more slender, almost similar to that of the female. Finally the first and second article of the second leg varies from 10:20-30. Rathbun's specimen from Monte Bello Island can be encompassed in this range of variability and we are placing it in synonymy. This species is separated from some related species in Table 2.

We list Coutière's report of *A. crinitus* Dana as a synonym of *A. bucephalus* with some doubts. In his thesis in 1899 Coutière offered a drawing of a large cheliped that he labelled as *A. crinitus* (p. 266, fig. 273). In 1900 (p. 413) he listed *A. crinitus* as coming from the Torres Straits. In 1905, when he described *A. bucephalus* he cited his use of *A. crinitus* in 1899 under synonymy, but he made no mention there or later about the identity of the specimen from Torres Straits. He did not list the Torres Straits distribution under *A. bucephalus*, but neither did he list that locality under his rather comprehensive distributions given for 3 other species listed in the 1900 paper. De Man (1911:357), in discussing Ortmann's specimen of *A. crinitus* from Samoa and giving the published accounts of its distribution also ignored Coutière's record from the Torres Straits. Inasmuch as the two species are easily separated by the relative lengths of the first two articles of the carpus of the second legs, with the first article about one-third the second in *A. bucephalus* and with the two equal in *A. crinitus*, and inasmuch as in the extensive collections of *A. bucephalus* from Australia, including the Torres Straits, we had no specimen that could be identified as *A. crinitus*, we are presuming that Coutière had the two species as confused in 1900 as he had in 1899, and that his record was that of *A. bucephalus*.

BIOLOGICAL NOTES: This species has been collected at Enewetak (=Eniwetok) in the Marshall Islands as cohabiting pairs from tubes of "several types of algae and sponges" (B&B, 1968:284). It is discussed under the section on tube dwelling species on p. 93. This species has been collected intertidally from dead coral heads and as deep as 44 fathoms. The following colour notes were supplied by J. C. Yaldwyn from specimens from Heron Island, "Body and hands transparent with scattered green chromatophores. Gut dark green, ovaries and eggs bright green". It is not a large species, our largest specimen being 20 mm.

AUSTRALIAN DISTRIBUTION: In western Australia we have specimens from Cape Jaubert and Monte Bello Island; in northern Australia from the Torres Straits and the Gulf of Capentaria and in eastern Australia from off Port Douglas, Qld., south to Heron Island in the Capricorn Group.

GENERAL DISTRIBUTION: Off Africa from the Red Sea to Mozambique; across the Indian Ocean to Indonesia; in the Pacific from the Philippines and Japan eastward to the Line Islands and the Societies. It has not been reported from Hawaii.

DIADEMA GROUP

Orbital teeth usually lacking and orbital hoods at times projecting as vertical keels; base of rostrum at times flattened and sharply demarked from orbitorostral grooves; some species with teeth on anterior carapace. Large chela rounded to oval in section, usually with transverse groove proximal to dactylar articulation and lacking marked longitudinal grooves. Small chela of males at times balaeniceps. Third legs with or without tooth on merus, dactylus almost always simple. (Dactylus may be variable within a species — *cf. A. cristatus* Coutière and *A. diadema* Dana, below).

Most specimens of most species were collected intertidally to subtidally, although a few were dredged; many species are apparently confined to dead coral heads found in areas of clean water and moderate wave action.

Alpheus cristatus Coutière

Fig. 33

Alpheus cristatus Coutière, 1879b:303 (Thursday Is.) 1899:89, fig. 56.

SPECIMENS EXAMINED: 1 specimen from AM 228 (AM P. 27828); 1, AM 259 (AM P. 28116).

DIAGNOSIS: Rostrum narrow, acute, awl-shaped, reaching to end of first antennular article; rostrum carina compressed, rounded dorsally, continued posteriorly to merge with carapace at level of posterior portion of eyes. Midline carrying 2 forward-pointing teeth posterior to rostral carina, anterior tooth narrow, acute and overhanging; posterior tooth broader with rounded tip and continuing posteriorly as rounded crest to posterior third of carapace. Orbital hoods inflated and well-demarcated on all margins except posterior; anteriorly with small but marked crest arising from upper anteromedial curvature of hood, overhanging curvature of hood and continued laterally and ventrally as definite curving crest that is finally confluent with outer margin of orbital tooth. Orbital teeth strong, acute, about one-third as long as rostrum, located somewhat medial to middle of eyes, separated from rostrum by concave margins. Surface of orbital teeth flattened and confluent with flattened orbitorostral area. Orbitorostral area broad anterior to eyes, narrow between eyes and again broadening posterior to eyes; posterolateral margin of area demarked by a narrow but overhanging crest, curving from behind orbital hoods towards base of anterior tooth of midline.

Visible part of the first antennular peduncle and second article almost equal, third article a little shorter; second article 1.6 times as long as broad. Stylocerite acute, reaching to end of first antennular article. Scaphocerite with outer margin concave and with lateral tooth reaching about half length of third article past that article. Squamous portion just a little past end of antennular peduncle. Lateral tooth of basicerite prominent, acute, as long as stylocerite.

Large chela rounded in section and tapering towards fingers, 3 times as long as broad with fingers occupying the distal 0.3. Palm bearing a narrow, deep, transverse groove just proximal to dactylus not extending into either face. Superior margin of dactylus not strongly carinate. Merus 1.6 times as long as broad, Superior margin terminating in a heavy acute curving tooth. Inferoexternal margin lightly serrate, terminating distally in a

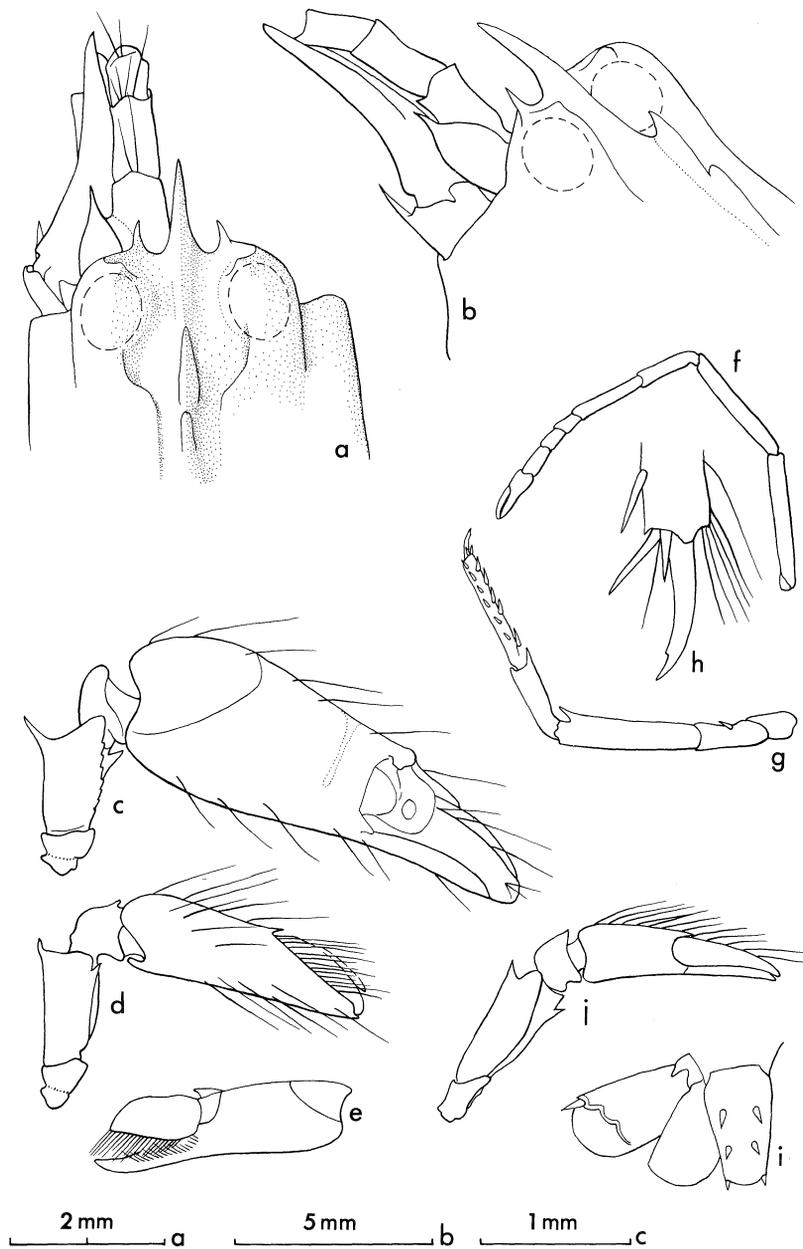


Fig. 33 *Alpheus cristatus* Coutière
 24 mm male from AM 259. **a, b.** Anterior region, dorsal and dorsolateral view; **c.** large cheliped, lateral face; **d, e.** small cheliped, medial and chela, lateral face; **f.** second leg; **g, h.** third leg and enlarged dactylus; **i.** telson and uropods. 27 mm female from AM 228. **j.** Small cheliped. **a, b** scale a; **c, d, e, f, g, i, j** scale b; **h,** scale c.

rounded projection; distal end of inferointernal margin bearing an acute subterminal tooth.

Small chela sexually dimorphic. Male chela 3.5 times as long as broad with fingers occupying distal 0.3. Dactylus balaeniceps, superior surface broad, slightly constricted at articulation. Palm bearing at the articulation of dactylus an acute tooth medially and a low obtuse tooth laterally. Merus 2.3 times as long as broad with small acute tooth subterminally on inferointernal margin, superior margin terminating in a tooth smaller than that of large chela. Small chela of female more slender, not balaeniceps, fingers and palm subequal. Merus similar to that of male.

Carpal articles of second leg with ratio: 10:10:3:3:5.

Ischium of third leg bearing a spine; merus 5.3 times as long as wide with strong distal tooth on inferior margin. Carpus 0.4 as long as merus, inferior margin terminating in strong acute tooth, superior margin in a smaller subacute tooth. Propodus a little shorter than merus; inferior bearing 5 spines and a pair distally, lateral face bearing row of 6 smaller spines. Dactylus with a slight accessory tubercle on inferior margin.

Telson 2.6 times as long as posterior margin is wide. Transverse articulation of outer uropod scalloped.

DISCUSSION: We were able to examine the holotype at the Muséum National d'Histoire Naturelle in Paris and our specimens agree well with it. Coutière stated that except for the differences in the anterior region of the carapace, *A. cristatus* exactly resembled *A. bidens* (Olivier). He failed to note that *A. cristatus* lacks the slightest trace of a transverse groove on the superior margin of the palm of the small chela which is found in *A. bidens*. Further the carpus of the third leg in *A. cristatus* does not project into two terminal teeth on the inferior margin as it does in *A. bidens*. The holotype lacks any swelling on the inferior margins of the dactylus of the third leg, but this has been found to be variable in the related *A. diadema* Dana (p. 140).

BIOLOGICAL NOTES: Nothing is known of the ecology or colour of this species. Coutière does not mention where his specimens were collected, but one of our specimens was collected intertidally and the other was dredged from 3-5 fathoms. The larger of our specimens was 25 mm.

AUSTRALIAN DISTRIBUTION: One specimen was collected at Cape Leveque in western Australia and the other at Darwin in the Northern Territories. Coutière's original specimen was collected in the Torres Straits.

GENERAL DISTRIBUTION: Coutière also reported this species from the Maldives.

***Alpheus bicostatus* De Man**

Fig. 34

Alpheus bicostatus De Man, 1908:102; 1911:375, fig. 82.

SPECIMENS EXAMINED: 1 specimen from AM 305 (AM P. 28117); 1, AM 324 (AM P. 28118); 1, WM 116-65.

DIAGNOSIS: Free portion of rostrum slender, awl-shaped, tip reaching slightly beyond end of first antennular article, with carina compressed, moderately high but rounded dorsally. Carina continued posteriorly with concave margins in regions of eyes and growing more confluent with carapace behind eyes; low carina interrupted in anterior gastric region by narrow rounded tubercle which continues as a low carina to

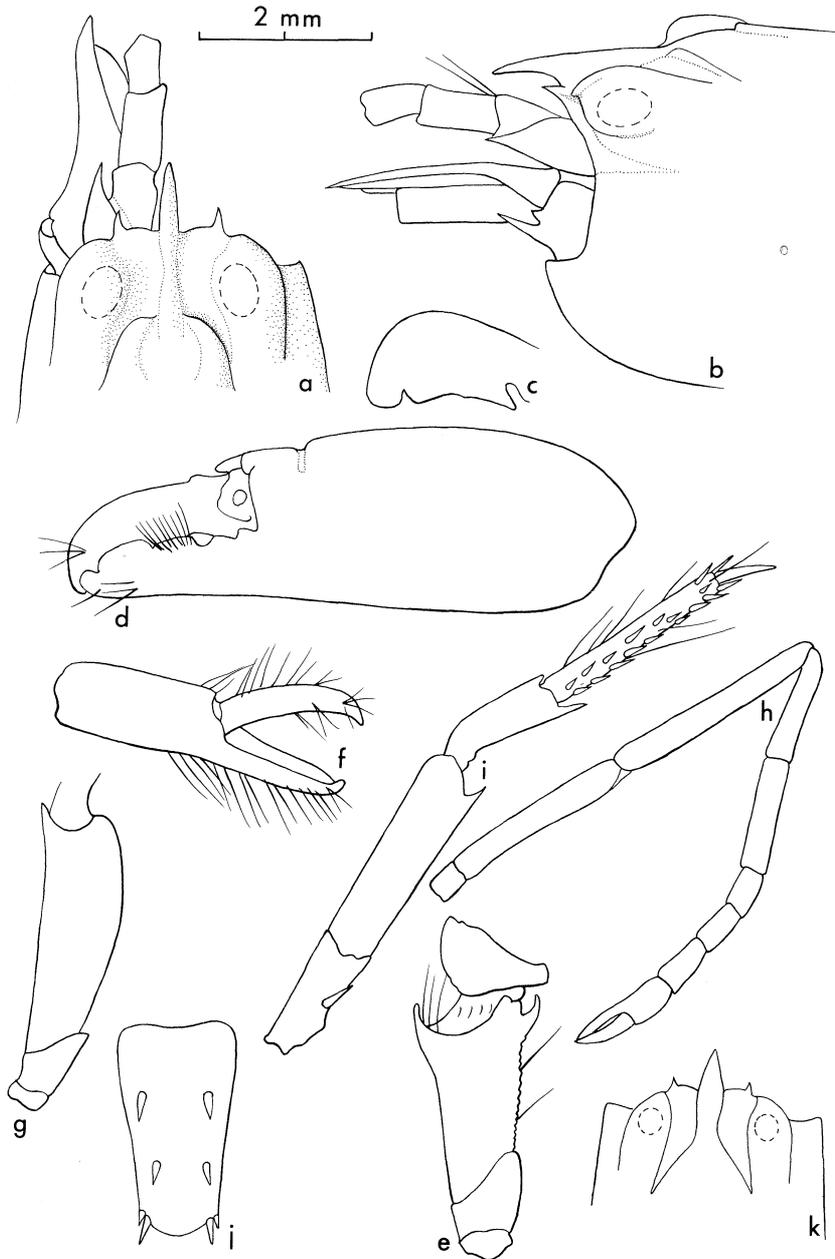


Fig. 34 *Alpheus bicostatus* De Man

19 mm female from AM 324. **a, b.** Anterior region, dorsal and lateral view; **c, d.** large chela and dactylus, lateral face; **e.** merus large cheliped, medial face; **f, g.** small chela and merus, lateral face; **h.** second leg; **i.** third leg; **j.** telson. 30 mm female from WM 116-65. **k.** Anterior region, dorsal view. All figures same scale.

midgastric region. Orbital hoods inflated, hemispherical, firmly demarked on anterior, medial and lateral margins and anteriorly projecting into a rounded, near vertical keel. Orbitorostral margin slightly arcuate, but almost at right angles to rostrum, bearing long setae and acute teeth laterally, with outer angle of teeth joining inner side of base of keel on orbital hoods. Orbitorostral area flattened between abrupt sides of rostrum and orbital hoods, broadening posteriorly behind eyes. Medioposterior margin of area terminated abruptly by curved and flattened crest, almost a narrow flap that overhangs area; near-horizontal crests arising near margins of rostrum and curving posterolaterally to terminate behind middle of eyes in anterior gastric region. Pterygostomial angle projecting, rounded and curving below basicerite.

Visible part of first and second antennular article nearly equal, third article a little shorter; second antennular article 2 times as long as broad. Stylocerite with slender tooth reaching just past end of first antennular article. Scaphocerite with outer margin concave, lateral tooth heavy, reaching well beyond antennular peduncle. Squamous portion narrow, reaching to end of antennular peduncle. Carpocerite reaching to middle of third antennular article. Prominent acute tooth on inferior margin of basicerite nearly as long as stylocerite; superior to this large tooth is a smaller subacute tooth.

Large chela subcylindrical, glabrous, 3 times as long as broad with fingers occupying distal 0.3. Superior margin of palm with narrow transverse groove proximal to dactylus continuing slightly into lateral and medial faces. Plunger of dactylus of minimal development. Merus 2 times as long as broad, bearing on superodistal margin a strong, acute and curved tooth. Inferointernal margin with small irregular teeth, without spines, but bearing subterminally a strong acute and curved tooth.

De Man (1911:377) reported the small chela as sexually dimorphic with that of male 3.8 times as long as broad with finger 0.4 total length; dactylus balaeniceps. Palm lacking transverse groove. Merus 2.5 times as long as broad with superior margin bearing tooth similar to that of large cheliped, but inferointernal margin unarmed. Small chela of female (our specimen) 4 times as long as broad, fingers and palm almost equal in length. Medial face of palm somewhat hirsute; lateral face glabrous. Fingers conical. Merus similar to that of male.

Ratio of carpal articles of second legs: 10:10:4:4:4.

Ischium of third leg bearing spine. Merus 4 times as long as broad, with acute tooth on distoinferior margin. Carpus 0.5 as long as merus. Inferior margin terminating in long acute tooth, superior margin terminating in a small rounded tooth. Propodus nearly as long as merus and bearing many spines on inferior margin and lateral face. Both inferior and superior margin bearing a pair of strong spines distally. Superior margin bearing a few long setae.

Telson 2.8 times as long as broad at posterior margin. Posterior margin strongly arcuate. Spines on superior surface prominent, anterior pair placed anterior to middle. Inner spines of posterolateral pairs nearly same size as dorsal spines.

DISCUSSION: Our specimens agree well with those described by De Man. However, we have one 30 mm female (WM 116-65) in which the rostral carina, instead of tapering uniformly, is markedly constricted near middle (fig. 34k). Since it agrees well with all other aspects of our specimens, we interpret this as an individual variation.

BIOLOGICAL NOTES: The specimen from Shark Bay was collected at 12 m. The others were collected intertidally. De Man's specimens were collected in a similar environment. Our largest specimen was 30 mm.

AUSTRALIAN DISTRIBUTION: One of our specimens was collected at Shark Bay in western Australia, another from the Torres Straits and the third from One Tree Island in the Capricorn Group in eastern Australia.

GENERAL DISTRIBUTION: Indonesia; Philippines.

Alpheus labis sp. nov.

Fig. 35

HOLOTYPE AND ONLY SPECIMEN: 17 mm male from Albany Passage area, Torres Straits, Qld. Collection by Melbourne Ward, Sept. 1928. AM 121 (AM P. 27234).

DIAGNOSIS: Rostrum triangular, as long as broad at base, not reaching beyond basal third of first antennular article. Rostrum without carina, anterior region of carapace smooth with slight orbitorostral grooves developed only near anterior margins. Visible part of first antennular article and second article equal, third 0.6 as long as second. Second article 1.7 times as long as broad. Stylocerite acute, not reaching end of first antennular article. Outer margin of scaphocerite straight, lateral tooth reaching just past end of second antennular article, squamous portion broad and reaching well beyond lateral tooth, carapocerite slightly longer than scaphocerite. Basicerite with acute, triangular tooth on its inferior margin.

Articles of third maxilliped: 10:2:4. All articles only slightly hirsute.

Large chela compressed, 3.4 times as broad (dorsoventrally) as thick laterally (measured at dactylar articulation), without notches or grooves, 3 times as long as broad, fingers occupying distal quarter. Palm 1.6 times wider than fingers when fingers are closed, plunger of dactylus well developed, of moderate length. Merus 3.2 times as long as broad, bearing on its inferoventral margin 2 small spines and strong, acute and curving subterminal tooth.

Small chela 6 times as long as broad. Palm 2 times as long as broad, fingers almost twice as long as palm, crossing at their tips and leaving fingers slightly agape. Fingers almost cylindrical with only a narrow cutting edge on opposing surfaces, bearing a few fine setae towards distal end. Carpus cup-shaped, 0.4 as long as palm. Merus slender, 9 times as long as broad, inermous.

Ratio of carpal articles of second legs: 10:7:3:3:4. All other thoracic legs missing.

Appendix masculina of endopod of second pleopod about half as long as adjacent *appendix interna*.

Telson 3 times as long as posterior margin is broad. Anterior margin 1.6 times wider than posterior portion, posterolateral pair of spines small, dorsal spines of normal development with anterior pair placed anterior to middle.

DISCUSSION: This species shows a relationship to both the *Diadema* and *Brevirostris* Groups. The compressed chela is found commonly in the latter group, but only a few species, such as *A. barbatus* Coutière, show compression to such a high degree. The extremely long fingers in relation to the palm of the small chela is found in such species as *A. rapax* Fabricius and *A. brevirostris* (Olivier). However, in the *Brevirostris* Group in general the large chela is usually more or less quadrangular in section, both chelae are almost never glabrous, but carry a fringe of setae at least along the margins, and those with long forceps-like development of the fingers of the small chela also carry dense rows of setae along the margins of the fingers. Often in the *Brevirostris* Group the third maxillipeds carry dense and long setae, the telson is broad

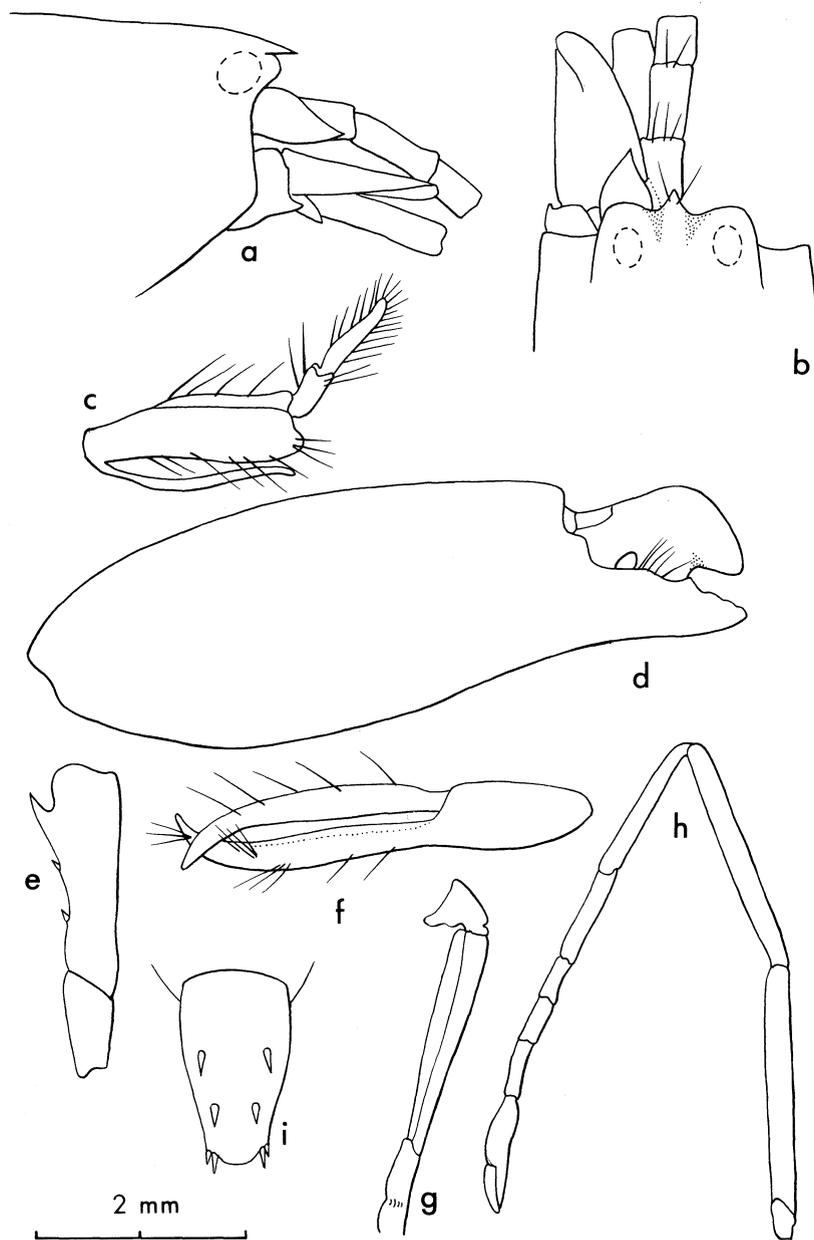


Fig. 35 *Alpheus labis* sp. nov.

Holotype (male) **a, b**. Anterior region, lateral and dorsal view; **c**. third maxilliped; **d, e**. large chela, lateral face and merus of large cheliped, medial face; **f, g**. small chela and merus, lateral face; **h**. second leg; **i**. telson. All figures same scale.

and with its tip projecting, and to our knowledge none have the almost complete lack of orbitorostral grooves.

This species is plainly different from all those in the Diadema Group that have deep orbitorostral grooves, with or without associated teeth such as *A. diadema* Dana or *A. bidens* (Olivier), and from those in which the large chela is more or less round in section. However, the species does resemble *A. paracrinitus* Miers in many ways: the form of the anterior carapace is quite similar, the lack of sculpturing on the large chela is the same (but it is only 1.4 times as broad as thick in *A. paracrinitus*); the armature of the merus of the large chela is almost identical, even the third maxillipeds, second legs and telson show similarities, but those are of rather generalized development. Other species in the Diadema Group showing some, but fewer, similarities are *A. mitis* Dana and *A. tenuipes* De Man. From all members of the Diadema Group this species may be differentiated by the development of the squame of the scaphocerite, the compression of the large chela and the proportions between the fingers and palm in that appendage and especially the long fingers of the small chela. We have decided to assign it to the Diadema Group because it shows none of the specialized adaptations for life on a muddy or silty bottom found usually in the Brevirostris Group; we suspect that the walking legs, when other specimens are found, will also show similar lack of adaptation.

Nothing is known of the habitat beyond the facts given on the label, reproduced above.

The name is derived from *labis*, Greek for forceps and refers to the form of the small chela. The holotype will be placed in the Australian Museum.

***Alpheus paracrinitus* Miers**

Fig. 36

Alpheus paracrinitus Miers, 1881:365, pl. 16, fig. 6. Chace, 1962:609. Crosnier and Forest, 1966:253, fig. 15. Banner and Banner, 1967:278, 2 tbls.

Alpheus paracrinitus bengalensis Coutière, 1905a:901, pl. 82, fig. 37.

Alpheus bengalensis Holthuis, 1958:25.

Crangon paracrinita bengalensis Banner, 1953:110, fig. 40.

Crangon togatus Armstrong, 1940:2, fig. 1.

SPECIMENS EXAMINED: 1 specimen from AM 109 (AM P. 28119); 2, BAU 46.

DIAGNOSIS: Rostrum triangular, acute, somewhat longer than wide at base, tip almost reaching middle of visible part of first antennular article, rounded dorsally; base separated from anterior orbital hoods by short shallow and rounded depressions. Orbital hoods not inflated, rounded anteriorly. Orbitorostral margin only slightly concave. Second antennular article 2 times as long as wide, 1.5 times longer than third article. Tip of stylocerite reaching to end of first antennular article. Lateral spine of scaphocerite not reaching end of third antennular article, squame slightly shorter. Carapocerite reaching by length of third article past that article. Lateral spine of basicerite small but acute.

Large chela slightly compressed, without sculpturing except for a slight concavity on inferior margin in region of dactylar articulation. Chela 3 times as long as broad, fingers about 0.3 length of entire chela. Plunger of dactylus fully developed. Merus slender, 3.4 times as long as wide, armed with strong tooth on inferointernal margin slightly distal to middle, superodistal margin not projected.

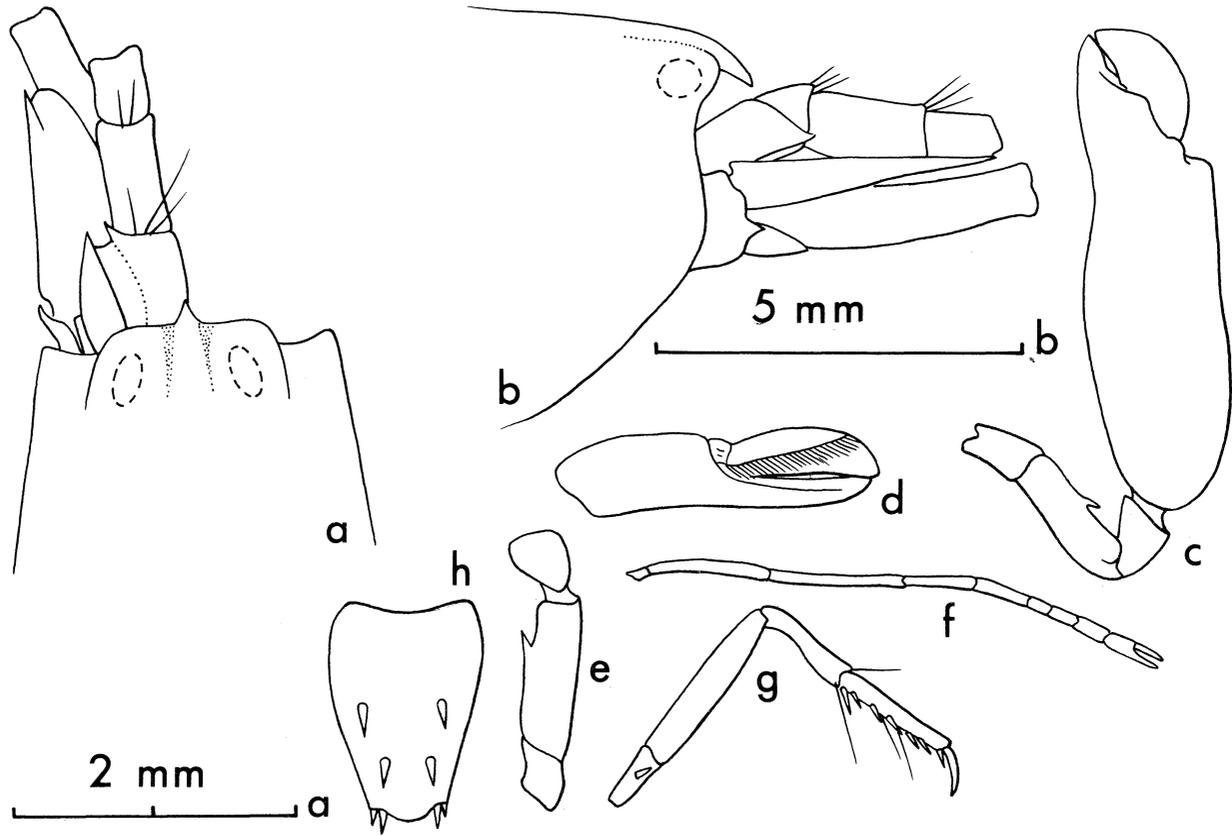


Fig. 36 *Alpheus paracrinitus* Miers
 17 mm male from BAU 46. **a, b.** Anterior region, dorsal and lateral view; **c.** large cheliped, medial face; **d.** small chela, lateral face; **e.** merus, small cheliped, medial face; **f.** second leg; **g.** third leg; **h.** telson. a, b, h scale a; c, d, e, f, g scale b.

Small chela sexually dimorphic. Male chela 4.2 times as long as broad with fingers occupying half entire length, dactylus variable, at times balaeniceps. Female chela more slender, tapering. Meri in both sexes with spine on inferointernal margin similar to that of large chela.

Carpal articles of second legs with first and second article varying in relative lengths: 10:8-18:3:3:4. (From B&B, 1966b:116).

Ischium of third leg armed with small spine, merus 7 times as long as broad, inermous. Carpus half as long as merus, both distal margins projected but rounded. Propodus 0.7 as long as merus and armed with 6-8 movable spines on inferior margin. Dactylus simple, curved and elongate.

Telson 3 times as long as posterior margin is broad. Anterior pair of dorsal spines placed anterior to middle.

DISCUSSION: Miers type locality was Senegambia, West Africa; Coutière described the variety *bengalensis* from the Maldives in the Indian Ocean. Holthuis believed the Atlantic form was separate from that found in the Indo-Pacific and raised *A. bengalensis* to specific level; finally, Chace, comparing West African specimens to some from Clipperton Island, came to the conclusion that there was but a single circumtropical species without distinct characteristics that would warrant the separation of subspecies. Crosnier and Forest placed into synonymy *A. togatus* that Armstrong had described from Bermuda.

In 1967 we reviewed the extent of variation in our central Pacific collections which included over 200 specimens from the Cook and Society Islands alone, and found extensive variation in the armature of the large and small cheliped, and the degree of balaeniceps development on the small chela of the male in the ratio of the first two carpal articles of the second leg, and in the carpal-propodal length ratio of the third legs. As these characteristics were those that were supposed to separate the two subspecies or species, we confirmed Chace's conclusion. We have examined the type of *A. togatus* at the American Museum of Natural History in New York and agree with the action of Crosnier and Forest.

BIOLOGICAL NOTES: The species apparently is confined to the intertidal and the upper subtidal with the greatest depth reported to be 18 m; it occurs under boulders in dead coral heads and in coralline algae. Miya (1974:159) reported that it has also been found from heads of *Tubipora*.

No one has published colour notes on the species, but our notes made in Hawaii showed that the entire specimen was transparent white with transverse bright red bands. The bands were broad and diffuse on the large and small chelae, slight on the anterior carapace, more defined but confined to the middle on the posterior carapace, and narrow and well-defined on each abdominal segment, running from pleuron to pleuron; both the antennular bases and the tip of the telson and uropods were splashed with red stellate chromatophores. We have observed similar colouration in other parts of the Pacific.

The largest specimen we have seen was 20 mm in length.

AUSTRALIAN DISTRIBUTION: Only 3 specimens have been collected, one from the Herald Cay in the Coral Sea and 2 from Heron Island on the Great Barrier Reef; considering how common it has been found to be in the central Pacific, it is surprising that more specimens have not been collected in Australian waters.

GENERAL DISTRIBUTION: As indicated, the species appears to be circumtropical, in the Indo-Pacific running from the Red Sea through the Hawaiian and Society Islands to Clipperton Island lying west of Central America; from the Ryukyus in the north to the Capricorn Group in the south; in the Atlantic from the Gulf of Mexico and the Caribbean to West Africa.

Alpheus ehlersii De Man

Fig. 37

*Alpheus ehlersii** De Man, 1909c:663, pl. 70. Banner and Banner, 1966b:114, fig. 40.

Alpheus macrochirus De Man, 1888a:519. (*Nec* Richters, 1880).

SPECIMENS EXAMINED: 1 specimen from BAU 16; 1, BAU 20; 7, BAU 29; 1, BAU 43; 2, BAU 44.

DIAGNOSIS: Rostrum acute, reaching well past middle of visible part of first antennular article. Rostral carina rounded, reaching to posterior margin of slightly inflated orbital hoods, orbitorostral grooves not pronounced. Orbitorostral margin bearing slight arcuate prominences. Visible part of first antennular article and second article equal, second article almost 2 times as long as broad, and 1.5 times as long as third article. Stylocerite acute, reaching past end of first antennular article. Lateral tooth of scaphocerite reaching to end of antennular peduncle, somewhat longer than narrow squamous portion and turned inward at tip. Carpocerite reaching beyond end of antennular peduncles. Basicerite with strong tooth.

Large chela slightly compressed, 2.7 times as long as broad, fingers not quite 0.3 of total length; superior margin proximal to dactylus bearing shallow transverse groove that extends obliquely toward medial face; groove so faint that chela often must be rotated to discern it; inferior margin bearing slight constriction opposite articulation of dactylus. Plunger of dactylus well developed. Merus 2.2 times as long as broad with inferointernal margin armed with 6-9 spines and bearing acute tooth distally. Superior margin not projecting. Merus of female more slender, but with similar armature.

Small chelipeds not sexually dimorphic, chela 4 times as long as broad with fingers a little longer than palm; rounded tooth on medial side of dactylar articulation. Merus 2.6 times as long as broad, bearing several small spines on inferointernal margin and distally a rounded tooth.

Carpal articles of second leg with ratio: 10:5:2:2:4.

Ischium of third and fourth legs with spine. Merus of third leg inermous, 4.3 times as long as broad. Carpus 0.6 as long as merus, superior margin projected into a rounded distal tooth, inferior margin truncate distally. Propodus 0.7 as long as merus, bearing on its inferior margin 5 spines and a pair distally. Dactylus simple, 0.3 as long as propodus.

Telson 2.5 times as long as posterior margin is broad. Anterior pair of dorsal spines placed just anterior to middle. Inner spines of posterolateral pair the same size as dorsal spines.

DISCUSSION: The holotype of this species is apparently missing so we were unable

*Spelled *ehlersi* according to the International Code of Zoological Nomenclature of 1961; *ehlersii* by the code of 1964, but not again changed in the revisions of 1974. These changes in rules have also been applied to the names *Synalpheus stimpsonii* (B&B, 1975:292) and *Alpheus edwardsii* (p. 404). Rule 32 (a)(ii) also requires that *Athanas haswelli* Coutière as used by Hale, 1927:47 and B&B, 1973:316 be returned to its original spelling of *A. hasswelli*.

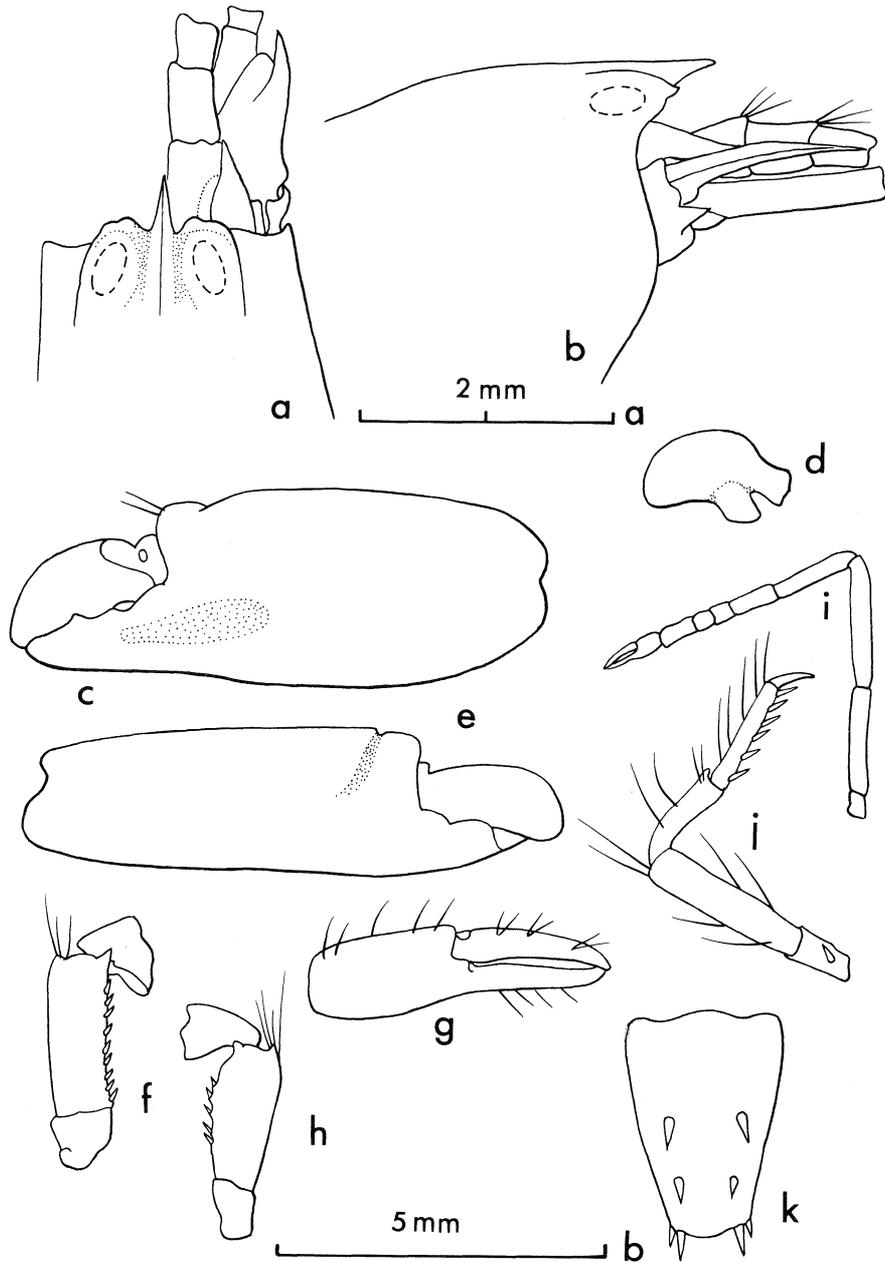


Fig. 37 *Alpheus ehlersii* De Man
 17 mm male from BAU 29. **a, b.** Anterior region, dorsal and lateral view; **c, d.** large chela and dactylus, lateral and dorsal face; **e.** large chela, superomedial face; **f.** merus, large cheliped, medial face; **g.** small chela, lateral face; **h.** merus, small cheliped, medial face; **i.** second leg; **j.** third leg; **k.** telson. **a, b,** scale a; **c, d, e, f, g, h, i, j,** scale b.

to compare our specimens with it. The anterior portion of this species is somewhat variable. The rostrum in some specimens reaches to the end of the first antennular article. The lateral tooth of the scaphocerite often extends much beyond the antennular peduncle and the carpocerite is sometimes as long as the third antennular article past that article. The lateral margins of the telson on the Australian specimens, as well as those from Thailand, are almost straight not having the broadly curved margins with the marked constriction posteriorly as was figured for the type.

BIOLOGICAL NOTES: This species has been collected intertidally from heads of dead coral. We made the following colour notes on the specimen from BAU 43. "With 2 longitudinal brown bands separated mid-dorsally by pinkish band, chelae more or less with a continuation of the brown band. Tail fan dark at base then with light band and terminating in dark band." It is not a large species with our largest specimen being 17 mm.

AUSTRALIAN DISTRIBUTION: We have specimens from Rudder Reef near Port Douglas to as far south as Hayman Island in central Queensland.

GENERAL DISTRIBUTION: Eylat, Israel; Bay of Djakarta; Philippines; Thailand; Tonga; Samoa; Marshall Is.; Phoenix Group.

***Alpheus mitis* Dana**

Fig. 38

Alpheus mitis Dana 1852:549, pl. 35, fig. 1.

SPECIMEN EXAMINED: 1 specimen from BAU 58.

DIAGNOSIS: Rostrum acute, almost twice as long as broad at base with a rounded carina that extends posteriorly to base of eyes. Orbital margins rounded, slightly concave at base of rostrum, orbitorostral grooves shallow. Visible part of first and second antennular article subequal, second article almost 2 times as long as broad; third article 0.6 as long as second. Stylocerite acute reaching just past end of first antennular article. Scaphocerite with outer margin slightly concave, lateral tooth strong, reaching past end of antennular peduncle, squamous portion reaching to middle of third antennular article. Carpocerite reaching length of third article past that article, basicerite with small acute tooth.

Ratio of articles of third maxilliped 10:3:6. Third article with tip bluntly rounded, bearing only several long setae.

Large chela smooth, 4.1 times as long as broad with fingers and palm almost equal, bearing only a few sparsely placed setae. Carpus somewhat elongate, about one-third length of merus, merus 3.3 times as long as broad, bearing a small acute tooth distally on inferointernal margin.

Small chela 4.1 times as long as broad, fingers a little longer than broad, dactylus conical. Merus 3 times as long as broad bearing an acute tooth distally on inferior margin, superior margin rounded.

(Small chela lacking in Australian specimen, description and figure of 10 mm male from the Philippines).

Ischium of third leg bearing an acute spine. Merus 5.0 times as long as broad, inermous. Carpus 0.5 as long as merus, distoinferior margin rounded; distosuperior margin terminating in small obtuse projection. Propodus 0.7 as long as merus, bearing 5-6

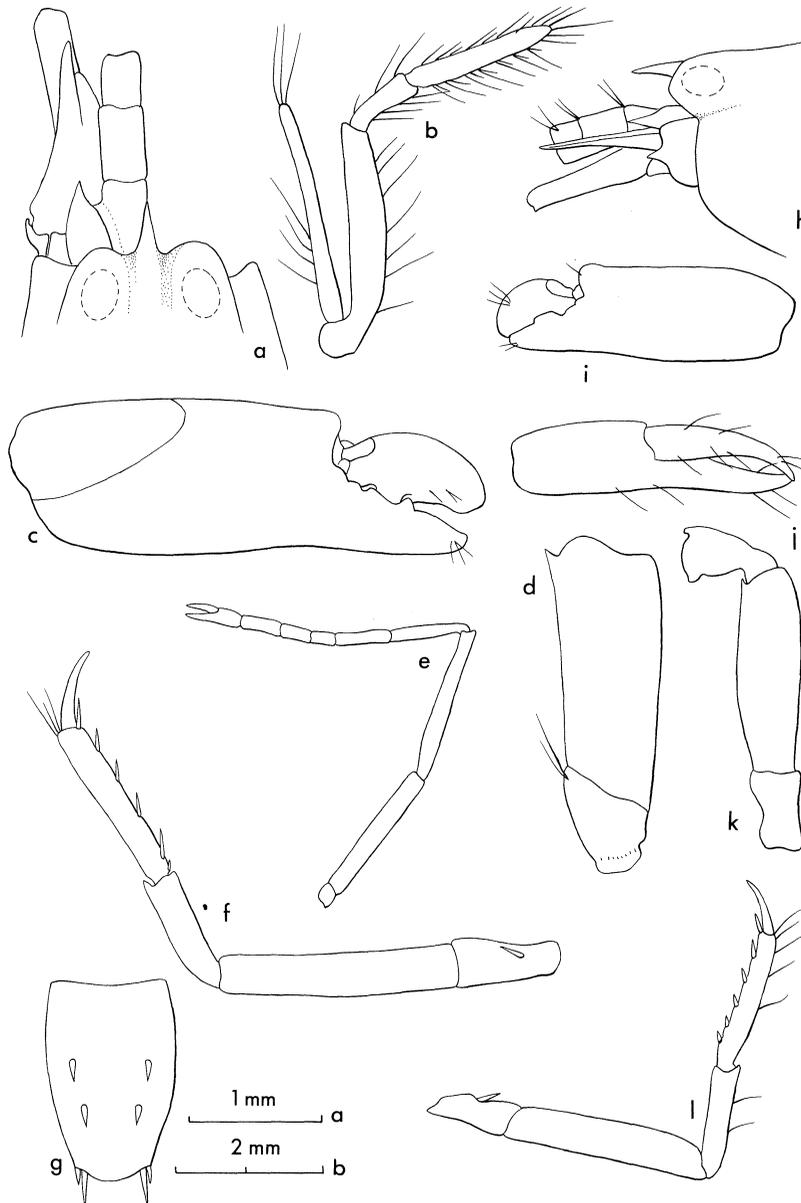


Fig. 38 *Alpheus mitis* Dana
 14 mm male from BAU 58. **a**. Anterior region, dorsal view; **b**. third maxilliped; **c**, **d**. large chela, lateral face and merus medial face; **e**. second leg; **f**. third leg; **g**. telson. 10 mm male from Zamboanga, Mindanao, Philippines. **h**. Anterior region, lateral view; **i**. large chela, medial face; **j**, **k**. small chela, lateral face and merus medial face; **l**. third leg. a, b, c, d, e, f, g, h, j, k, l scale a; i scale b.

spines and one distally. Dactylus simple, slender, 0.4 as long as propodus.

Telson 2.5 times as long as posterior margin is broad; inner spines of posterolateral pairs with length equal to half breadth of tip and over twice as long as outer pair.

DISCUSSION: In addition to the single 14 mm male from Australia, we have in our present collections two specimens from Madagascar, the larger being 15 mm long, and one 10 mm male from near Zamboanga in the southern Philippines. Inasmuch as the species is little known, being recorded only twice since its original description by Dana (Nobili, 1907:355, Sandler, 1923:46, both from the Tuamotus), and inasmuch as the Philippine specimen was collected only about 600 km away from the type locality, the Balabac Straits, we have decided to use this paper for reconsideration of the species. Unfortunately, all specimens are smaller than Dana's which was 9 lines, or about 19 mm long. There are some slight differences in relative proportions: In the Australian specimen the rostrum reaches only to the final third of the first antennular article instead of to the end and the stylocerite reaches only to the end of the article instead of clearly surpassing it. The carpopocrite reaches beyond the end of the antennular peduncles almost by the length of the third article, and the lateral spine of the scaphocerite is approximately equal to the antennular peduncle, while in Dana's figure the conditions are reversed with the carpopocrite being equal and the scaphocerite markedly longer. The chelae in our specimens are slender, the larger being 2.5 times as long as broad and the smaller chela 4.1 instead of 2.5 and 3.2 times, respectively (from plate). Finally, the merus of the third leg is heavier, 4.5 times as long as broad in this specimen and 5.0 in Dana (from plate). However, as these proportions differ in the other specimens and may also reflect maturity of the specimens we do not attach great significance to the differences. It is interesting to note that all 4 specimens had the long inner spines on the posterolateral margins of the telson.

AUSTRALIAN DISTRIBUTION: This specimen, the only one known from Australia, came from a small pocket on the reef flat at Heron Island in the Capricorn Group.

GENERAL DISTRIBUTION: Madagascar; Southern Philippines and Tuamotus.

Alpheus bidens (Olivier)

Fig. 39

Palaemon bidens Olivier, 1811:663.

Alpheus bidens Milne-Edwards, 1837:353, pl. 24, fig. 11, 12. Coutière, 1899: figs. 57, 274.
De Man, 1911:371, fig. 80. Banner, 1957:203.

Alpheus tridentatus Zehntner, 1894:204, pl. 8, fig. 24.

Alpheus praedator De Man, 1908:103, 1911:373, fig. 81.

Alpheus dissodontonotus Stebbing, 1915:83, pl. 86.

Previous Australian Records

Olivier, 1811:663. New Holland.

Hale, 1927a:47; 1927b:308. South Australia (as *Crangon praedator*)

McNeill, 1968:16. Near Low Isles, Great Barrier Reef.

SPECIMENS EXAMINED: 1 specimen from AM P. 2349; 1, AM P. 10837; 1, AM P. 13509; 1, BAU 11; 2, BAU 20; 2, BAU 43; 2 BAU 48; 1, SM 3; 3, SM C-514; 2, SM C-515; 1, VM 32; 1, WM 31-65; 2, 75 LIZ-8 (AM P. 27913).

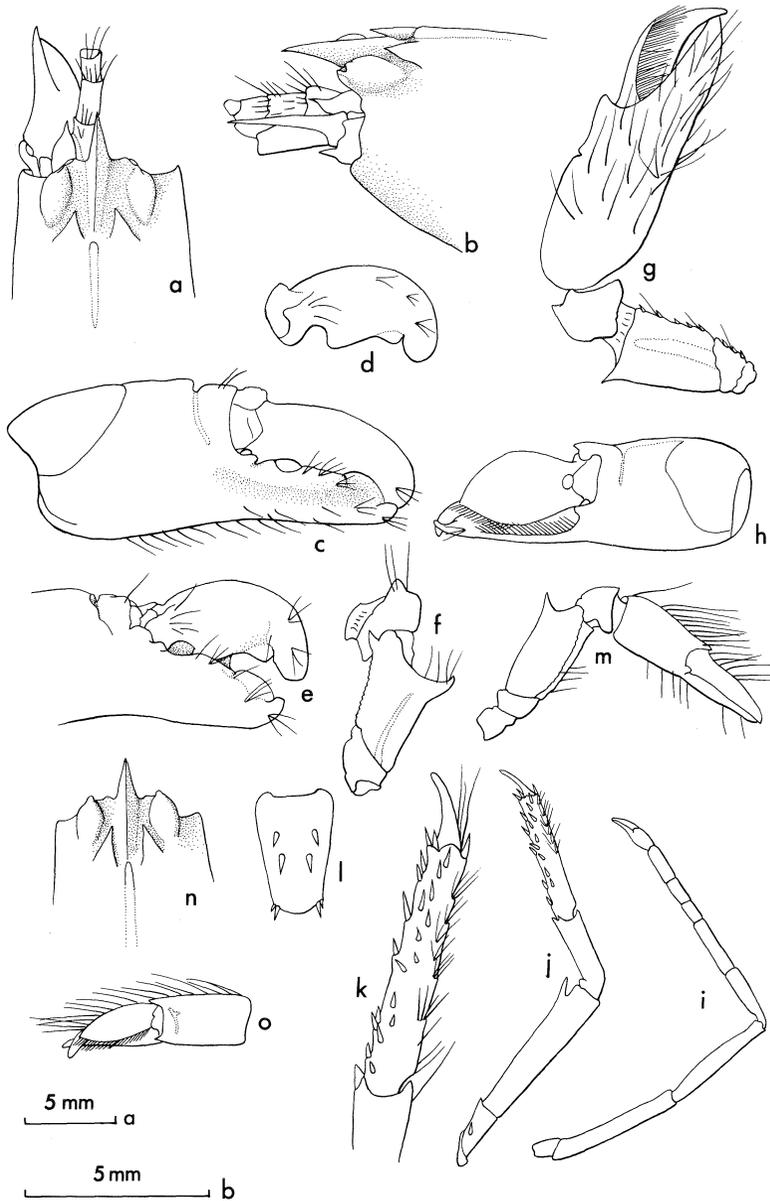


Fig. 39 *Alpheus bidens* (Olivier)

55 mm male from WM 31-65. **a, b.** Anterior region, dorsal and lateral view; **c, d.** large chela and dactylus, lateral face; **e.** distal region of large chela, lateral face; **f.** merus of large cheliped, medial face; **g.** small cheliped, medial face; **h.** small chela, lateral face; **i.** second leg; **j, k.** third leg and enlarged propodus and dactylus, lateral face; **l.** telson. 47 mm female from AM P. 10837. **m.** Small cheliped, lateral face. 48 mm male from SM C 517. **n.** Anterior region of carapace, dorsal view; **o.** small chela, superior face. a, b, c, d, e, f, g, h, i, j, l, m, n, o scale a; k scale b.

DIAGNOSIS: Rostrum narrowly triangular, acute, reaching to or beyond end of first antennular article; high and sharp rostral crest reaching from tip to level of posterior end of orbital hoods. Posterior to rostral crest lies a small flattened area followed by a second dorsal carina, anteriorly somewhat rounded and overhanging flattened area, laterally rounded and posteriorly merging with carapace in gastric region. Orbital hoods hemispheric in section; in dorsal view elongate, oval, almost egg-shaped, with middle to anterior portion abruptly set off from surrounding carapace and with anterior margin bearing definite keel which becomes confluent with orbitorostral margin. Orbitorostral margin convex; orbitorostral area depressed and slightly concave. A pair of acute triangular dorsal teeth arising near level of anterior end of posterior dorsal carina with tips reaching slightly posterior to middle of orbital hoods; these thin, flat teeth are slightly rounded to curvature of carapace and overhang orbitorostral depressions.

Visible part of first antennular article and second article nearly equal, second article 1.3 times as long as broad; third article a little shorter than second. Distal margins of antennular articles bearing stiff setae. Stylocerite acute, reaching to end of first antennular article. Scaphocerite with outer margin concave, with strong lateral tooth directed inward at its tip; squamous portion narrow, reaching just beyond end of antennular peduncle. Carpocerite reaching middle of third antennular article. Basicerite with strong acute lateral tooth.

Large chela nearly cylindrical in section 2.6 times as long as broad with fingers occupying distal 0.4. Dactylar articulation at about 90° angle to axis of body flanked by heavy, blunt teeth. Superior margin of palm, with narrow deep transverse groove curving on lateral face toward dactylar articulation, but continuing only a short distance into medial face. Medial face of chela bearing stiff forward directed setae. Lateral face glabrous and bearing a very slight rounded longitudinal depression on inferior portion of lateral face of palm starting near level of transverse articulation and continuing past socket of pollex. Dactylus thickened with broad carina on superior surface. Both fingers with opposite faces distal to plunger and socket developed into thin knife-like shearing teeth that cross when fingers are closed. Plunger of minimal development. Merus 1.5 times as long as broad; superodistal margin strongly projected into a subacute tooth; inferoventral margin minutely dentate and bearing a few small spines, and terminating in strong tooth. Superoexternal margin also minutely dentate. Medial face of merus with longitudinal groove.

Small chela sexually dimorphic. Male chela with balaeniceps dactylus, 2.8 times as long as broad with fingers and palm almost equal. Superior surface of dactylus with broad triangle which is 1.5 times as long as broad at its widest point. Outer margins of triangle with continuous fringe of thick, short, stiff setae. Pollex also bearing upward directed crest of hair on both faces that continues distally to distal quarter of pollex. Dactylar articulation flanked by heavy blunt teeth. Superior surface proximal to dactylus bearing transverse groove similar to large chela. Medial face of palm hirsute, lateral glabrous. Merus 1.7 times as long as broad; superodistal angle projecting as a strong inwardly curving subacute tooth; inferoventral margin bearing short heavy spines and an occasional seta, without distal tooth. Medial face bearing longitudinal groove near inferolateral margin. Small chela of female 3.4 times as long as broad, fingers and palm equal, fingers simple and tapering, palm without sculpture, medial surface hirsute, lateral surface glabrous. Merus similar to that of male.

Ratio of carpal articles of second leg: 10:10:3:3:6.

Ischium of third leg with spine. Merus 4.5 times as long as broad; inferior margin bearing acute subterminal tooth. Carpus 0.5 as long as merus, superior margin

terminating in subacute tooth; inferior margin terminating in 2 subacute teeth. Propodus 0.8 as long as merus bearing on its inferior margin 7 spines with a pair distally, and many randomly placed smaller spines. Superior margin bearing setae set in clusters of 2 to 4 and one distal spine. Dactylus simple and 0.2 as long as propodus.

Telson 2.2 times as long as posterior margin is broad. Anterior pair of dorsal spines placed anterior to middle, inner spines of posterolateral pair equal in size to dorsal spines.

DISCUSSION: In 1811 Olivier described this species based on a specimen collected by Péron from "Nouvelle-Hollande" and Péron's collections could have been made anywhere from Sydney around the southern, western and northern coasts of Melville Island, near Darwin (see p. 52). We have been able to examine the holotype in the Muséum National d'Histoire Naturelle in Paris. In it the large chela is missing, but it was figured by Milne-Edwards.

In 1908 and 1911 De Man described a species he called *A. praedator* from Ambon in Indonesia, which he separated from the specimens he identified from the Siboga Expedition as *A. bidens* by three characteristics: 1. the interorbital portion of the rostral carina was higher and sharper in *A. praedator* than in *A. bidens*; 2. the portion of the crest posterior to the post-orbital tubercle was prolonged into a demarked crest running to the posterior third of the carapace in *A. praedator* instead of being higher anteriorly and fading more abruptly into the carapace in *A. bidens*; 3. the transverse groove proximal to the dactylus of the large chela extended to the lateral (or lower) face of the palm where it continued as a broad shallow depression in *A. praedator* while in *A. bidens* the groove was not continued onto the lateral face.

We were able to examine the holotype of *A. praedator* and 18 specimens De Man had identified as *A. bidens* from the Siboga Expedition at the Zoologisch Museum in Amsterdam. Of the 20 specimens in the present study collection as well as De Man's 18 specimens these three characteristics are variable, with the form of the anterior and posterior portions of the dorsal carina varying from that described by De Man as the *bidens*-condition to that approaching but not reaching the development found in De Man's holotype. It should be noted in passing that the holotype for *A. bidens* was also intermediate between the two extremes discussed by De Man. The large chela of Olivier's type was drawn by Coutière (1899:fig. 274), and its development was accurately described by De Man and found in the 2 of his 18 specimens that at present have the chela present. The Australian specimens in the present collection again are variable, but most have a depression in the lateral face of the palm, similar to *A. praedator*.

There remains one difference between the Australian forms and those from Indonesia: neither Olivier's type nor any of the present collection bear teeth on the distal margin of the first antennular article, but rather they carry short, stiff setae, while all of De Man's specimens under both names had 2 teeth at the end of this article. We regard this difference as rather insignificant, probably even at the subspecies level, and therefore, in view of the variation remarked upon above, place *A. praedator* into synonymy under *A. bidens*.

Stebbing described a new species from South Africa, *A. dissodontonotus* (1915:83) which he regarded as close to *A. bidens*. The first characteristic he used to separate the two was the dorsal carina which we have found to be variable. The second characteristic he gave was the presence of an "anterior tubercle" on the eye hoods, which apparently is the anterior keel found on the hoods in all specimens we have examined. The third difference was the length relationship between the visible portion of the first and second

antennular articles, but this will vary in any specimen within the limits of his differences by the angle that the first article makes to the carapace in death. Finally, he stated that the first carpal article of the second leg was "decidedly longer than the second" and showed it in his figure to be 1.2 times as long, and in the present series the first article is 1.0 to 1.4 times the length of the second. The figures he gives for his species are easily within the range we have found for the Australian specimens, so this species, too, we are placing in synonymy.

In one of our specimens (SM C-517) the usual acute teeth on the carapace at the base of the eyes are placed much further forward, reaching about the middle of the orbits. The small chela is also more slender, being 3.4 times as long as broad instead of 2.8 as in our specimens. In all other ways it is the same as our other specimens. We feel this is probably an individual variation.

BIOLOGICAL NOTES: All of the Australian specimens were collected intertidally with the exception of the specimen from SM C-517 which was collected at 24 m. The specimens of *A. bidens* from the Siboga Expedition were dredged as deep as 83 m. The species was collected in the Marshall Islands from heads of the coral *Stylophora mordax* (Banner, 1957:203; B&B, 1968:287). Olivier described his type as "*La couleur de ce crustacé, conservé dans l'eau-de-vie, est d'un rouge tres-pâle, avec trois taches blanches, grandes & ovales sur chaque anneau de la queue*". Our field notes indicate for a pair from Heron Island (BAU 48) "*Chela pale pink, small chela, pale pink, fingers brown. Abdomen with uneven stripes of brown and pale pink. Antennae with pink and brown stripes*". Our specimens range in size up to 58 mm. However, Hale (1927a:47) mentions specimens as long as 67 mm; Olivier's type was 77 mm in length.

AUSTRALIAN DISTRIBUTION: The collections extend from Lizard Island in northern Queensland to Heron Island in the Capricorn Group; also in Victoria, Melbourne and Tasmania; one specimen came from near Perth in western Australia.

GENERAL DISTRIBUTION: Indonesia; "*mers d'Asie*" (Milne-Edwards, *loc. cit.*); Ryukyus; Marshall Islands.

***Alpheus diadema* Dana**

Fig. 40

Alpheus diadema Dana, 1852:555, pl. 35, fig. 7.

Alpheus insignis Heller, 1861:269, pl. 3, fig. 17, 18.

Crangon diadema Banner, 1953:118, fig. 43 [Neotype established].

Previous Australian records:

McNeill, 1968:16. Low Isles, Qld.

?Nobili, 1899:233. Beagle Bay, W.A. [as *A. insignis*].

SPECIMENS EXAMINED: 1 specimen from AM 74 (AM P. 27471); 1, AM 109 (AM P. 27509); 1, AM 123 (AM P. 27320); 2, AM 186 (AM P. 27321); 5, AM 283 (AM P. 27322); 5, AM 324 (AM P. 27357); 1, AM 335 (AM P. 27358); 1, AM 336 (AM P. 27359); 2, AM 340 (AM P. 27360); 1, AM P. 27434; 1, AM P. 27436; 1, BAU 10; 1, BAU 11; 1, BAU 20; 1, BAU 29; 1, BAU 32; 1, BAU 43; 1, BAU 48; 2, BAU 53; 2, BAU 54; 2, BAU 55.

DIAGNOSIS: Rostrum variable, usually short, reaching to middle of visible portion of first antennular article; rostral crest on carapace broad, reaching posterior to orbital

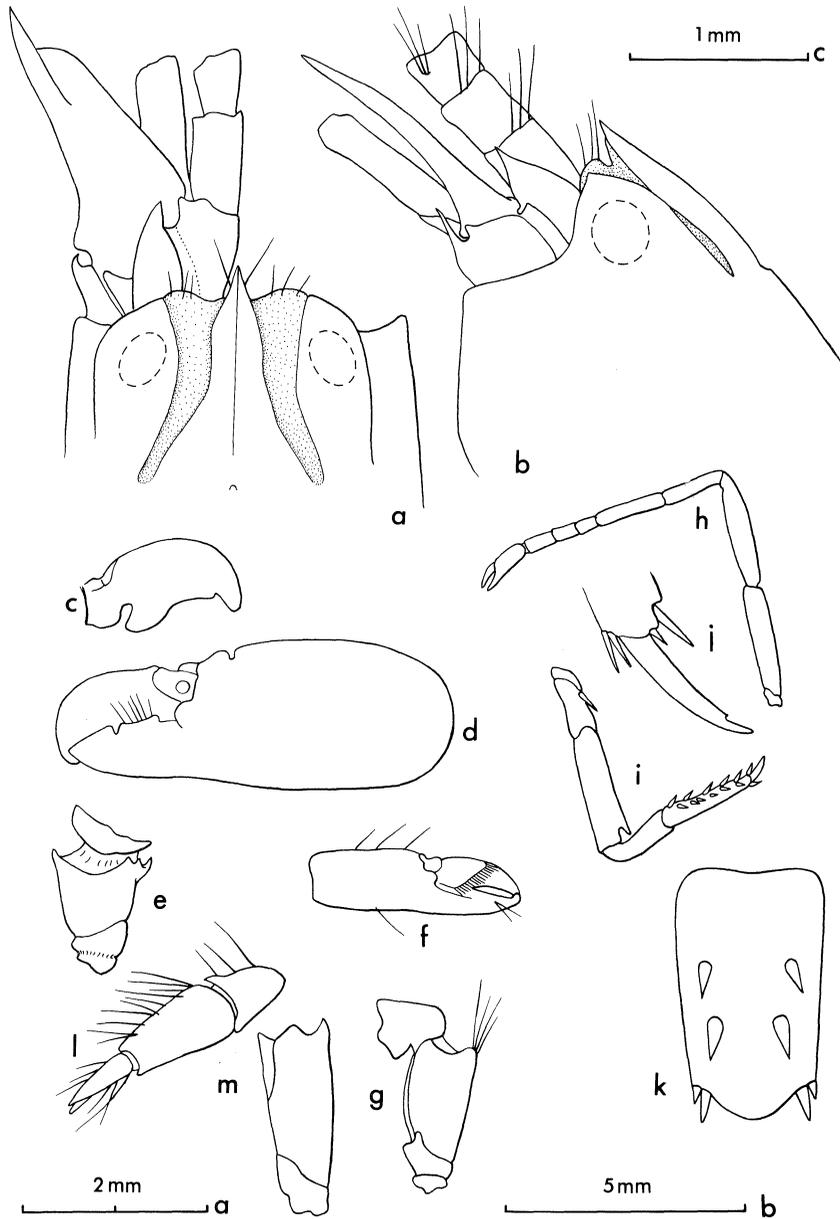


Fig. 40 *Alpheus diadema* Dana

19 mm male from BAU 54. **a, b.** Anterior region, dorsal and lateral view; **c.** dactylus of large chela, medial face; **d.** large chela, lateral face; **e.** merus of large cheliped, medial face; **f, g.** small chela, lateral face and merus medial face; **h.** second leg; **i, j.** third leg and enlarged dactylus; **k.** telson. 27 mm. female from BAU 54. **l, m.** Small chela, superior face and merus lateral face. **a, b, k** scale a; **c, d, e, f, g, h, i, l, m** scale b; **j,** scale c.

hoods, with margins anterior to eyes tapering to acute tip, middle portion in region of eyes with sides almost parallel, and posterior portion rapidly broadening; dorsal surface with carina prominent only in middle section, and midline carrying slight protuberance at posterior limit of rostrum. Rostral margins overhanging flattened orbitorostral grooves, in posterior sections almost meeting corresponding overhanging ridge on orbital hoods. Anterior orbitorostral margins convex and reaching beyond orbital hoods. Orbital hoods high, rounded, conspicuously demarked on all sides and anteriorly projecting as slight, rounded vertical keel.

Antennular peduncle with visible part of first and second article almost equal in length; third article shorter; second article almost twice as long as broad. Stylocerite short and broad, lateral spine reaching to end of first antennular article. Scaphocerite with outer margin concave, with strong lateral tooth reaching well beyond antennular peduncle; squamous portion reduced, reaching to end of antennular peduncle. Carpocerite reaching to end of antennular peduncle. Lateral spine of basicerite prominent, reaching as far forward as rostrum.

Large chela subcylindrical, almost as broad as high, about 3 times as long as broad, tapering distally; surface without sculpture except for transverse groove proximal to articulation of dactylus. Chela sparsely hirsute on upper and medial surfaces. Dactylus about 0.4 length of chela, strong, with superior margin arcuate. Plunger of dactylus moderately long. Merus 0.6 as long as broad, about a quarter as long as chela; superior distal margin projecting as acute tooth, inferoventral margin with strong tooth distally. Large chela of female similar in form but relatively much smaller.

Small chela sexually dimorphic. Male chela 0.8 as long as carapace, subcylindrical, tapering, 3 times as long as broad, without sculpturing. Dactylus balaeniceps, approaching half length of chela. Carpus slightly elongate, 0.25 length of chela. Merus 2 times as long as broad without inferoventral tooth. Small chela of female conical and tapering, fingers 0.7 length of palm, without balaeniceps dactylus.

Carpal articles of second legs with ratio: 10:10:3:4:5.

Third leg with strong spine on ischium. Merus 3.5 times as long as broad, with acute tooth subterminally on inferior margin. Carpus 0.5 as long as merus, inferior margin projecting as a strong tooth. Propodus about 0.8 as long as merus, tapering, with many spines. Dactylus variable, from simple to carrying small secondary unguis.

Telson almost twice as long as broad, sides almost parallel, posterior margin arcuate. Dorsal spines heavy, distolateral margins of inner uropod with several spines.

DISCUSSION: The rostrum in this species is extremely variable. In some specimens, particularly in the small ones, the taper of the sides of the rostrum is uniform to the tip. The tip of the rostrum varies from reaching just beyond the orbital margin to near the end of the first antennular article. The carpus of the second leg may have the second article somewhat longer than the first. The variation in the dactylus of the third leg has been remarked upon before (Banner 1959:141).

BIOLOGICAL NOTES: This species is found mainly intertidally under rocks or in heads of coral. However, it was dredged off Hawaii at a moderate depth (Banner, 1953:122). The colour in the Hawaiian specimens was ". . . variable, but it was usually dark, olive green, reddish brown, etc. with pronounced mottling of lighter colour; specimens at times almost transparent." (Banner, 1953:119).

AUSTRALIAN DISTRIBUTION: This species has been collected on the east coast from off Port Douglas, Qld., south to the Whitsunday Group. We also have some specimens

from the Coral Sea. Nobili himself (*loc. cit.*) thought the identity of his specimen from Beagle Bay in Western Australia was questionable.

GENERAL DISTRIBUTION: This species has been collected from the Red Sea, Indian Ocean, Japan and across the central Pacific to Hawaii.

***Alpheus gracilipes* Stimpson**

Fig. 41

Alpheus gracilipes Stimpson, 1861:31. De Man, 1924:43, fig. 15. Banner and Banner, 1966b:112, fig. 39.

Crangon gracilipes Banner, 1953:115, fig. 41.

Nec Alpheus gracilipes Miers, 1884:287 (= *A. miersi* Coutière, 1898d.)

Nec Alpheus gracilipes Bate, 1888:561, pl. 101, fig. 3. Bass Strait Victoria. (Identity uncertain).

Previous Australian records:

Coutière, 1900:411. Thursday Is., Murray Is., Torres Straits.

McNeill, 1968:17. Low Is., Qld.

SPECIMENS EXAMINED: 1 specimen from AM74 (AM P. 27499); 2, AM 151 (AM P. 27826); 1, AM 186 (AM P. 27327); 4, AM 305 (AM P. 27778); 2, AM P. 7522; 1, AM P. 27431; 2, BAU 10; 1, BAU 46; 2, JG 22-73; 1, WM 221-65.

DIAGNOSIS: Rostrum narrow, triangular, acute, flattened dorsally, without carina, reaching almost to end of first antennular article. Rostral base separated from posterior portion of orbital hoods by deep narrow depressions, more anteriorly by wide flattened areas; abrupt sides of rostrum overhanging grooves. Orbital hoods inflated, large with abrupt medial margin, posteriorly merging with carapace, anteriorly with a rounded dorsoventral keel, which project beyond concave orbitorostral margin.

Antennular peduncle with second article 2 times as long as broad, 1.5 times longer than visible part of first article and over twice as long as third article. Stylocerite reaching to end of first antennular article. Scaphocerite with lateral margin slightly concave, squamous portion narrow, reaching to end of peduncle, lateral tooth reaching beyond end. Carpcerite reaching only slightly beyond second antennular article. Acute tooth of basicerite nearly as long as stylocerite.

Large chela slender, sub-cylindrical, 3.5 times as long as wide, with fingers occupying distal 0.4. Dactylus heavy, compressed, strongly arcuate, longer than fixed finger; plunger of minimal development. Palm with deep broad transverse groove proximal to articulation of dactylus. Merus 2 times as long as broad proximally, bearing an acute tooth distally on inferior margin and 2 small spines proximally; superior margin projecting into rounded tooth.

Small chela slender, 5 times as long as broad. Dactylus balaeniceps in both male and female with continuous setiferous crest passing over superior margin proximal to tip, but without usual lateral expansion of finger. Merus similar to that of large chela except tooth on superodistal margin is acute.

Carpal articles of second legs with ratio: 10:8:3:3:5.

Ischium of third leg with spine. Merus 6 times as long as broad, innermous. Carpus 0.5 as long as merus, superior margin terminating in a subacute tooth. Propodus nearly as

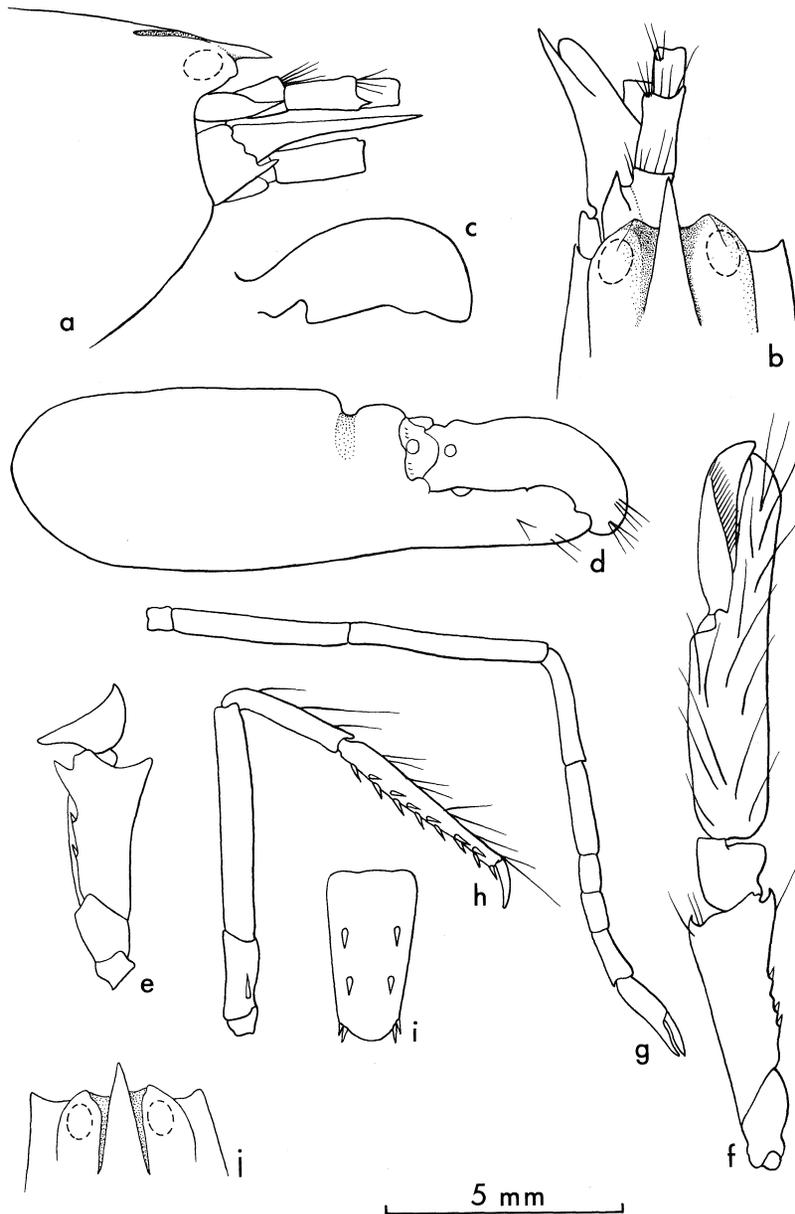


Fig. 41 *Alpheus gracilipes* Stimpson

35 mm female from AM P. 2577. **a, b.** Anterior region lateral and dorsal view; **c, d.** large chela and dactylus, lateral face; **e.** merus of large cheliped, medial face; **f.** small cheliped, medial face; **g.** second leg; **h.** third leg; **i.** telson. 24 mm male from AM 305. **j.** Anterior region, dorsal view. All figures same scale.

long as merus, bearing on inferior margin 10-16 spines and a pair distally. Dactylus slender, simple, 0.2 as long as propodus.

Telson 3.2 times as long as posterior margin is broad, posterior margin broadly arcuate, anterior pair of dorsal spines placed anterior to middle. Inner spines of posterior pair equal in length to dorsal spines.

DISCUSSION: The ratio of the length of the rostrum to its width at the base varies from 1.7-2.5 (compare figures 41b and 41j). Its length also varies from 0.7 length of visible part of the first article to the end of the that article. On the orbital hoods the anterior crest varies from rounded to almost acute giving the appearance from dorsal view of subacute teeth. The second antennular article is often more slender and may be over 2 times as long as the visible part of first. The first carpal article of the second leg varies from being equal in length to the second article to being somewhat longer.

The specimen that Bate reported as *A. gracilipes* from the Bass Straits is far beyond the tropical range we have found for this species in Australia. The frontal regions of the carapace are shown without orbitorostral grooves (fig. 3c) and are somewhat reminiscent of the fronts found in the genus *Synalpheus*; Bate himself remarks that the antennular peduncles are not of the proportions reported for *A. gracilipes*; the two views of the large chela (fig. 3, 3k) are difficult to interpret, but do not show the strong transverse groove behind the dactylar articulation; the slender and lightly armed distal end of the propodus and the very slender dactylus of the third leg (fig. 3m) again is unlike this species, and finally the telson is unlike any we have seen in this family. Inasmuch as the specimen cannot be found with the other *Challenger* material at the British Museum (Natural History), we will have to leave it without being able to assign it to a genus, let alone to any known species.

BIOLOGICAL NOTES: This species is apparently an intertidal form and has been collected under rocks and in heads of dead coral taken from water less than 6 m deep. We have no colour notes for the Australian specimens, but we do have colour notes from Hawaii and they compare favourably with the colour notes Coutière made from specimens from Djibouti (1898i:197). The chelipeds and thoracic legs were blue tinged with orange-red. The body was blue with oblong irregular patches of white which were sprinkled with orange-red pigment spots giving an overall rusty appearance. The most characteristic thing was a large round black spot tinged with orange on the pleura of the second to fourth abdominal segments. This colour pattern has appeared consistently on every specimen we have collected in Hawaii. Miya (1974:152) also reports these "eye spots" on the abdominal segments in specimens from Japan. This is a large species, the largest in our collection being 44 mm in length.

AUSTRALIAN DISTRIBUTION: In western Australia we have specimens from Yampi Sound and Cape Leveque; it has been collected in the north at the Torres Straits, and on the east coast from the Coral Sea to Heron Island in the Capricorn Group.

GENERAL DISTRIBUTION: Red Sea; East Africa; Indonesia; Vietnam; Korea; Japan; New Caledonia* and across the central Pacific to Hawaii and Tahiti.

***Alpheus novaezealandiae** Miers**

Fig. 42

Alpheus novae-zealandiae Miers, 1876:224. Yaldwyn, 1956:806, figs. 1-7 (redescription of

*To be spelled without hyphen according to both 1961 and 1964 revisions of the International Codes of Zoological Nomenclature.

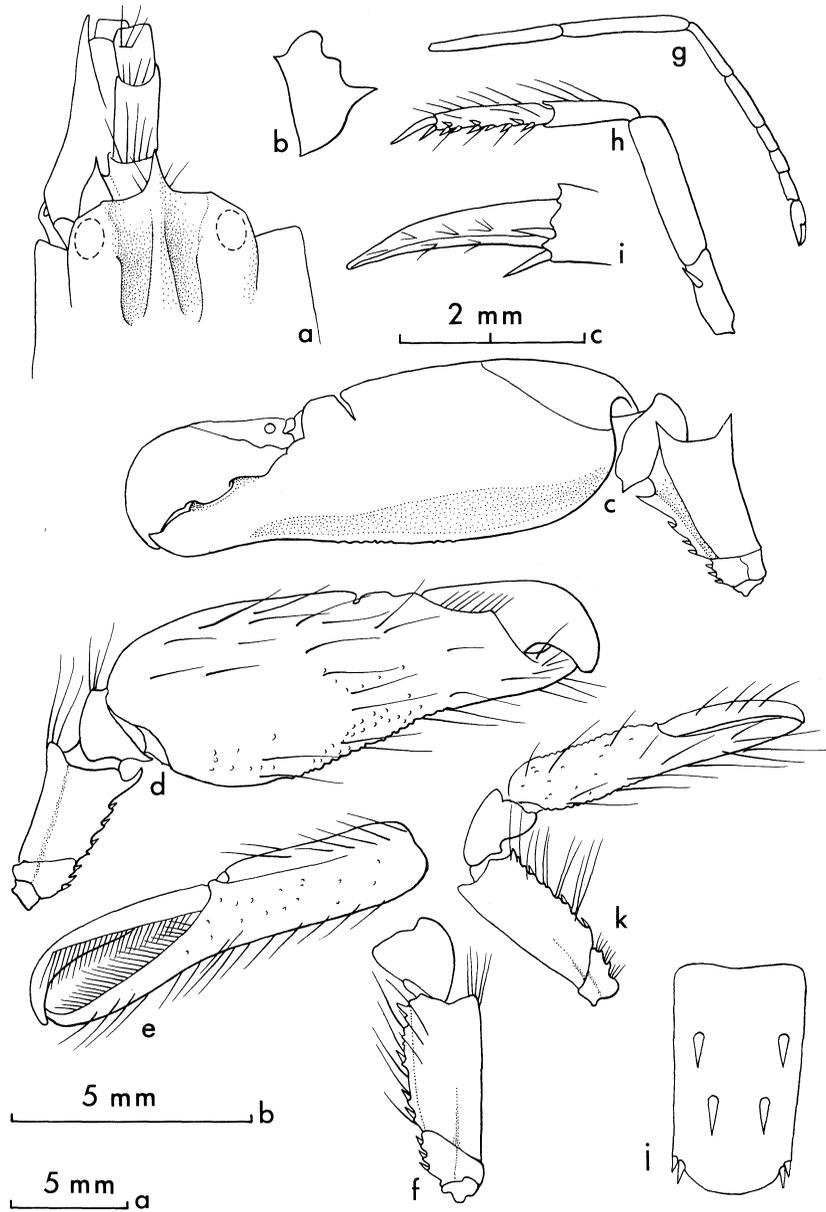


Fig. 42 *Alpheus novaezealandiae* Miers
 45 mm male from AM P. 9423. **a.** Anterior region, dorsal view; **b.** basicerite; **c, d.** large cheliped, lateral and medial face; **e, f.** small chela and merus, medial face; **g.** second leg; **h, i.** third leg and enlarged dactylus; **j.** telson. 50 mm female from AM 320. **k.** Small cheliped, medial face, c, d, e, f, g, h, k scale a; a, b, j scale b; i scale c.

type material).

Crangon novae-zealandiae Hale, 1927a:47, fig. 39; 1927b:308.

Previous Australian records:

Hale, 1927a. South Australia

Hale, 1927b. Baeres Pt., Kangaroo Is.

Specimens examined: 1 specimen from AM13 (AM P. 27528); 2, AM 230 (AM P. 27854); 1, AM 296 (AM 27883); 2, AM 320 (AM P. 28149); 2, AM 323 (AM P. 27355); 6, AM 325 (AM P. 27356); 1, AM 452 (AM P. 27855); 2, AM G. 4249; 1, AM P. 1542; 1, AM P. 1543; 1, AM P. 3662; 1, AM P. 4480; 1, AM P. 4760; 8, AM P. 4838; 6, AM P. 6102; 1, AM P. 9337; 1, AM P. 9423; 2, AM P. 11732; 1, AM P. 13557; 1, AM P. 13575; 6, BAU 5; 2, BAU 42; 1, BAU 55; 1, CS 44; 1, CS 45; 1, MM 204; 161, QV 1971-10-2, 4-13; 6, SM C-511; 4, MM 161; 3, SM C-514; 1, SM C-518; 1, SM C-1066; 1, TM G1102; 1, TM 12879/G52; 1, TM 16630/G425; 1 specimen each from VM 3-9; 33, VM 10; 2, VM 12; 1, VM 13; 6, VM 14; 1, VM 26S; 4, VM 984; 1, WM 23-65a; 1, WM 29-65; 2, WM 84-65; 1, WM 126-65; 1, WM 127-65; 1, WM 147-65; 1, WM 178-65; 1, WM 188-65; 1, WM 202-65; 1, WM 211-65; 3, WM 227-65; 1, WM 237-65; 1, WM 258-65; 1, WM 9522; 1, WM 12112.

DIAGNOSIS: Rostrum narrow, awl-shaped, reaching just beyond end of first antennular article, free portion somewhat rounded dorsally; portion from front edge of carapace to between eyes with parallel sides and flattened dorsally, posterior portion of base triangular and without carinae or knobs; margins overhanging grooves from near orbitorostral margin to posterior end. Orbital hoods inflated, rounded, but carrying crest also overhanging groove from posterior termination to mid-eye region; anterior to mid-eye region crest continues as sharp and well-demarcated, but not overhanging, curving laterally to form rounded vertical crest on anterior margin of orbital hoods; crest finally flowing into orbitorostral margin. Orbitorostral margin concave, orbitorostral grooves deep and with surface flattened. Visible part of first antennular article 0.5 as long as third article; second article 1.7 times longer than first and 1.7 times as long as broad. Distal margins and surface of antennular article beset with setae, distal margins of first and third article bearing short setiferous bristles. Stylocerite acute, reaching to end of first antennular article, also bearing setiferous bristles on lateral margins. Outer margin of scaphocerite concave, distal tooth directed inward at tip, reaching just past antennular article; squame moderately broad, reaching to near end of antennular peduncles. Carpocerite stout, 3 times as long as broad and as long as lateral tooth of scaphocerite. Basicerite with strong inferior tooth.

Large chela compressed, 2.8 times as long as broad, fingers occupying little more than distal third. Palm with narrow and deep transverse groove proximal to dactylus. Lateral face glabrous with longitudinal depression along lower margin arising near carpal articulation, disappearing near middle of pollex; superior margin of depression confluent with face; lower margin of depression separated from margin of palm by narrow to broad rounded crest. Superior margin of palm distal to transverse groove somewhat flattened. Internal face papillose and moderately setiferous. Dactylus compressed, rounded on superior margin, tip truncate and crossing pollex; plunger low. Carpus with rounded tooth projecting toward superomedial face of palm. Merus 1.5 as long as broad, not papillose, bearing on inferoventral margin 3 spines set on heavy protruding bases and bearing distally a strong curved and acute tooth. Ischium also bearing 3 spines on its inferoventral margin.

Small cheliped sexually dimorphic. Male chela 5 times as long as broad, fingers equal to palm. Palm papillose and setiferous on both faces, but less so on lateral face. Dactylus balaeniceps but not broadened, hairy crests not meeting on superior surface but nearly so. Tips of fingers crossing when closed, but cutting margins agape. Carpus cup-shaped, a little longer than that of large chela, bearing only one large rounded tooth on the distal

margin proximal to medial face. Merus 2.2 times as long as broad, similar to that of large chela. Small cheliped of female similar to that of male but not balaeniceps, and smaller in relation to the specimen than that of male.

Ratio of carpal articles of second legs; 10:10:3:3:5.

Ischium of third leg with spine. Merus inermous, 4 times as long as broad. Carpus 0.5 as long as merus with superior and inferior margins projecting distally as acute teeth. Propodus 0.7 as long as merus bearing on its inferior margin about 10 spines in an irregular row, and a pair of spines distally; superior margin bearing long fine setae. Dactylus 0.4 as long as propodus, trigonal, bearing tufts of short setae; inferior surface flattened but not excavate.

Telson about 2 times as long as broad at posterior margin, posterior margin nearly as broad as anterior margin and broadly arcuate. Posterolateral spines much smaller than dorsal spines.

DISCUSSION: The large chelae in the young specimens are not as papillose as the larger specimens, and the inferior margins are rounded, not knifelike. The small cheliped of the male is much larger in relation to the specimen than in the female. It is also noteworthy that on the anterolateral surface of the orbital hoods the exoskeleton is thin and transparent, providing a clear "window" through the hoods.

BIOLOGICAL NOTES: Their colour appears to be dark with white mottling, but variable. Hale (1927a:47) describes them as "...green, purplish or blue with white mottlings and spots; each branch of the uropods has a white marking on the upper side; the fingers of the large chela are tipped with orange, their outer margins are the same colour, and the inner margins are yellow." On the other hand, Yaldwyn noted with his collection (AM 325) a dark grey-green ground colour, with white mottling on body, but not on chelae, and with two purplish black spots on each side; he added that the legs were purple and the eggs brown.

In the intertidal zone this species has been collected under rocks; it has also been dredged as deep as 14 fathoms. In Jurien Bay the specimens were trawled at night above a stand of *Posidonia* grass. (BAU 5a) Dr. Gary Poore of the Fisheries and Wildlife Department in Melbourne reported that specimens of *A. novaezealandiae* collected at Port Phillip Bay (VM 984) came from cavities in the bases of clumps of the tunicate *Pyura stolonifera* but that the association "did not seem to be a commensal one" (personal communication).

Specimens in the collection ranged from 15-68 mm in length. (See *Alpheus* sp. following).

AUSTRALIAN DISTRIBUTION: Specimens have been collected on all coasts of Australia; in Western Australia from Albany to Exmouth Gulf; in the north from the Gulf of Carpentaria; in the east from Swains Reef to Sydney, and around the southern coast to St. Vincent's Gulf and Tasmania. One specimen came from Lord Howe Island.

GENERAL DISTRIBUTION: All records of this species have been from Australia and New Zealand.

Alpheus species

(= *Alpheus novaezealandiae* Miers, immature?)

Fig. 43

SPECIMEN DESCRIBED: a broken and incomplete female specimen, 10 mm long from Heron Island in the Capricorn group (BAU 54).

DIAGNOSIS: Rostrum slender, awl-shaped, reaching to last quarter of second

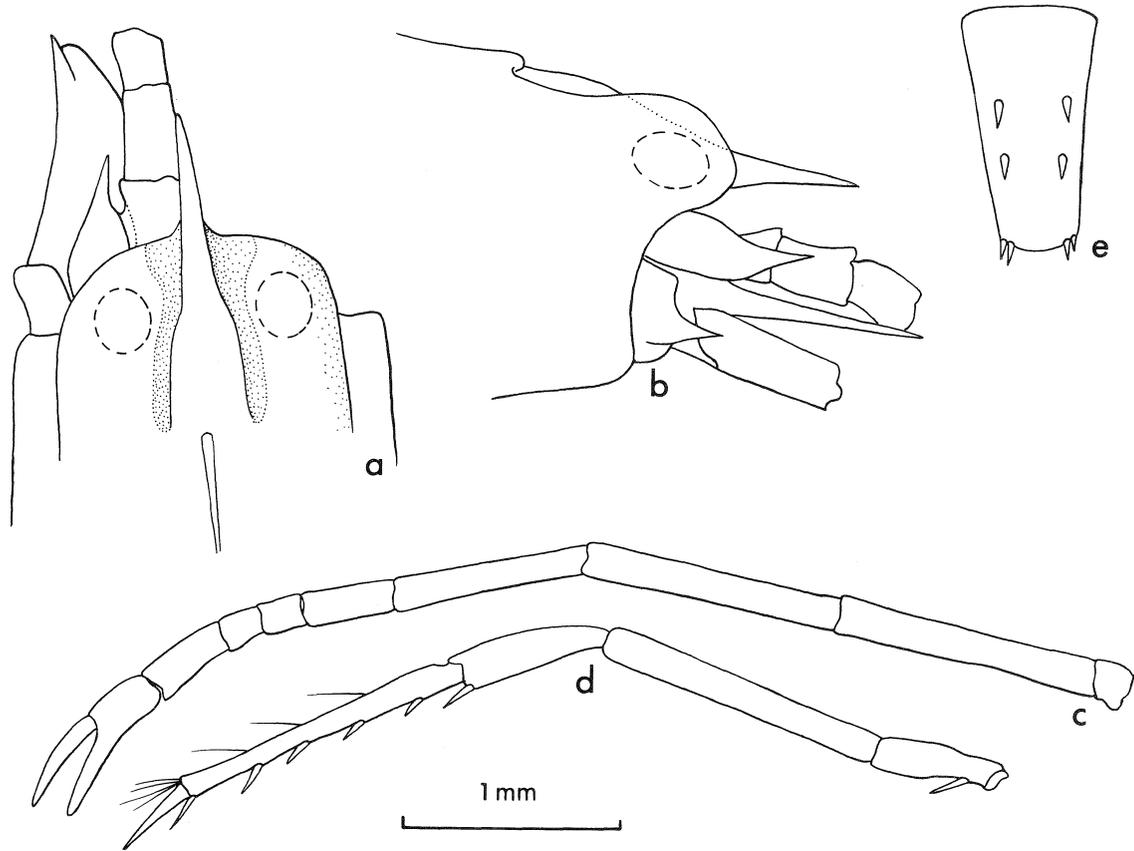


Fig. 43 *Alpheus* species
a, b. Anterior region dorsal and lateral view; c. second leg; d. third leg; e. telson. All figures same scale.

antennular article, free portion rounded dorsally, but flattening near margin of carapace; rostral base a narrow triangle expanding posterior to level of eyes, dorsally flattened with lateral margins overhanging orbitorostral grooves. At level of termination of rostral base lies a small rounded tubercle in midline that continues to mid-carapace as slight crest. Orbital hoods somewhat inflated, rounded with slight medial crest in position comparable to heavy overhanging crest of *A. novaezealandiae*; crest merging with anterior rounded vertical keel; keel of slight development. Orbitorostral margins not produced but flowing into margins of rostrum. Orbitorostral grooves deep, somewhat rounded. Visible part of first antennular article and third article subequal, second article a little longer, 1.7 times as long as broad. Stylocerite with prominent acute tooth that reaches to middle of second antennular article. Outer margin of scaphocerite concave, lateral tooth reaching to end of antennular peduncle, squamous portion a little shorter. Carapocerite reaching to middle of third antennular article.

Chelipeds missing.

Articles of the second legs with ratio: 10:5:2:2:4.

Ischium of third leg with spine, merus inermous, 8 times as long as broad. Carpus 0.5 as long as merus, superior margin projected as an obtuse tooth distally, inferior margin not projected distally but bearing a slender spine. Propodus slender, as long as merus, bearing on its inferior margin 4 spines and a pair distally. Dactylus simple, slender, 0.3 as long as propodus.

Telson 3 times as long as posterior margin is broad. Anterior pair of dorsal spines placed anterior to the middle.

DISCUSSION: We are cautious about this sole specimen because it is small, probably immature, and in poor condition. While obviously related in the form of the rostral base and orbital hoods to other species in the *Diadema* Group it differs from these other species by its long rostrum, the long stylocerites and the presence of a movable spine on the carpus of the third legs.

We are reminded of the small specimen we described as *Crangon* (= *Alpheus*) *latipes* (1953:82) which was later found to be a juvenile stage of *A. lottini* Guérin (Banner, 1958:164). In this small specimen the most distinctive characteristics of *A. lottini* were absent — the flattened rostral base, the hoof-like dactylus of the third legs, even the proportions of the appendages. We suggest, therefore, that perhaps this present specimen may be an early stage in the development of the common and much larger *A. novaezealandiae*; the smallest specimen in the collection we could identify as *A. novaezealandiae* was 15 mm long. This suggestion is based primarily upon the form of the rostral base and the presence of crests on the orbital hoods which in the same location are the strong crests of the mature *A. novaezealandiae*. However, in addition to the three differing characteristics listed above, the specimen also differs from *A. novaezealandiae* in the mid-dorsal tubercle and crest on the carapace, in the relative proportions of the first and second carpal articles of the second legs. It also has a more narrow and tapering telson and lacks the setae on the antennular peduncles. These differences may all be from immaturity, or this may be an immature stage of some yet undescribed species. This specimen was collected within the same depth range of *A. novaezealandiae*.

BREVIROSTRIS GROUP

Orbital teeth lacking; orbital hoods often prominent. Large chela always

compressed, more or less quadrangular in section often with faces demarked by noticeable angles; with or without transverse groove proximal to dactylus. Small chela of males at times balaeniceps. Third legs with merus usually unarmed, dactylus always simple, at times flattened and subspatulate.

The species in this group are found characteristically in burrows of their own construction in silty to silty-sandy bottoms, often in quiet estuarine conditions or in the mud of deeper bottoms where they are gathered in commercial shrimp trawls. They are seen using their chelae as bulldozer blades to shove the finer sediments from their burrows, but carry the small pebbles out individually. Some species live commensally in their burrows with gobiid fishes (see p. 182). In some species may be found some of the largest individuals reported in the family.

Chace (1974:67) has suggested that some of the variable Indo-Pacific species in the Brevirostris Group should be compared to some equally variable species known from the Atlantic, such as *A. floridanus* Kingsley, to determine if they might not be one or several species of circumtropical distribution. While there is much merit in Dr. Chace's suggestion we have not done so in this paper as we lack the Atlantic species for comparison (see discussion under *A. djiboutensis* De Man, p. 180).

***Alpheus acutocarinatus* De Man**

Fig. 44

Alpheus acutocarinatus De Man, 1909a:104; 1911:401, fig. 94. Banner and Banner, 1966b:120, fig. 43.

SPECIMENS EXAMINED: 1 specimen from UQ 13; 2, UQ 18.

DIAGNOSIS: Rostrum acute, longer than broad at base; tip reaching just past middle of visible part of first antennular article; rostral carina sharp and interrupted well posterior to orbital hoods by a tooth and continuing to posterior third of carapace. Orbital hoods strongly inflated forming deep orbitorostral grooves. Second antennular article 4.5 times as long as wide, almost twice as long as visible part of first article and 3 times as long as third article. Stylocerite acute, not reaching end of first antennular article. Scaphocerite narrow, lateral tooth reaching to near middle of third antennular article, squamous portion almost equal to lateral tooth; outer margin slightly concave. Carpocerite reaching to end of second antennular article.

Ratio of articles of third maxilliped: 10:3:5. Inner distal margin of second article bearing tuft of long hairs that slightly surpasses third article.

Large chela oval in section, only moderately compressed, 6.0 times as long as broad, fingers occupying distal 0.3, plunger of dactylus minimal. Superior and inferior margins bearing long, fine, forward-sweeping hairs. Surface of chela lightly granular. Carpus cup-shaped, 0.2 as long as chela. Merus slender, almost 5.0 times as long as wide, inferointernal margin bearing acute tooth distally and one strong spine slightly proximal to middle; surface of merus more granular than chela, margins rough and irregular.

Small chela nearly as long as large chela but more slender. According to De Man (1911:403) small chela sexually dimorphic with elongate dactylus in males only slightly shorter than palm and balaeniceps; in the females in this collection the dactylus was normal and subequal in length to palm; chela in both males and females 9 times as long as broad, with palm oval in section and bearing long, forward-sweeping hairs on margins; surface less granular than that of large chela. Merus similar to large cheliped.

Carpal articles of second legs with the ratio: 10:10:5:5:4.

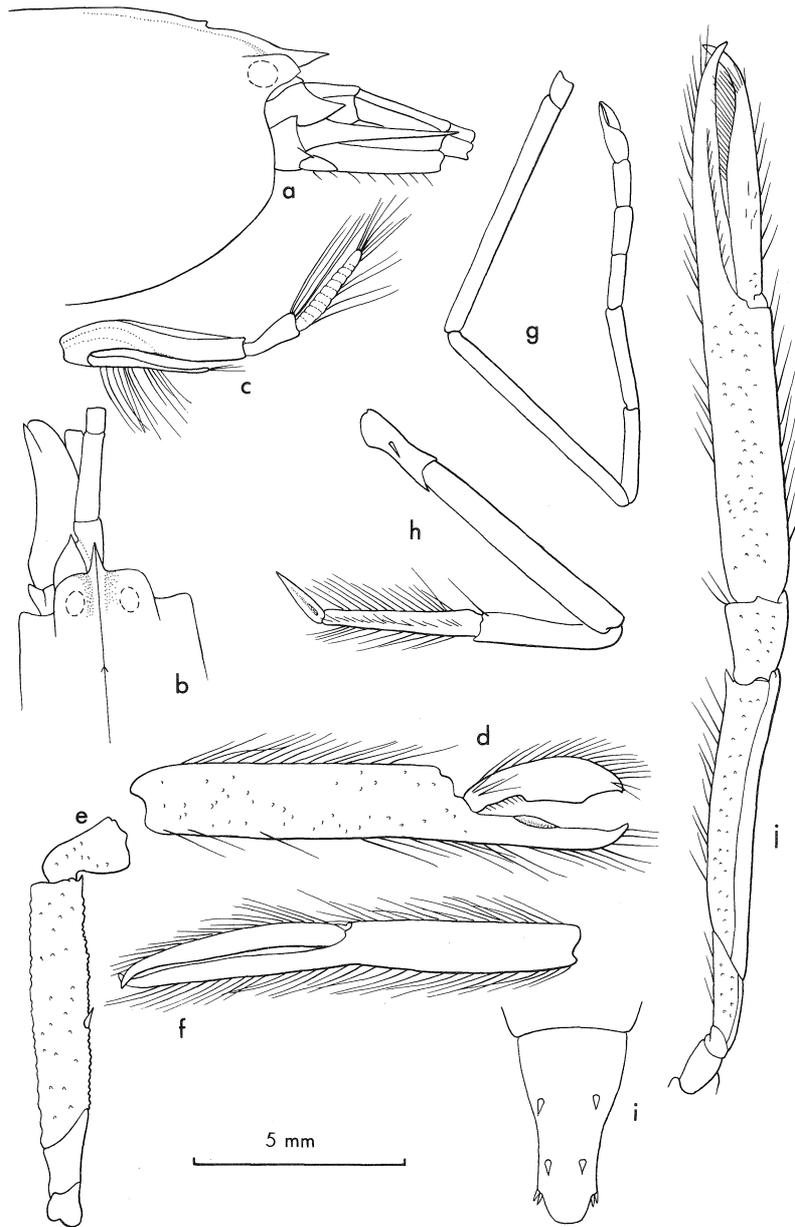


Fig. 44 *Alpheus acutocarinatus* De Man
 35 mm female from UQ 18. **a**, **b**. Anterior region, lateral and dorsal view; **c**. third maxilliped; **d**, **e**. large chela and merus, medial face; **f**. small chela, medial face; **g**. second leg; **h**. third leg; **i**. telson. After De Man, 1911, fig. 94D. **j**. Cheliped of male. All drawings same scale except **j**.

Ischium of third legs bearing small spine. Merus inermous, 8 times as long as broad. Carpus 0.5 as long as merus, superior margin projected as an obtuse tooth. Propodus 0.6 as long as merus, inferior margins without spines, but both superior and inferior margins bearing long fine setae; two other rows of short setae on flattened faces, parallel to margins. Dactylus 0.4 as long as propodus, spatulate, slightly excavate on its inferior surface.

Telson elongate, 3.3 times as long as posterior margin is wide, 1.9 times as wide anteriorly as posteriorly; lateral margins concave; strongly arcuate tip extending by 0.15 of total telson length beyond small posterolateral spines.

DISCUSSION: We have compared our specimens to De Man's holotype in the Zoologisch Museum in Amsterdam and find only one slight difference. The third leg on our 3 specimens had a merus that was 9 rather than 8 times as long as broad. De Man noted, but failed to show, the ischial spine on the third leg; it is present in the holotype as well as the Australian specimens. The extent of variation in this species cannot be projected from the 8 specimens ever reported.

BIOLOGICAL NOTES: The specimens from Moreton Bay were from 10 fathoms and De Man's 5 specimens were dredged from 26-72 m. He reported them from muddy bottoms and presumably the habitat in Moreton Bay was similar. The Thai specimens were also dredged and probably from sandy-to-muddy bottoms.

AUSTRALIAN DISTRIBUTION: The only record is from Moreton Bay, Queensland.

GENERAL DISTRIBUTION: Indonesia and Gulf of Thailand.

Alpheus stephensoni Banner and Smalley

Figs. 45, 46

Alpheus stephensoni Banner and Smalley, 1969:43, fig. 2.

Previous Australian records:

Banner and Smalley, (*loc cit.*). Moreton Bay, Qld.

SPECIMENS EXAMINED: 1 specimen from AM P. 12927; 1, AM P. 12936; 1, QM W 2238; 1, UQ 27; 21, UQ 30; 32, UQ 31; 39, UQ 32; 3, UQ 34; 1, VM 23.

DIAGNOSIS: "Rostrum acute, awl-shaped, reaching past end of first antennular article. Rostral carina pronounced, knife-edged, disappearing abruptly at 0.4 length of carapace. Orbital hoods inflated, forming moderately deep grooves between hoods and high rostral carina. Orbitorostral area set off distinctly from lateral regions of carapace, more narrow in relation to carapace than usual for *Alpheus*. Carapace covered with small bosses. Second article of antennular peduncle 3 times as long as broad. Visible part of first antennular article and third article sub-equal, first article about one-third as long as second. Lateral margins of antennular peduncles beset with dense, fine hair. Antennular flagella somewhat shorter than body length; antennal flagella somewhat longer than body. Lateral margin of scaphocerite straight, lateral spine only slightly longer than squamous portion. Squamous portion narrow distally. Carpocerite reaching to end of second antennular article, antennae long, often as long as entire shrimp. Stylocerite acute, reaching to end of first antennular article, lateral margin fringed with fine hairs. Basicerite with strong lateral spine. Tip of third maxilliped reaching beyond end of antennular peduncles when extended.

"Large chela compressed, 3.7 times as long as broad. Palm covered with small bosses, less abundant near distal end; superior margin rounded, bearing towards the

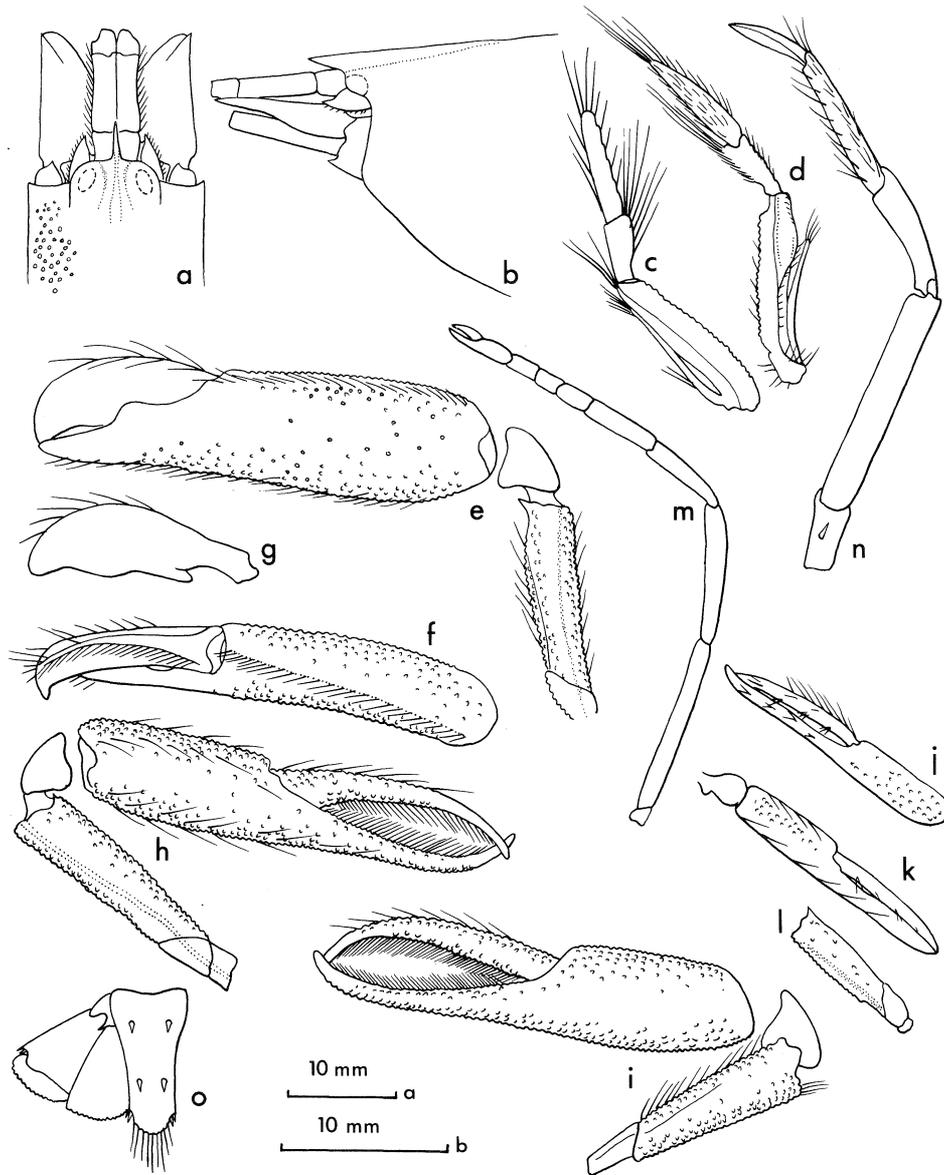


Fig. 45 *Alpheus stephensoni* Banner and Smalley

a, b. Anterior region, dorsal and lateral view; **c, d.** third maxilliped, lateral and medial face; **e.** large cheliped, medial face; **f.** large chela, superior face; **g.** dactylus of large chela, medial face; **h, i.** small cheliped, male, medial and lateral face; **j, k.** small chela, female, medial and lateral face; **l.** merus small chela, female, medial face; **m.** second leg; **n.** third leg; **o.** telson and uropods. **a, b, e, f, g, h, i, j, k, l** scale **a**; **c, d, m, n, o** scale **b**. (Figures from 70 mm male holotype and 64 mm female. After Banner and Smalley, 1969, fig. 2 with the exception of figure **g**).

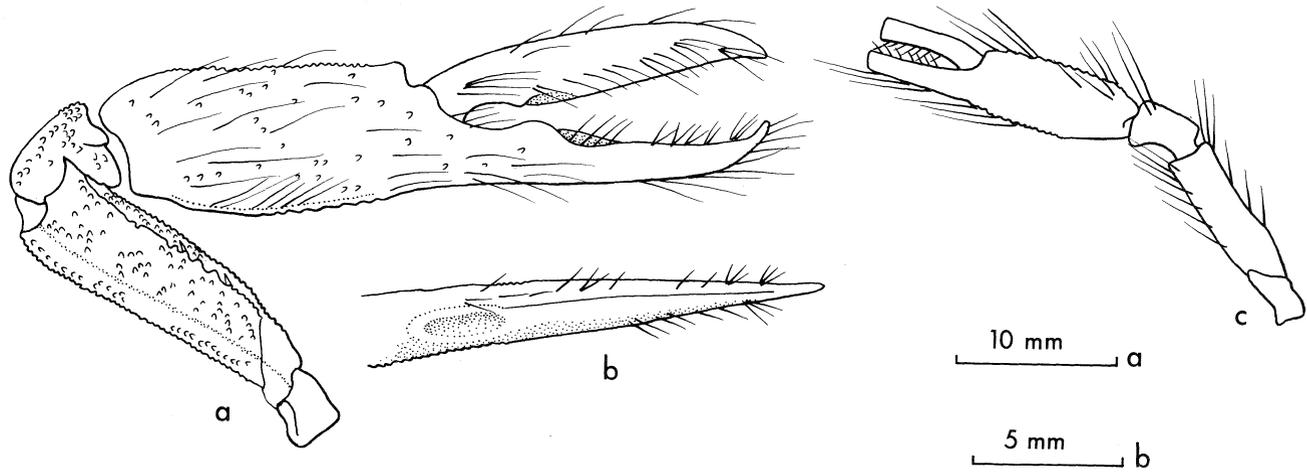


Fig. 46 *Alpheus stephensoni*, regenerating chelae
75 mm male from AM 347. **a.** Large cheliped, medial face; **b.** view of opposite face of pollex
showing developing socket; **c.** small cheliped (fingers broken). a, c scale a; b scale b.

inner face a row of forward-sweeping hairs; inferior margin flattened and bearing rows of hairs similar to superior margin; inner face flat; outer face a little rounded toward the superior margin but longitudinally slightly grooved near the inferior margin; groove not extending into finger. Dactylus 0.38 as long as entire chela, superior margin slightly flattened bearing a row of fine setae on inner margin of flattened portion. Fingers slightly crossing; surfaces with a few long setae, but no bosses. Merus 3.7 times as long as broad, surface covered with small bosses. Distal end of superior margin not armed, inferior internal margin bearing row of fine hairs, distal end with strong acute tooth. Inner face bearing a shallow longitudinal groove near superior margin. Large chela of female slightly smaller than male chela.

"Small chela of male highly compressed, 4.8 times as long as broad, entire surface covered with small bosses. Fingers only slightly longer than palm. Inner face of chela beset with forward-sweeping hairs, superior and inferior margins rounded. Superior margin of dactylus with sharp crest. Fingers bearing dense fringe of setae along lateral margins of opposing faces. Fingers gaping, tips crossing. Merus 3.6 times as long as broad, surface covered with small bosses. Inferointernal margin bearing fine hairs, distal end armed with pronounced tooth. Inner face bearing a narrow longitudinal groove near superior margin, similar to groove on merus of large chela.

"Small chela of female highly compressed, about one-third as large as that of male, 6.5 times as long as broad, fingers a little longer than palm. Dactylus slightly shorter than fixed fingers. Fingers with patches of short stiff setae near opposing surfaces, but no fringe of setae as found in male. Palmar surface with bosses similar to large chelae. Inner face partially covered with forward-sweeping setae set into superior and inferior margins. Merus similar to that for large chela with tooth on inferodistal margin and a slight narrow groove longitudinally near the superior margin.

"Carpal articles of second leg with ratio: 10:8:3:3:3.

"Ischium of third leg with small spine. Merus 6 times as long as broad, unarmed. Carpus almost half as long as merus. Propodus 0.6 as long as merus, without movable spinules but with 3 longitudinal rows of stiff setae. Dactylus spatulate, 0.3 as long as merus.

"Telson 3.2 times as long as posterior margin is broad. Posterior margin strongly arcuate with rounded tip extending well beyond lateral spines." (Original description).

DISCUSSION: The variation in this species is discussed in the 1969 paper.

The chelae on the 75 mm male specimen from AM 347 are anomalous (fig. 46). The large chela is 2.8 times as long as broad, with the fingers slightly longer than the palm; the socket of pollex is well demarked and relatively deep, but the plunger of the dactylus is only slightly developed and cannot reach the bottom of the socket. The distal portions of the fingers carry knife-like edges, meeting only in the middle third and gaping in the distal third; tips curved and crossing. The large chela is covered with rounded bosses and hairs. The small chela is simple with distal portion of fingers broken off; the fingers, where broken, are oval in section with oppositive faces slightly angular and bearing rows of short stiff setae that cross. The palm is relatively smooth and bears only slightly developed rows of setae. Otherwise the specimen falls well within the range of variation of *A. stephensoni*. We were originally going to give the specimen a separate description as a questionable *A. stephensoni*, but Dr. John C. Yaldwyn has suggested to us that it was likely that the specimen had lost its large chela and was in a series of moults in which the small chela was changing to the form of the large chela and the regenerating chela was being transformed into a normal small chela. This phenomenon is well known, but

seldom have we seen chelae of such intermediate development.

BIOLOGICAL NOTES: This species has been largely caught in shrimp trawls in water up to 10 fms. It has been caught especially at night and seems to be more abundant in the summer months. Specimens caught in early spring often are heavily encrusted with hydroids and tube worm cases. All alpheids caught on muddy grounds east of Redcliffe, Qld. are likely to be this species.

"The carapace is blue-green dorsally; rostral carina is brown. Abdomen olive dorsally, and often red laterally; along lower edges of pleura is a white band continuous with the white branchiostegites. Tergum markings usually include brown transverse band along posterior edge of each tergum, various small colourless patches assuming bilateral symmetry, and a medial colourless line on anterior of first tergum and on sixth tergum continuing posteriorly on telson. Telson also with two white patches proximally and a white spot around base of each of the four spines.

"Antennules and antennae mostly brown, but blue-green at bases. Inner faces of large and small chelipeds with proximal ends of fingers, palm, and carpus, and distal end of merus all olive mottled on pale pink background, but for blue inferior internal edge of palm; most of fingers blue over pale pink with extreme tips white. Outer faces of chelae purplish or pink. Uropod reddish with blue and brown borders. Other appendages red distally, white proximally." (Colour notes by Smalley, *loc. cit.*.)

AUSTRALIAN DISTRIBUTION: This species has been reported in eastern Australia from Bundaberg, Qld. to Port Jackson, N.S.W.

GENERAL DISTRIBUTION: This species has never been reported out of Australia.

***Alpheus distinguendus* De Man**

Fig. 47

Alpheus distinguendus De Man, 1909b:155, pl. 7, figs. 9-14. Banner and Smalley, 1969:47, fig. 3.

Alpheus rapax De Haan, 1850:177, pl. 45, fig. 2.? Bate, 1888:552, pl. 99, fig. 1. De Man, 1888b:264; 1892:404. Ortmann, 1890:481. Nobili, 1903:7. (Nec Fabricius, 1798.)

? *Alpheus brevirostris* De Man, 1907:427, pl. 33, figs. 51, 52.

? *Alpheus digitalis* De Haan, 1850:178, pl. 45, fig. 4. Coutière, 1898h:249, fig. 2 (= *A. rapax* De Haan).

Previous Australian record:

Banner and Smalley, *loc. cit.* Moreton Bay, Qld.

SPECIMENS EXAMINED: 1 specimen from AM 99 (AM P. 27771); 1, AM 125; (AM P. 27530); 1, AM 148; (AM P. 27869); 1, AM 354; (AM P. 27536); 1, AM P. 14630; 1 each from CS 50, 51; 1, MM 355; 1, QM W 2381; 1, UQ 17; 1, UQ19, 1, UQ 20; 32, UQ 28; 20, UQ 29; 1, UQ 33; 1, WM 134-65; 1, WM 162-65; 1, WM 199-65; 2, WM 237-65; 1, WM 241-65; 1, WM 242-65; 5, WM 284-65; 1, WM 131-76.

DIAGNOSIS: Rostrum awl-shaped, reaching to near end of first antennular article. Dorsal carina high and narrow, extending into carapace beyond orbits. Eye hoods inflated, forming broad deep grooves between eye hoods and dorsal carina. Visible part of first antennular article equal to third. Second article 3 times as long as third article and 3 times as long as wide. Stylocerite reaching to end of first antennular article, acute tip not

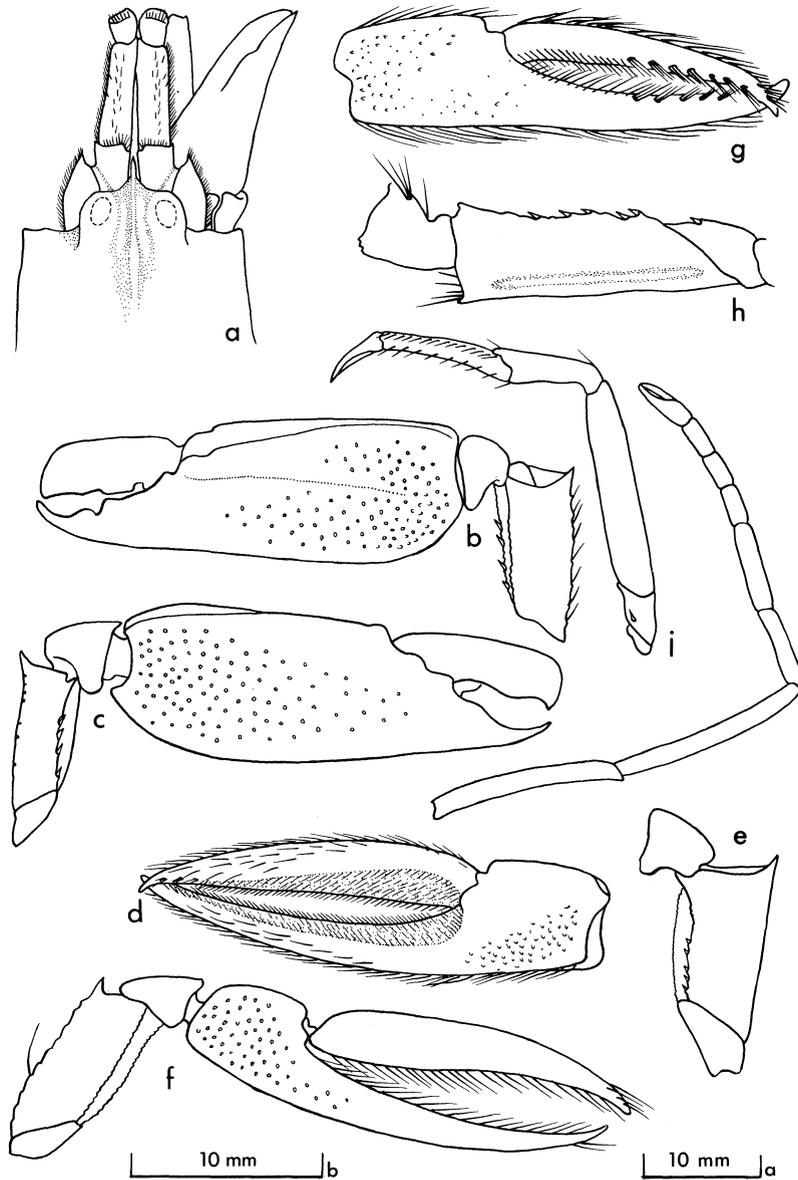


Fig. 47 *Alpheus distinguendus* De Man
a. Anterior region, dorsal view; **b, c.** large cheliped, lateral and medial face; **d, e.** small chela and merus, medial face; **f.** small cheliped, lateral face; **g, h.** small chela and merus, female, medial face; **i.** second leg; **j.** third leg. **a, b, c, d, e, f, h, i, j** scale a; **g, h** scale b. (Figures of 74 mm male and 70 mm female. After Banner and Smalley, 1969, fig. 3.)

directed medially, lateral margin of stylocerite and antennules beset with row of dense, fine setae. Scaphocerite with outer margin slightly concave, reaching well beyond antennular peduncle with tip of lateral tooth slightly longer than squamous portion. Carpopocerite as long as antennular peduncle. Basicerite bearing small acute tooth.

Large chela compressed, 3 times as long as wide, with fingers occupying distal 0.3. Superior margin without transverse groove, but bearing along its entire length a flattened angled slant toward the outer face at the distal end of palm. Inner edge of flattened area bearing fine hairs directed forward. Lateral face bearing a diffuse longitudinal ridge about the middle of the face. Medial face flat. Inferior margin of chela knife-like, and bearing fine hairs directed forward along its entire length. Entire chela bearing fine bosses. Merus 2.7 times as long as broad. Superior margin terminating in an acute tooth. Inferoexternal margin lightly serrate and bearing 4 movable spinules, terminating distally in an acute tooth. Inferoexternal margin without spinules, but bearing fine serrations along margin.

Small chela of male slender, 4.5 times as long as wide, palm covered with minute bosses. Fingers 2.8 times as long as palm, fingers crossing at tips. Dactylus longer than fixed finger. Opposing margins of fingers bearing brush of forward directed hairs. Outer faces of fingers show gape only near distal end when closed, but inner face shows wide arched gape along its entire length giving an excavate appearance. Opposing faces of fingers heavily hirsute. Merus similar to that of large chela.

Small chela of female about half the size of male small chela. Fingers 1.7 times as long as palm, fingers slightly gaping, crossing at tips. Opposing margins bearing slight row of criss-cross hairs. Patches of setae on lateral margins of fingers. Superior and inferior margin carrying long fine, forward-sweeping hairs. Merus similar to that for male but slightly more slender.

Ratio of carpal articles of second leg: 10:10:5:4:4.

Ischium of third legs with spine. Merus 7 times as long as wide, without spines. Carpus half as long as merus; propodus a little longer than carpus, bearing 2 rows of short hairs on its lateral face and inferior margin. Dactylus 0.5 as long as propodus, spatulate.

Telson 2.5 times as long as posterior margin is broad, proximal margin 1.5 times wider than distal. Distal margin broadly rounded. (Description modified from Banner and Smalley, *loc. cit.*).

DISCUSSION: When we redescribed *A. distinguendus* from specimens from Australia in 1969 we suggested that the overhang of the pollex of the dactylus of the small chela of the male might separate the Australian form from the Japanese form, the type locality. (The differences in finger length appearing in fig. 47d,f are the result of differing angles of view.) Since that time Dr. Yasuhiko Miya of the Institute of Biology, Nagasaki University, Japan has informed us that the specimens in Japan also have the overhanging dactylus (personal communication). The variation in the length-breadth ratio of the chelae that Miya found was also similar to that found in the Australian specimens.

After over 20 years of study during which time he was trying to separate various authors' use of the names *A. brevirostris* (Olivier) and *A. rapax* Fabricius, De Man came to the conclusion that almost all of the specimens he had placed under *A. brevirostris* were in actuality a different species to which he gave the name *A. distinguendus*. As we indicate under *A. brevirostris*, we have sincere doubts about the validity of this separation, but are continuing to use part of De Man's separation between the two nominal species.

Coutière after studying the specimens of De Haan from Japan, reported (1898h) that

A. digitalis De Haan, whose distinguishing characteristic was a strange large chela that Coutière decided was an anomalous form due to regeneration, was the form that De Haan had named *A. rapax* Fabricius (1850:177), but that De Haan's *A. rapax* was actually *A. brevisrostris* (Olivier). Later, De Man (1909b:155) in his reconsideration of the *Brevirostris* Group, stated that De Haan's *A. rapax* and part of the specimens Coutière considered to be *A. brevisrostris* belonged to his, De Man's, new species, *A. distinguendus*. Presumably, therefore, *A. digitalis* is a synonym of *A. distinguendus*, but this synonymy was never listed by De Man.

BIOLOGICAL NOTES: The specimens discussed in 1969 (*loc. cit.*) from Moreton Bay as well as most of the abovementioned specimens were caught in prawn trawls in less than 20 fathoms. Miya reports that specimens from Japan are caught on summer nights in prawn trawls, further he stated that in "... Hakata Bay, Fukuoka City, they are caught with the mantis shrimps *Oratosquilla oratoria* (De Haan)..." (Personal communication). The collecting notes indicated in the Australian specimens that they are commonly found in brackish water at the mouth of rivers. This species appears to live on the bottom or slightly above it. One 54 mm specimen from the Gulf of Carpentaria (AM 345) had an abnormal growth on the carapace giving it a "furry" appearance. The growth was tentatively identified by Dr. Michael Hadfield of the University of Hawaii as the bryozoan, *Triticella* sp. This genus is known to be attached to the exoskeleton of crustaceans (see: Hyman, 1959:431), but we previously have not seen any alpheids with this epizoic. In life the shrimp is green to brown dorsally, colourless to pale blue laterally, with longitudinal streaks on abdomen; tips of chelae orange to pink; legs lighter in colour (for full colour notes see Banner and Smalley, *loc. cit.*). Our specimens range up to 80 mm in length.

AUSTRALIAN DISTRIBUTION: This species has been collected in Western Australia from near Perth to Shark Bay and Kuri Bay in northwestern Australia; in northern Australia in the Gulf of Carpentaria and in eastern Australia from Cooktown, Qld. to Botany Bay, N.S.W.

GENERAL DISTRIBUTION: Mergui Archipelago; Singapore; China; Japan. (De Man was of the opinion that many of the earlier records of *A. rapax* Fabricius were actually *A. distinguendus*. As there can be no way to retroactively sort them, we have ignored them here. The range, therefore, may be much broader).

***Alpheus rapacida* De Man**

Fig. 48

Alpheus rapacida De Man 1908:105; 1911:394, fig. 91. Barnard, 1950:750, figs. 142 a-f. Tiwari, 1963:302, fig. 21, 22. Lewinsohn and Holthuis, 1964:47, fig. 1. Banner and Banner, 1966b:118, fig. 42.

Alpheus rapax Bate, 1888:552, pl. 99, fig. 1. (*Nec* Fabricius, 1798.)

SPECIMENS EXAMINED: 2 specimens from AM 149; (AM P. 27553); 2, AM 288; (AM P. 27880); 1, JR 9; 2, UQ 1; 1 UQ 15; 1, UQ 16; 1, UQ 26; 2, WM 244-65.

DIAGNOSIS: Rostrum acute, reaching almost to end of first antennular article, with carina that extends almost to middle of carapace; anteriorly knife-like, posteriorly carina broader and rounded. Orbitorostral grooves deep with flattened bottoms. Visible part of first antennular article and third article subequal, second article 3 times as long as third and 3.5 times as long as broad. Outer margins of first and second article and stylocerite beset with setiferous bristles. Stylocerite acute, reaching to end of first antennular article. Outer margin of scaphocerite slightly concave; squamous portion narrow, reaching length of third article past antennular peduncle, lateral tooth a little longer. Carpocerite

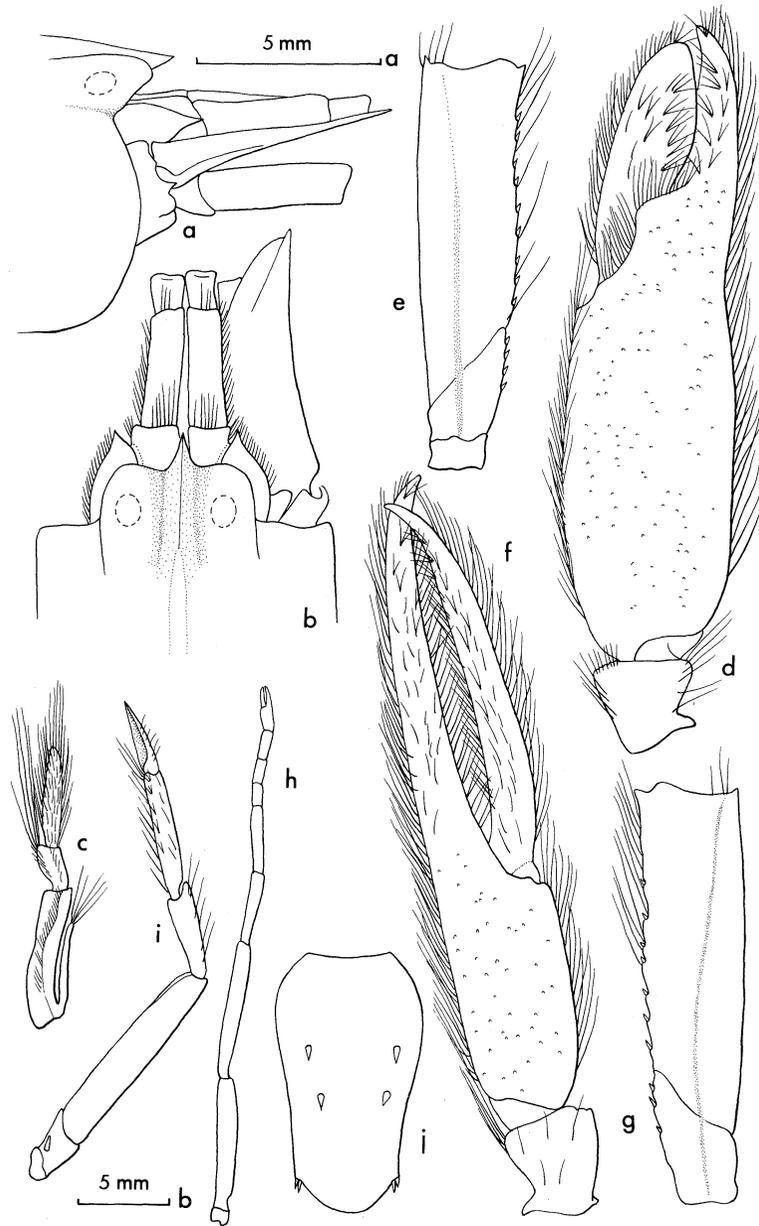


Fig. 48 *Alpheus rapacida* De Man
 57 mm female from AM 288. **a, b.** Anterior region, lateral and dorsal view; **c.** third maxilliped, medial face; **d, e.** large chela and merus, medial face; **f, g.** small chela and merus, medial face; **h.** second leg; **i.** third leg; **j.** telson. a, b, c, d, e, f, g, j scale a; h, i scale b.

reaching to middle of third antennular article. Basicerite with small acute tooth on inferior margin.

Ratio of articles of third maxilliped: 10:3:7. Inferodistal margin of second article bearing patch of long setae most of which surpass tip of distal article. Tip of distal article bearing long setae. Third maxilliped exceeds length of antennules by half length of distal article.

Large chela compressed, 4 times as long as broad with fingers occupying distal 0.4. Upper margin of palm with flattened area, not cut by a transverse groove; medial margin of area carrying a row of long, forward-sweeping bristles; outer margin with row of sparsely set shorter hairs. Inferior margin thin but rounded bearing a row of setae directed anterolaterally. Entire surface of palm and proximal section of propodal finger granular. Dactylus smooth, superior margin carinate, tip truncate and slightly shorter than pollex. Plunger of dactylus of minimal development. Carpus short, slightly granular and sparsely hirsute. Merus 3.4 times as long as broad, surface slightly granular. Superior margin bearing obtuse tooth distally; inferointernal margin dentate, bearing a number of small spines and an acute tooth distally. Inferior margin of ischium also bearing a few small spines. Medial surface of both merus and ischium with narrow, deep, longitudinal groove located slightly superior to middle.

Small chelae of males and females similar, about as long as large chela, without ridges or grooves, 5.3 times as long as broad, fingers 1.8 times longer than palm. Inferior and superior margin bearing long forward sweeping hairs similar to large chela; surface of fingers bearing sparsely set, short, stiff setae. Opposing edges of fingers beset with short forward-sweeping hairs that cross in middle. Tips of fingers cross when closed, leaving a gape proximally. Merus similar to that of large chela.

Ratio of articles of second leg: 10:10:3:3:3.

Ischium of third leg with spine. Merus inermous, 5 times as long as broad. Carpus 0.4 as long as merus, superior margin projected slightly as a rounded tooth. Propodus 0.6 as long as merus, without spines on inferior margin, but with row of long setae; a second row of setae on lateral face with short and stiff bristles set in groups of 2 or 3; superior margin bearing similar bristles, but set singly. Dactylus spatulate and more than 0.4 length of propodus.

Telson 2.5 times as long as posterior margin is broad. Posterior margin arcuate, projecting far behind posterolateral spines. Anterior pair of dorsal spines set well anterior to middle.

DISCUSSION: The Australian specimens differ from De Man's in the following characters:

1. The rostrum reaches to near the end of the first antennular article instead of the middle.
2. The second antennular article is much longer in relation to the first and third with a ratio of 10:30:10 instead of De Man's ratio of 10:12:6.
3. The third maxillipeds reach beyond the antennules in our specimens instead of equal as in De Man's.

In addition, specimens in our collections from Hawaii and Madagascar have a slight transverse groove behind the dactylus of the large chela, a condition not noted in the Australian specimens. This seemed also to be indicated in Tiwari's figure of a specimen from Vietnam.

The first three differences were remarked upon by Lewinsohn and Holthuis (*loc. cit.*) with specimens from Israel and by Tiwari with his specimens from Vietnam; we find the same from Hawaii. We do not attach importance to any of these differences. We should remark that the condition of the large chela shown in figure 48d in which the dactylus is shorter than the pollex is not common.

We have examined the specimen from Hong Kong collected by the Challenger Expedition at the British Museum (Natural History) and identified by Bate as *A. rapax*, who probably based his identification upon De Haan's figure of what he, De Haan, thought was that species. Later, when De Man separated *A. rapax* Fabricius from the form De Haan had described, giving De Haan's form the name *A. distinguendus*, he did not know what to do with Bate's reference so merely listed it "??*Alpheus rapax* Spence-Bate" in the synonymy of *A. distinguendus*. The only difference between Bate's specimen and *A. rapacida* was the very long lateral spine of the scaphocerite as shown in his figures; our examination of the specimen shows the drawing to be inaccurate and we find this specimen to be *A. rapacida*.

BIOLOGICAL NOTES: This species appears to be a form that burrows in sandy to muddy bottoms. It has been collected as deep as 56 m. The specimens in our collections from Hawaii were from the intertidal region and were found in association with the gobiid fish *Psilogobius mainlandi* Baldwin. Dr. Randall of the Bishop Museum, Honolulu, Hawaii, caught this species in 2 metres of water near One Tree Island, Great Barrier Reef, in association with an, as yet to be identified, goby. We have no colour notes from Australian specimens but the specimens we have from Hawaii are almost transparent with widely dispersed red stellate chromatophores. The lateral margins of the carapace are delicately coloured with a shifting band of rainbow colours and the anterior portion of the carapace carry a sprinkling of lemon-green pigment spots. The eyes are pale violet and the eggs green. When a living specimen is twisted in the light the whole animal displays a delicate iridescence. Our largest Australian specimen is 57 mm in length.

AUSTRALIAN DISTRIBUTION. We have specimens from Shark Bay in Western Australia; in northern Australia from the Gulf of Carpentaria and from eastern Australia from One Tree Island in the Capricorn Group to Yamba, N.S.W.

GENERAL DISTRIBUTION: South Africa; Red Sea; Mediterranean coast of Israel (a migrant species through the Suez Canal — Steinitz, 1967:167); Singapore; Thailand; Vietnam; Indonesia and Hawaii.

***Alpheus barbatus* Coutière**

Fig. 49

Alpheus barbatus Coutière, 1897a:235; 1899: fig. 279, 280. De Man, 1911:387, fig. 88.

SPECIMENS EXAMINED: 1 specimen from AM P. 4103; 1, AM P. 5573.

DIAGNOSIS: Rostrum short, obtusely triangular, not reaching middle of visible part of first antennular article. Slight rostral carina reaching to posterior margin of orbital hoods; orbitorostral grooves shallow. Antennules stout, articles nearly equal in length, second antennular article only a little longer than broad. Stylocerite rounded distally, reaching near end of first antennular article. Scaphocerite with lateral tooth broad and straight, reaching well past end of antennular peduncles, squamous portion reaching just past end of peduncles. Carpocerite stout, 2.7 times as long as broad viewed laterally, reaching well past end of lateral tooth of scaphocerite. Basicerite without inferior tooth.

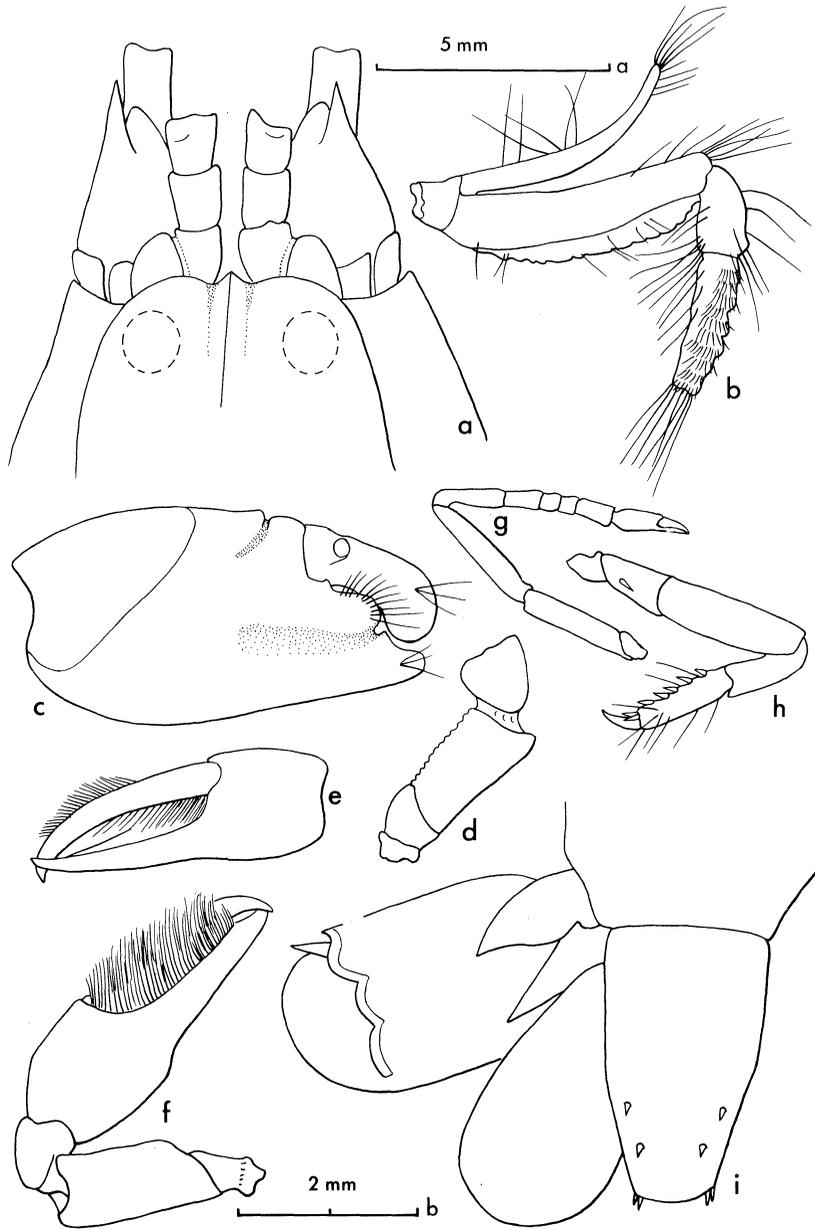


Fig. 49 *Alpheus barbatus* De Man
 27 mm female from AM P. 5573. **a.** Anterior region, dorsal view; **b.** third maxilliped; **c.** large chela, lateral face and merus, medial face; **e.** small cheliped, lateral and medial faces; **g.** second leg; **h.** third leg; **i.** telson and uropods. **c.** **d.** **e.** **f.** **g.** **h.** scale **a**; **a.** **b.** **i.** scale **b**.

Articles of third maxilliped with ratio of: 10:3:5. Inferior margin of first article with series of low irregular protuberances. Setae on tip of second article few and not reaching middle of third article; setae on tip of third article not heavy and slightly more than half as long as article.

Large chela compressed, somewhat trapezoid, 2 times as long as broad with fingers occupying distal 0.3. Superior margin of palm bearing narrow and curving transverse groove proximal to dactylus. Inferior margin rounded without grooves or indentations. Lateral face with shallow longitudinal groove extending from near mid-palm to mid-pollex. Dactylus heavy, bulbous at tip. Merus 1.9 times as long as broad. Inferoexternal margin smooth, inferointernal margin rough without tooth distally; superior margin not projecting.

Small chela not sexually dimorphic, 2.6 times as long as broad, finger 1.7 times longer than palm which is as broad as long. Fingers gape, tips cross when closed. Proximal half of lateral face of dactylus bearing dense fringe of hair on cutting margin; medial face of both fingers with tufts of densely-set short setae on cutting margins that obscure fingers almost to tips.

Ratio of carpal articles of second legs: 10:5:2:2:5.

Ischium of third leg with spine, 0.4 as long as merus. Merus inermous, 3 times as long as broad. Carpus 0.6 as long as merus, superior margin projected into an obtuse tooth. Propodus 0.7 as long as merus bearing on its inferior margin 5 spines and a pair distally. Dactylus simple, conical, 0.4 as long as propodus.

Telson 2.7 times as long as posterior margin is broad. Dorsal spinules small and located in posterior third. Articulation of outer uropod in the form of 3 scallop-shaped flaps.

DISCUSSION: Our specimens compared well with the three syntypes of Coutière, now fragmentary, that we examined at the Muséum National d'Histoire Naturelle in Paris; these were also used by De Man for his expanded description (1911:387). The only difference is that the orbitorostral border in our specimens recedes slightly at the margins of the rostrum while this margin is straight and confluent with the rostrum in both Coutière and De Man's specimens; we do not regard this as important, especially with so few specimens known.

This species is easily recognized by the obtuse rostral triangle, by the trapezoidal shape of the large chela, and particularly by the thick tuft of hair that obscures the medial face of the fingers of the small chela.

BIOLOGICAL NOTES: Coutière's specimens were taken from 10 metres, but De Man's specimens were from the "coral reef". The collecting notes on the specimens from Australia gave no indication as to the type of habitat from which they were collected. Coutière stated that the colour was "...*rouge orange brilliant; les branchiostégites, l'espace sus-stomacal et toutes les soies sont d'un blanc opaque.*" Our specimens reach up to 27 mm in length.

AUSTRALIAN DISTRIBUTION: Both of our specimens came from North Queensland.

GENERAL DISTRIBUTION: Djibouti, Indonesia; we also have unreported specimens from East Africa and Christmas Island in the Indian Ocean.

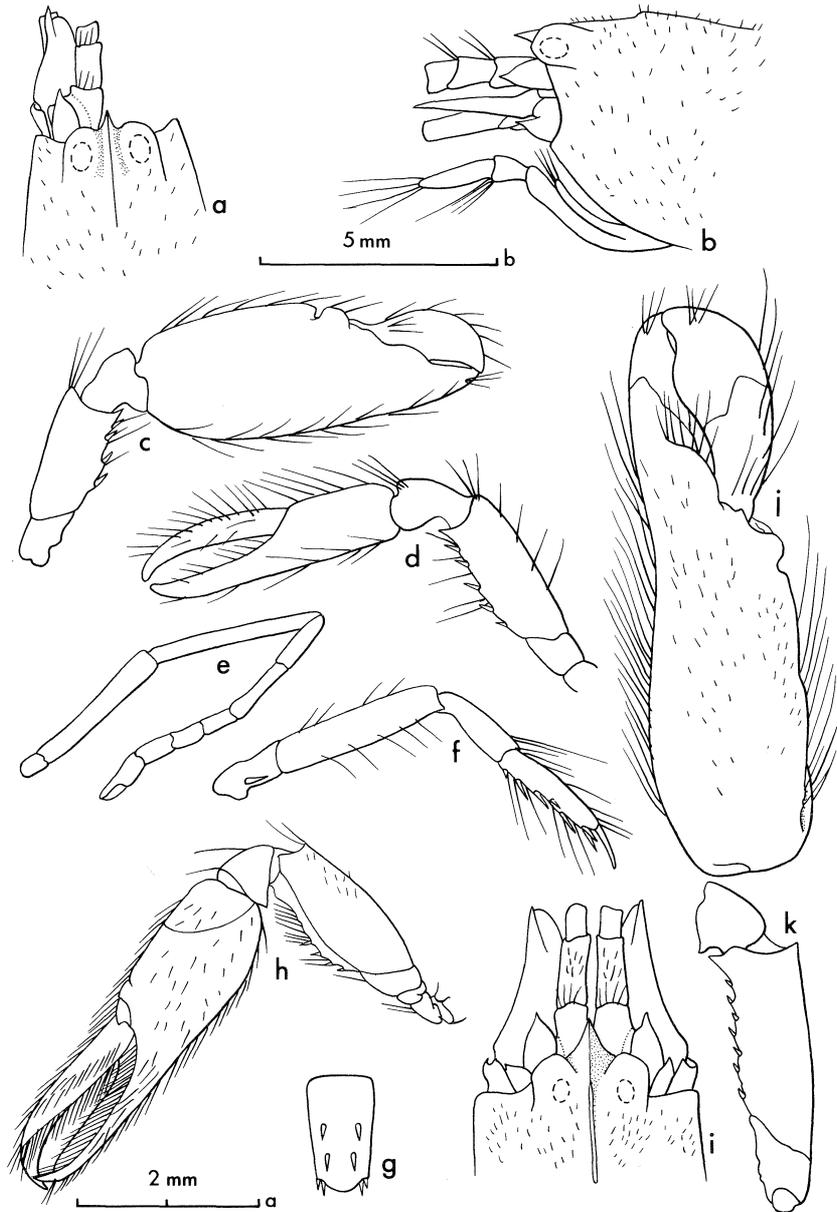


Fig. 50 *Alpheus pubescens* De Man

14 mm female from AM 121. **a, b.** Anterior region, dorsal and lateral view; **c.** large cheliped, medial face; **d.** small cheliped, medial face; **e.** second leg; **f.** third leg; **g.** telson; **h.** Small cheliped of male, lateral face (after De Man, 1911: fig. 89d). 34 mm male from BAU 27; **i.** Anterior region, dorsal view; **j, k.** Large chela and merus, medial face. **a, b, c, d, e, f, g** scale a; **i, j, k**, scale b.

Alpheus pubescens De Man

Fig. 50

Alpheus pubescens De Man, 1908:109; 1911:389, fig. 89. Tiwari, 1963:300, fig. 20.

SPECIMENS EXAMINED: 1 specimen from AM 121; (AM P. 27931); 1, BAU 27.

DIAGNOSIS: Carapace covered with a light pubescence of short stiff setae. Rostrum acute, reaching to middle of visible part of first antennular article, bearing rostral carina which is slightly concave between orbital hoods and continues to near posterior margin of hoods where it is interrupted and rises again as a crest continuing to mid-carapace. Margin between somewhat inflated orbital hoods and rostrum concave. Orbitorostral grooves moderately deep. Visible part of first antennular article and second article subequal; second article 1.6 times as long as broad, third article half as long as second. Stylocerite reaching to end of first antennular article. Squamous portion of scaphocerite reaching just past end of antennular peduncle, outer margin concave just proximal to lateral tooth; tooth directed slightly inward at tip and reaching well beyond squamous portion. Carpocerite as long as squame. Basicerite with acute tooth on inferior margin.

Second article of third maxilliped bearing a minimal brush of hairs distally on inferior margin of second article and a brush of moderately long hairs at tip of third article.

Large chela 2.7 times as long as broad with fingers occupying distal third. Superior margin with a transverse groove proximal to dactylus. Superior margin rounded and bearing towards medial side a sparsely set row of long forward-directed setae. Inferior margin also rounded and bearing setae similar to superior margin. Both dactylus and pollex with similar setae on superior and inferior margins. Merus 3 times as long as broad, superodistal margin not projected, inferointernal margin bearing 4 strong spines and an acute tooth distally.

Small chela sexually dimorphic. The dactylus of the male according to De Man (our male lacked this chela) is balaeniceps and the fingers are slightly longer than palm "... upper border which is flattened, with a transverse groove near dactylus and with the outer margin ridged; this chela is 3.45 times as long as high". Female chela in our specimen 4.5 times as long as broad and fingers are slightly longer than palm; inferior and superior margins carrying setae similar to large chela, and with a few setae on opposite surfaces of fingers that cross. Carpus 0.3 as long as chela. Merus 0.7 as long as chela, inferointernal margin bearing 5 spines and an acute terminal tooth.

Carpal articles of second leg with ratio: 10:10:4:4:4.

Ischium of third leg with spine. Merus 5 times as long as broad, inermous. Carpus 0.5 as long as merus, superodistal margin terminating in a subacute tooth, inferodistal margin rounded. Propodus 0.6 as long as merus, bearing on its inferior margin 5 spines and a pair distally; both margins bearing scattered setae. Dactylus simple, 0.4 as long as propodus.

Telson 2 times as long as posterior margin is broad. Posterior margin arcuate and slightly projected; inner spines of posterior pair twice as long as outer. Dorsal spines equal in length to inner spines of posterior pair, anterior pair placed just anterior to midline.

DISCUSSION: We have been able to compare our 2 specimens to De Man's holotype and paratypes at the Zoologisch Museum in Amsterdam. The 14 mm female (AM 121) agrees well in general, although the small chela is heavier, 4.5 instead of 5.6 times as long as broad. The posterior portion of the rostral carina virtually disappears before the

mid-dorsal carina abruptly arises in this specimen, but in De Man's series this characteristic is variable. The other specimen (BAU 27) is 34 mm long and probably a male, but is badly mutilated, retaining only the large chela and one third leg. In it the rostral crest continues without interruption into the dorsal crest, the rostral triangle is much broader, the large chela more slender (fig. 50k) and the third maxillipeds are almost devoid of setae (we suspect these setae may have been broken off in collecting). In both specimens the pubescence of the carapace is slight (the 34 mm specimen also has light pubescence on the large chela), but we discovered that in the eight specimens of De Man this characteristic was variable, and even in the holotype the condition did not approach the impression given by De Man's figures. Tiwari found his specimens less hirsute than De Man's holotype.

BIOLOGICAL NOTES: The mutilated specimen was from dead coral in waters up to 10 feet deep; the other Australian specimen was without ecological data. De Man reported his specimens coming from 3 metres or less down to a possible 30 metres, from coral, "Lithothamnion", and dredged from various types of bottom. Tiwari's specimen was dredged from "coral rock".

AUSTRALIAN DISTRIBUTION: Both specimens came from the Torres Straits.

GENERAL DISTRIBUTION: Indonesia and Vietnam.

***Alpheus miersi* Coutière**

Fig. 51

Alpheus rapax Miersi Coutière, 1898d: 166, fig. 1.

Alpheus miersi Coutière, 1905a:903, fig. 42.

Alpheus gracilipes Miers, 1884:287. (Nec Stimpson, 1861)

Previous Australian records:

Miers, (*loc. cit.*). Port Molle, Qld., Flinders Is., Qld.

SPECIMENS EXAMINED: 2 specimens from BAU 46; 2, BAU 51; 1, JG 21-73.

DIAGNOSIS: Rostrum triangular, reaching to middle of first antennular article. Visible part of first antennular articles equal to third article. Second article a little longer than 2 times as long as broad. Stylocerite reaching to end of first antennular article. Scaphocerite with squamous portion reaching to end of antennular peduncle, lateral tooth a little longer; carpoperite as long as scaphocerite. Inferior margin of basiperite with acute tooth.

Ratio of articles of third maxilliped: 10:2:3.

Large chela subcylindrical, 3.2 times as long as broad with fingers occupying distal 0.4. Superior margin of palm bearing a small transverse groove proximal to dactylus, inferior margin smooth, slightly constricted opposite articulation of dactylus. Medial face of chela bearing a moderately dense sprinkling of setae, lateral face glabrous. Merus 2 times as long as broad; inferointernal margin slightly serrate bearing 3 spines and an acute tooth distally. Carpus cup-shaped, 0.4 as long as merus.

Small cheliped sexually dimorphic. Male chela (according to Coutière, we have only female specimens) 4.7 times as long as broad and fingers and palm are equal. Dactylus balaeniceps. Merus similar to female. Female chela 4.2 times as long as broad, fingers and palm equal. Dactylus not balaeniceps. Medial face of palm somewhat hirsute and lateral face glabrous. Merus 3.6 times as long as broad; inferointernal margin smoother than

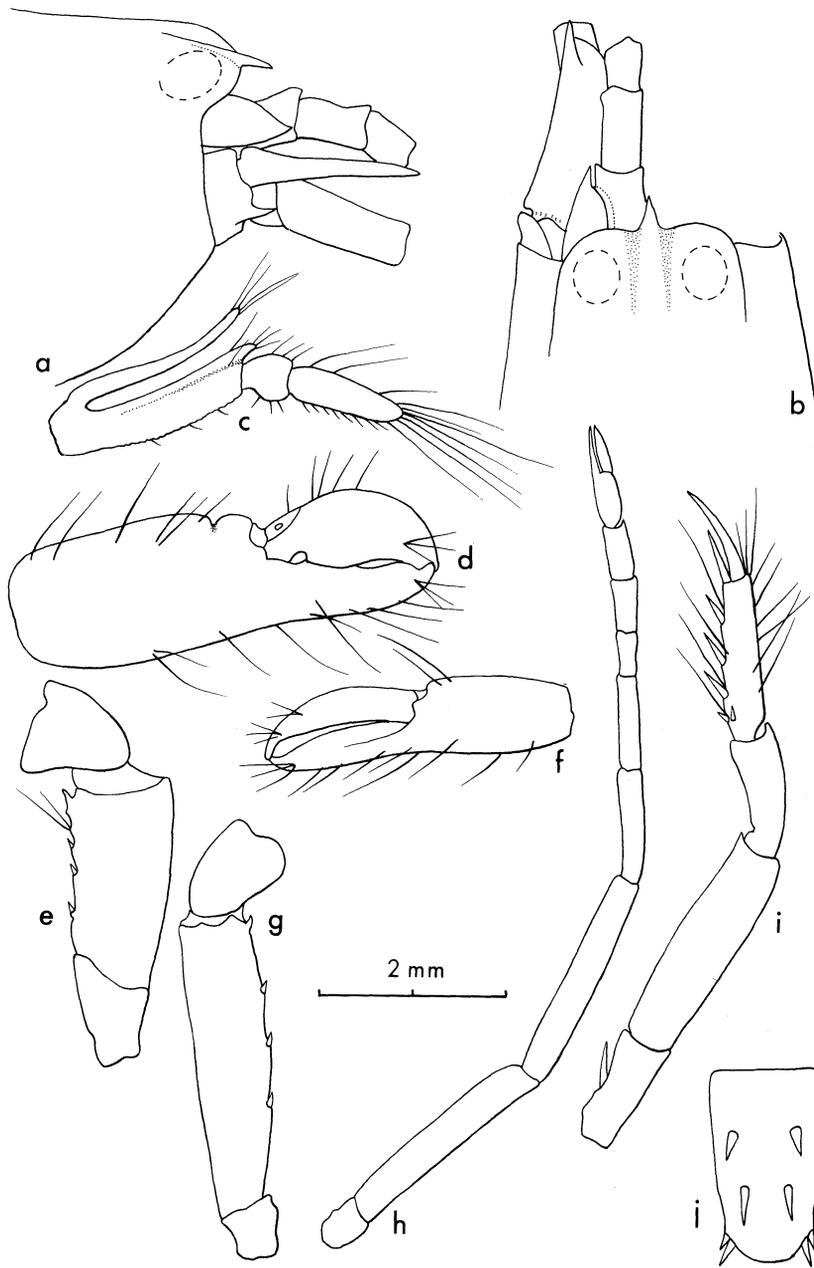


Fig. 51 *Alpheus miersi* Coutière
 20 mm female from BAU 51. **a, b.** Anterior region lateral and dorsal view; **d, e.** third maxilliped, lateral face; **f, g.** small chela, lateral face and merus, medial face; **h.** second leg; **i.** third leg; **j.** telson. All figures same scale.

that of male but bears 3 similar spines and a small acute tooth distally.

Ratio of articles of second leg: 10:10:4:4:4.

Ischium of third leg bears strong spine. Merus 3.5 times as long as broad and bearing distally on inferointernal margin a small acute tooth. Carpus 0.5 as long as merus; inferior margin terminates distally in a subacute tooth; superodistal margin truncate. Propodus 0.7 as long as merus, bearing on inferior margin 5 spines and a pair distally. Dactylus slender, long, simple, 0.6 as long as propodus.

Telson 2 times as long as posterior margin is broad. Posterior margin only a little more narrow than anterior. Anterior pair of dorsal spines placed anterior to middle.

DISCUSSION: Coutière (1898d:166) was able to examine in the British Museum (Natural History) the two specimens from Australia that were collected by the **Alert** and reported by Miers (1884:287) to be *A. gracilipes*. Coutière decided they were different and gave them the name of *A. rapax Miersi*. He raised the subspecies to specific rank in 1905.

Our 4 specimens agree well with Coutière's description and figures (the types are missing) except for the merus of the third leg which in our specimens varies from 3.5-4.0 times as long as broad while in Coutière's specimens the merus is 5 times as long as broad. As this is often a variable character, with so few specimens we do not attach any significance to it. We have one specimen in our collections from the Indian Ocean in which the tooth on the merus of the third leg is missing.

BIOLOGICAL NOTES: Our specimens were collected intertidally. The specimens range in size up to 20 mm.

AUSTRALIAN DISTRIBUTION: Heron Is., Port Molle, Flinders Is., Lizard Is., Qld.

GENERAL DISTRIBUTION: Maldives and Laccadives; Ceylon; Indonesia; Philippines; Japan.

***Alpheus brevirostris* (Olivier)**

Fig. 52

Palaemon brevirostris Olivier, 1811:664, pl. 319, fig. 4.

Alpheus brevirostris Milne-Edwards, 1837:350. Haswell, 1882b:187. Coutière, 1899:93, 230, figs. 61, 281 (anterior region of carapace and large chela of type).

Nec Alpheus brevirostris De Man, 1888b:261 and 1897:757 (both = *Alpheus rapax* Fabricius); 1902:877 (= ?); 1907:427 (= *Alpheus distinguendus* De Man). (For synonymy of this and related species see De Man, 1909b:146, *et seq.*; he does not mention the true identity of his 1902 specimen.)

Nec Alpheus brevirostris Ortman, 1890:479 (= *Alpheus djeddensis* Coutière).

Nec Alpheus brevirostris Coutière, 1898h:249, fig. 1 (= *Alpheus distinguendus* De Man).

?*Alpheus brevirostris* Lenz, 1905:384. (Specimen fragmentary, identity uncertain).

SPECIMEN EXAMINED: Holotype and only specimen known, male of 50 mm from "New Holland" through the courtesy of the Museum National d'Histoire Naturelle, Paris.

DESCRIPTION: "Palaemon with rostrum short, acute, simple; left chela large,

compressed, smooth." (Olivier, *loc. cit.* Translated from the Latin by the authors).

"It resembles the two preceding species (*P. diversimanus* and *P. bidens*, now *Alpheus*). The *corcelet* (carapace) is smooth, rounded nearly cylindrical. The rostrum is very short, simple, acute. The eyes are small, rounded and fixed. The external antennae are of the length of the body. The external scale which accompanies them (scaphocerite) is strongly ciliated on its internal border and is terminated by a strong and acute spine on its external border. The interior antennae are terminated by a small setiferous filament. The anterior pair of legs are (in the form of) unequal and very large pinchers; the left is larger than the right. The hand is very large, compressed, smooth on its two sides, with both upper and lower margins sharp and a little hairy. The movable finger is broad, compressed, rounded and hairy on its external border, less rounded on its internal border and provided with a molar tooth at its base. The inferior finger is excavated at its base to receive the molar tooth of the other finger. It is distally arched and a little sharp up to its tip. The fingers of the left (= right?) chela are simple, very long, a little arched at their extremity, strongly hairy on their inner side. The second feet are very small, a little longer than those that follow, and terminate in chelae. The superior scale of the tail (= telson) is broad, supplied with four spines on its superior surface, strongly setiferous on its extremity.

"It is found on the coasts of New Holland, from where it was collected by the late Péron." (Olivier, *loc. cit.* Translated from the French by the authors.)

To this description H. Milne-Edwards adds: (1) the anterior margins of the orbital hoods are rounded and without spines. (2) The second article of the antennular peduncle is more than twice as long as the first. (3) The scaphocerite tapers towards its tip and is pointed; it exceeds the length of the antennular peduncles. (4) Third maxillipeds are slender and reach well beyond the end of the scaphocerite. (5) The large cheliped carries on its superior margin two small crests, but none on its external face, but the inferior margin is almost sharp and is terminated by the pointed fixed finger, which carries at its base a circular cavity to receive the tubercle of the movable finger; the dactylus is very compressed and very obtuse at its tip. (6) The fingers of the small chela are very long, slender, punctate and a little curved and bearing hairs on their prehensile (opposite) faces, and gape when closed. (7) The merus bears an acute spine on the superior margin, but it is not quite at the extremity ("*si ce n'est tout à fait à son extrémité*"). Length, 2 inches (*pouces*). It is evident that Milne-Edwards had no additional specimens and was describing the holotype established by Olivier.

DISCUSSION: In 1909, after over twenty years of lengthy concern about certain species in the *Brevirostris* group, De Man finally compared the holotype of *A. brevirostris* with the specimen De Haan had listed from Japan as *A. rapax* Fabricius. He decided that none of the specimens he had called variously *A. brevirostris* or *A. rapax* were like that of Olivier's, and to this different form he applied the name *A. distinguendus*. He also rejected Coutière's contention (1899:14, 1905a:905) that *A. rapax* was a synonym of *A. brevirostris*. De Man stated that he found that the tooth of the stylocerite was directed outward in *A. brevirostris*, but straight ahead in *A. distinguendus*. He also found that in *A. brevirostris* the carpocerite was much shorter than the scaphocerite and reached only to the end of the middle article of the antennular peduncle, while the scaphocerite itself reached two-thirds of the length of the distal article of the antennular peduncle beyond that article. In contrast, he stated that in *A. distinguendus* the carpocerite and the scaphocerite were equal and both passed the end of the antennular peduncle by one-third the length of the last article. He also found that the transverse groove behind the dactylar articulation of the large chela present in *A. brevirostris*, was lacking in *A. distinguendus*, and also that the surface in *A. brevirostris* was smooth, and definitely

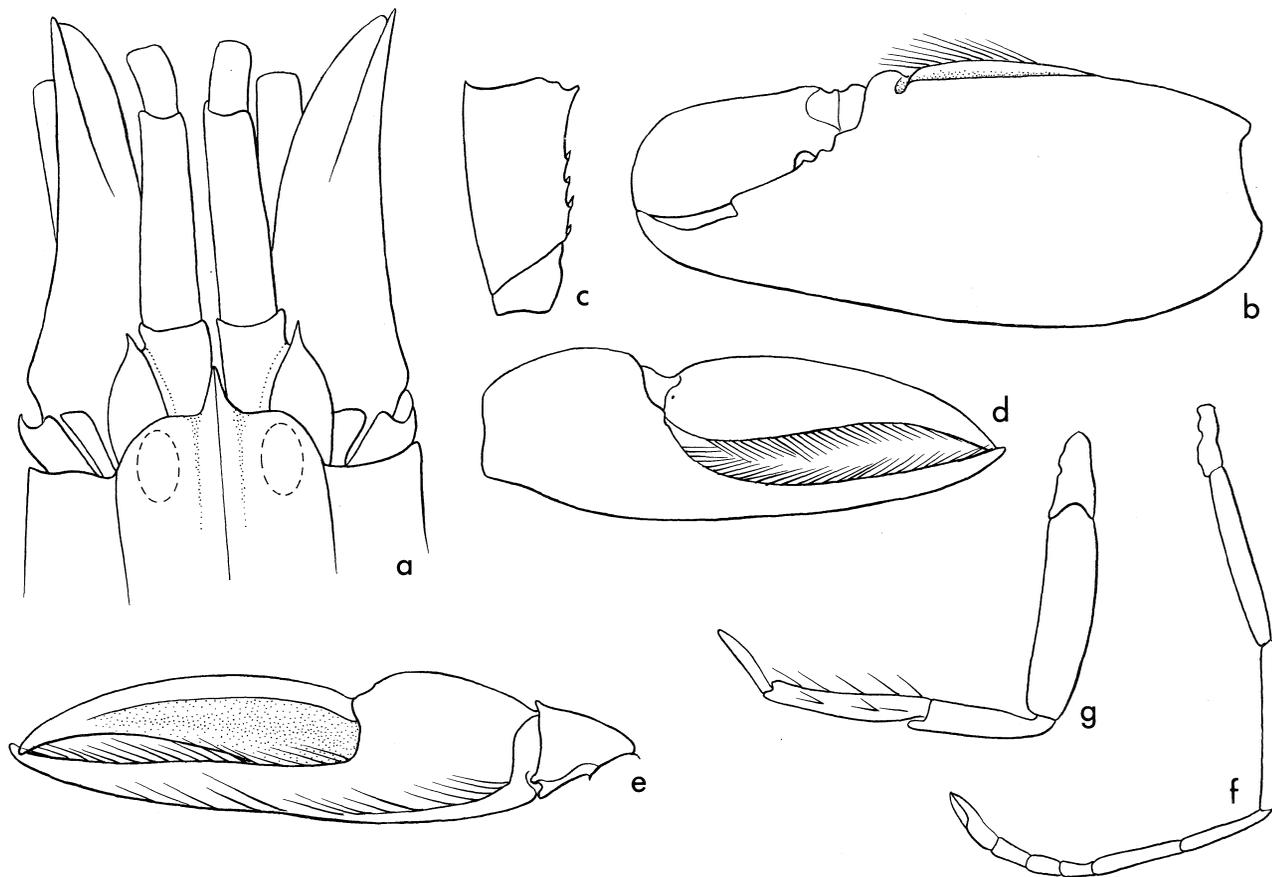


Fig. 52 *Alpheus brevirostris* (Olivier)

Holotype of Olivier, a 50 mm male from "New Holland". **a.** Anterior region, dorsal view; **b, c.** large cheliped, chela lateral face, merus medial face; **d, e.** small chela, lateral and medial face; **f.** second leg; **g.** third leg. All figures same scale.

granular in *A. distinguendus*. Finally, he found that the dactylus of the small chela (both specimens were males) to be two-thirds as wide at its base in *A. distinguendus* as it was in *A. brevirostris*.

We have re-examined the type specimen of *A. brevirostris* through the courtesy of the Muséum National d'Histoire Naturelle of Paris and found it to be in surprisingly good condition considering its age. We did not examine the specimen that De Haan regarded as *A. rapax* and that De Man later used as his type for *A. distinguendus* (but did not so specify). In *A. brevirostris* it is true that the stylocerite does turn slightly outward, but to this characteristic we do not attach great significance. We are at loss to understand De Man's description of the relative lengths of the antennular and antennal peduncular articles, for in Olivier's specimen the carpopodite reaches almost to the end of the antennular peduncle and in the specimens we have identified as *A. distinguendus* from Australia, the relative lengths of the three parts are both variable and similar, in general, to Olivier's type. As the breadth of the dactylus of the small chela usually varies with sex and also maturity of the specimen, again we attach no great significance to the slight differences cited by De Man.

The only reliable characteristic for separation of *A. brevirostris* from the form we have identified as *A. distinguendus* in Australian waters is the form of the large chela. In the holotype for *A. brevirostris* two small carinae, almost merely angles, run along the superior margin towards the articulation of the dactylus, leaving a triangular flattened area between them. Just proximal to the dactylus these carinae and the flattened area is cut by a slight but definite transverse groove. In the form that we have identified as *A. distinguendus* the carinae and the flattened area occurs, but instead of a transverse groove the carinae terminate at the position where the groove would occur with small, rounded shoulders. The second characteristic which is plainly mentioned by Olivier is that the surface of the chela in *A. brevirostris* is smooth (*laevi*), while De Man states that in *A. distinguendus* it is definitely "*plus grossierement granuleuse*" than in *A. brevirostris*. We have compared our specimens of *A. distinguendus* of equal size to Olivier's holotype and find the large chelae are definitely granulose, particularly on the medial surface.

These appear to be the only differences between Olivier's holotype and *A. distinguendus*. The unique form of the small chela, excavate and setiferous on opposing surfaces of the medial face, the ratios of the carpal articles of the second legs, the subspatulate condition of the third legs, even such minor points as the armature of the meri of the chelipeds and the heavy rounded distosuperior lobe of the carpus of the third legs are identical. But none of the specimens available in the collections had the transverse groove, or even approached it.

Olivier's specimen was collected by Péron from "New Holland" and might have been from most anywhere that Péron visited, from near Sydney around southern and western Australia to Melville Island on the northern coast (see discussion under *A. villosus* p. 52). Our records for *A. distinguendus* run from near Perth, W.A. around the western, northern, and eastern coasts to Botany Bay, N.S.W. We suspect that somewhere, possibly out of our recorded range for *A. distinguendus* a population will be found in which these characteristics are variable and some specimens will be found with a large chela with the transverse groove and smooth surface characteristic of the true *A. brevirostris*. Until that happens, we reluctantly consider the two forms as separate species; when such a population is found, *A. distinguendus* will be the junior synonym of *A. brevirostris*.

Without any specimens of this species, we are not considering the validity of *A. brevirostris* var. *angustodigitus* that De Man described from the coast of Borneo. It should

also be noted that Coutière considered *A. digitalis* De Haan from Japan to be a species erected on the basis of an anomalous form of a regenerating large chela, which he then put into synonymy under *A. brevisrostris* (1898h:429); while De Man did not specifically list Coutière's citation of the name in synonymy under *A. distinguendus*, he evidently so considered it (see quotation below).

AUSTRALIAN DISTRIBUTION: "New Holland".

GENERAL DISTRIBUTION: It is difficult to follow the changes of names produced by De Man and other workers of his time in the complex of *A. brevisrostris*, *A. rapax*, *A. distinguendus*, but De Man, 1911:386 summarizes: "The typical *A. brevisrostris* from New Holland is . . . only known . . . from Olivier's type for this rare species has seemingly not yet been found back since it was described in the Encyclopaedie Méthodique."

Alpheus rapax Fabricius

Fig. 53

Alpheus rapax Fabricius, 1798:405. De Man, 1909b:147, pl. 7, figs. 1-8.

Alpheus malabaricus Hilgendorf, 1878:832. (Nec Fabricius, 1798.)

Alpheus brevisrostris De Man, 1888b:261; 1897:757. (Nec Olivier, 1811.)

Nec *Alpheus rapax* De Haan, 1850:177, pl. 45, fig. 2 (= *Alpheus distinguendus* De Man).

Nec *Alpheus rapax* Bate 1888:155, pl. 99, fig. 1 (= *Alpheus rapacida* De Man).

Nec *Alpheus rapax* De Man, 1888:264 and 1892:404 (both = *Alpheus distinguendus* De Man).

Nec *Alpheus rapax* Ortmann, 1890:481 (= *Alpheus distinguendus* De Man).

Nec *Alpheus rapax* Coutière, 1905a:905 (=?, according to De Man, 1909b:155).

?*Alpheus rapax* Boone, 1935:142, pl. 37.

?*Alpheus rapax* Ledoyer, 1970:126, pl. 12.

SPECIMENS EXAMINED: 1 specimen from AM 92 (AM P. 27762); 2, AM 172 (AM P. 27542); 1, AM 287 (AM P. 27543); 1, AM P. 8794; 1, JC 12; 1, JC 14.

DIAGNOSIS: Rostrum acute, reaching variously from first quarter of visible part of first antennular article to end of that article. Rostral carina, high and narrow, reaching posteriorly to base of orbital hoods. Orbital hoods inflated, forming deep orbitorostral grooves. Antennular peduncles slender, second article 2.2-2.7 times as long as broad, twice as long as visible part of first and third articles. Stylocerite with tooth reaching nearly to end of first antennular article. Outer margin of scaphocerite and first and second antennular articles with fringe of setiferous bristles. Scaphocerite with lateral margin slightly concave, squamous portion broad and reaching a little beyond antennular peduncles with lateral tooth a little longer. Carpocerite reaching to end of antennular peduncle. Basicerite with acute tooth on inferior margin.

Third maxilliped with ratio of articles: 10:3:8; distal end of second article bearing a group of long hairs reaching to and beyond tip of third article; third article with long hairs at tip.

Large chela compressed, 2.8 times as long as broad with fingers occupying distal 0.4. Superior margin flattened with transverse groove proximal to dactylus, medial edge of flattened area bearing row of long forward-sweeping hairs, lateral edge also bearing a similar row of shorter hairs. Inferior margin flattened on palmar portion, knife-like in distal section and bearing a row of forward-sweeping hairs that extends to tip of propodal finger. Opposite articulation of dactylus, lower margin with slight constriction. Dactylus

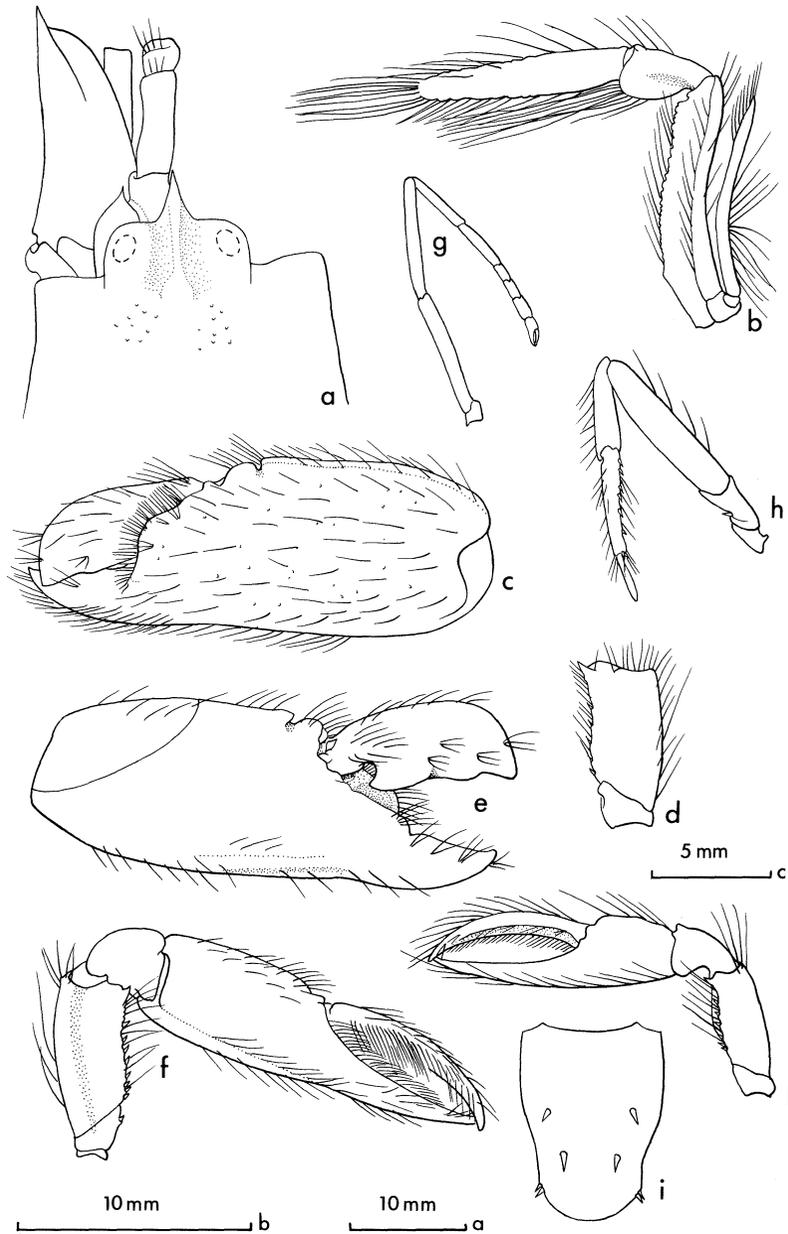


Fig. 53 *Alpheus rapax* Fabricius

70 mm male from AM 92. a. Anterior region, dorsal view; b. third maxilliped, medial face; c, d. large chela and merus, medial face; e. large chela, lateral face; f. small cheliped, medial face; g. second leg; h. third leg; i. telson. 34 mm female from AM P. 12949 (from Indonesia, no further data). j. Small cheliped, medial face. c, d, e, f, g, h scale a; a, b, i scale b; j scale c.

bearing long forward-sweeping hairs similar to propodal finger; plunger of dactylus of minimal development.

Small chela never balaeniceps, but with some sexual differentiation (*cf.* fig. 53f and j), highly compressed, over 4 times as long as wide with fingers 1.8 times as long as palm. fingers with opposing faces fringed with dense row of bristles, both fingers strongly curved at tip. Superior and inferior margin bearing forward sweeping hairs particularly in dactylar region. Merus similar to that of large chela.

Carpal articles of second leg with ratio: 10:(7-10):3:3:5.

Ischium of third leg with small spine. Merus 4.5 times as long as wide, inermous. Carpus 0.4 as long as merus, superodistal margin projected as rounded tooth. Propodus 0.7 length of merus and bearing on inferior margin 3-7 small spines with a pair distally. Superior and inferior margins bearing long sparsely-set hairs. Dactylus spatulate, slightly excavate on ventral surface.

Telson 2.5 times as long as posterior margin is broad, posterior margin strongly arcuate.

DISCUSSION: We do not have enough specimens from Australia to define the limits of variation in this extremely variable species in these waters. However, from our more extensive Thai collections the following variations were observed: The rostrum reached variously from the first third of the visible part of the first antennular article to the end of that article. The second antennular article varied from 2.0 to 3.5 times as long as broad. The flattened areas of the superior and inferior margin of the large chela were at times rounded. The first and second carpal articles of the second legs varied from 0.7-1.0 times the length of the first. The fingers of the small chela were sometimes only a little longer than the palm and sometimes were almost twice as long as the palm. The fringes of setae on the opposing faces of both fingers varied with size and sex of the specimen, being of minimal development in small specimens and very dense in large males; these males never reach the true balaeniceps condition.

We feel the specimen Ledoyer figured (1970:pl. 12) is probably not *A. rapax* since the large chela does not have a transverse groove and the dactylus of the small chela far exceeds the propodal fingers which is not typical for *A. rapax*. However, as Ledoyer pointed out, it is a small specimen (15 mm) and possibly its aberrant appearance is the result of immaturity. We do not believe Boone's specimens from Queensland (*loc. cit.*) to be *A. rapax*. She stated that the fingers of the small chela were "... armed on the inferior lateral margin with a double longitudinal series of six pairs of acuminate spines; the dactyl is two-fifths as long as propodus, curved, thickish, with a strong pointed tip". We feel this implies that the dactylus of the third leg was not spatulate. Also she stated that the telson margin was truncate. These characters are not typical of *A. rapax*. Further, her specimens were all taken from coral rather than the typical bottom dwelling habitat of *A. rapax*. We have been unable to examine the specimens at the Vanderbilt Marine Museum, and without this examination, we cannot assign the specimens to their correct species. The synonymy (above), except for Bate's and Boone's reports, is that of De Man (1909b:147).

BIOLOGICAL NOTES: This species is a bottom dwelling form, found largely intertidally on sandy bottoms. However, De Man's 2 specimens from Indonesia were reported from 46 m on "stony bottom". We have observed it in many places associated with a gobiid fish. In Hawaii it is known to be associated with *Psilogobius mainlandi* Baldwin (Moehring 1972). Yaldwyn supplies the following colour notes for the specimen we have figured: "Irregular banding of green on carapace and abdomen, hands with

irregular green bands across upper surface, some blue on fingers and legs" Hawaiian specimens have similar banding. We have noted that the diffuse manner of the banding gives an excellent protective coloration on the sandy substrate. Specimens range in size up to 70 mm.

AUSTRALIAN DISTRIBUTION: We have specimens from Clarence Straits and the Gulf of Carpentaria in northern Australia and from near Townsville, Qld.

GENERAL DISTRIBUTION: South Africa; East Africa; Madagascar; Red Sea; Maldive Archipelago; Ceylon (Sri Lanka); Mergui Archipelago; Singapore; Indonesia; Thailand; Japan; Mariana and Marshall Islands and Hawaii.

***Alpheus moretensis* sp. nov.**

Fig. 54

HOLOTYPE AND SOLE SPECIMEN: 28 mm male from 27°10' S; 153°21' E. 8 fathoms, Moreton Bay. (UQ 35). AM P.30802.

DIAGNOSIS: Rostrum acute, reaching to last quarter of visible part of first antennular article, with rostral carina high and narrow, concave between the orbits and extends to middle of carapace. Anterior margins of carapace slightly concave at base of rostrum. Orbital hoods inflated, forming narrow deep orbitorostral grooves. Carapace smooth, not punctate nor pubescent. Second antennular article 3.3 times as long as broad, 2 times as long as visible part of first article, third article 0.4 as long as second. Stylocerite acute, reaching to near end of first antennular article. Scaphocerite with squamous portion as long as antennules, lateral tooth a little longer. Carpocerite as long as lateral tooth of scaphocerite. Basicerite with small acute tooth on inferior margin.

Ratio of articles of third maxilliped beginning with base: 10:3:6. Setae of distal end of inferior margin of second article not long. Tip of last article with tuft of long setae.

Large chela 2.8 times as long as broad with fingers occupying distal 0.46. Superior margin flattened and bearing deep transverse groove proximal to dactylus. Superior margin bearing a sparse row of setae toward medial face. Inferior margin without grooves, rounded, not knife-edge, and bearing toward medial face moderately long setae that sweep forward and upward. Setae on pollex and dactylus less dense than on palm. Surface of palm and proximal part of pollex granular, dactylus smooth. Plunger of dactylus a low crest. Merus 2.3 times as long as broad; inferoexternal margin with 6 spines, fine irregular dentition and with an acute distal tooth. Inferoexternal margin also with minute dentition. Carpus 0.4 as long as merus.

Small chela of male 4.4 times as long as broad with fingers balaeniceps and 1.3 times longer than palm. Tips of fingers cross when closed without leaving a gape. Superior margin of palm with slight transverse groove proximal to dactylus. Superior and inferior margin beset with hairs similar to that of large chela. Merus 2.2 times as long as broad with margins similar to that of large cheliped. (Female chelae unknown).

Carpal articles of second legs with ratio: 10:10:4:4:4.

Only one thoracic leg present, possibly fourth. Ischium with spine; merus 5.8 times as long as broad, inermous. Carpus 0.7 as long as merus with superodistal margin projected as a subacute tooth. Propodus 0.8 as long as merus, bearing setae on both margins with those of superior margin set in tufts; six spines on lateral face and a pair of spines on inferodistal angle. Both inferior and superior margins bearing many fine setae, those of superior margin set in clusters of 3 or 4 setae. Dactylus spatulate, 0.3 as long as propodus.

TABLE 4
The separation of *A. moretensis* from related species

| | <i>A. moretensis</i> sp. nov. | <i>A. djeddensis</i> Coutière | <i>A. djiboutensis</i> De Man | <i>A. pubescens</i> De Man | <i>A. savuensis</i> De Man | <i>A. miersi</i> Coutière | <i>A. platyunguiculatus</i> (Banner) |
|---|----------------------------------|----------------------------------|----------------------------------|-------------------------------|-------------------------------|------------------------------|---|
| Carapace punctate or pubescent | No | Yes | Yes ¹ | Yes | No | No | No |
| Dorsal carina to mid-carapace | Yes | No | No | Yes | No | No | No |
| Transverse groove on palm of small chela, male | Yes | Yes | No | Yes | No | No | No |
| Second leg: ratio of first two carpal articles | 10:10 | 10:7 | 10:7 | 10:15 | 10:15 | 10:11 | 10:27 |
| Third leg: tooth on merus | No | No | No | No | No | Yes | No |
| dactylus spatulate | Yes | No ² | Yes | No | No | No | Yes |

1. Variable, but usually to some degree

2. Variable, but not greatly broadened

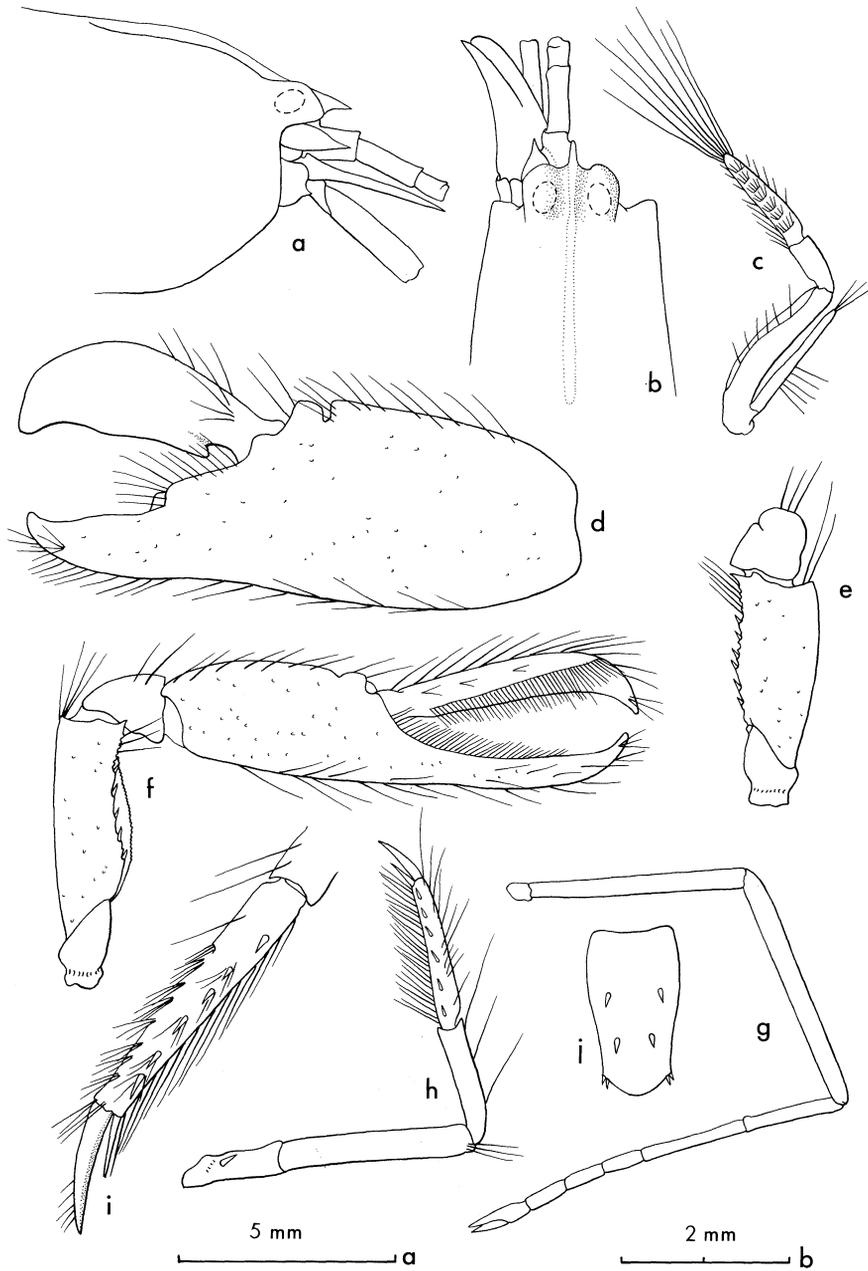


Fig. 54 *Alpheus moretensis* sp. nov.
 Holotype (male). **a, b**. Anterior region, lateral and dorsal view; **c**. third maxilliped; **d, e**. large chela and merus, medial face; **f**. small cheliped, medial face; **g**. second leg; **h, i**. fourth leg (?) and enlarged propodus and dactylus; distal region; **j**. telson. **a, b, c, d, e, f, g, h, j** scale **a**; **i** scale **b**.

Telson 2.5 times as long as posterior margin is broad. Posterior margin arcuate and projecting well beyond tips of posterolateral spines. Anterior pair of dorsal spines placed anterior to middle.

DISCUSSION: It is unfortunate that this is a sole specimen and lacking all but one of the walking legs. It does have enough parts, however, to place it firmly in the Brevirostris Group, and to separate it from other species within that group. The transverse groove proximal to the dactylar articulation of the large chela and the presence of a balaeniceps dactylus on the small chela of this male are rather firm characteristics that relate to a number of species, from which it can be separated by the characteristics given in Table 4. (*Alpheus platyunguiculatus* Banner has been included in the table, but in it the small chela of the male is of sub-balaeniceps form.) There are also differences amongst these species in the proportions of the chelae and of the articles of the third legs.

The specimen was "collected over sand" in 8 fathoms and probably has a habitat similar to *A. stephensoni* Banner and Smalley. Nothing is known of its colour in life.

The name is derived from the locality of its capture, with a syllable dropped for euphony. The holotype will be placed in the Australian Museum.

***Alpheus djiboutensis* De Man**

Fig. 55

Alpheus djiboutensis De Man*, 1909b:160, pl. 7, fig. 17-24. Holthuis, 1958:25, fig. 9.

SPECIMENS EXAMINED: 2 specimens from JR1; 2, JR2; 1, JR3; 2, JR4; 1, JR12.

DIAGNOSIS: Rostrum subacute reaching near end of first antennular article, with strong carina that reaches slightly posterior to orbital hoods, orbitorostral grooves moderately deep. Orbitorostral margin confluent with rostrum, without indentation. Carapace somewhat granular. First and third antennular article subequal, half as long as second antennular article which is 1.7 times as long as broad, lateral margin of first and second article beset with short, setiferous bristles. Stylocerite acute, not reaching end of first antennular article. Lateral margin of scaphocerite concave; lateral tooth strong, reaching well beyond antennules; squamous portion narrow, reaching end of antennular peduncle. Carpocerite stout, reaching end of antennular peduncle. Basicerite with inferior margin bearing small acute tooth.

Second article of third maxilliped a little longer than broad, bearing distally on inferior margin small tuft of long fine setae. Third article 4 times as long as broad, margins with many long hairs, distal tip with brush of long hairs.

Large chela 2.5 times as long as broad. Superior margin somewhat flattened, bearing narrow transverse groove proximal to dactylus and on either side of flattened area a row of forward-sweeping hairs, hairs on medial margin longer than lateral. Inferior margin bearing a row of long hairs that are directed forward and medially. Medial face granulate, lateral face less so. Dactylus truncate, plunger of minimal development. Merus 2.5 times

*In an annotated checklist of the alpheids of the Red Sea, now (November, 1978) in preparation, we will review the separation of *A. duboutensis* De Man 1909b from *A. djeddensis* Coutière 1897e, and will conclude that with the inherent variation in this species the distinction between these two nominate species is invalid. When the Red Sea paper is published, all references to *A. djiboutensis*, including this reference, will be placed in synonymy. It should be noted that although *A. djeddensis* has appeared only three times in the literature (the original description, two passing references and one figure in Coutière's thesis (1899) and a mention by De Man in his description of *A. djiboutensis*), Article 23b of the 1964 *International Rules of Zoological Nomenclature* . . . which permitted an unused or forgotten name to be considered a *nomen oblitum* was deleted by the XVIIth International Congress of Zoology, Monaco (see Bull. Zool. Nom. 31(2): 79.)'

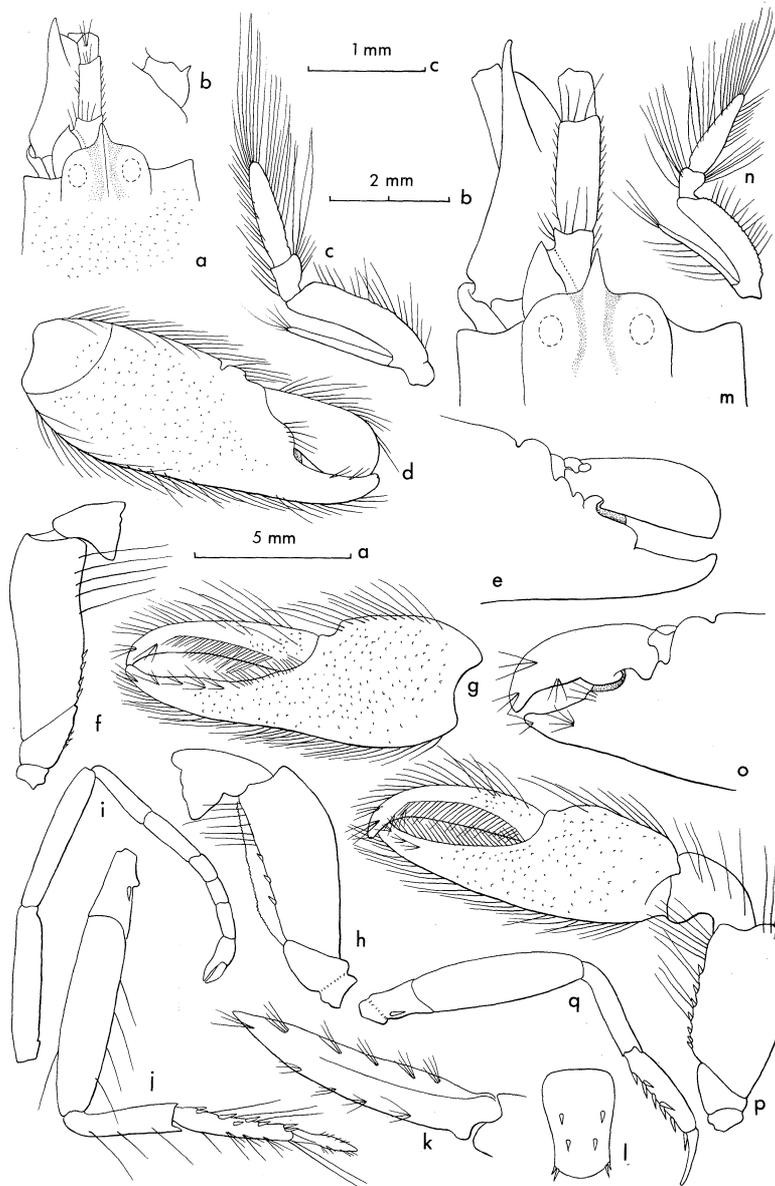


Fig. 55 *Alpheus djiboutensis* De Man

36 mm male from JR 2. a. Anterior region, dorsal view; b. basicerite; c. third maxilliped; d, e. large chela and distal end, medial face; f. merus of large cheliped, medial face; g, h. small chela and merus, medial face; i. second leg; j, k. third leg and enlarged dactylus superior face; l. telson. 32 mm male from JR 3. m. Anterior region, dorsal view; n. third maxilliped; o. anterior region of large chela, lateral face; p. small cheliped, medial face; q. third leg. a, b, c, d, e, f, g, h, i, j, l, o, p, q scale a; m, n, scale b; k scale c.

as long as broad, inferointernal margin bearing only several long setae distally but more proximally bearing several small spines. Ineroexternal margin serrate. Inferior margin of ischium also dentate, sometimes bearing a few spines.

Small chela of both sexes 2.7 times as long as broad, with fingers slightly longer than palm; margins of palm and fingers bearing long setae. Dactylus of male sub-balaeniceps, not markedly broadened with setiferous crests not joining over distosuperior surface, occasional old, large females similar. Merus similar to that of large chela.

Ratio of articles of second legs: 10:8:3:3:4, with first article varying from slightly longer to slightly shorter than second article.

Ischium of third leg with spine. Merus inermous, 4 times as long as broad. Carpus a little more than half as long as merus, distoinferior margin projecting as obtuse tooth, distosuperior margin as small acute tooth. Propodus 0.6 as long as merus, bearing on its inferior margin 7 spines with a pair distally. Dactylus 0.5 as long as propodus, slightly broadened in middle and flattened on inferior surface; superior surface convex, with longitudinal ridge in middle and bearing small patches of setae near outer edges.

Telson 2 times as long as posterior margin is broad, anterior pair of dorsal spines placed anterior to middle.

DISCUSSION: In addition to the specimens collected by Dr J. E. Randall listed above, for this species we have several specimens from the following archipelagoes or areas: Elat and the Sudanese coast, Red Sea; coast of Tanzania; Aldabra Atoll; Ceylon; Ambon, Indonesia; New Guinea; Solomon Islands; Marshall Islands; Fiji Islands; Society Islands. All were collected by ichthyologists who were studying goby-shrimp symbiotism and most were collected by Dr Randall who also supplied us with colour transparencies of the freshly caught shrimp (often speared with a small multipronged spear). Others were supplied by Dr L. Karplus, D. B. E. Magnus, N.V.C. Polunin, and M. Tsumamal. In our study we were reminded of the statment of Chace (1972:66); "Several species of the *Brevirostris* Group, to which *A. floridanus* belongs, are so variable that they should be popular with those biologists who would deny the species concept."

We should note in passing that while this species of alpheid is the one most studied in the shrimp-goby association, *A. rapax* Fabricius, *A. distinguendus* De Man and *A. rapacida* De Man are also in our collections with reports of such association. Further, from Japan Miya and Miyake (1969:307) have described a new species, *A. bellulus*, and Takagi (1966:83) lists *A. brevicristatus* De Haan also as in the same type of association. In the Atlantic Randall has remarked that the goby *Nes longus* (Nichols) of the Caribbean "shares a burrow in the sand with an indefatigable snapping shrimp" (Randall, 1968:247). The shrimp has since been identified as *A. floridanus* Kingsley by Dr F. A. Chace Jr. at the National Museum of Natural History, Washington D.C. (Randall, personal communciations).

All of these shrimp are of the *Brevirostris* Group. There is one species, however, in the *Edwardsii* Group that has been reported with similar associations. MacNae (1957:361) reporting from South Africa, Thomassin (1971:381) from Madagascar and Farrow (1971:487) from Aldabra Atoll, have reported *A. lobidens* De Haan (as *A. crassimanus* Heller) living in burrows in association with a goby. Certainly *A. lobidens* is not an obligate commensal, for we have collected it in rather great number throughout the Indo-Pacific and have never noticed a goby near or in its burrow.

The gobies of the association have been reported to belong to several genera and a number of species — Karplus *et al.* (1974:259) report 6 species in 4 genera in the northern

Red Sea alone. Dr Randall believes that some of the species he has captured with alpheidids have not yet been named (personal communication).

Like Dr Chace with his *A. floridanus*, we have observed much variation in this species. Some of the major differences are:

1. Anterior carapace. The anterior margin varied from where the curve reaching to the rostrum started at the middle of the orbital hoods and reached almost to the middle of the rostral projection to where the orbitorostral margin curved slightly posteriorly at the edge of the orbital hoods before joining the rostral base (as shown in figs. 55a and m). The rostral carina varied from moderately sharp to rounded.

2. Surface of the carapace. De Man described and figured the carapace of his specimen from Djibouti having large punctations laterally and a smooth area on the midline. In none of our specimens were the punctations as coarse as those figured by De Man, and in some this sculpturing was scarcely discernible. In 2 specimens we could detect a light pubescence.

3. Third maxillipeds. Three of the Australian specimens carried a brush of long hairs on the inferodistal portion of the second article, while 5 had only a sparse patch of short hair. Three specimens from New Guinea and the Solomons carried long hair in a yet-denser tuft, while all of the specimens from the Red Sea lacked the tuft. Unfortunately this characteristic was correlated neither with other variation nor with colour pattern. In most specimens the third article was about 4 times as long as broad, but in one specimen from New Guinea the article was almost 7 times as long as broad.

4. Large cheliped. The length-breadth ratio did not vary greatly, but in some specimens the dactylus was markedly truncate at the tip and the plunger was a continuation of the distal cutting edge (fig. 55e) while in others the dactylar tip was extended as a rounded tooth and the plunger, while low, was definitely demarked from the more distal margin. The number of spines on the merus varied, and while none of the Australian specimens carried a distal tooth on the inferointernal margin, it was present in one specimen from the Solomons.

5. Small cheliped. The small chela varied from 2.7 to 3.1 times as long as broad, and of the 3 females from Australia with their small chelae present, 2 were sub-balaeniceps. However, in some large females from the Red Sea the dactylus had the two rows of setae almost joining on the superodistal margin.

6. Second legs: In De Man's specimen the first 2 carpal articles had the ratio of 10:7; in the series before us it varies from 10:6 to almost 10:10.

7. Third leg: The merus varied from 4.0-5.0 times as long as broad. De Man stated that the dactylus was simple and a little broader in the middle than at the base. In some of these specimens the article was definitely broadened and spatulate, but in others it approached a trigonal condition. The patches of setae were more numerous on the wider type of dactyl.

8. Colour: No two specimens for which Dr Randall had supplied colour transparencies are of the same colour pattern. Most have a white ground colour with olive-green to reddish-brown mottling or transverse stripes, often with a broad dark band across the chelae; in one, definitely red chromatophores made a coarse irregular reticulum on the carapace, while the abdomen carried more green-brown colour. Some have a white "saddle" at the posterior end of the carapace. One of the Australian specimens had a light reddish-grey ground colour and thin longitudinal stripes of light red. Another set of specimens (one from the Great Barrier Reef, and one each from Tanzania and the Societies) had a light to bright blue ground colour with darker blue transverse stripes, sometimes turning more olive towards the midline. Unique among the specimens was the blue specimen from the Societies (Moorea) for it also had a conspicuous spot on the posterolateral portions of the carapace of irregular oval shape

drawn out anteriorly and reaching from the level of the third maxillipeds to that of the fourth legs. The anterior portions were intense blue, but the wide posterior portion was mostly bright red.

Karplus *et al.* (1974) have reported they could recognize four major colour patterns, and that these colour types were usually associated with different species, or groups of species, of gobies and with different types of burrows. They conclude: "The diversity of the activities in the 4 types of shrimps, the composition of their associations, their burrow structures, and their substrate preferences lead us to the conclusion that these 4 types of shrimps may represent 4 valid species."

We suggest that the answer to this complex lies not in museum work with dead specimens, but in careful field observations correlated with laboratory studies on living specimens, such as that of Karplus *et al.* (1974), and those currently being studied by Ms Robina Cummins of the University of Sydney for her doctoral research (personal communication, Cummins). Some of the obvious questions are: Will shrimps of one "species" or of one colour pattern accept one of another colour pattern as a mate? Will one species of goby, always found in the field with one "species", or colour pattern, of shrimp, accept shrimps of another "species" under laboratory conditions? If the species of goby is changed, will the colour of its shrimp commensal change? It is only through studies like these that the question may be solved.*

BIOLOGICAL NOTES: A series of papers have been written on the behaviour patterns of the fish and shrimp in the association (see for example, Harada, 1969, Karplus *et al.*, 1972, Luther, 1958a and b, and Magnus, 1967). The shrimp obviously makes the burrow, but may be blind and certainly depends upon the fish for warning of danger. Under ordinary conditions during the day the fish rests on the sand slightly beyond the entrance to the burrow while the shrimp, when not excavating the burrow, rests closer to, or in, the entrance, resting its antennae on the fish. In the retreat response, the goby dives into the burrow head first, but the shrimp darts backwards. Both feed on articles of food falling near the mouth of the burrow and in addition the shrimp "cleans" the fish for ectoparasites, using its second legs (all taken from Karplus *et al.*, 1972).

AUSTRALIAN DISTRIBUTION: Seven of the specimens were collected at One Tree Island in the Capricorn Group and the other was collected from Lizard Island in the northern Great Barrier Reef.

GENERAL DISTRIBUTION: This species has been reported several times from the Red Sea and we have seen specimens from the head of the Red Sea eastward across the Indo-Pacific to the Society Islands (see above). It does not occur in Hawaii.

EDWARDSII GROUP

Orbital teeth lacking except in *A. euchirus* Dana (see p.197); in *A. hoplites* Nobili the

*N. V. C. Polunin and R. Lubbock, 1977, in "Prawn-associated gobies (Teleostei: Gobiidae) from the Seychelles, Western Indian Ocean: systematics and ecology" (J. Zool. Lond., 183:63-101) reported that they could separate 7 "types" of shrimp, based upon colour pattern in association with 11 species of gobies. The "types" of shrimp were not positively identified, but some may have been *A. rapax*, *A. bellulus*, *A. djiboutensis* and *A. rapacida*. They found in their narrow study area that some species of gobies were found in association with as many as 4 "types" of shrimps, and some "types" of shrimp associated with as many as 5 species of gobies. There was only one goby-shrimp association that was collected in sufficient numbers to show a species specificity on both sides of the relationship; that was the goby *Vanderhorstia ornatissima* Smith that was found always in association with the shrimp species "that may have been *Alpheus rapax*", and this alpheid was only found with *V. ornatissima* (Table V). This species association was the most common association found on sea grass beds (Table III), but it was a "particularly loose association" for the fish was "frequently found out of its burrow, and very occasionally individuals were found to shelter in the cylindrical shafts . . . thought to be made by callianassid prawns . . ." (p. 99). (Note added in press).

hoods themselves are acute, but without separate teeth (neither species has been reported from Australia). Large chela with marked compression, with a transverse groove on superior margin proximal to dactylus and, in all Australian species, a shoulder of various development opposite on inferior margin; groove on superior margin usually extending into both faces as triangular or quadrangular areas. Small chela of male often balaeniceps. Third legs with merus usually unarmed, dactylus usually simple, at times subspatulate.

Most species in this group are found in burrows in sandy to silty bottoms, often constructed under rocks lying on the substrate; they frequently penetrate into brackish water or occur where brackish water is leaked from beaches at low tide. They may be of large size and some species are collected by commercial shrimp trawls. A few species, most notably *A. parvirostris*, *A. hippothoe*, and *A. dolerus*, live in heads of dead coral on reefs well removed from terrestrial influences.

***Alpheus parvirostris* Dana**

Fig. 56

Alpheus parvirostris Dana, 1852:551, pl. 35, fig. 3. Ortmann, 1890:483. De Man, 1911:432, fig. 106. Barnard, 1950:753, fig. 143 e-i. Banner and Banner, 1966b:149, fig. 57.

Alpheus lineifer Miers, 1875:343.

Alpheus braschi Boone, 1935:131, pl. 34, text fig. 10.

Previous Australian Records:

Coutière, 1900:413. Torres Straits,

McNeill, 1968:17. Low Isles.

SPECIMENS EXAMINED: 1 specimen from AC 15; 1 specimen, from AC 42, 43, 44, 45, 46, 48, 52, 53, 55, 59, 63, 66, 69, 71, 82; 2 AC C-59; 2, AH 1; 2, AH 4; 9, AM 52 (AM P. 27514); 3, AM 63 (AM P. 27794); 1, AM 80 (AM P. 27315); 1, AM 109 (AM P. 27511); 14, AM 123 (AM P. 28150); 1, AM 151 (AM P. 27827); 1, AM 163 (AM P. 27521); 1, AM 196 (AM P. 27316); 2, AM 201 (AM P. 27317); 9, AM 283 (AM P. 28151); 3, AM 305 (AM P. 28152); 2, AM 324 (AM P. 27345); 2, AM 331 (AM P. 27346); 1, AM 339 (AM P. 27347); 2, AM 340 (AM P. 27348); 2, AM 342 (AM P. 28153); 12, AM 343 (AM P. 27349); 3, AM P. 2579; 1, AM P. 7520; 1, AM P. 8043; 1, AM P. 10364; 1, AM P. 27433; 19, BAU 10; 8, BAU 11; 8, BAU 13; 1, BAU 15; 1, BAU 16; 1, BAU 17; 44, BAU 20; 4, BAU 21; 19, BAU 23; 9, BAU 24; 7, BAU 25; 19, BAU 27; 3, BAU 28; 17, BAU 29; 5, BAU 30; 3, BAU 31; 1, BAU 32; 2, BAU 37; 1, BAU 38; 5, BAU 39; 5, BAU 40; 2, BAU 41; 4, BAU 42; 16, BAU 43; 18, BAU 44; 2, BAU 47; 5, BAU 48; 2, BAU 49; 49, BAU 50; 14, BAU 52; 7, BAU 53; 21, BAU 54; 27, BAU 55; 32, BAU 56; 1, BAU 57; 6, BAU 58; 1, JC 18; 1, MM 263; 1, VM 29; 2, US 123564; 3, US 123578; 3, US 123584; 2, US 123585; 1, US 123586; 4, US 123588; 2, WM 70-65; 1, WM 281-65.

DIAGNOSIS: Rostrum narrow, over 2 times as long as broad at base, with tip reaching to near end of first antennular article, with short carina that disappears at base of eyes. Orbital hoods moderately inflated, orbitorostral groove shallow and flattened and extending forward to form flattened convex prominences between margins of orbital hoods and rostrum. Second antennular article 1.8 times as long as wide and a little longer than visible part of first and third article which are subequal. Stylocerite acute, reaching

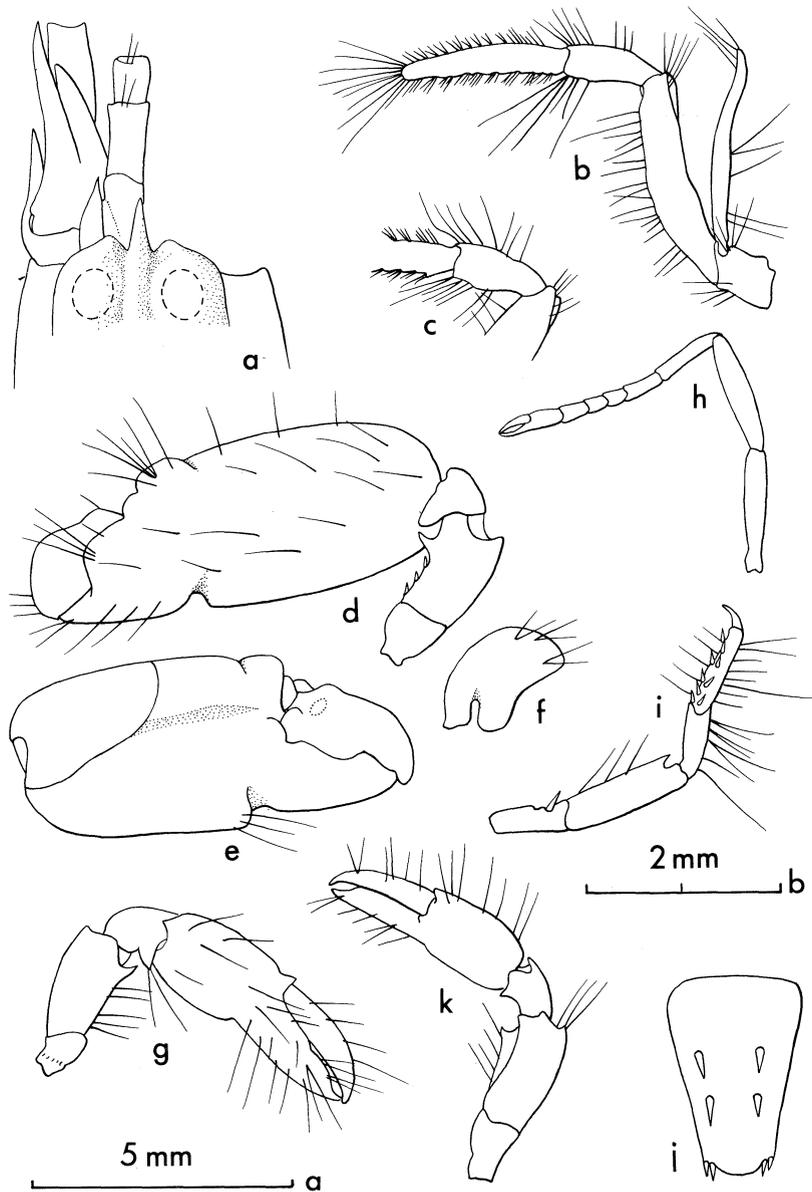


Fig. 56 *Alpheus parvirostris* Dana
 12 mm male from BAU 20. a. Anterior region, dorsal view; b, c. third maxilliped, lateral face and detail of second article; d. large cheliped, medial face; e, f. large chela and dactylus, lateral face; g. small cheliped, medial face; h. second leg; i. third leg; j. telson. 17 mm female from BAU 20. k. Small cheliped, lateral face. a, d, e, f, g, h, i, j, k scale a; b, c scale b.

slightly past end of first antennular article. Scaphocerite with outer margin markedly concave, lateral tooth strong and longer than antennular peduncle, equal to carpocerite; squamous portion narrow, reaching to end of antennular peduncle. Lateral spine of basicerite conspicuous in dorsal and lateral views, acute, reaching past first antennular article.

Ratio of the articles of third maxilliped: 10:4:8.

Large chela somewhat hirsute on medial face, 2.5 times as long as broad, fingers occupying distal 0.3. Superior saddle in form of a strong but narrow oblique groove that continues into medial face in a short U-shaped groove; other superior medial palmar depressions lacking. Superior saddle continuing into lateral face as small and abruptly terminating groove. Lateral face of chela bearing longitudinally a narrow and often deep groove arising at *linea impressa* and terminating below superior saddle; groove not confluent with groove of saddle. Inferior shoulder heavy but rounded and bearing a few long setae; inferior groove extending a short distance into both faces. Plunger on dactylus long. Merus of males stout, 1.7 times as long as broad bearing on inferointernal margin strong subterminal tooth and three small heavy spines. Merus of female more slender than that of male but with similar armature.

Small chela of male 3.0 times as long as broad, fingers a little shorter than palm, conical; broad but acute tooth above dactylar articulation. Inferior shoulder present but not heavy. Inner face bearing many fine setae, outer face glabrous. Carpus cup-shaped, 0.3 as long as chela, bearing on its distosuperior margin a strong acute tooth. Merus similar to that of large chela but without spines. Small chela of female more slender with diminished sculpturing and less hirsute.

Ratio of the articles of the second legs: 10:7:3:3:4.

Ischium of third leg armed with heavy spine. Merus varying from 3.3-4.4 times as long as broad; inferior margin bearing several conspicuous bristles and usually a terminal tooth of varying development but at times absent. Merus of fourth leg usually with similar tooth. Carpus 0.5 as long as merus with both margins projected as acute teeth. Propodus 0.7 as long as merus, bearing on its inferior margin about 10 spines. Dactylus simple, 0.3 as long as propodus.

Telson 2.7 times as long as posterior margin is broad; anterior margin about twice breadth of posterior; posterior margin slightly arcuate.

DISCUSSION: *A. parvirostris* is one of the most common species of the genus *Alpheus* in the dead coral habitat throughout the Pacific. It does not vary much in proportions and is readily recognized by the unusually long lateral tooth of the basicerite coupled with the flattened prominences lateral to the rostrum. It does, however, vary in the teeth on the meri of the third and fourth legs, and we noted that the development of the teeth in a specimen is parallel in the two legs. We also noted that none of the specimens from Houtman Abrolhos carried these teeth which may indicate a subspecific type of isolation.

We have been able to examine the type for *A. braschi* Boone at the Vanderbilt Marine Museum. The sole apparent difference between this nominal species and *A. parvirostris* was the long groove on the median face of the large chela. On inspection this was found to be an artifact from preservation as the exoskeleton was newly moulted and soft. Since this species agrees in every other way with *A. parvirostris* we are placing it in synonymy. Couitière examined the type for *A. lineifer* and placed it in synonymy (1899:25).

BIOLOGICAL NOTES: This species has been dredged from 32 metres and is abundant on the reef flats. In addition to dead coral, it is found living in sponges.

Dr A. J. Bruce of the Heron Island Marine Station also loaned us a pair he found living on a head of the coral *Galaxea* sp. In our experience this is a unique habitat for this species, for while we have collected literally hundreds of *Racilius compressus* Paulson from *Galaxea* and even more *A. parvirostris* from many other habitats, we have never observed this species on living *Galaxea*. *A. parvirostris* is not a large species, we have not seen any specimens larger than 17 mm. The following colour notes were supplied by J. C. Yaldwyn from some specimens he collected at One Tree Island in the Capricorn Group. "Body transparent with green hands, broad dark green bands across the abdomen, eggs bright green, tips of fingers of big hand opaque, white." In the specimens collected by Davis and Bannon from Houtman Abrolhos the transverse bands were described as "dark brown". Colour notes on the specimen from AC 15 are as follows ". . . brown bands on back, claw has dark brown band, then yellow at end of claw. Dark region near head (eye). Light grey green colour for rest of body". This does not differ essentially from Yaldwyn's colour notes, the difference in banding colour is a common variation in alpheids.

AUSTRALIAN DISTRIBUTION: The species is represented in the collections from Houtman Abrolhos to Cockatoo Island in western Australia; in northern Australia from Darwin and the Torres Straits and in eastern Australia from Cooktown to the Capricorn Group.

GENERAL DISTRIBUTION: This species has been found from the Red Sea and South Africa, in the Indian Ocean and eastward across to Pacific to the Society Islands. It has been found in Japan, but not in Hawaii.

***Alpheus edamensis* De Man**

Fig. 57

Alpheus hippothoe edamensis De Man, 1888a:518.

Alpheus edamensis De Man, 1911:437, fig. 107. Banner and Banner, 1966b:157, fig. 61.

Alpheus acanthomerus Ortmann, 1890:474, pl. 36, fig. 12. Coutière, 1897e:202.

Nec Alpheus Hippothoe edamensis De Man, 1897:757; 1902:891 (= *A. funafutensis* Borradaile).

SPECIMENS EXAMINED: 1 specimen from AM 302 (AM P. 28120); 1, AM 315 (AM P. 28121); 1, AM P. 8787; 1, AM P. 11400; 1, AM P. 28122; 2, AM P. 28123; 4, AM P. 28125; 2, BAU 29; 2, JC 7; 2, MC 1.

DIAGNOSIS: Rostrum slender, awl-shaped, reaching to end of first antennular article; carina high but rounded, depressed between orbits. Orbital hoods inflated, forming moderately deep orbitorostral grooves; anterior margins rounded, slightly concave near rostrum. Second antennular article 3 times as long as wide and 2 times as long as visible part of first and third article which are subequal. Stylocerite acute and reaching slightly past end of first antennular article, outer margin of scaphocerite concave; squamous portion narrow, reaching to end of antennular peduncle; lateral tooth reaching beyond carpocerite. Carpocerite 4.5 times as long as broad, reaching past end of antennular peduncle. Basicerite with acute lateral tooth.

Large chela 2.2 times as long as broad, with fingers occupying the distal 0.25. Plunger of dactylus long and heavy. Superior saddle U-shaped, proximal shoulder gradually rounded. Lateral palmar depression well defined, quadrangular, extending from saddle

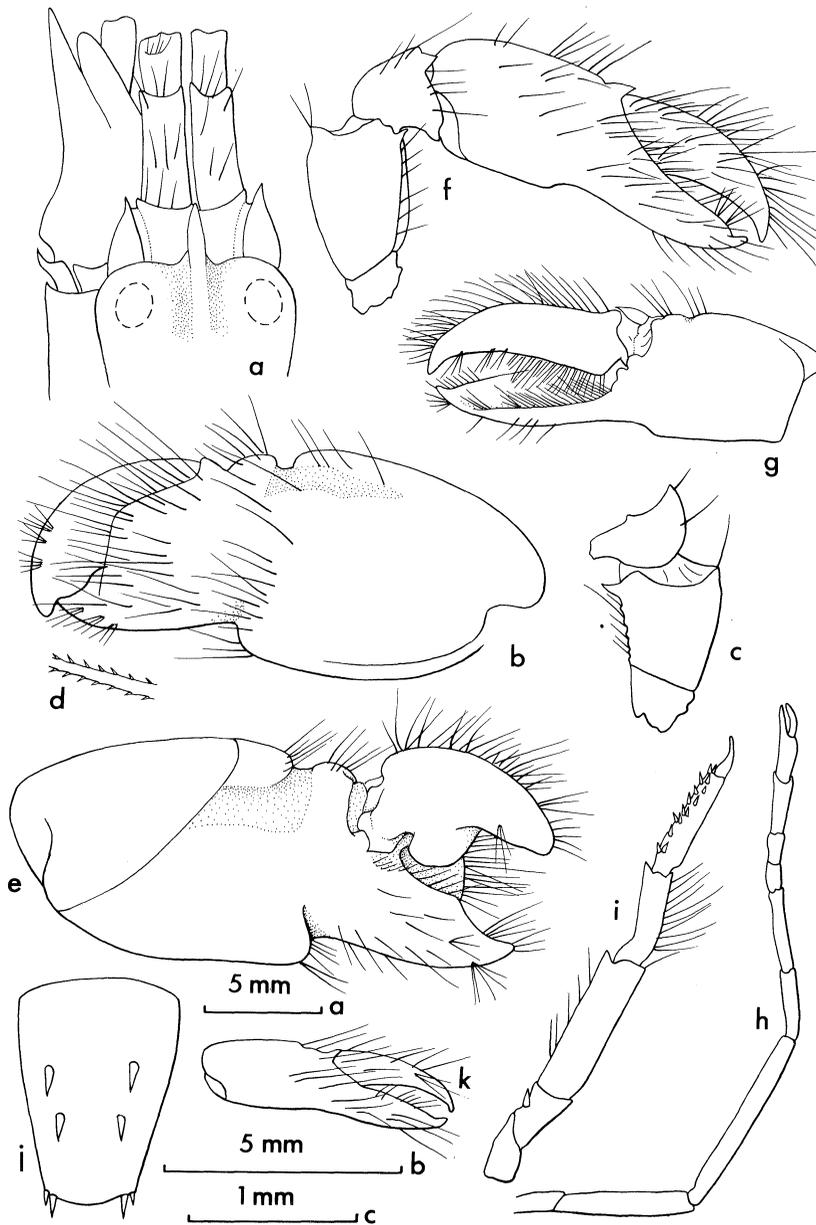


Fig. 57 *Alpheus edamensis* De Man

42 mm male from AM P. 14960. **a**. Anterior region, dorsal view; **b**, **c**. large chela and merus, medial face; **d**. detail of bristles of large chela; **e**. large chela, lateral face; **f**. small cheliped, medial face; **g**. small chela, lateral face; **h**. second leg; **i**. third leg; **j**. telson. 40 mm female from AM P. 14960. **k**. Small chela of female, medial face. **b**, **c**, **e**, **f**, **g**, **h**, **i**, **k** scale a; **a**, **j** scale b; **d** scale c.

groove proximally to *linea impressa*. Medial palmar depression extending proximally as a rough ill-defined triangle with apex near middle of palm. Inferior shoulder heavy, rounded and slightly projected. Inferior notch continuing into both lateral and medial face as poorly defined grooves. Medial face of chela hirsute in distal half. Merus nearly as broad as long with setae on its inferoventral margin and a strong distal tooth; other distal margins not projecting.

Small chela of male 3.0 times as long as broad with fingers slightly longer than palm. Dactylus broadened but without balaeniceps rows of hairs. Palm bearing trace of superior saddle and inferior shoulder and bearing strong tooth medial to dactylar articulation. Medial face of chela hirsute, hairs more abundant near fingers and directed forward. Lateral face of palm glabrous, lateral margin of pollex bearing patches of short stiff setae that cross with long, forward directed hairs on opposing margin of dactylus. Female chela more slender, 4.0 times as long as broad. Medial face less hirsute than in males; lateral face almost glabrous except near fingers. Merus of male similar to that of large chela, 1.5 times as long as broad and bearing on inferoventral margin short stiff setae and distally a strong tooth. Merus of female more slender, 2.0 times as long as broad.

Second legs with ratio: 10:12:3:3:7. Chela almost as long as last two articles.

Ischium of third leg with spine. Merus 4 times as long as broad with inferior margin projecting as an acute tooth distally and bearing several short fine setae. Carpus 0.6 as long as broad, both distal margins projecting as acute teeth. Propodus 0.7 as long as merus, bearing on inferior margin 14 short heavy spines with a pair distally. Dactylus simple, curved, 0.3 as long as propodus. Inferoventral margin of merus of fourth leg also armed distally.

Telson 2.4 times as long as posterior margin is broad. Dorsal spines with both posterior and anterior pair placed equal distance from middle.

DISCUSSION: Some confusion may arise with the differentiation of De Man in his key (1911:331) between this species and *A. funafutensis* Borradaile. The first two characteristics — the proportions of the merus of the third legs and the armature of the merus of the chelipeds — are valid, but for the third characteristic he states that the dactylus of the small chela of the male bears "a hairy crest on the inner side" in *A. edamensis* which is lacking in *A. funafutensis*. (Incidentally, *A. funafutensis*, which is known from the Malayo-Thai peninsula to the archipelagoes of the central Pacific, is not represented in the Australian collections). We interpreted this crest to be possibly like the crest observed in some of the species which have a sub-balaeniceps development; but we could not find it in any of the Australian specimens. De Man, who had no male specimens in his type material, has based his description on four specimens reported upon by Zehntner and also collected from Amboina. We were able to examine these same four specimens which were deposited in the Muséum d'Histoire Naturelle Ville de Genève through the courtesy of Dr Bernd Hauser, Curator of Arthropoda. We found that these males, too, lacked any marked setiferous crest; what De Man had interpreted as a crest was the rounded edge of the inner margin of the dactylus that had slightly more setae than elsewhere on the distal portions of the medial face of the chela. The small chela of Zehntner's specimen were exactly the same as the Australian specimens except that the larger males from Australia had more setae on the medial face than did Zehntner's smaller specimens. The separation between the two species otherwise is valid.

BIOLOGICAL NOTES: This species has been collected intertidally as well as dredged from 50 m. It is a large species, the largest in our collections being 48 mm.

AUSTRALIAN DISTRIBUTION: These specimens were all collected on the coast of Queensland from Princess Charlotte Bay to the Capricorn Group.

GENERAL DISTRIBUTION: Malaya; Thailand; Indonesia; Fiji; Samoa; Society Is.

***Alpheus hutchingsae* sp. nov.**

Fig. 58

HOLOTYPE: 11 mm female from Lizard Island, Qld. 75 LIZ-3 (AM P. 27252).

ALLOTYPE: 11 mm male from same collection as type (specimen mutilated). (AM P. 27253).

DIAGNOSIS: Rostrum triangular, a little longer than broad at base, reaching to near end of first antennular article; bearing rounded carina that extends just past base of eyes. Orbital margins regularly rounded and confluent with rostrum, not indented at base of rostrum. Orbital hoods moderately inflated forming moderately deep but rounded grooves between carina and orbital hoods. Visible part of first and third antennular articles equal, second article 2 times as long as first and 1.8 times as long as broad. Stylocerite acute, reaching end of first antennular article. Outer margin of scaphocerite concave, squamous portion reaching to last quarter of third antennular article, lateral tooth strong, reaching well past antennules; carpocerite reaching slightly past end of antennules. Basicerite bearing small but acute tooth.

Ratio of articles of third maxilliped: 10:2.5:6, tip blunt and with only sparse setae.

Large chela 2.5 times as long as wide, fingers occupying distal 0.3. Dactylus truncate, plunger low and confluent with margin of dactylus. Superior saddle narrow and shallow; proximal shoulder rounded, not overhanging; distal shoulder gradually rounded. Saddle continuing medially into small, poorly defined triangular depression, not reaching middle of palm and extending laterally into poorly defined quadrangular depression reaching slightly past mid-palm. Inferior shoulder low, rounded and followed distally on lateral face by small triangular depression. Medial face of chela lightly hirsute. Merus 2.8 times as long as broad, bearing a small acute tooth distally on inferointernal margin, superior margin terminating in rounded projection bearing a few setae.

Carpal articles of second leg with ratio: 10:5:2.5:2.5:4.

Ischium of third leg with spine. Merus 3.8 times as long as broad, bearing distally a small acute tooth, margins bearing scattered setae. Carpus 0.6 as long as merus, distal margins projected into rounded teeth. Propodus 0.7 as long as merus, bearing on its internal margin 6 spines and a pair distally; distal pair nearly as long as dactylus. Dactylus 0.3 as long as propodus, simple.

Telson 2.8 times as long as posterior margin is broad, and 2.2 times as broad anteriorly as posteriorly. Anterior pair of dorsal spines placed just anterior to middle.

DISCUSSION: We have two 11 mm specimens, one male and one female from Lizard Island. Of the two specimens the female is better preserved so we have designated it as the holotype. Both specimens lack the small chela and the male also lacks the large chela.

These specimens belong to that group of species in the Edwardsii Group that have a tooth on the merus of the third leg, a simple dactylus, and have the second carpal article of the second leg about half the length of the first; these include *A. hippothoe* De Man, *A.*

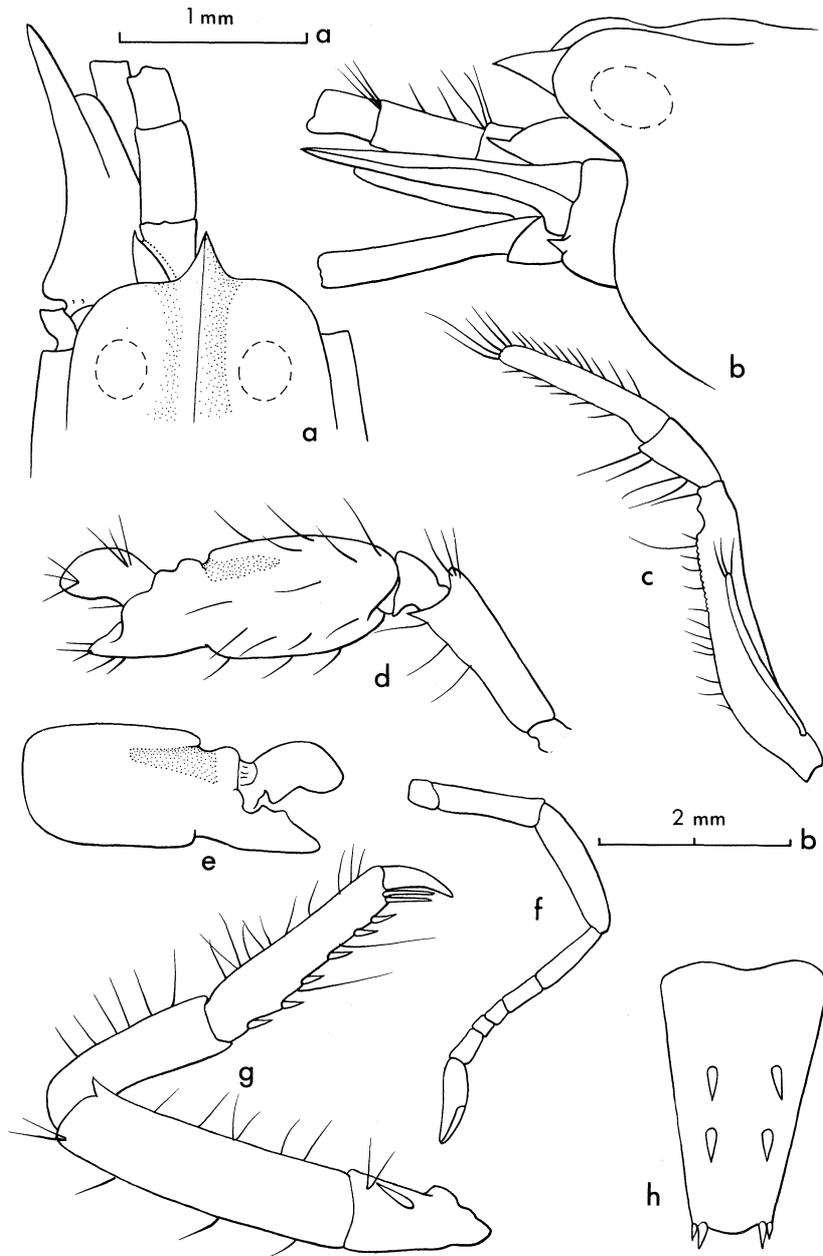


Fig. 58 *Alpheus hutchingsae* sp. nov.

Holotype (female). a, b. Anterior region, dorsal and lateral view; c. third maxilliped; d. large cheliped, medial face; e. large chela, lateral face; f. second leg; g. third leg; h. telson. a, b, c, f, g, h scale a; d, e scale b.

serenei Tiwari, *A. georgei* B&B and *A. euchiroides* Nobili. The group does not include *A. euchirus* Dana which lacks the tooth on the merus of the third leg (see discussion under *A. serenei*, p. 197). From all it differs in the confluence, without an indentation, of the orbital margins with the rostral margin, and in the small number of spines on the propodus of the third legs (even *A. euchiroides* has six pairs, rather than six spines).

The sculpturing of the large chela is markedly less than in all except *A. euchiroides*, but that species, to judge from Nobili's figure (1907:pl. 1, fig. 6b), has even less sculpturing than this species. We do not know if this species has a tendency to develop a notch on the dactylus of the third leg as does *A. serenei* and possibly *A. georgei*. There are other differences, some of which may be found to be significant when a greater series of specimens are studied, in the proportions of the antennular peduncle, the large chela and the third legs. It is unfortunate that the small chela of the male is not available as this often shows significant characteristics in the *Edwardsii* Group.

The species is named after Dr Patricia Hutchings of the Australian Museum who collected this and other interesting specimens for us at Lizard Island (see, for example, *Prionalphes*). The holotype and paratype will be placed in the Australian Museum, Sydney.

BIOLOGICAL NOTES: These specimens were collected in 35 ft of water, from a solid reef rock habitat and were found among the encrusting sponges and algae.

***Alpheus hippothoe* De Man**

Fig. 59

Alpheus hippothoe De Man, 1888b:268, pl. 17, fig. 1-5. Coutière, 1898i:197.

Nec Alpheus hippothoe Banner and Banner, 1966b:151, fig. 58 (= *A. serenei* Tiwari).

SPECIMENS EXAMINED: 2 specimens from AM 160 (AM P. 27800); 2, WM 26-65; 1, WM 79-65; 1, WM 156-65; 2, WM 172-65; 1, WM 217-65; 2, WM 233-65; 1, WM 279-65.

DIAGNOSIS: Rostrum slender, 2.5 times longer than broad, reaching to end of first antennular article; bearing rounded carina that extends to end of gastric region. Carina depressed between the moderately inflated orbits and rising abruptly just anterior to base of eyes so that in profile the carapace appears humped. Visible part of first and third antennular articles equal, second article more than twice as long as third and 2.7 times as long as broad. Stylocerite acute, reaching near end of first antennular article. Squamous portion of scaphocerite reduced and narrow, reaching near middle of third antennular article; lateral margin markedly concave, lateral tooth reaching well past antennular article. Carpocerite reaching slightly past end of lateral tooth of scaphocerite, four times as long as broad. Basicerite bearing narrow acute lateral tooth.

Second and third articles of third maxilliped bearing numerous slender setae on superior margin, distal end of third article with dense brush of long setae.

Large chela 2.3 times as long as wide, fingers occupying the distal 0.3. Dactylus truncate distally, plunger low and truncate. Proximal shoulder on superior margin rounded but strongly overhanging saddle; saddle deep, narrow, distal shoulder gradually rounded. Lateral palmar depression quadrangular, well defined, reaching to *linea impressa*. Medial palmar depression triangular, well defined, reaching proximally to middle of palm. Inferior shoulder heavy, rounded, at right angles to palm. Inferior notch continuing onto lateral face as a small but ill-defined triangular depression. Pollex bearing a longitudinal depression on lateral face placed well above the inferior margin and expanding proximally into a roughly triangular depression disappearing near middle

of chela; depression not confluent with inferior notch. Inferior notch continues onto the medial face as a slight diffuse triangular groove that extends somewhat proximally into palm. Medial face lightly hirsute. Merus 1.3 times as long as broad, superodistal margin slightly projected, rounded; inferodistal margin bearing a few fine setae and acute tooth distally.

Small chela stout, 2.7 times as long as broad, fingers a little shorter than palm. Palm without sculpturing except for a small rounded ridge on superior margin terminating in a subacute tooth on medial side of dactylar articulation. In small male specimens this shoulder is lacking. Opposing surfaces of fingers excavate. Medial face of chela moderately hirsute, more dense distally than proximally, lateral face nearly glabrous. Merus similar to that for large chela, but with inferodistal tooth reduced.

Carpal articles of second leg with a ratio: 10:5:2:2:4. Chela as long as last three articles.

Ischium of third leg bearing strong spine. Merus 3 times as long as broad, bearing strong acute tooth subterminally on inferior margin. Carpus 0.5 as long as merus, inferior and superior margins projected distally. Propodus 0.7 as long as merus, bearing on its inferior margin about 7 pairs of spines. Dactylus simple, 0.3 as long as propodus.

Telson 2.8 times as long as posterior margin is broad. Distal and proximal spines on dorsal surface located equidistance from midline. Distolateral margin on inner uropod bearing several heavy spines.

DISCUSSION: Evidently of the three specimens from the Mergui Archipelago that De Man based his description upon none was selected as the holotype, and the male and female from Sullivan Island were deposited in the Indian Museum in Calcutta and the lone male from King Island Bay in the British Museum (Natural History) in London. We have examined these three specimens as well as the two specimens collected by the Siboga Expedition from "Sulu-island" (=Jolo Is) that he identified as this species in the Zoologisch Museum in Amsterdam. Our specimens agree well with his specimens from Sulu, but we found the Australian specimens and the Sulu specimens differ slightly from those from Mergui. As De Man noted (1911:434) the meri of both chelipeds bear acute teeth in the Siboga specimens that are merely angular in the syntypes. On the small chela of the male in the Indian Museum there is a slight but definite transverse groove behind the dactylus that continues slightly into the lateral face of the palm, which is lacking on the female syntype while in the Australian males and females it is a slight notch leading to a flattened area behind the dactylar articulation. We regard these slight differences as unimportant, as did De Man with his Siboga specimens. We should note that De Man in his description overlooked the presence of a spine on the basicerite and we are including the drawing of the syntype at the British Museum (Natural History) to illustrate the characteristic.

This species is most closely related to *A. euchirus* Dana and *A. serenei* Tiwari. From both it differs in that the medial side of the dactylus of the small chela of the male bears many long setae, but none in a distinct crest while the other two species have a definite setiferous crest. In addition, in *A. hippothoe* the merus of the third leg is 3 times as long as broad and in *A. euchirus* it is over 4 times. In *A. hippothoe* the small chela is 2.6-2.8 times as long as broad, and the dactylus of the third leg is simple, whereas in *A. serenei* the small chela is more slender, 3.0-3.8 times as long as broad and the third legs have a secondary unguis on the dactylus.

BIOLOGICAL NOTES: This species is found most commonly in interstices of dead coral collected intertidally or in dredge hauls made in fairly shallow water. However, the

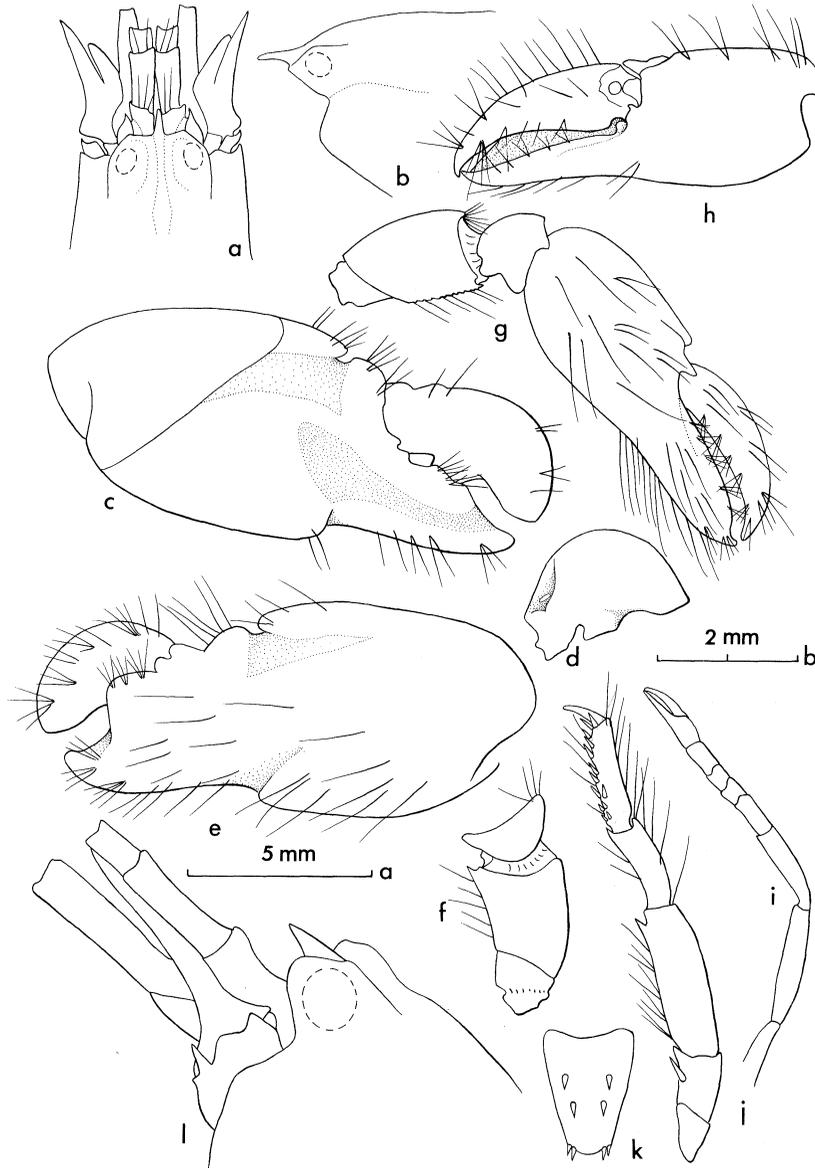


Fig. 59 *Alpheus hippothoe* De Man
 28 mm male from WM 172-65. **a, b.** Anterior region, dorsal and lateral view; **c, d.** large chela and dactylus, lateral and dorsal view; **e, f.** large chela and merus, medial and lateral view; **g.** small cheliped, medial view; **h.** small chela, lateral view; **i.** second leg; **j.** third leg; **k.** telson. Syntypic specimen, a 28 mm male, from the Mergui Archipelago. **l.** Anterior region, lateral view. **a, b, c, d, e, f, g, h, i, j, k** scale **a**; **l** scale **b**.

specimen from Bedout Island (WM 79-65) was collected at 25 fathoms. Coutière (1898i:197) reports on the colour for some specimens from Djibouti ". . . *marqué de bandes transversales vert olive, nuancées de brun clair, et la rame externe des uropodes porte . . . une tache bleue oculiforme sur son tiers distal.*" Our specimens range up to 30 mm in length.

AUSTRALIAN DISTRIBUTION: All except 2 of our specimens were collected from northwest Australia, the remaining two were collected near Darwin.

GENERAL DISTRIBUTION: Red Sea; South Africa; Indian Ocean; Malaysia; Indonesia; Philippines; Fiji; Tonga.

***Alpheus serenei* Tiwari**

Fig. 60

Alpheus serenei Tiwari, 1963:310, figs. 27, 28; 1964:314.

Alpheus hippothoe De Man var.? De Man, 1897:754, figs. 66-66c.

Alpheus euchirus Coutière, 1899 (*passim*). De Man, 1911:434; 1922:42, pl. 4, figs. 18, 18b (*partim*). Calman, 1939:209. Johnson, 1962a:54. (*Nec Dana, 1852.*)

Alpheus hippothoe Banner and Banner, 1966b:151, fig. 58. (*Nec De Man, 1888b.*)

SPECIMENS EXAMINED: 2 specimens from AM 200 (AM P. 28126); 2, BAU 27; 2, WM 233-65.

DIAGNOSIS: Rostrum reaching variously from middle to end of first antennular article. Rostral carina strong, depressed between anterior orbital hoods, rapidly rising near their posterior margins to form slight hump and continuing to middle of carapace. Orbitorostral grooves moderately shallow. Frontal borders of orbital hoods extended as slight arcuate prominences almost giving appearance of orbital teeth in lateral view. Second antennular article 2.5 times as long as broad, 1.7 times as long as first and 2.1 times as long as third. Stylocerite acute, reaching to end of first antennular article. Scaphocerite with squamous portion narrow, reaching to end of antennular peduncle; lateral tooth reaching well past end and equal in length to carapocerite. Inferior margin of basicerite with strong tooth.

Large cheliped 2.2 times as long as broad, with fingers occupying distal 0.35. Superior saddle deep, proximal shoulder overhanging groove, distal shoulder gradually rounded. Lateral depression quadrangular, extending to *linea impressa*, medial depression triangular with apex reaching proximally beyond middle of palm. Plunger of dactylus almost confluent with distal margin. Merus almost as broad distally as long, inferointernal margin projecting distally as strong tooth; superodistal angle slightly projecting but rounded.

Small chela of male 3.5 times as long as broad, palm without sculpture. Lengths of fingers and palm subequal, fingers slightly broadened proximally. Medial face of dactylus bearing an oblique crest of hairs that almost reaches superior surface. Medial face of chela moderately hirsute. Lateral face of dactylus with oblique ridge similar to medial face but much shorter and without hairs. Lateral face of chela nearly glabrous. Merus 2 times as long as broad, bearing small acute tooth distally on inferointernal margin. Small chela of female similar to male, but with oblique crest on medial face of dactylus lacking hairs.

Carpal article of second legs with a ratio: 10:5:2:2:4.

Ischium of third leg with heavy spine. Merus of third leg more than 4 times as long as broad, bearing large acute subapical tooth on inferior margin. Merus of fourth leg

bearing similar tooth but apically. Carpus 0.5 as long as merus; superodistal margin terminating in a rounded tooth, inferodistal margin terminating in a strong subacute tooth. Propodus 0.6 as long as merus, bearing on its superior margin long slender hairs and 8 pairs of spines on inferior margin. Dactylus 0.3 as long as propodus, usually bearing on its inferior surface a notch representing a secondary unguis, but notch at times lacking.

Telson 2 times as long as posterior margin is broad. Anterior pair of dorsal spines placed anterior to middle; distolateral margins of inner uropods bearing some small spines.

DISCUSSION: Our specimens vary only slightly from Tiwari's. The merus of the large cheliped and the telson are stouter, the first article of the second leg is shorter in relation to the second and the secondary unguis of the dactylus of the third leg appears almost obsolete in our specimens. However, these characters are variable and we do not attach any significance to the differences.

This species is very close to *A. euchirus* Dana and *A. hippothoe* De Man and has been confused with both species in the previous literature. The separation from *A. euchirus* is given below; possibly the best separation of it from *A. hippothoe* lies in the presence of the flattened area in front of the orbital hoods and the setiferous crest on the medial side of the dactylus of the small chela which are not found in *A. hippothoe*; the tendency to develop a notch on the inferior surface of the dactylus of the third leg has not been noted in *A. hippothoe* as well. Using these criteria, we now find that all of the 128 specimens we reported from Thailand are *A. serenei* although most of them lacked the trace of biunguiculation on the dactylus of the third legs.

This species is also similar in several ways to *A. georgei* and *A. hutchingsae*, both described as new in the adjacent sections; their separation will be discussed under each.

BIOLOGICAL NOTES: We reported that we found this species in Thailand in association with an ophiuroid which was identified by Dr Dennis Devaney of the Bishop Museum, Honolulu, Hawaii as *Macrophiothrix longipeda*. The ophiuroid was located in a deep recess at the base of a dead coral head and the shrimp was found at the mouth of the recess. Johnson (*loc. cit.*) found it was "a crevice dweller and thus limited to hard bottoms". This species has been collected in water as deep as 60 metres. Tiwari's specimens were taken from the "coral reef" in one metre of water and we have several specimens collected at about 3 metres in the southern Philippines. We have seen specimens up to 28 mm in length.

AUSTRALIAN DISTRIBUTION: Specimens came from Broome and Dampier Archipelago in Western Australia and from Torres Straits in northern Australia.

GENERAL DISTRIBUTION: Red Sea; Indonesia; Singapore; Gulf of Thailand; Vietnam; Philippines.

The identity of *A. euchirus* Dana, 1852

In 1852 (p. 545) Dana described a specimen (sex undesignated) as *A. euchirus* from the Balabac Straits, lying between northern Borneo and the Philippine island of Palawan. The depicted form of the large chela places this in the Edwardsii Group. In the description itself, in the key leading to the description of the species, and in the figures (which are very small, rendering it difficult to discern details), Dana specified certain characteristics that would separate this species from all of the others placed within the Edwardsii Group. As far as we can determine the holotype has been lost so Dana's description and figures

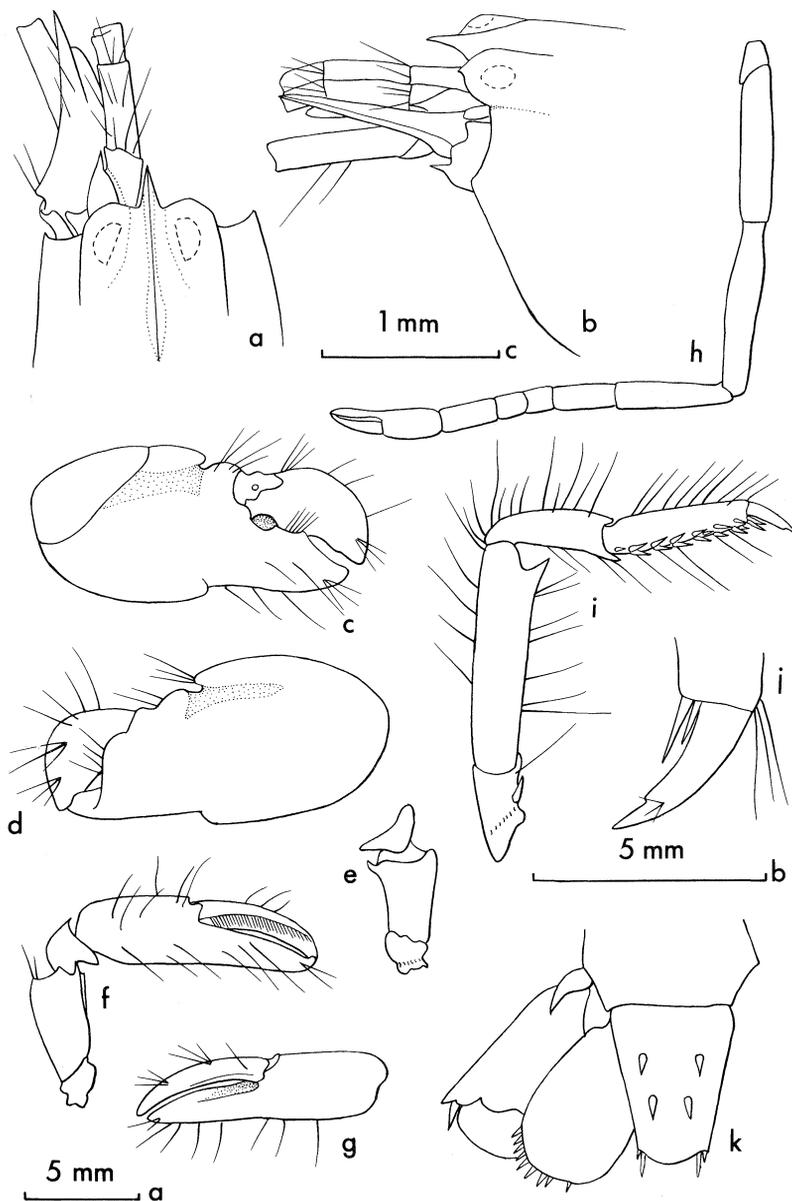


Fig. 60 *Alpheus serenei* Tiwari

30 mm male from BAU 27. **a, b.** Anterior region, dorsal and lateral view; **c.** large chela, lateral face; **d,** **e.** large chela and merus, medial face; **f.** small cheliped, medial face; **g.** small chela, lateral face; **h.** second leg; **i, j.** third leg and enlarged dactylus; **k.** telson and uropods. **c, d, e, f, g** scale **a**; **a, b, h, i, k** scale **b**; **j** scale **c**.

alone must be used to establish the characteristics of the species. Using these sources in Dana, we have assembled a description of the species as follows:

Rostrum acute, reaching to near end of first antennular article, continued posteriorly between eyes as a carina. Margins of orbital hoods armed with small teeth. Second antennular article a little longer than first. Scaphocerite not longer than carapocerite. Spine on basicerite absent or obsolescent (not shown at all in fig. 6a).

Third article of third maxilliped tapering to narrow tip; superior margin and tip carrying long setae, with those of tip about equal in length to article.

Large chela about twice as long as broad, with fingers about half as long and half as broad as palm. Superior saddle not well marked distally, with proximal shoulder apparently not overhanging floor of groove; inferior shoulder heavy but not acute; an apparent groove or rounded ridge reaching on outer face from *linea impressa* to superior saddle. Merus not spinose on apex. Small chela with fingers heavy, not balaeniceps (in specimen drawn), slightly longer than palm; palm about 1.2 times as long as broad. Both chelae with light pubescence on both faces, but with more hair on superior portions of inner faces.

Second legs a little longer than third, with first carpal article twice length of second and chela "hardly shorter than sum of three preceding".

Third and fourth legs "sparingly hairy". Merus of third legs about 4 times as long as broad, "very short acute at inner apex" (yet specified in dichotomy A of key as "*omnino inermis*" and shown in figure 6f as having the inferior margin meet the distal margin at approximately a right angle). Propodus "with seven or eight sets of spinules" on inferior margin.

Length "three-fourths of an inch" (19 mm).

The outstanding characteristics of the species would be these: First, and most important, would be the orbital teeth and we can see no other interpretation of Dana's key characteristic of "*b. Orbitae margo spinula armatus*" and his depiction of a short thin tooth in side view; this characteristic is unique within the Edwardsii Group. Other characteristics would include the reduced or absent tooth on the basicerite; the tapering third article of the third maxilliped; the lack of a tooth on the merus of the large cheliped; and the lack of a tooth on the merus of the third leg. All of these characteristics separate *A. euchirus* from *A. serenei*, *A. hutchingsae* B&B and *A. georgei* B&B.

The species has been reported a few times in the literature since its description. Coutière in 1899 reported a single specimen from Djibouti (p. 488) but he specified that the merus of the third leg carried a tooth (p. 260) which is contrary to Dana's characterization. De Man also applied Dana's name to some specimens in 1911 (p. 434) and 1922 (p. 42) (and retroactively, to specimens he had reported in 1897:754 and 1898c:210 as *A. hippothoe* var. ?); he had Coutière's specimen for comparison and while all of the specimens were somewhat similar, he was doubtful if the group was identical with the species described by Dana. He thought that a rounded shelf extending in front of the margins of the orbital hoods might, in side view, be confused with an orbital tooth; he had misgivings about the presence of a tooth on the merus of the large chela, but he rather ignored the fact that in all the specimens the inferodistal angle of the third legs projected as an acute tooth. Through the courtesy of the Zoologisch Museum in Amsterdam we were able to examine the 10 specimens De Man reported in 1911 and the 4 specimens reported in 1922 and found all, save one, to have the characteristics of *A. serenei* and not those given by Dana. The one specimen, that from Sumatra, is *A. georgei*

that we are describing below. We were unable to locate either Coutière's specimen or the six that De Man had earlier reported as *A. hippothoe* var.? from Atjeh, but we presume that as De Man had examined them and found them similar to the 1911 specimens, they, too, were *A. serenei*.

The name *A. euchirus* was also used by Calman for a male and a female specimen from the Red Sea (1939:209). These, too, we were able to examine through the courtesy of the British Museum (Natural History). They differed from *A. serenei* of the western Pacific in only three characteristics; (1) the dactylus of the small chela of the male had a setiferous fringe on both faces; (2) the merus of the third leg carried only a small apical tooth and that of the fourth leg was inermous, while in the Pacific specimens the tooth on the third leg was larger and slightly subapical and the fourth leg had a small apical tooth; (3) the dactylus of the third legs in both specimens were devoid of any indication of biunguiculation (a characteristic we found in many of our Thai specimens). These characteristics may be found in the future to be adequate for a subspecific separation of the two forms.

The last person to use the name *A. euchirus* was Johnson (1962a:54) who found the form he discussed to be common in the waters about Singapore. Through the courtesy of Dr S. H. Chuang of the University of Singapore we were able to examine three of the specimens Johnson called *A. euchirus*. These specimens agree exactly with Tiwari's description of *A. serenei* and with the Australian and Thai specimens except all three lacked the biunguiculate dactylus on the third legs, but that is, as we have pointed out above, a variable characteristic.

We had the hope that in our extensive collections made in southern Mindanao and the Sulu Archipelago in the Philippines, only about 600 miles east of Balabac Straits, we would have one or more specimens that could be identified as *A. euchirus* without any question, but no such specimens were found. We conclude that if Dana's description of *A. euchirus* is correct, there is no way to expand upon it unless a very similar form is found in the type location and is used as a neotype. A similar situation has occurred in *A. pugnax* that Dana described from the island of Maui, Hawaiian Islands (1852:554). The species is clearly defined and can easily be separated from all related forms in the Hawaiian Islands, yet has never been reported since the original record in spite of the fact that we have made many trips to the type locality to search for it (Banner, 1953:116).

***Alpheus georgei* sp. nov.**

Fig. 61

Alpheus euchirus De Man, 1922:42 (*partim*), pl. 4, figs. 18, 18b. (*Nec* Dana, 1852. see p.303).

HOLOTYPE: 22 mm male from 40 mi. W. of Cape Jaubert. 23 fms. Collected by R. W. George on the Dorothea, 13/10/62, from sponge. (WM 226-65).

ALLOTYPE: "1 full-grown (37 mm) ova-bearing female collected 10 May by Mr Van Nohuys west of Segli, north coast of Sumatra, at a depth of 72-126 m." (De Man, *loc. cit.*)

DIAGNOSIS: Rostrum triangular, as long as broad at base, tip rounded, reaching to last quarter of visible part of first antennular article. Orbitorostral grooves shallow, disappearing just posterior to orbital hoods. Rostral carina rounded. Frontal border of orbital hoods extended as slight arcuate prominences giving appearance of small orbital teeth when seen in lateral view. Second antennular article 1.6 times as long as broad and visible part of first antennular article and third article equal in length, 0.6 as long as

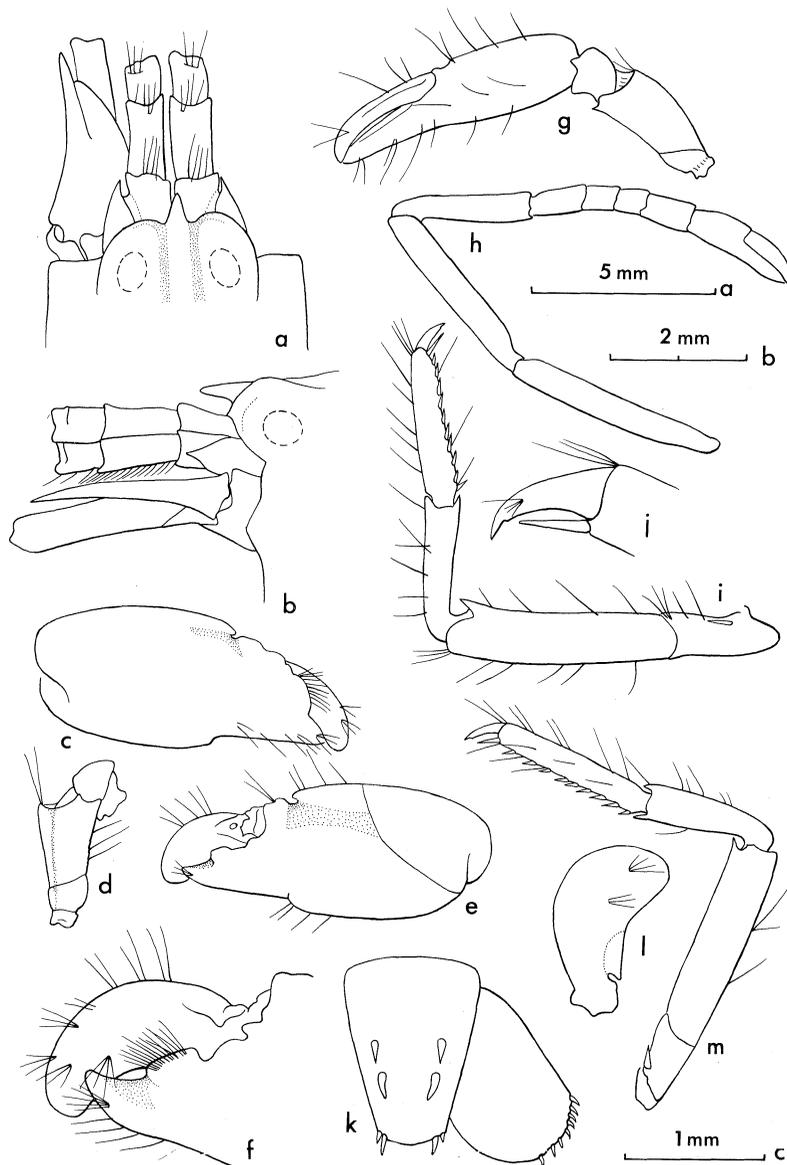


Fig. 61 *Alpheus georgei* sp. nov.

Holotype (22 mm male). **a, b.** Anterior region, dorsal and lateral view; **c, d.** large chela and merus, medial face; **e, f.** large chela and enlarged distal portion, lateral face; **g.** small cheliped, medial face; **h.** second leg; **i, j.** third leg and enlarged dactylus; **k.** telson and uropods. Allotype, 37 mm female from Sumatra (= *A. euchirus* Dana of De Man, 1922 see text). **l.** Dactylus large chela; **m.** third leg. **c, d, e, g, l, m** scale a; **a, b, f, h, i, k** scale b; **j** scale c.

second. Stylocerite acute, reaching to end of first antennular article. Scaphocerite with squamous portion narrow, reaching to end of antennular peduncle, lateral tooth reaching well past end of squame, nearly equal in length to carpocerite. Carpocerite reaching past the third antennular article by 0.7 its length. Inferior margin of basicerite with acute tooth.

Ratio of articles of third maxilliped: 10:3:6.6.

Large cheliped 2.4 times as long as broad with fingers occupying the distal 0.3; palm 2.0 times as wide as fingers. Superior saddle deep, proximal shoulder overhanging, distal shoulder gradually rounded. Lateral depression quadrangular, extending to *linea impressa*, medial depression triangular reaching to almost half length of palm. Inferior shoulder rounded, only moderately heavy, not extended. Dactylus moderately compressed, truncate at tip and markedly overhanging pollex. Distal margin of plunger almost confluent with cutting edge. Merus 1.7 times as long as broad, inferoventral margin bearing several long setae, terminating in a strong rounded tooth, superodistal and inferoexternal margins not projected distally.

Small chela of male 3.7 times as long as broad, fingers and palm almost equal. Palm without grooves, terminating in a small subacute tooth at dactylar articulation, medial face lightly hirsute, lateral face glabrous. Medial face of dactylus bearing a slight longitudinal crest in the proximal 0.7 which does not have the usual setae. Merus similar to that of large chela, but inferoventral margin terminates in an acute tooth.

Carpal articles of second leg with ratio: 10:4:2:2:5.

Following leg detached, presumed from proportions of paratype to be third. Ischium with spine. Merus 4 times as long as broad, bearing large acute tooth distally on inferior margin. Carpus 0.6 as long as merus; superodistal margin terminating in a rounded tooth, inferodistal margin terminating in a strong acute tooth. Propodus 0.7 as long as merus, bearing on or near inferior margin 3 pairs of spines, 6 single spines and a pair distally; margin also carrying several long slender setae. Dactylus 0.2 as long as propodus, bearing on its inferior surface the vestige of a secondary unguis near the distal one-fifth.

Telson 3 times as long as posterior margin is broad. Spines on dorsal surface heavy, much larger than posterolateral spines, anterior pair of dorsal spines placed anterior to middle. Posterolateral margins or inner uropod bearing some acute spines.

DISCUSSION: In 1922 De Man separated a 37 mm female from Sumatra from a group of 4 specimens that he regarded as *A. euchirus* Dana. We have been able to re-examine this group of specimens through the courtesy of the Zoologisch Museum in Amsterdam and find the two specimens from Aru Island and the specimen from the Bay of Batavia to be *A. serenei* Tiwari (see above). The specimen from Sumatra, however, is plainly different and resembles the specimen from off Cape Jaubert. The two specimens differ only in the tooth on the merus of the third leg which is small in the Sumatra specimen and larger in the Australian. The differences between these two specimens and *A. serenei* are: (1) The rostrum is as long as broad with a rounded tip while in *A. serenei* the rostrum varies from 1.7-2.5 times as long as broad with an acute tip. (2) The dactylus of the large chela of *A. georgei* markedly overhangs the pollex and is longer and more compressed in the distal region than *A. serenei*. (3) The palm of the large chela in *A. serenei* is 1.5 times as high as the fingers while in *A. georgei* it is 2 times. (4) The dactylus of the small chela of the male (our specimen) does not have a hairy crest on the medial surface typical of *A. serenei*, but merely the crest without hairs. (5) Finally, the propodus of the third leg in *A. serenei* bears about 20 spines usually set in pairs while in *A. georgei* there are only 11 spines with only 6 set in pairs. The third leg in *A. serenei* is more hirsute than in *A. georgei*.

This species has none of the outstanding characteristics of *A. euchirus* (given above under the discussion for *A. serenei*).

The differences in characteristics discussed above are subject to variation in other species and we hesitate to describe this species as new. Still we feel the marked difference in the anterior region of the carapace and the distal region of the large chela are sufficient to separate this species. It should be mentioned that De Man's specimen lacks the distolateral spines on the inner uropod and also the strong spine on the posterolateral margins of the outer uropods. These appear to have been broken off.

The species is named for R. W. George of the Western Australian Museum who collected the holotype and who has given us much help with the collections from the Western Australian Museum. The holotype will be placed in the Western Australian Museum and the paratype is at the Zoologisch Museum in Amsterdam.

***Alpheus maindroni* Coutière**

Fig. 62

Alpheus maindroni Coutière, 1898b:133, figs. 2, 2'.

SPECIMENS EXAMINED: 1 specimen from AM P. 11359; 2, BAU 10.

DIAGNOSIS: Rostrum slightly longer than broad at base, reaching not quite to middle of first antennular article. Rostrum with prominent but rounded short carina that extends only to base of eyes. Orbitorostral grooves shallow. Anterior margin of carapace between rostrum and orbital hoods extended as slight arcuate prominences; margins of orbital hoods rounded. Visible part of first and second antennular article equal and third article a little shorter; second article 1.5 times as long as broad. Stylocerite acute, reaching to end of first antennular article. Squamous portion of scaphocerite of moderate width, reaching to middle of third antennular article; lateral tooth prominent and reaching beyond end of third antennular article. Carpocerite 4.3 times as long as broad viewed laterally, reaching length of third antennular article past that article. Inferior margin of basicerite with slender acute tooth.

Large chela compressed, 2.5 times as long as broad, fingers occupying distal 0.3; palm 1.4 times as wide as fingers. Superior saddle reduced, forming a shallow oblique groove, not continuing into medial palmar depression; lateral palmar depression a narrow deep longitudinal groove running distally from *linea impressa* that may or may not join depression of superior saddle. Inferior shoulder rounded, lying at right angles to palm; inferomedial depression a well-defined and U-shaped groove 0.3 height of palmar face; inferolateral depression triangular extending on to palm 0.3 height of the palm. Plunger of dactylus prominent. Merus 2.2 times as long as broad with small acute tooth distally on inferointernal margins.

Small chela not sexually dimorphic, 3.0 times as long as broad, fingers 1.1 times length of palm. Palm bearing rounded tooth medially at dactylar articulation and slightly constricted in width at this point. Medial face of fingers moderately hirsute, bearing numerous scattered patches of short setae interspersed with longer setae. Lateral face of fingers glabrous. Merus similar to that of large chela, 2.5 times as long as broad, bearing acute tooth distally on inferointernal margin.

Ratio of articles of carpus of second leg: 10:4:2:2:4.

Ischium and merus of third leg unarmed; merus 4 times as long as broad. Carpus 0.6 as long as merus, both distal margins slightly projected, inferodistal rounded, superodistal projection acute. Propodus only slightly longer than carpus, bearing on its



Fig. 62 *Alpheus maindroni* Coutière
 20 mm female from BAU 10. **a.** Anterior region, dorsal view; **b.** large cheliped, medial face; **c, d.** large chela and dactylus, lateral face; **e.** small cheliped; **f.** second leg; **g.** third leg; **h.** telson. All figures same scale.

inferior margin 7 slender spines and a pair distally. Dactylus simple, acute, 0.3 as long as propodus.

Telson 2.5 times as long as posterior margin, anterior pair of spines on dorsal surface placed just anterior to midline.

DISCUSSION: This species resembles most closely *A. parvirostris* Dana. However, it lacks the tooth on the merus of the third leg and the prominent inferior tooth on the basicerite. The projections between the rostrum and the orbital hoods are similar to, but smaller than those of *A. parvirostris*. We examined the holotype of *A. maindroni* at the University Museum of Zoology in Cambridge, England. We found our specimens agree very well except the superior saddle of the large chela on the holotype does not continue into the lateral palmar depression but terminates just short of it. We interpret this as an individual difference.

BIOLOGICAL NOTES: The two specimens we personally collected came from the reef flat from dead coral heads. We have one specimen in our collections from the Philippines that appeared to be living commensally with a fire worm (genus *Eurythoe*). Coutière reports the following colour notes. “. . . faiblement coloré avec quelques bandes diffuses d'un rouge clair sur le thorax et l'abdomen. Les pinces sont marquées irrégulièrement de taches blanches et rouges sur la face supérieure ou interne, surtout à l'extrémité des doigts et au bord antéro-distal de la paume” Our specimens range in size from 15 to 26 mm.

AUSTRALIAN DISTRIBUTION: Two specimens were collected at Green Island, near Cairns, Qld., and one from near Angourie, N.S.W.

GENERAL DISTRIBUTION: Mascate (Gulf of Oman), Djibouti and the southern Philippines.

***Alpheus dolerus* Banner**

Fig. 63

Alpheus dolerus Banner, 1956:362, fig. 21.

SPECIMENS EXAMINED: 1 specimen from AM 74 (AM P. 27472); 3, BAU 29; 7, BAU 32; 4, BAU 56; 1, US 123601.

DIAGNOSIS: Rostrum acute, bearing a few stiff setae on margins, reaching to distal half of first antennular article, with rounded carina continuing posteriorly to slightly behind corneas. Orbitorostral grooves shallow, extending just past base of eyes. Anterior margins of orbital hoods rounded and bearing a stiff seta on margin of orbitorostral concavity. First and second antennular articles subequal, second article twice as long as broad, third article slightly shorter than second. Lateral spine of stylocerite reaching to end of first antennular article. Lateral tooth of scaphocerite reaching beyond end of antennular peduncle, squamous portion reaching to end of peduncle. Carpcerite only slightly longer than peduncle. Lateral spine of basicerite small but acute.

Large chela 2.3 times as long as broad with fingers occupying the distal 0.3. Superior margin with U-shaped saddle; proximal shoulder rounded, not overhanging saddle; distal shoulder gradually rounded. Lateral palmar depression well-defined, quadrangular, continued proximally to *linea impressa*. Medial palmar depression well-defined, triangular, apex reaching middle of palm. Inferior shoulder heavy, rounded and continues as slight shoulder to middle of lateral face. Inferolateral depression shallow, no inferomedial depression. Plunger well developed. Merus 2 times

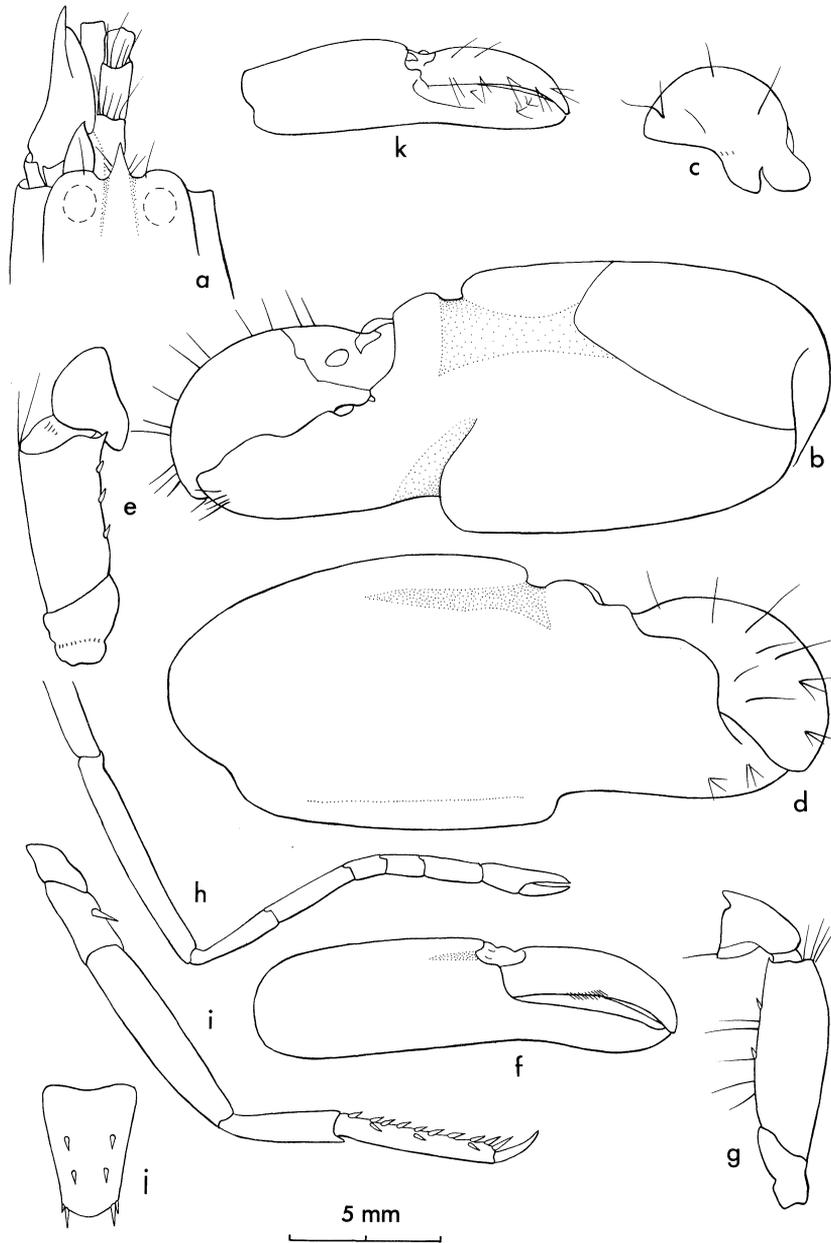


Fig. 63 *Alpheus dolerus* Banner
 17 mm male from BAU 29. **a.** Anterior region, dorsal view; **b, c.** large chela and dactylus, lateral face; **d, e.** large chela and merus, medial face; **f, g.** small chela, lateral face, and merus, medial face; **h.** second leg; **i.** third leg; **j.** telson. 16 mm female from BAU 29. **k.** Small chela, lateral face. All figures same scale.

as long as broad, bearing 2 or 3 spines on inferointernal margin and an acute tooth distally.

Small chela of male 3.5 times as long as broad, fingers and palm equal in length. Superior margin of palm proximal to dactylar articulation developed as a rounded ridge flanked by a shallow depression on either side; articulation without teeth. Dactylus slightly expanded proximally on lateral face, with expansion bearing row of short setae. Both finger and pollex bearing knife-like ridges on medial side of opposite faces that meet when chela is closed; tips somewhat curved and crossing when closed. Merus similar to that of large chela but more slender. Small chela of female more slender, 2.8 times as long as broad, but usually without setiferous crests on dactyl.

Carpus of second legs with ratio: 10:11:4:4:7.

Ischium of third leg bearing strong spine. Merus 4.8 times as long as broad, inermous. Carpus 0.5 length of merus, superodistal and inferodistal margins produced but rounded. Propodus 0.7 as long as merus, bearing 11 spines on or near inferior margin and a pair distally. Dactylus simple, 0.25 length of merus.

Telson 2.4 times as long as posterior margin is broad, posterior margin broadly arcuate. Inner spine of posterior pair much longer than outer.

DISCUSSION: The variation in this species is not marked: 1. The tip of the rostrum may reach from middle to end of first antennular article. 2. The setiferous expansion on the dactyl of the small chela of the male is at times heavier than the one figured (fig. 63f) and we have even seen females with a slightly developed comparable row of setae. 3. The first articles of the second leg may be slightly longer or shorter than the second. 4. Finally, the telson may be somewhat more slender than that described.

This species is most closely related to *A. leptochirus* Coutière which has not been reported from Australia, but the appendages in *A. leptochirus* are much more slender. In *A. leptochirus* the large chela is over 3 times as long as broad and the merus of the third leg is 7 times as long as broad. The grooves on the superior and inferior border and the lateral depression much less pronounced. On the small chela of the male the setiferous crests on the dactyl extend around the margins and meet on the superior surface in *A. leptochirus*. Finally, the orbital margins do not bear the 2 stiff setae that are so characteristic of *A. dolerus*.

BIOLOGICAL NOTES: This species has only been collected by breaking up coral heads from not more than 15 ft deep. It is not a large species, the largest specimen in the present collections being only 18 mm long.

AUSTRALIAN DISTRIBUTION: This species has been collected from Diamond Islet in the Coral Sea, south to Heron Island in the Capricorn Group.

GENERAL DISTRIBUTION: To date this species is known only from Pacific Islands: Marianas, Marshall, Gilbert, Cook and Society Islands; we have some as yet unreported from the Philippines.

***Alpheus malabaricus trefzae* subspec. nov.**

Fig. 64

HOLOTYPE: 18 mm female from Brammo Bay, Dunk Is., (near Tully), northern Queensland. Collected by Shirley Trefz, 2/6/73, from rocky shore in sandy-muddy

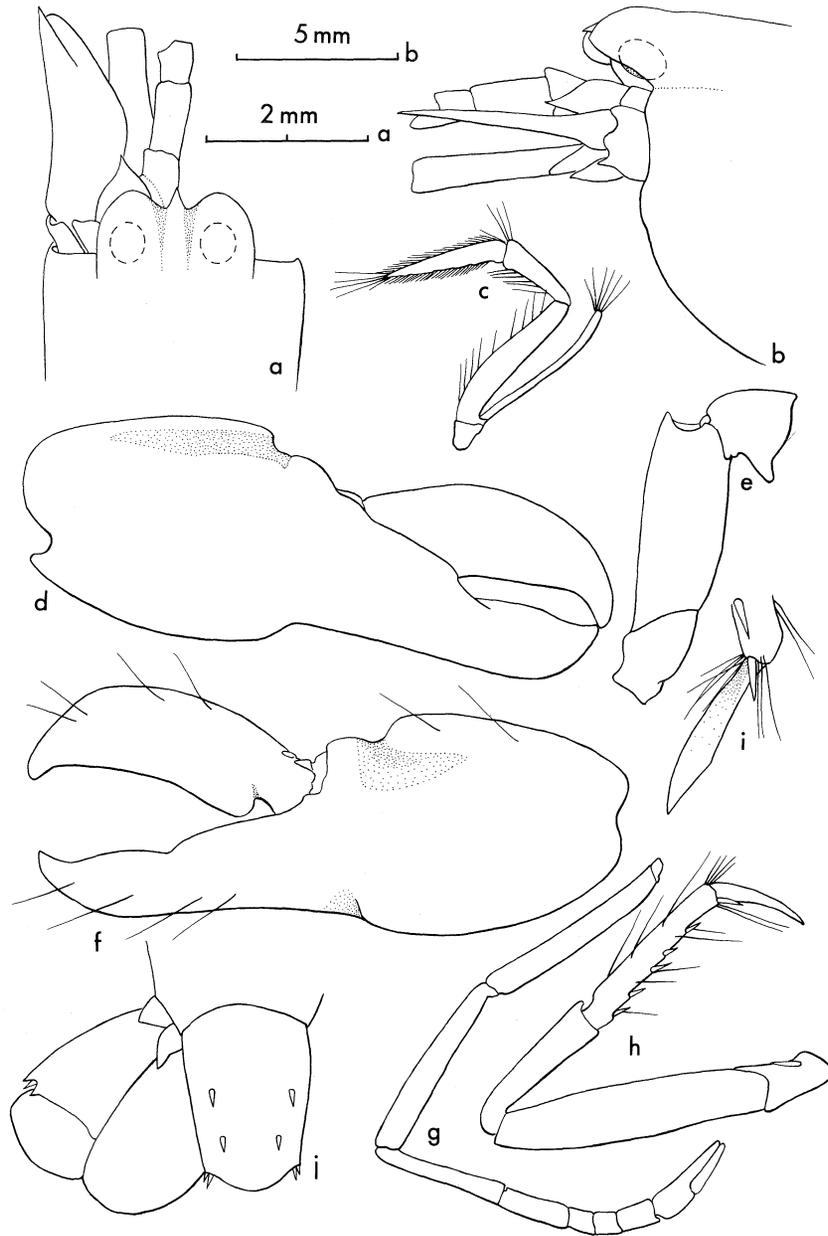


Fig. 64 *Alpheus malabaricus trefzae* subsp. nov.

Holotype (female). **a, b.** Anterior region, dorsal and lateral view; **c.** third maxilliped, lateral face; **d, e.** large chela and merus, medial face; **f.** large chela, lateral face; **g.** second leg; **h, i.** third leg and enlarged dactylus; **j.** telson and uropods. **a, b, c, d, e, f, g, h, j** scale a; **i** scale b.

substrate at 0.0 tide level. (JG 20-73).

DIAGNOSIS: Orbital hoods and rostrum protruding far beyond anterolateral margins of carapace. Orbital hoods inflated, high, rounded; rostrum short, scarcely reaching beyond anterior margin of orbital hoods. Carina short, rounded, reaching only to base of eyehoods; orbitorostral grooves shallow and not extending beyond base of orbits. Visible part of first antennular article 0.7 as long as second; second twice as long as wide; third 0.6 as long as second. Stylocerite acute, reaching to end of first antennular article. Outer margin of scaphocerite slightly concave, lateral tooth reaching well beyond antennular peduncle, squamous portion narrow, only slightly shorter than lateral tooth. Carpocerite reaching only slightly past end of antennular peduncle. Basicerite with acute lateral tooth.

Articles of third maxilliped beginning at base 10:5:7. All articles slender, tip of third article bearing a scant brush of hairs.

Large chela compressed, 2.7 times as long as broad; fingers equal in length to palm, palm 1.4 times wider than fingers when closed. Palm with superior saddle rounded, with proximal shoulder heavy but rounded, distal shoulder evenly rounded and lower than proximal. Lateral palmar depression triangular, well defined, apex reaching to about middle of palm; medial palmar depression faint, bordered on lower margin in proximal part by a slight shoulder, with apex of depression reaching to proximal 0.2 of palm. Inferior shoulder low in profile, rounded, inferolateral depression slight, inferomedial depression lacking. Distal portion of both fingers somewhat hooked and crossing but with tips rounded. Plunger of dactylus low, with distal margin confluent with cutting edge of dactylus. Merus 2.4 times as long as wide, bearing subterminally on inferointernal margin a small acute tooth. Small cheliped missing.

Carpal articles of the second leg with ratio: 10:5:2:2:3; chela as long as sum of last three articles.

Ischium of third leg with spine. Merus unarmed, 5 times as long as broad. Carpus 0.5 as long as merus, superodistal margin slightly projected. Propodus 0.6 as long as merus, bearing on its inferior face 5 spines and a pair distally, interspersed with long setae. Superior margin also bearing many long setae. Dactylus 0.4 as long as propodus, spatulate and slightly excavate on its inferior surface.

Telson twice as long as posterior margin is broad, base 1.4 times as broad as tip; tip strongly convex; anterior pair of dorsal spines placed at middle, posterolateral spines small. Articulation of the outer uropod nearly straight.

DISCUSSION: The following four subspecies of this nominate species have been separated: *A. m. malabaricus* Fabricius from the Malabar coast of India; *A. m. dolichodactylus* Ortman from Tokyo Bay; *A. m. leptopus* De Man from Indonesia; and *A. m. songkla* B&B from peninsular Thailand. In addition *A. m. mackayi* B. was described from the Hawaiian Islands, but it was later elevated to specific rank (B&B, 1974:428). These subspecies differ one from another in a series of characteristics such as the size of the rostrum, the armature of the merus of the large cheliped and the proportions of the third legs; however, the principal difference was found in the proportions of the small cheliped and the shape of its fingers. As this Australian form is lacking the small cheliped, contrast cannot be made upon this point. The most important difference appears to us to be in the proportions between the fingers and the palm of the large chela which in this subspecies are approximately equal, but in the other subspecies the palm varies from 1.3-2.2 times the length of the fingers. In all other subspecies the rostrum reaches well beyond the orbital hoods, and in all except *A. m. songkla* the merus of the large chela has

a terminal rather than a subterminal tooth while in *A. m. songkla* this tooth is absent. Finally, in *A. m. songkla* and the Australian subspecies the first two carpal articles of the second leg bear the ratio of approximately 10:5 while in the others these articles are approximately equal.

BIOLOGICAL NOTES: Most, if not all, of the forms of this species have been reported from muddy and usually estuarine conditions (*A.m. malabaricus* "From the backwater at Pulicat (India) and apparently burrowing in a muddy bottom" Henderson (1893:434); *A. m. dolichodactylus* from "Tokyo Bay"; *A. m. leptopus* from various types of muddy bottoms from 18-289 metres; *A. m. songkla* from the muddy bottom of a shallow brackish water lake. *A. mackayi* came from the muddy bottom of a brackish Hawaiian fishpond.) Dr Shirley Trefz described the habitat on Brammo Bay, Dunk Island as having a substrate with a mixture of sand and mud, not so soft that a person walking would sink into it more than a centimetre or so; there were no permanent streams on Dunk Island, but at the time of her visit after heavy rains, there appeared to be brackish water seeping onto the beach at low tide from an island freshwater lens. At the time of her visit the waters around Dunk Island were heavy with sediments, presumably from the rains. The specimen was collected from a burrow under a rock on the substrate either in the lowest intertidal or the immediate subtidal zone (the island was visited at a period of neap tides).

The subspecies is named in honour of Dr Shirley Trefz of Leeward Community College, Honolulu, Hawaii, our personal friend who has often supplied us with specimens. The holotype will be placed in the Australian Museum, Sydney, N.S.W.

GENERAL DISTRIBUTION: The other subspecies are known from East Africa to Hawaii, but have not been collected from Australia.

***Alpheus macrodactylus* Ortmann**

Fig. 65

Alpheus macrodactylus Ortmann, 1890:473, pl. 36, fig. 10. De Man, 1898b:321, pl. 4, fig. 4.

Nec Alpheus macrodactylus Coutière, 1898c:196. (See below).

Previous Australian record:

Ortmann, *loc. cit.* Sydney N.S.W.

SPECIMENS EXAMINED: 3 specimens from AM P. 4288.

DIAGNOSIS: Rostrum slender, longer than broad at base, with slightly rounded carina; orbitorostral grooves not deep and disappearing at base of eyes. Anterior margins of orbital hoods convex, orbitorostral margins recessed at base of rostrum. Second antennular article 1.3 times longer than visible part of first antennular article and twice as long as broad; third article 0.5 as long as second. Stylocerite acute, reaching near end of first antennular article. Squamous portion of scaphocerite moderately broad, reaching to end of antennular peduncle, lateral tooth a little longer. Carpocerite stout, 3.2 times as long as broad, reaching to end of antennular peduncle. Basicerite with small acute lateral tooth.

Large chela 2.3 times as long as broad, fingers as long as palm. Superior saddle broad and shallow. Proximal and distal shoulders gradually rounded. Lateral palmar depression shallow, quadrangular, reaching to *linea impessa*. Medial palmar depression a well-defined narrow triangle with apex almost reaching to proximal end of palm. Inferior shoulder pronounced, rounded, making less than a right angle to lower margin of palm.

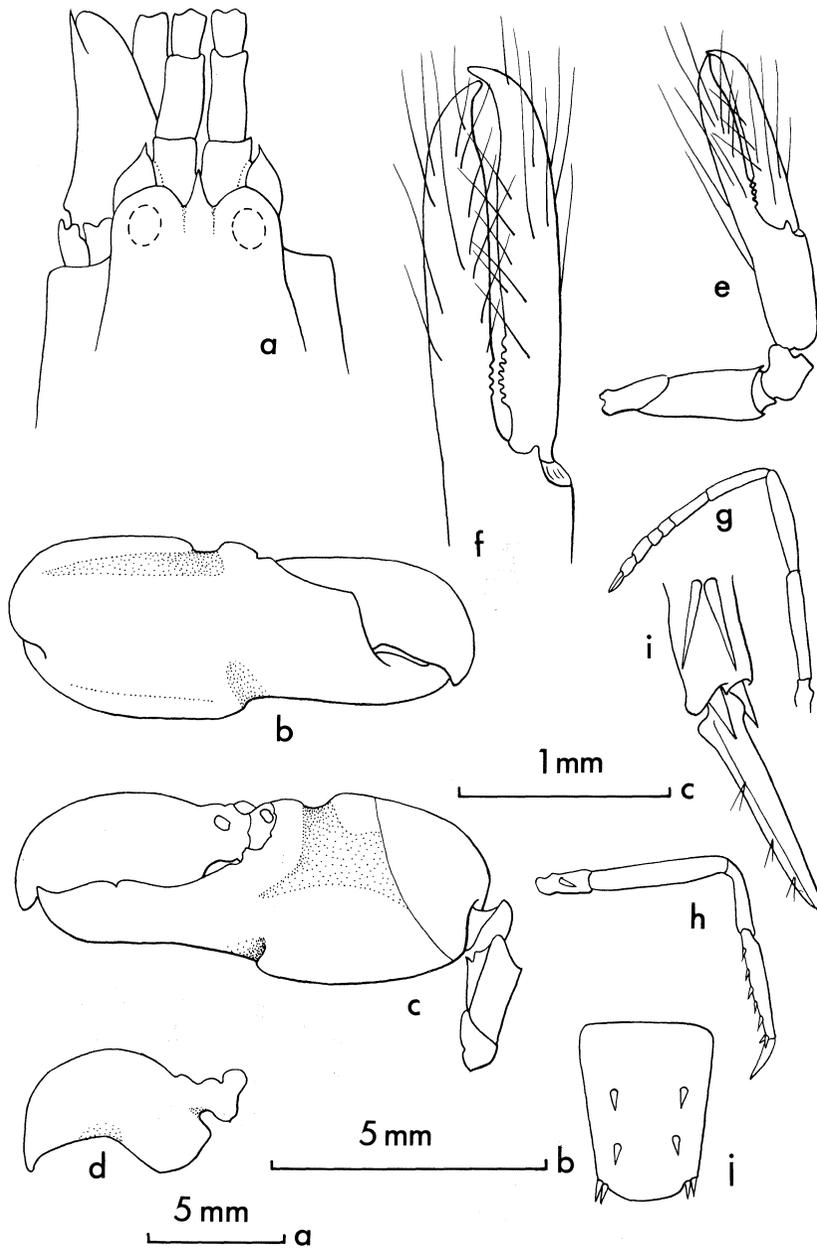


Fig. 65 *Alpheus macrodactylus* Ortmann
 35 mm male from AM P. 4288. **a**. Anterior region, dorsal view; **b**. large chela, medial face; **c**, **d**. large cheliped and dactylus, lateral face; **e**, **f**. small cheliped medial view and enlarged distal region; **g**. second leg; **h**, **i**. third leg and enlarged dactylus; **j**. telson. **b**, **c**, **d**, **e** scale a; **a**, **f**, **g**, **h**, **j** scale b; **i** scale c.

Inferior notch continues into lateral and medial face as faint rounded grooves about 0.2 width of palm. Plunger of dactylus pronounced. Merus 2.0 times as long as broad, bearing a sharp tooth distally on inferointernal margin.

Small cheliped not sexually dimorphic, 5 times as long as broad. Fingers 1.7 times longer than palm, palm without sculpture, but bearing small tooth on medial side of dactylar articulation. Oppositive face of dactylus near articulation bearing 7 rounded teeth in low crest, meeting but not meshing with teeth on pollex opposite; both oppositive faces bearing scattered long, forward-directed setae that cross. Tips of fingers hooked and crossing.

Second leg with ratio of carpal articles: 10:6:2:2:4.

Ischium of third leg with spine. Merus 5 times as long as broad and unarmed. Carpus 0.5 as long as merus with inferior and superior margins projecting distally but rounded. Propodus 0.8 as long as merus, bearing 5 spines on inferior margin and a pair distally. Dactylus 0.4 as long as propodus, trigonal, inferior surface flattened.

Telson broad, 1.6 times as long as broad posteriorly. Anterior pair of dorsal spines placed slightly anterior to midline.

DISCUSSION: We have been able to examine the holotype at the Musée Zoologique de l'Université et de la Ville, Strasbourg, France and find our specimens agree with it. Ortmann stated that the fingers of the small chela were in contact when closed the full length "*dicht zusammenschleissend*", but in the examination of the type we found they were agape, curved and crossed at their tips the same as in our specimen.

We do not believe that the specimens from the Leiden Museum discussed by Coutière (1897c:196) under this name are actually of this species; however, we have to base our opinion upon the description he has given as we could not find the specimens either in Leiden or Paris. The brief description of the first two specimens he discusses, those without the chelipeds and without indication of locality, would fit *A. euphrosyne euphrosyne* De Man better. Apparently the next group of specimens (8 from Bangkok, one from Suez and one from "*Pescabury*") all show sexual dimorphism in the small chelae and have the second carpal article of the second leg one-fourth the length of the first; both of these characteristics rule out the possibility of the specimens being *A. macrodactylus*. The final four specimens from Bangkok in which the lobe proximal to the superior saddle is "*presque aigu*" and the sculpturing on the palm of the small chela is marked, also cannot be this species. However, without the specimens to examine, we do not wish to guess what species they may be.

BIOLOGICAL NOTES: Previous records of this species have not indicated the type of habitat, and the collection cited above gives merely "*Finches Bay, Cooktown, Qld*" (which is not shown on sheets 1 or 2 of "*Strip Map, Great Barrier Reef and Adjacent Islands*"). However, we have some specimens in our personal collections, previously unreported, from Guam collected by H. Kami that come from the mouth of a river. The spatulate condition of the dactyli of the walking legs would lead one to presume the species lives in soft, probably muddy, bottoms. Our largest specimen was 33 mm in length.

AUSTRALIAN DISTRIBUTION: As mentioned the specimens came from Cooktown, Qld. The type location is Sydney, N.S.W.

GENERAL DISTRIBUTION: Ceylon; Annam; Formosa; Guam (see above).

Alpheus bunburius sp. nov.

Fig. 66

HOLOTYPE: 38 mm female from Bunbury, W.A. Collected by W. H. Butler, March, 1962 (WM 271-65).

DIAGNOSIS: Rostrum triangular, acute, slightly longer than broad, reaching to distal quarter of first antennular article. Orbitorostral margins concave; rostral carina slight; orbitorostral grooves shallow. Orbital hoods somewhat inflated. First and third antennular articles subequal, second article 1.6 times as long as visible portion of first and twice as long as broad; lateral margins armed with setiferous bristles. Stylocerite acute, reaching to end of first antennular article, lateral margins bearing setiferous bristles. Scaphocerite with squamous portion narrow, reaching to end of antennular peduncles, lateral tooth a little longer. Carpocerite reaching almost length of third article past that article. Basicerite with small but acute lateral tooth.

Ratio of articles of third maxilliped: 10:4:8.

Large chela 3 times as long as broad. Fingers heavy, distally rounded, almost equal to palm in length and breadth, plunger of dactylus low and confluent with distal margin. Superior saddle shallow, proximal and distal shoulders gradually rounded. Lateral palmar depression shallow, forming a quadrangular groove that disappears at *linea impressa*. Medial palmar depression slight, triangular, with inferior margin of depression marked by a strong shoulder. Inferior shoulder not projecting, rounded; inferior notch continues into lateral face in a slight triangular depression. Distal two-thirds of medial face of chela armed with sparsely set long hairs. Merus inermous, 2.7 times as long as broad.

Small chela of female not balaeniceps, 4.3 times as long as broad, fingers slightly longer than palm. Medial side of dactylar articulation with small blunt tooth. Distal two-thirds of chela with scattered hairs on medial face similar to large chela. Merus inermous, 3.0 times as long as broad.

Second leg with ratio of carpal articles: 10:5:3:3:4.

Third leg missing. Ischium of fourth leg inermous, 0.5 length of merus. Merus 4.7 times as long as broad, inermous. Carpus 0.6 as long as merus with superodistal margin projecting; inferodistal margin rounded and bearing a long seta. Propodus 0.8 as long as merus, bearing 5 spines on inferior margin and a pair distally, interspersed with long setae, superior margin bearing long setae. Dactylus trigonal in section, slightly curved, with inferior surface flattened but not broadened.

Telson 1.6 times as long as wide at posterior margin, posterior margin arcuate. Dorsal and posterolateral spines small.

DISCUSSION: In the *Edwardsii* Group there is only one species and one subspecies in which the fingers of the large chela are equal or almost equal to the length of the palm; these are *A. macrodactylus* Ortmann and *A. malabaricus trefzae* subsp. nov. *A. macrodactylus* has a trigonal dactylus of the third legs as does this species, but it differs markedly in the form of the chelipeds. In Ortmann's species the fingers of the small chela are markedly longer than the palm and bear numerous teeth proximally, while on the large cheliped the palm is heavier with more extensive depressed areas on both faces, the plunger of the dactylus is heavier and the merus bears a tooth (see fig. 65 b-f). *A. bunburius* is quite similar to *A. malabaricus trefzae* in the large chela (unfortunately, the small cheliped of that subspecies is unknown) but in *A. malabaricus trefzae* the merus bears a small but definite tooth; moreover, the dactylus of the third leg in *A. malabaricus*

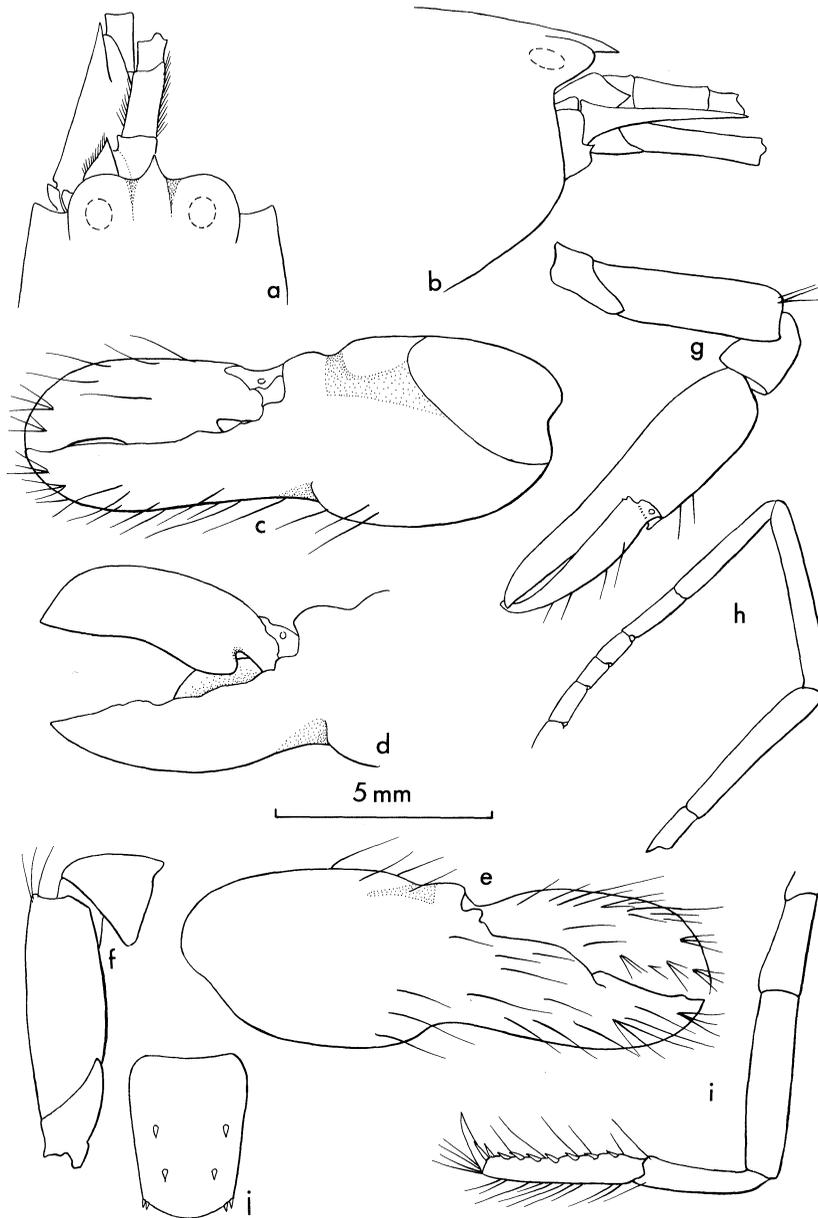


Fig. 66 *Alpheus bunburius* sp. nov.

Holotype (female). **a, b.** Anterior region, dorsal and lateral view; **c, d.** large chela and detail of dactylus, lateral face; **e, f.** large chela and merus, medial view; **g.** small cheliped, lateral view; **h.** second leg; **i.** fourth leg; **j.** telson. All figures same scale.

trefzae is not trigonal but definitely subspatulate.

In general the form of this species is very similar to *Alpheus euphrosyne euphrosyne* De Man and *A. euphrosyne richardsoni* Yaldwyn, but in addition to the differences in the palmar/finger length this species differs in the low plunger of the dactylus of the large chela and the trigonal dactylus of the third legs.

This species is named for the place in Western Australia where it was collected. The holotype will be placed in the Western Australian Museum.

***Alpheus tasmanicus* sp. nov.**

Fig. 67

HOLOTYPE: 22 mm male from MM 161. Collection notes state only the specimen was from Tasmania.

DESCRIPTION: Rostrum acute, 1.8 times as long as broad at base and reaching to middle of visible part of first antennular article. Rostral carina low, rounded, reaching to base of eyes. Orbitorostral grooves shallow. Anterior margin of orbital hoods only slightly rounded, with slight concavity towards rostral base. Second antennular article 1.7 times as long as broad, slightly longer than visible part of first, third a little shorter than first. Stylocerite acute, reaching to end of first antennular article. Scaphocerite with outer margin slightly concave, lateral tooth reaching almost length of third article past that article, squamous portion moderately broad, reaching just proximal to lateral tooth. Carpocerite as long as lateral tooth of scaphocerite. Basicerite with prominent acute tooth.

Ratio of articles of third maxilliped: 10:2.5:6.

Chela 2.6 times as long as broad with fingers occupying distal 0.4. Superior saddle well defined with proximal shoulder at right angles to, not overhanging, saddle; distal shoulder gradually rounded and lower than proximal shoulder. Lateral palmar depression well defined, quadrangular, extending to *linea impressa*. Medial palmar depression triangular with apex reaching to middle of palm. Inferior shoulder heavy but rounded. Inferior groove moderate, extending into lateral face as a shallow triangle and into medial face as shallow, ill-defined depression. Lateral face of palm carrying shallow rounded depression extending from level of middle of superior depression to a triangular apex at level of distal end of socket of fixed finger; this depressed area is separated by rounded ridges from both superior and inferior depressions. Lower surface of palm flattened. (Note: exoskeleton of specimen soft due to recent moulting; the last two features may be the result of distortion). Plunger of dactylus low, distal margin confluent with cutting edge. Merus 1.8 times as long as wide and distally inermous.

Small chela presumably not sexually dimorphic, 4 times as long as high and fingers are 1.3 times as long as palm. Medial face of palm and fingers bearing long forward-sweeping hairs, sparsely placed. Merus 2.5 times as long as broad and inermous distally.

Carpal articles of second leg with ratio: 10:4:2:2:4.

Ischium of third leg with spine. Merus inermous, 4 times as long as broad. Carpus 0.5 as long as merus, distal margins terminating in obtuse projections. Propodus 0.7 as long as merus, bearing on its inner face 9 spines and a pair distally. Dactylus conical, almost half as long as propodus.

Telson 2.3 times as long as posterior margin is broad. Anterior pair of dorsal spines

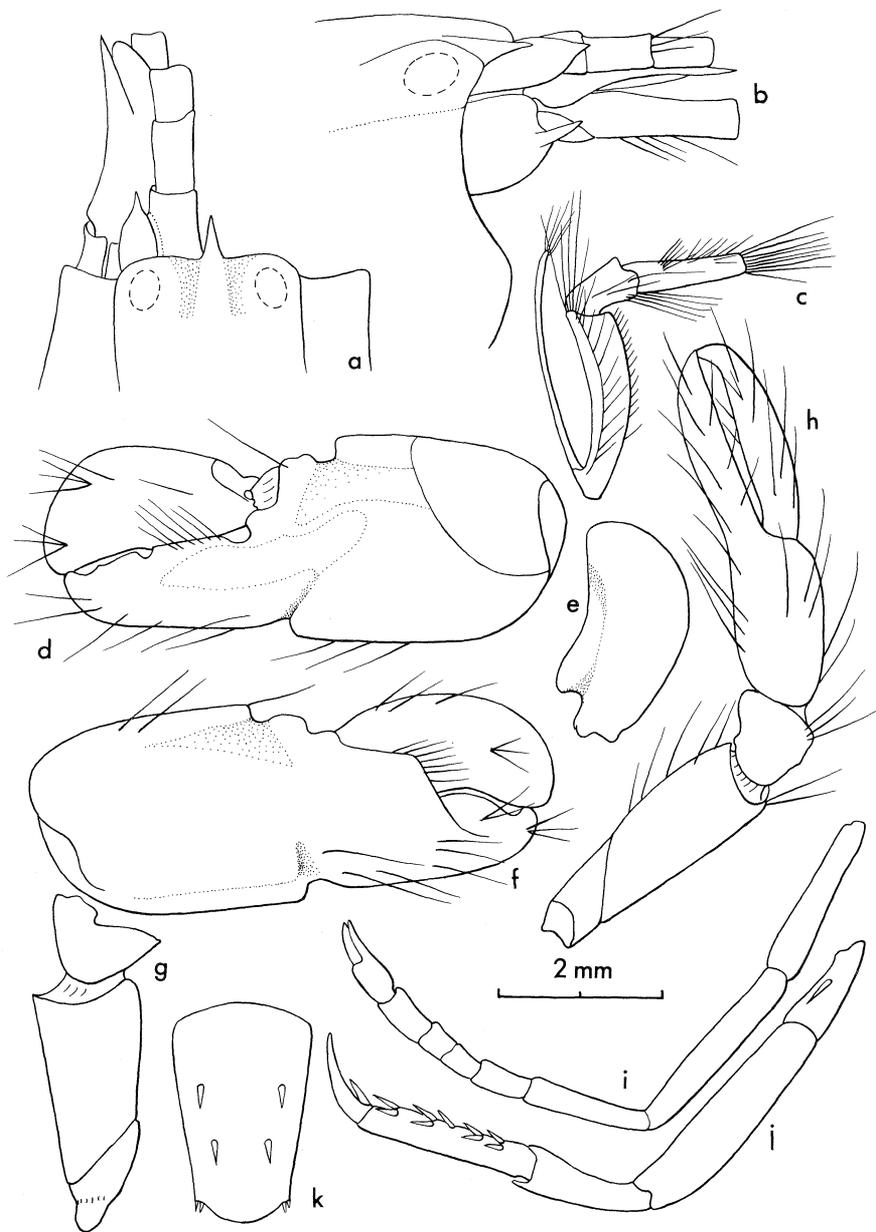


Fig. 67 *Alpheus tasmanicus* sp. nov.

Holotype (male). **a, b.** Anterior region, dorsal and lateral view; **c.** third maxilliped, lateral face; **d, e.** large chela and dactylus, lateral face; **f, g.** large chela and merus, medial face; **h.** small cheliped, medial face; **i.** second leg; **j.** third leg; **k.** telson. All drawings same scale.

placed anterior to middle. Posterolateral spines smaller than dorsal.

DISCUSSION: This species is most probably related to the species in the Edwardsii Group in which the small chela of neither the male nor the female is balaeniceps. We have only the male, but in no species known does the female carry a balaeniceps dactylus when the male does not. The following species are included in this group, and may be differentiated from this species as follows: *A. bisincisus* De Haan which has a flattened rather than a rounded rostral carina; *A. hululensis* Coutière, which has the superior depression on the medial face of the large chela in the form of a "U" rather than a triangle; *A. pacificus* Dana, which has the proximal shoulder of the superior saddle of the large chela overhanging the saddle rather than at right angles; further the rather dense hairs between the fingers of the small chela in *A. pacificus*, here are reduced to a sparse condition; *A. haanii* Ortmann, which, like *A. pacificus*, has a proximal shoulder overhanging the groove on the large chela and both chelipeds carry teeth distally on their meri; *A. macrodactylus* Ortmann, *A. malabaricus* Fabricius, *A. m. songkla* B&B and *A. mackayi* B which have spatulate dactyli on the third leg, rather than trigonal; moreover, the fingers of the small chela are approximately 1.7 to 2.0 the length of the palm in the four species, rather than 1.2 times the palmar length as in this species.

This species has been named for the place from where it was collected. The holotype will be placed in the Australian Museum, Sydney, N.S.W.

***Alpheus pacificus* Dana**

Fig. 68

Alpheus pacificus Dana, 1852:544, pl. 34, fig. 5. Coutière, 1905a: 909, fig. 47. Tiwari, 1963:315, fig. 30. Banner and Banner, 1966b:143, fig. 54.

Crangon pacifica Banner, 1953:138, fig. 50. (Neotype established).

Alpheus gracilidigitus Miers, 1884:287.

Previous Australian records:

Nobili, 1899:233, Double Bay, N.S.W. (as *A. gracilidigitus*).

Gillett and Yaldwyn 1969:70, 110, fig. 41. Heron Is., Qld.

SPECIMENS EXAMINED: 1 specimen from AC 39; 1, AC 40; 1, AC 78; 1, AC 79; 2, AM 52 (AM P. 27515); 3, AM 53 (AM P. 27516); 1, AM 78 (AM P. 27886); 1, AM 80 (AM P. 27308); 1, AM 88 (AM P. 27309); 2, AM 89 (AM P. 27310); 7, AM 93 (AM P. 27889); 3, AM 104 (AM P. 27311); 2, AM 107 (AM P. 27519); 2, AM 108 (AM P. 27312); 5, AM 113 (AM P. 27463); 1, AM 120 (AM P. 27520); 9, AM 123 (AM P. 27313); 2, AM 153 (AM P. 27456); 1, AM 164 (AM P. 27557); 2, AM 192 (AM P. 27853); 2, AM 205 (AM P. 27887); 1, AM 211 (AM P. 27888); 1, AM 240 (AM P. 27568); 2, AM 243 (AM P. 27314); 1 AM 246 (AM P. 27466); 3, AM 290 (AM P. 27361); 1, AM 311 (AM P. 27437); 1 AM 328 (AM P. 27362); 1, AM 339 (AM P. 28167); 2, AM P. 1182; 2, AM P. 1183; 2, AM P. 1649; 1, AM P. 2220; 3, AM P. 4229; 4, AM P. 4996; 3, AM P. 5277; 1, AM P. 5710; 1, AM P. 6350; 1, AM P. 6495; 2, AM P. 6863; 1, AM P. 7027; 2, AM P. 8963; 1, AM P. 10311; 1, AM P. 10784; 1, AM P. 12920; 1, AM P. 13555; 12, AM P. 13571; 5, AM P. 13574; 1, AM P. 27407; 1, AM P. 27408; 3, AM P. 27432; 1, AM P. 27765; 1, AM P. 27767; 3, AM P. 27878; 1, BAU 15; 2, BAU 54; 7, BAU 56; 5, BAU 58; 1, JC 17; 1, JC 18; 1, JC 22; 1, JC 24; 1, JC 25; 1, JC 31; 1, JG 21-73; 1, MM 108; 1, UQ 16; 3, US 123572; 2, US 123573; 3, US 123574; 2, US 123575; 1, US 123576; 23, US 123587; 1, VM 25; 1, WM 43-65; 1, WM 96-65; 6, WM 204-65.

DIAGNOSIS: Rostrum reaching just past middle of visible part of first antennular article, bearing a few short setae on lateral margins. Orbital hoods slightly inflated, orbitorostral grooves moderately deep and reaching posterior to eyes. Anterior margin

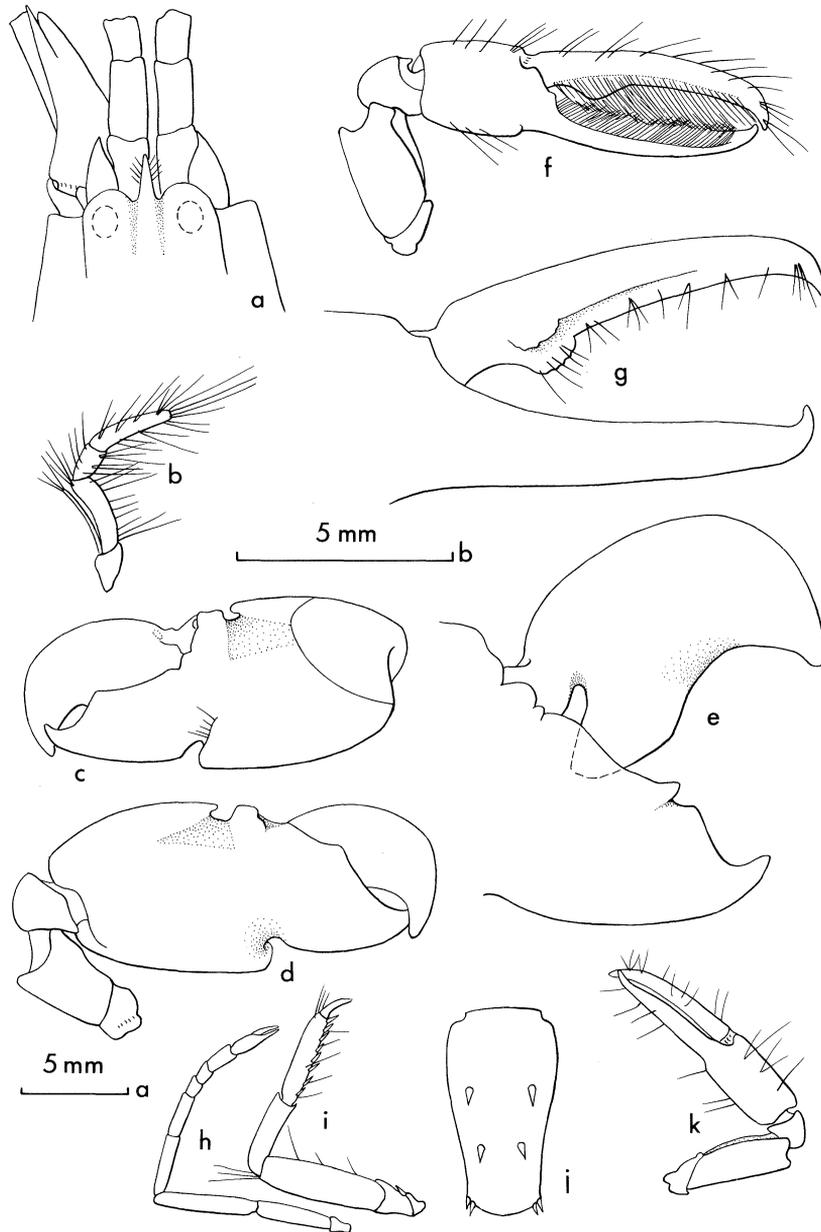


Fig. 68 *Alpheus pacificus* Dana

40 mm male from AM 211. **a.** Anterior region, dorsal view; **b.** third maxilliped; **c.** large chela, lateral face; **d, e.** large cheliped and enlargement of distal region, medial face; **f, g.** small cheliped and enlargement of distal region (with setae removed), lateral face; **h.** second leg; **i.** third leg; **j.** telson. 36 mm female from AM 53. **k.** Small cheliped. **b, c, d, f, h, i, k** scale a; **a, e, g, j** scale b.

of orbital hoods rounded. Second antennular article 2.2 times as long as broad and 1.5 times longer than visible part of first antennular article. Third antennular article subequal to visible part of first article. Stylocerite acute, reaching to end of first antennular article. Scaphocerite with outer margin slightly concave, lateral tooth reaching past antennular peduncle; squamous portion narrow, slightly shorter than lateral tooth. Carpocerite as long as lateral tooth of scaphocerite. Lateral tooth of basicerite broad at base, as long as stylocerite.

Apex of ultimate article of third maxilliped bearing many long slender setae.

Large chela 2.2 times as long as broad, fingers occupying the distal 0.4. Superior saddle well defined with proximal shoulder rounded, overhanging; distal shoulder strong and abrupt. Lateral palmar depression well defined, quadrangular, extending to *linea impressa*. Medial palmar depression triangular, reaching proximally just past middle of palm. Inferior shoulder heavy, rounded, slanted distally. Inferior notch deep, in profile forming a "U". Inferolateral depression a well-defined "V"-shaped groove which continues up face of palm for 0.3 total width. Inferomedial depression "V"-shaped, broad and not well defined. Plunger of dactylus long. Distal margin of socket for plunger in pollex protrudes as a small rounded tooth (diminished in small males and in females). Merus 2.3 times as long as broad, lacking teeth on inferior margins, superior apex projecting but rounded.

Small chela of male 3.7 times as long as broad with fingers varying from 1.5-2.2 times as long as palm. Inferior margin of palm carrying a rounded to abrupt shoulder below dactylar articulation. Both fingers curved, slender and with acute tips. Dactylus not balaeniceps, bearing on lateral cutting edge a dense series of long, forward-sweeping setae that cross a similar series of setae on pollex. Cutting surface of dactylus with two thin crests near articulation, the larger crest placed in the middle of cutting surface and fitting into shallow groove in pollex when fingers are closed; the smaller near medial edge, not touching pollex when fingers are closed; fingers with tips overlapping, but gaping between tips and dactylar crests when closed. Crests smaller or lacking in immature males and females. Chela of females smaller, with fingers 1.2-1.5 times as long as palm and bearing only scattered setae instead of rows of long hairs. In both sexes carpus cup-shaped, bearing subacute tooth on superodistal margin. Merus similar to that of large chela.

Carpal articles of second leg with ratio of: 10:8:2:2:5.

Ischium of third leg with spine. Merus inermous, 4.0 times as long as broad, inferior margin bearing a few stiff setae. Carpus 0.4 as long as merus, superior margin somewhat extended distally, inferior margin produced as a subactue tooth and bearing two setae. Propodus 0.7 as long as merus, bearing on its inferior margin 8 spines. Dactylus simple, 0.3 as long as propodus.

Telson 2.0 times as long as broad, lateral margins constricted near posterior section. Posterolateral spines feeble, posterior margin slightly arcuate.

DISCUSSION: This species has been discussed and depicted many times. We only want to add here that we found in the small chelae of our male specimens a greater variation in the ratio of the fingers to palm than has previously been reported. In 20 males varying from 20-40 mm in length the fingers varied from 1.2-2.0 times as long as palm. In fact, we found one 40 mm male specimen from Queensland (JC 22) and also a specimen from the northern Indian Ocean in our collections in which the fingers of the small chelae were 2.5 times as long as the palm. There was no correlation between the size of the specimen and the finger-palm ratio. We have re-examined the small chelae of some of the

male specimens of *A. pacificus* from Hawaii and find they have only minimal crests on the cutting surface of the dactylus.

BIOLOGICAL NOTES: This species is largely intertidal, living under rocks. It has been collected from dead coral in water up to 20 metres. In Hawaii we have found this species characteristically burrowing in clean sand, under rocks and coral heads in areas of moderate surf (B&B, 1974); all we personally collected in Australia seemed to have come from similar habitats on reef flats.

From a colour photograph taken by Keith Gillett, an associate of the Australian Museum, of a specimen of *A. pacificus* collected by J. C. Yaldwyn from Heron Island we have made the following colour notes: Tip of large chela brown, rest of fingers and palm banded with irregular white, olive green and blue green. Fingers of small chela light green, distal three-fourths of palm white and olive green at base. Carpus and dactylus blue. Thoracic legs blue with white band at meral-carpal joint. Antennae blue, antennules olive green. Scaphocerite and carpocerite blue. Carapace and abdomen reddish brown with faint brown line extending from middle of carapace to sixth abdominal somite. On the lateral margins where each abdominal somite meets the next is a diffuse white spot. Telson same colour as abdomen, uropods light green. In Hawaii we have found the colour pattern and intensity in this species varies in the same locality and may also change when a specimen is moved from its habitat to an aquarium. Our specimens ranged up to 40 mm in length.

AUSTRALIAN DISTRIBUTION: In Western Australia this species has been collected from Perth to Northwest Cape; in northern Australia from the Gulf of Carpentaria; in eastern Australia from off Cooktown, Qld. to Sydney, N.S.W. We have also examined specimens from Lord Howe and Norfolk Islands.

GENERAL DISTRIBUTION: This species has been reported throughout the Indo-Pacific area from the Red Sea and Madagascar to Clipperton Island in the far eastern North Pacific. We have also seen specimens from Mombasa, Kenya. Its type locality is Hawaii.

***Alpheus heronicus* sp. nov.**

Fig. 69

HOLOTYPE: 28 mm female from Heron Is., Capricorn Group, Qld. Collected by Julie Booth, 1965, AM 390, (AM P. 27235). (Probably intertidal).

PARATYPES: 4 females from the same location as the types, 20-30 mm, (AM P. 27236); 2 females, 16, 27 mm from Moreton Bay, J. S. Hynd collection, 19/5/46, trawled below low water mark, AM 70 (AM P. 27214).

DIAGNOSIS: Rostrum a little longer than broad, reaching just past middle of visible part of first antennular article, bearing on lateral margins a few stiff setae. Rostral carina rounded, extending to base of eyes, orbitorostral grooves moderately deep. Anterior margin of orbital hoods gradually rounded, with a shallow concavity at base of rostrum. Visible part of first and third antennular articles subequal, second article 1.5 times as long as third, 2 times as long as broad. Stylocerite acute, reaching end of first antennular article. Scaphocerite with squamous portion reaching to end of antennular peduncle, lateral tooth reaching to end of carpocerite; carpocerite exceeding length of antennular peduncles almost by length of third article. Basicerite bearing slender lateral tooth.

Ratio of articles of third maxilliped: 10:3:6.6.

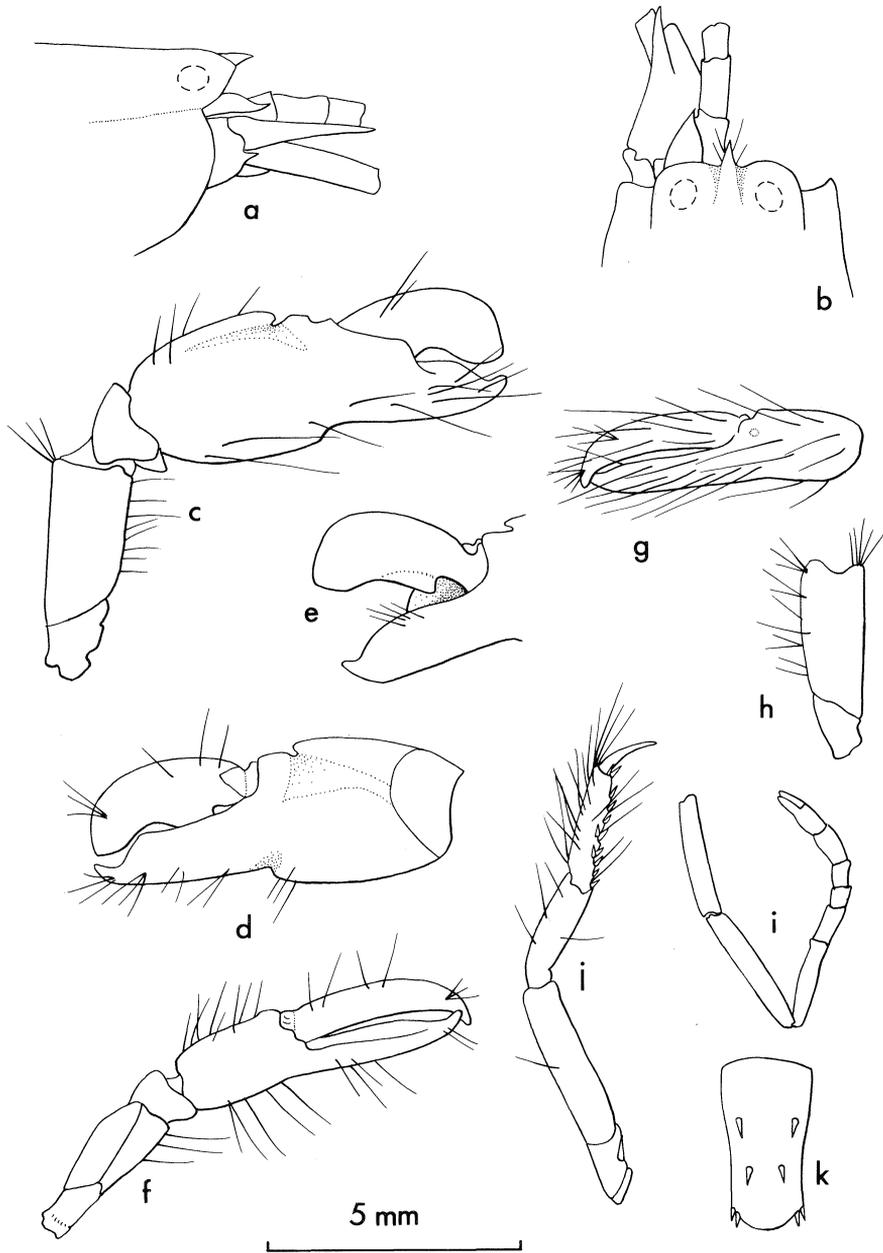


Fig. 69 *Alpheus heronicus* sp. nov.
 Holotype (female). **a, b.** Anterior region, lateral and dorsal view; **c.** large cheliped, medial face; **d, e.** large chela and detail of plunger, lateral face; **f.** small cheliped, lateral face; **g, h.** small chela and merus, medial face; **i.** second leg; **j.** third leg; **k.** telson. All figures same scale.

Large chela 2.6 times as long as broad with dactylus occupying the distal 0.4. Proximal shoulder rounded, overhanging superior saddle, distal shoulder gradually rounded. Superior saddle continuing into lateral face as a quadrangular depression which extends to *linea impressa*. Medial palmar depression a narrow triangle with apex almost reaching to proximal quarter of palm. Inferior shoulder low and rounded, continuing as slight depression on lateral face. Plunger of dactylus developed only as a low crest, confluent with cutting edge. Merus 2.2 times as long as broad; distal margins inermous, but bearing setae on superodistal margin and along inferointernal margin.

Small chela of female 4.2 times as long as broad with finger 1.5 times longer than palm, without sculpture except for small depression on superior margin proximal to articulation of dactylus. Medial face of chela beset with many long fine setae; neither dactylus nor pollex with setiferous crests. Merus 2.4 times as long as broad, without teeth distally. Male small chela unknown.

Second legs with ratio of carpal articles: 10:4:2:2:3.

Ischium of third leg carrying a strong spine. Merus inermous, 4.5 times as long as broad. Carpus 0.6 as long as merus, with subacute superodistal projection and acute inferodistal projection. Propodus 0.6 as long as merus, bearing on its inferior margin 10 spines and a pair distally interspersed with long setae and with long setae on superior margin. Dactylus simple, slender, 0.5 as long as propodus.

Telson with width anteriorly 1.3 times that of tip and 2.3 times as long as broad posteriorly. Anterior pair of dorsal spinules set just anterior to middle. Inner spine of posterolateral pair a little more than 2 times as long as outer.

DISCUSSION: The ratio of the first 2 articles of the second legs in our specimens varies from 10:4 to 10:6. The merus of the third leg varies from 4.2 to 5.0 times as long as broad.

This species is related to the species in the Edwardsii Group in which the meri of the chelipeds are unarmed distally. This includes in Australia *A. euphrosyne euphrosyne* De Man, *A. e. richardsoni* Yaldwyn, *A. inopinatus* Holthuis and Gottlieb, *A. sudara* B&B, *A. australiensis* sp. nov., *A. bunburius* sp. nov., *A. pacificus* Dana and two Indo-Pacific species *A. microrhynchus* De Man, and *A. paludicola* Kemp. It differs from all except *A. pacificus* by having the proximal shoulder of the large chela overhanging the superior saddle but unlike *A. pacificus* the inferior shoulder is not projected forward but is no more than a right angle to the plane of the chela. From other individual species other differences occur: from *A. inopinatus* it differs by the minimal development of the inferior shoulder of the large chela; from *A. sudara* by the lack of markedly concave lateral margins of the scaphocerite; from *A. e. euphrosyne* and *A. e. richardsoni* by the lack of a spatulate dactylus on the third leg; from *A. bunburius* by the shorter fingers on the large chela and finally from *A. australiensis* by the lack of setiferous crests on the dactylus of the small chela. This species is close to *A. pareuchirus pareuchirus* Coutière, but that species has strong teeth on the meri of the chelipeds and it also differs in the breadth of the superior saddle, the ratio of the lengths of the first two carpal articles of the second leg, further the proportions of the third legs are more slender. The relationship of this species within the Edwardsii Group would be more certain with knowledge of the male small cheliped.

This species is named for the island on which it was collected. The holotype and paratypes will be placed in the Australian Museum, Sydney, N.S.W.

BIOLOGICAL NOTES: All ecological information available is given under the listing

of the type and paratypes. We cannot account for the fact that the collections had 7 females and no males.

***Alpheus balaenodigitus* sp. nov.**

Fig. 70

HOLOTYPE: 28 mm ovigerous female from Port Walcott, W.A. 20°39' S; 117°10'E. 8 fms. Coll. Royce on the *Davena*, 3/6/60. (WM 172-65).

ADDITIONAL SPECIMEN: 22 mm female from Darwin, N.T. Collected intertidally from under rocks lying on clean sand. (BAU 72).

DESCRIPTION: Rostrum acute, reaching to end of first antennular article, bearing on margins 6 short setae. Rostral carina rounded, disappearing at posterior margin of eyes. Orbitorostral grooves of moderate depth. Anterior margin of orbital hoods almost straight, only slightly concave at base of rostrum. Visible part of first antennular article and third article subequal, second article 1.6 times as long as third and 2 times as long as wide. Stylocerite reaching to slightly beyond end of first antennular article. Outer margin of scaphocerite concave, squamous portion reaching to end of antennular peduncle, lateral tooth reaching well past. Carpocerite reaching to end of antennular peduncle. Basicerite with small lateral tooth.

Ratio of articles of third maxilliped: 10:3:8.

Large chela 3.5 times as long as broad, fingers occupying distal 0.4. Superior saddle shallow, broad, with proximal and distal shoulders low and rounded; depression on lateral face quadrangular and shallow, merging with the face proximally near *linea impressa*; medial depression shallow, triangular, with apex reaching to about middle of palm. Inferior margin with only a slight constriction opposite superior saddle. Merus 2.5 times as long as broad, bearing a few stiff setae and a small subacute tooth distally on inferionternal margin.

Small chela of female 4.3 times as long as broad with fingers and palm equal. Dactylus nearly conical, bearing on both faces crests of short hairs that almost meet distally on superior margin (sub-balaeniceps). Palm with shallow superior saddle and low rounded shoulders; medial and lateral palmar depressions present but smaller and more indistinct than those of large chela. Inferior margin with slight constriction opposite superior saddle. Palm bearing rounded tooth flanking medial side of dactylar articulation. Medial face of chela with only scattered long setae, lateral face glabrous. Merus 3 times as long as broad, inferointernal margin bearing a small subacute tooth directed distally.

Carpal articles of second legs with ratio 10:10:3:3:6.

Ischium of third leg bearing strong spine. Merus 5.6 times as long as broad, inermous. Carpus 0.6 as long as merus, distal margins slightly projected. Propodus 0.7 as long as merus, bearing on inferior margin 14 spines, more or less in pairs and a pair distally. Dactylus slender, conical, 0.3 as long as propodus.

Telson 2.3 times as long as broad at posterior margin, posterior margin arcuate and projecting. Anterior pair of dorsal spines set well anterior to midline.

DISCUSSION: In the specimen from Darwin the anterior margin of the carapace at the base of the rostrum is more concave. The proximal shoulder of the groove on the superior margin of the large chela is more nearly at right angles to the floor of the groove, not gradually sloping and there is a small but definite inferior shoulder. The tooth on the

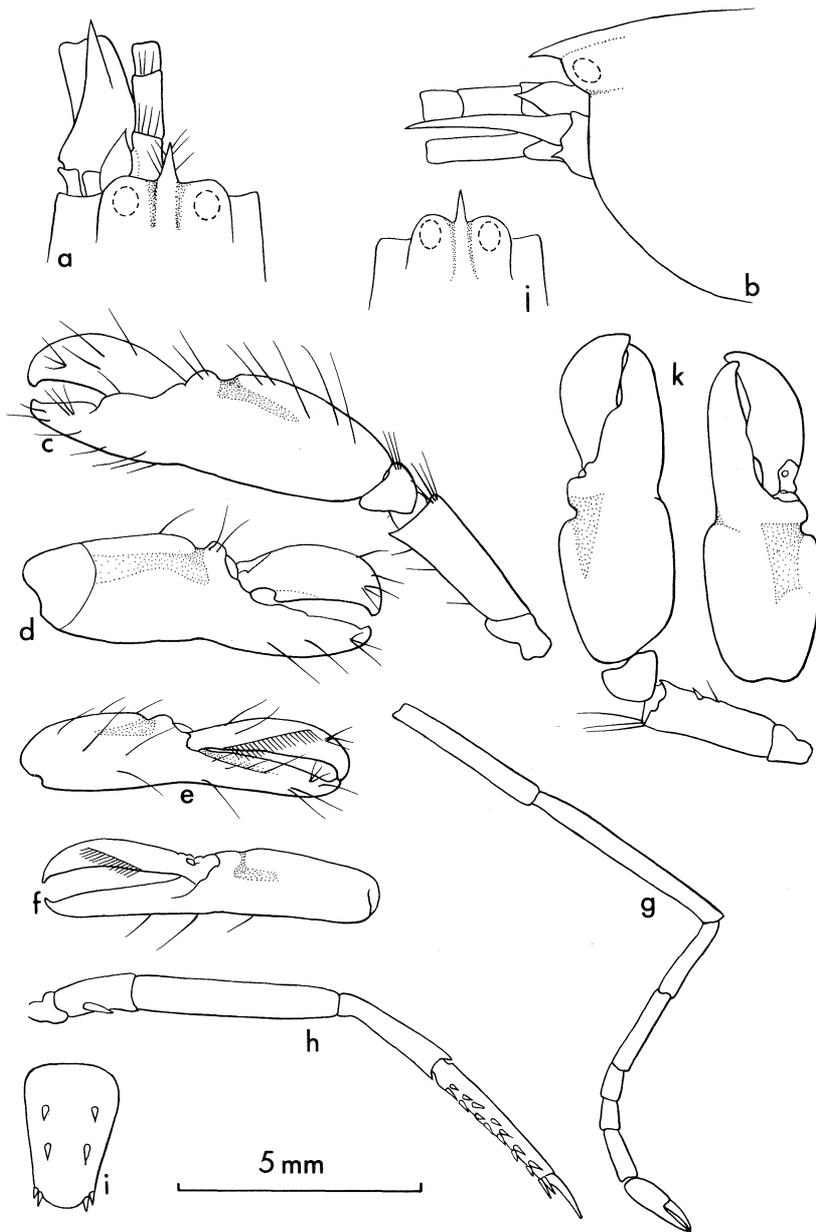


Fig. 70 *Alpheus balaenodigitus* sp. nov.
 Holotype (female). **a, b.** Anterior region, dorsal and lateral view; **c.** large cheliped, medial face; **d.** large chela, lateral face; **e, f.** small chela, lateral and medial face; **g.** second leg; **h.** third leg; **i.** telson. 22 mm female from BAU 72. **j.** Anterior region, dorsal view; **k.** large cheliped, medial face; **l.** large chela, lateral face. All drawings same scale.

distal end of the inferointernal margin of the merus of the large chela is larger and more acute and the margin bears an articulated spine at about two-thirds the length. The third leg is 5.0 times as long as broad and there are less spines on the propodus.

This species is among the group of species in the Edwardsii Group in which the female bears crests of hairs on the dactylus of the small chela. These include *A. pareuchirus imitatrix* De Man, *A. strenuus strenuus* Dana, *A. s. cremnus subsp. nov.*, *A. heeia* B&B and *A. australiensis sp. nov.* It differs from both *A. s. strenuus* and *A. s. cremnus* by having the proximal shoulder of the superior saddle of the large chela gradually rounded; not at all projected; the plunger on the dactylus of the large chela is long and heavy in the two subspecies while in *A. balaenodigitus* it is low and not distally demarked; finally the orbital margin of the orbitorostral groove in *A. s. cremnus* is a sharp ridge while in *A. balaenodigitus* it is gradually rounded. In *A. p. imitatrix* the proximal shoulder of the small chela of the female overhangs the superior groove, but is only low and gradually rounded in this species. It can be distinguished from *A. heeia* by the lack of spines on the inferior margin of the second article of the third maxilliped. Finally it can be separated from *A. australiensis* by the presence of the distal tooth on the inferointernal margin of the meri of both chelipeds and again by the low confluent plunger on the dactylus of the large chela. The profile of the superior margin of the large chela of the holotype resembles *A. euphrosyne euphrosyne* De Man, *A. microrhynchus* De Man and *A. paludicola* Kemp, but the rostrum of this species is better developed than in any of those species and in none of those does the female bear a crest of hair on the dactylus of the small chela.

It is unfortunate that we lack the male of this species, but the female appears sufficiently distinct for us to consider it a new species. We note the differences in the large chelae of the holotype and the specimen from Darwin and suggest that they may eventually be found to be of separate genetic stocks, and for that reason we are not designating the second specimen as a paratype. Yet with but two specimens we are loath at this time to give them separate designations.

The name is taken from *balaena*, Latin for whale, and refers to the sub-balaeniceps condition of the dactylus of the small chela, a rare condition for a female in this genus.

The holotype will be placed in the Western Australian Museum and the additional specimen will be deposited in the Australian Museum.

***Alpheus strenuus strenuus* Dana**

Fig. 71

Alpheus strenuus Dana, 1852:543, pl. 34, fig. 4. Coutière, 1905a:913, fig. 53. Pearson, 1911:185, pl. 7, fig. 6. Gravely, 1930:79, pl. 1, figs. 6a, b. Banner and Banner, 1966a:191, fig. 20; 1966b:140, fig. 53.

Alpheus strenuus var. *angulatus* Coutière, 1905a:914.

Alpheus doris White, 1847:75 (*nomen nudum*).

Previous Australian records:

White, *loc. cit.* Torres Straits (as *A. doris*).

Heller, 1865:108. Sydney, N.S.W. (as *A. avarus*).

Haswell, 1882b:188. Torres Straits.

Ortmann, 1890:475. Rockhampton, Qld.

Ortmann, 1894:14. Thursday Island.

Pope, 1949:326. Discussion of sound production (as *Crangon strenuus*).

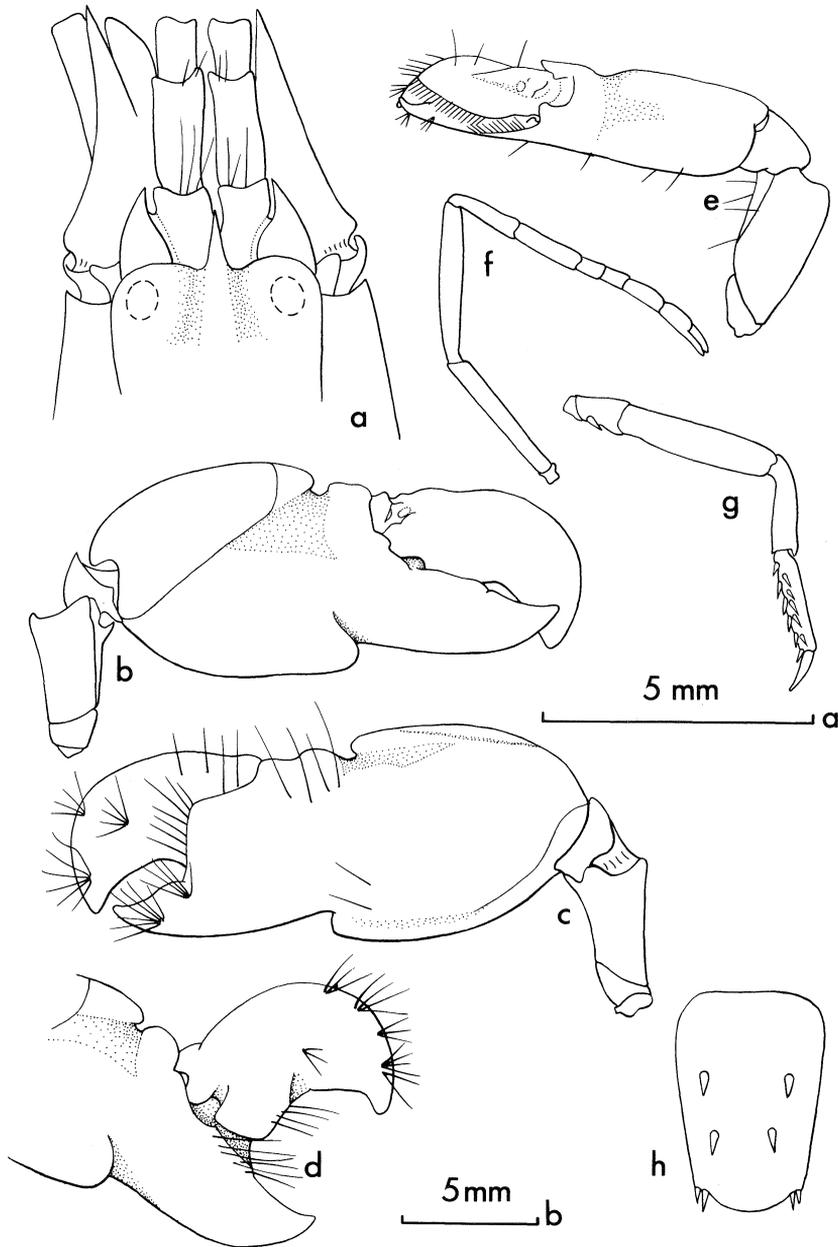


Fig. 71 *Alpheus strenuus strenuus* Dana

40 mm male from BAU 23. **a.** Anterior region, dorsal view; **b, c.** cheliped, lateral and medial face; **d.** fingers of large chela, lateral face; **e.** small cheliped, lateral face; **f.** second leg; **g.** third leg; **h.** telson. **b, c, d, e, f, g** scale a; **a, h** scale b.

Dakin, 1960:178. Discussion of sound production.
McNeill, 1968:15. North Qld.

SPECIMENS EXAMINED: 1 specimen from AH 1; 1, AH 2; 2, AM 4 (AM P. 27512); 1, AM 19 (AM P. 27801); 1, AM 104 (AM P. 27318); 1, AM 107 (AM P. 27518); 1, AM 108 (AM P. 28154); 2, AM 167 (AM P. 27465); 1, AM 218 (AM P. 27464); 2, AM 230 (AM P. 28105); 1, AM 249 (AM P. 27319); 2, AM 274 (AM P. 27804); 1, AM 276 (AM P. 27406); 1, AM 293 (AM P. 27805); 6, AM 298 (AM P. 27768); 1, AM 308 (AM P. 27806); 3, AM 309 (AM P. 27453); 2, AM 317 (AM P. 27350); 1, AM 318 (AM P. 27351); 1, AM 319 (AM P. 27352); 1, AM 321 (AM P. 27353); 5, AM 322 (AM P. 27354); 1, AM P. 2289; 1, AM P. 4313; 3, AM P. 5572; 2, AM P. 5610; 2, AM P. 6786; 1, AM P. 7187; 1, AM P. 7240; 1, AM P. 7421; 11, AM P. 7443; 2, AM P. 7523; 2, AM P. 7982; 1, AM P. 8565; 1, AM P. 10401; 2, AM P. 10979; 1, AM P. 11408; 1, AM P. 13549; 4, AM P. 14960; 1, AM P. 27766; 3, AM P. 28155; 16, BAU 12; 1, BAU 23; 4, BAU 27; 1, BAU 29; 7, BAU 46; 12, BAU 51; 1, BAU 52; 3, BAU 54; 11 BAU 72; 3, JB 1; 2, JC 24; 1, JG 22-73; 3, QM W 1000; 3, QM W 2236; 3, UQ 23; 1, US 123589; 1, US 123591; 1, WM 245-65; 1, WM 285-65; 7, WM 292-65; 1, WM 8973.

DIAGNOSIS: Rostrum acute, slender, over 2 times as long as broad at the base, reaching into distal half of first antennular article. Orbital hoods slightly inflated; orbitorostral grooves shallow and gradually confluent with hoods and rounded rostral carina, extending posteriorly only slightly behind pigmented portion of eyes. Antennular peduncle with second article varying from 1.6 to 2.5 times as long as broad and almost 1.5 times as long as visible part of first antennular article; third article shorter than visible part of first. Stylocerite acute, reaching to end of first article of antennular peduncle. Lateral tooth of scaphocerite a little longer than antennules, squamous portion of normal width, a little shorter than lateral tooth. Carpocerite reaching to end of antennular peduncle. Basicerite with acute slender tooth.

Large chela 2.3 times as long as broad, fingers occupying distal 0.4, and when closed approaching breadth of palm. Superior saddle deep, moderately broad. Proximal shoulder heavy, rounded and overhanging saddle slightly. Distal shoulder also heavy, gradually rounded. Lateral palmar depression well defined, quadrangular, reaching to *linea impressa*. Medial palmar depression triangular reaching to proximal half of palm. Inferior shoulder strong, rounded, and projecting slightly. Inferolateral depression "V"-shaped; inferomedial depression almost quadrangular and with proximal apex continuing longitudinally as a narrow but pronounced groove that terminates near carpal articulation. Dactylus with plunger long. Merus 2.4 times as long as broad, superior margin rounded, inferointernal margin bearing distally an acute tooth.

Small chela of both sexes, in both large and small specimens, with balaeniceps dactylus. Chela varying from 3.3-4.3 times as long as broad with fingers occupying distal 0.4. Palm bearing slight rounded superior saddle. On large specimens the groove continues into a slight, poorly defined depression on lateral face. No trace of inferior shoulder. Superior surface of dactylus broadened with carinate ridge extending from articulation and fading near middle of broadened area. Broadened area demarcated by setiferous crests typical of balaeniceps development; tip narrow and hooked, crossing tip of pollex when closed. Merus 2.3 times as long as broad; superior margin rounded, inferointernal margin bearing a small acute tooth distally.

Carpal articles of second leg with ratio of: 10:10:3:3:6.

Ischium of third leg armed with spine. Merus inermous, 4.3 times as long as broad. Carpus 0.5 as long as merus with superodistal margin projected into a tooth. Propodus 0.7 as long as merus and bearing on its inferior margin 10 spines, roughly paired. Superior

margin bearing many long fine setae. Dactylus simple, triangular in cross section, 0.4 as long as propodus.

Telson 2 times as long as posterior margin is broad, anterior pair of dorsal spines placed slightly anterior to middle.

DISCUSSION: Dana's holotype for this species was collected from Tongatabu, Tonga and was presumed to be lost, probably with W. Stimpson's collections in the Chicago, Ill. fire of 1871. With that in mind, in 1954 when the senior author visited the type locality, he collected a series of specimens from which we selected one to be a neotype. Before the collection could be published upon most of the specimens of the neotypic series and the figures of the neotype-to-be were destroyed by fire. However, the description and the comparative studies we had made did survive and we published them, along with new drawings of a smaller specimen from Tongatabu that also came through the fire (1966a:181). No neotype was designated.

This year (1978) we discovered in the Museum of Comparative Zoology at Harvard University a specimen from the U.S. Exploring Expedition collections that was labelled as "1469 TYPE *Alpheus strennus* Dana. Tongatabu. U.S. Exploring Expedition." (A later label said the same thing except it was to "*Crangon strennus* (Dana)"). However, this specimen, a male, is but 25 mm long and Dana specified his type to be 1¾ inches (about 44 mm) long, so this specimen must be from his paratypic series. Moreover, of all the walking legs it has only one fourth and both fifth legs remaining, so it cannot be used to establish the characteristics of the species. We have compared what remains of it with our 1966 description and our specimens and find no apparent differences. Therefore our description of the topotype can be taken as a fair representation of the form that Dana had described.

In our 1966 paper we discussed the extent of variation we had observed in our specimens together with its differentiation from related species. We found variation in the specimens from the Central Pacific in the proportions of some of the appendages, especially in the antennular peduncles, the large and small chela (those of the more mature specimens being heavier), and the third legs. However, the form was quite constant. We regard the balaeniceps development of the small chela in the females as an excellent characteristic for the separation of this species from most of the other species of the Edwardsii Group.

The variation we found in the Australian specimens parallels that which we found in those from the Central Pacific, with one exception. While we found the sculpturing of the palm of the small chela to be variable in both males and females from the Central Pacific, in no case did it reach the marked sculpturing we found in some, but not all, of the Australian specimens. Even greater sculpturing is found in the new subspecies *A. s. cremnus*. We regard the sculpturing of the palm of this chela as too variable to be used as a criterion for specific or subspecific separation. It should be noted in passing that the small chela figured by Tiwari from Vietnam (1963, fig. 29e) approaches the condition we found in many specimens from Australia. We found (1966a:185) the characteristics used by Coutière for the separation of *A. s. angulatus* from the Maldives and Laccadives to be within the normal variation we described. We accepted *A. s. galapagensis* of Sivertsen (1934:3) as distinct. Inasmuch as he depicted the small chela of the male with a simple, conical dactylus, we now suggest it may be a separate species.

BIOLOGICAL NOTES: This species is most commonly collected under rocks on sandy beaches in the lower portion of the intertidal zone. It has been our observation from other collecting sites in the Indo-Pacific area that this species does not occur where the substrate carries a great deal of mud. For further discussion see *A. s. cremnus*. One of

the specimens (BAU 72) was found in a hole in the coral directly underneath a brittle star *Macrophiothrix longipeda* (Lamarck, 1816). (Ophiuroid identified by Dr Dennis Devaney of the Bishop Museum, Honolulu, Hawaii). We have also often found the "fire worm" *Eurythoe* occupying the burrows of this shrimp.

The colour is apparently variable. For this subspecies we have colour notes supplied by Yaldwyn for specimens from One Tree Island (AM 317) "Green yellow with some white markings on carapace and abdomen"; (AM 318) "Hands mottled with large areas of olive green and white"; (AM 319) "Hands orange with irregular patches of dark grey, eggs orange". Gravelly (1930:79) reports on a specimen from the Gulf of Manaar: "The colour of the living animal is greenish brown, often either mottled or striped more or less distinctly with white. When stripes are present they are usually longitudinal, but may be transverse". Our specimens ranged in size up to 64 mm in length, but Couitière (1905a:913) reports specimens as large as 95 mm.

AUSTRALIAN DISTRIBUTION: Specimens in western Australia were collected between Dampier and Cockatoo Island; in the north they came from Darwin, Gulf of Carpentaria and the Torres Straits; the majority of specimens came from eastern Australia and were collected between Cooktown, Qld. and Sydney, N.S.W. (See also discussion under *A. s. cremnus* subsec. nov. following).

GENERAL DISTRIBUTION: This subspecies has been collected all through the Indo-Pacific from the Red Sea to the Society Islands and possibly to the Galapagos Islands (Schmitt 1939:26, as *Crangon strenuus*), but it does not occur in Hawaii.

***Alpheus strenuus cremnus* subsec. nov.**

Fig. 72

HOLOTYPE: 50 mm male collected on the intertidal rock platform at Minnie Waters, near Grafton, N.S.W. in Feb. 1965 by J. C. Yaldwyn. AM 12 (AM P. 27194).

ALLOTYPE: 60 mm female collected with the holotype. (Presumed to be a cohabiting pair.) (AM P. 27195).

PARATYPES: 2 specimens from AM 14 (AM P. 27196); 1, AM 37 (AM P. 27197); 1, AM 41 (AM P. 27265); 1, AM 77 (AM P. 27206); 1, AM 84 (AM P. 27244); 1, AM 132 (AM P. 27245); 2, AM 152 (AM P. 27198); 1, AM 212 (AM P. 27207); 1, AM 344 (AM P. 27208); 1, AM 345 (AM P. 27246); 1, AM 349 (AM P. 27200); 3, AM 383 (AM P. 27247); 1, AM 385 (AM P. 27199); 1, AM 399 (AM P. 27209); 4, AM 422 (AM P. 27210); 2, AM 441 (AM P. 27211); 2, AM 445 (AM P. 27226); 3, AM P. 4950; 1, AM P. 6914; 3, WM 89-65; 3, WM 131-65; 9, WM 185-65; 5, WM 221-65; 11, WM 278-65; 2, WM 299-65.

DIAGNOSIS: Rostrum narrow, acute, with tip reaching almost to or slightly beyond end of first antennular article; rostral carina dorsally rounded but laterally abrupt, reaching well behind pigmented portions of eyes. Orbitorostral grooves pronounced and broad, posteriorly "U"-shaped when seen dorsally with margin anteriorly divergent. Orbital hoods not markedly inflated, but well demarked from grooves by sharp ridge that posterior to eyes may overhang an abrupt and concave lateral wall of groove; anterior wall of groove abrupt but not concave and ridge not overhanging; ridge of orbital hoods at times lying dorsal to medial portion of pigmented facets of eyes. Frontal margins of orbital hoods hemispherical. Second antennular article 1.8 times as long as broad and 1.7 times longer than visible part of first antennular article; third article subequal to visible part of first. Stylocerite acute, reaching end of first antennular article. Scaphocerite with lateral tooth strong, reaching well past end of antennular peduncle; squamous portion as normal, reaching to end of antennular peduncle. Carpocerite a little longer than lateral

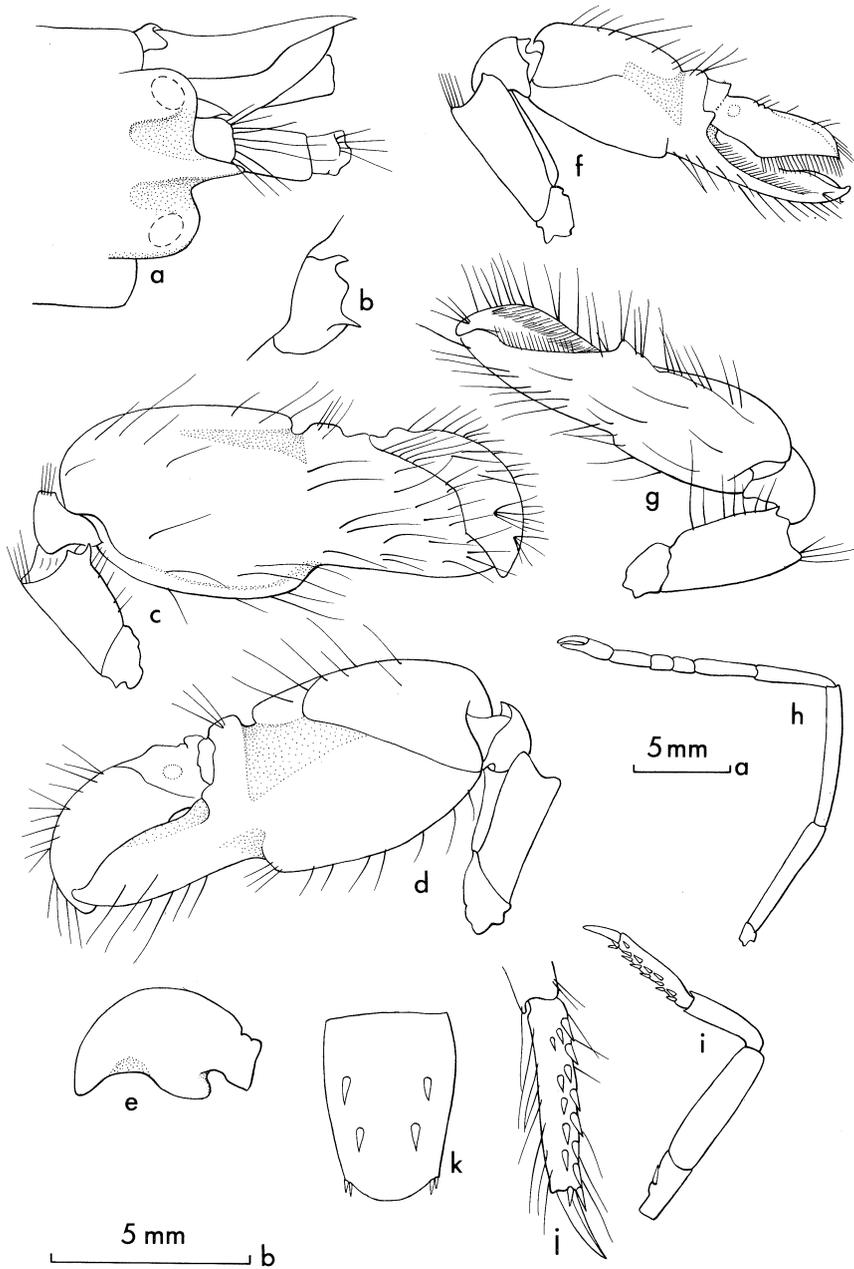


Fig. 72 *Alpheus strenuus cremnus* subsp. nov.
 Holotype (male). a. Anterior region, dorsal view; b. basicerite, lateral view; c, d, e. large cheliped, medial and lateral face and dactylus; f, g. small cheliped, lateral and medial face; h. second leg; i, j. third leg and enlarged propodus and dactylus; k. telson. b, c, d, e, f, g, h, i scale a; a, j, k scale b.

spine of scaphocerite. Basicerite bearing acute slender tooth.

Ratio of articles of third maxilliped: 10:3:7.

Large chela compressed, massive, 2.5 times as long as broad with fingers occupying approximately the distal third. Superior saddle deep and quite narrow; proximal shoulder slightly overhanging saddle, distal shoulder prominent and initially abrupt. Lateral palmar depression well defined, quadrangular, reaching proximally to *linea impressa*. Medial palmar depression a narrow triangle with apex reaching to proximal third of chela. Inferior shoulder heavy and rounded; inferior notch prominent. Inferolateral depression continued up face of palm 0.2 total width, disappearing into pollex distally. Inferomedial depression small, but continuing proximally as a narrow longitudinal groove almost reaching to articulation at proximal end of chela. Medial face of chela sparsely hirsute, lateral face glabrous. Plunger of dactylus only moderately developed. Merus 1.6 times as long as broad; and inferoexternal and superior margins rounded distally; inferointernal margin with acute tooth distally.

Small chela of both male and female of balaeniceps form. Cheliped 3.4 times as long as broad; fingers a little shorter than palm. Superior and inferior margin of palm bearing shoulders, grooves and depressions similar to palm of large chela but not as pronounced. Articulation of dactylus flanked medially by a small obtuse projection. Adhesive plaque of dactylus borne on flattened triangular areas, laterally rounded, but demarked medially by rounded ridge that continues distally, disappearing slightly proximal to point of union of balaeniceps setiferous crests; ridge proximally bearing scattered setae. Medial face of entire chela bearing long forward-sweeping hairs, more distally than proximally; lateral face glabrous. Merus similar to that of large chela, 2.7 times as long as wide.

Second leg with ratio of carpal articles: 10:8:2:2:5.

Ischium of third leg bearing tooth. Merus 3.8 times as long as broad, inermous; carpus 0.6 as long as merus, distosuperior and distoinferior margins slightly projected. Propodus 0.7 as long as merus, inner face bearing 14 spines, roughly paired. Dactylus triangular in section, simple, 0.4 as long as propodus.

Telson 1.8 times as long as posterior margin is broad; posterolateral spines small, spines on dorsal surface of telson prominent.

DISCUSSION: This subspecies is identical to the nominate subspecies except in two morphological characteristics and apparently in its ecology. The most pronounced and consistent difference in the structure in is in the orbital grooves. In *A. s. strenuus* they are shallow and rounded, with the margins confluent with curvature of rostrum and the orbital hoods; they extend only slightly posterior to the pigmented portions of the eyes. In *A. s. cremnus*, they are deeper, broader and extend further posteriorly; medially the sides of the rostrum are more abrupt, and laterally, posterior to the pigmented portion of the eyes, a ridge of the orbital hood overhangs the concave margin of the groove; even at the posterior end the grooves are firmly demarked from the carapace.

The second morphological characteristic is in the sculpturing of the palm and the ridge of the dactylus of the small chela of both males and females. As remarked under *A. s. strenuus*, the degree of sculpturing of the palm of the small chela was found to be variable but usually slight in the Central Pacific specimens; those from Australia are also variable but usually have a greater degree of sculpturing. However, this difference between the Australian and the Central Pacific specimens is not great enough or constant enough to warrant in our opinion the designation of the Australian form as a separate subspecies. On the other hand the difference in sculpturing of the small chelae between *A. s. strenuus* and *A. s. cremnus* is marked and almost always present, with that of *A. s.*

cremnus much more like that of the large chela — contrast figs. 71e and 72f. In only a few specimens of *A. s. strenuus*, as determined by the nature of the orbital grooves, did the sculpturing approach the extreme conditions characteristic of this subspecies. As these occurred in the waters of New South Wales where evidently the two subspecies coexist, they may be hybrids.

We believe there may be an ecological separation between the two subspecies, as well, but this cannot be proven by the collection data available with the two subspecies. The two forms overlap geographically. However *A. s. strenuus* occurs definitely on coral reefs and coral cays, and along more continental shores, but apparently in clean sand and cleaner waters, while *A. s. cremnus* may occur more commonly in muddy and estuarine environments, such as Moreton Bay, the mouth of the Clarence River, near the mouth of Tuggerah Lake, etc. Yet both subspecies have been collected from Long Reef, Collaroy, on the ocean coast of north Sydney. If the two forms we are here calling subspecies are indeed found to overlap ecologically, then *A. s. cremnus* should be considered to be a separate species.

The name is derived from the Greek word *cremnos*, which means, in part, an overhanging wall or bank and refers to the lateral margins of the orbitorostral grooves. The holotype and allotype as well as some paratypes will be deposited at the Australian Museum in Sydney, N.S.W. Paratypes will be placed in the Western Australian Museum, Perth, W.A.

BIOLOGICAL NOTES: The evidently cohabiting pair we selected for the holotype and allotype had the female larger, but in other pairs this size relationship did not hold.

Healy and Yaldwyn, (1970, pl. 18) published a colour picture of a specimen from Long Reef, N.S.W. (AM 399); it shows an overall red cast with the cephalic and thoracic appendages definitely light red. The carapace is a brownish-red and the abdomen with transverse bands separated by pinkish-white, brown and white irregular bands on caudal fan. Yaldwyn described the holotype and allotype as "purplish-red with transverse abdominal bands of the same colour". He described a similar coloration for four other specimens. However, one specimen from the Clarence River was noted by Cameron, the collector, as "striped with olive green and white, brick red hands." (AM 132).

AUSTRALIAN DISTRIBUTION: Most of the specimens came from near Sydney and on the other parts of the coast of New South Wales; however, collections of it were made near Hopetoun (near Albany) from Cape Leveque and Yampi Sound, W.A. and from Darwin, N.T., the Gulf of Carpentaria and Moreton Bay, Qld.

***Alpheus euphrosyne euphrosyne* De Man**

Fig. 73

Alpheus euphrosyne De Man, 1897:745, fig. 64 a-d; 1898b:317, pl. 4, fig. 2. Banner and Banner, 1966b:130, fig. 49.

Alpheus eurydactylus De Man, 1920:109; 1924:48, fig. 17.

SPECIMENS EXAMINED: 4 specimens from AM 81 (AM P. 28127); 2, AM 96 (AM P. 28128); 1, AM 162 (AM P. 28129); 1, AM 202 (AM P. 28130); 1, AM 279 (AM P. 28131); 1, AM 310 (AM P. 28132); 1, QM W 2248.

DIAGNOSIS: Rostrum triangular, short and variable in length, not reaching further than middle of visible part of first antennular article. Rostral carina low, rounded, extending past posterior end of orbital hoods; orbitorostral grooves shallow, at times non-existent. Second antennular article almost twice as long as broad and 1.5 times as

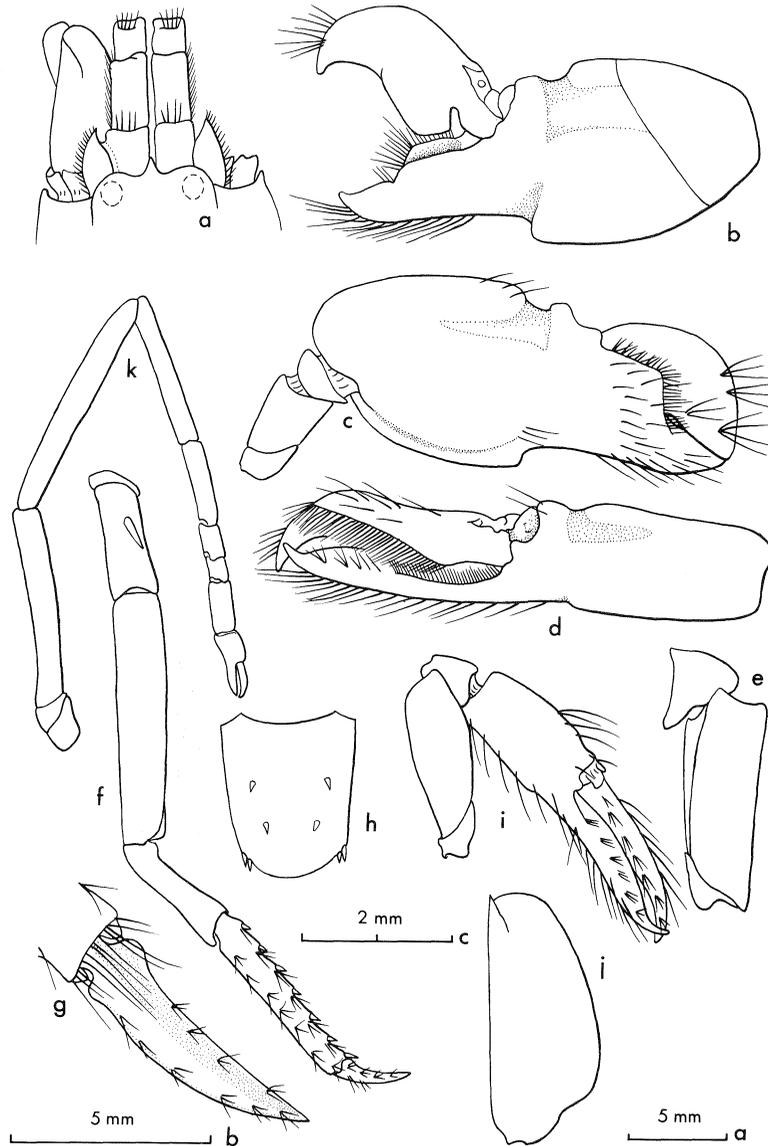


Fig. 73 *Alpheus euphosyne euphosyne* De Man
 78 mm male from AM 162. **a**. Anterior region, dorsal view; **b**. large chela, lateral face; **c**. large cheliped, medial face; **d**, **e**. small chela and merus, lateral face; **f**, **g**. third leg and enlarged dactylus, superomedial face (spatulate side not shown); **h**. telson. 55 mm female from AM 96. **i**. Small cheliped, lateral face; **j**. scaphocerite. 43 mm female from AM 2; **k**. Second leg. a, b, c, d, e, f, h, i scale a; j, k scale b; g scale c.

long as visible part of first; third article 0.7 length of first; lateral margins bearing many short setiferous bristles. Stylocerite broad, tip acute, and reaching to end of first antennular article, with short stiff setiferous bristles on lateral margins. Scaphocerite with outer margins slightly convex, squamous portion broad, usually equal to lateral tooth, but sometimes longer. Carpocerite as long as antennular peduncle. Basicerite usually unarmed.

Large chela heavy, 2.3 times as long as broad. Superior saddle broad and shallow with proximal and distal shoulders gently rounded; medial palmar depression shallow and triangular with apex reaching to middle of palm, lateral palmar depression a little deeper, quadrangular and reaching to *linea impressa*. Inferior shoulder at right angles to margin, rounded; inferior notch continued on lateral face as slight triangular depression, but not appearing on medial face. Inferior margin carrying on medial side a longitudinal groove arising in proximal third of palm and extending almost to inferior shoulder where it turns upward. Plunger well developed. Merus only slightly longer than broad, unarmed.

Small chela sexually dimorphic with male bearing typical *balaeniceps dactylus*. Male chela 4.5 times as long as broad, fingers equal to palm in length. Sculpturing similar to that of large chela but much less pronounced. Crest of hairs on margins of dactylus cross superior surface proximal to curved acute tip; flattened area conspicuously triangular. Pollex bearing fringe of setae proximally. Merus 3 times as long as broad, unarmed. Female chela 5.3 times as long as wide, fingers 1.2 times length of palm. Palm with slight traces of superior saddle and inferior shoulder. Merus similar to that of male.

Second leg with ratio of carpal articles: 10:(4-8):2:2:3.

Ischium of third leg often without spine. Merus inermous, 5 times as long as broad. Carpus 0.5 as long as merus with superior margin projecting but rounded. Propodus 0.8 as long as merus and bearing 7 stout spines on inferior margin and a pair distally; propodus also bearing tufts of short stiff setae in rows on either face near row of spines and a third row near superior margin on medial face. Dactylus 0.4 as long as propodus, spatulate and slightly curved; also bearing tufts of setae similar to propodus near superior and inferior margins.

Telson broad, 1.3 times as broad anteriorly as posteriorly and 1.4 times as long as posterior margin is broad; lateral margins slightly convex, posterior margins strongly convex, superior and posterolateral spines small.

DISCUSSION: De Man had only 2 females from the Java Sea upon which to base his original description. Later (1898b:317) with a smaller specimen from Bangkok he was able to describe and figure the small chela of the male. He reported on a large specimen from Postillon Is. (Indonesia) (1911:413), but unfortunately the specimen was mutilated. We examined this specimen at the Zoologisch Museum in Amsterdam and while it does lack the anterior thoracic legs the parts remaining are certainly typical for the species. The only other report was ours based on 127 specimens from Thailand, largely from mangrove swamps (1966b:130) from which we established the extent of variation. These variations included the proportions of the articles of the antennular peduncle, the presence or absence of the lateral tooth of the basicerite, the length of the lateral spine to the blade of the scaphocerite, the proportions and to some degree the sculpturing of the large and small chela (the absence of sculpturing in the male small chela did not always appear to be associated with smaller size), the occasional presence of a small inferointernal spine on the merus of the large cheliped, the relative proportions of the first two carpal articles of the second legs, the presence or absence of a spine on the ischium, and the proportions of the meri of the third legs. The few Australian specimens available fall well within the range reported from Thailand.

In view of the variation we noted in our specimens from Thailand, we wish to review the status of *A. eurydactylus* which De Man described from an unspecified location and habitat on Java. In 1924 he redescribed the species in greater detail and expressed doubts about its separation from *A. euphrosyne*. He finally decided to let the species stand until more specimens of *A. euphrosyne* were known. The differences he reported were in the size of the orbitorostral groove, and in the proportions of some of the appendages. In our examination of his holotype and allotype at the Zoologisch Museum in Amsterdam we found the differences between this nominal species and *A. euphrosyne euphrosyne* were easily bridged by the variation noted in the Thai specimens. Therefore we are placing the name *A. eurydactylus* in synonymy.

We are also reducing *A. richardsoni* Yaldwyn and *A. langi* (Schmitt) to subspecific rank under this species; these will be discussed under *A. e. richardsoni* following. This has required the nominate form to bear a subspecific designation.

BIOLOGICAL NOTES: The species appears to be adapted for muddy estuarine conditions. The Australian specimens were all found in such conditions, some being specifically reported from burrows of the crab *Sesarma* sp. which were dug in river banks. In Thailand the species was the only species found in mangrove swamps, but some were also found under rocks on sandy-muddy beaches where there was a fresh water leakage and in the shrimp trawls from the bottom of a shallow brackish lake (Lake Songkla).

AUSTRALIAN DISTRIBUTION: The specimens in the collections ranged from Townsville to Princess Charlotte Bay, Queensland; we would suspect that the species will also be found elsewhere under similar conditions along the tropical coasts of Australia.

GENERAL DISTRIBUTION: Indonesia and Thailand.

Alpheus euphrosyne richardsoni Yaldwyn, new combination

Fig. 74

Alpheus sp. of the Edwardsii Group, Richardson and Yaldwyn, 1958:37, fig. 35.

Alpheus richardsoni Yaldwyn, 1971:88.

Alpheus euphrosyne Hutching and Recher, 1974:106.

SPECIMENSEXAMINED: 6 specimens from AM 51 (AM P. 27879); 1, AM 87 (AM P. 27881); 4, AM 103 (AM P. 27882); 4, AM 127 (AM P. 27870); 2, AM 195 (AM P. 27860); 1, AM 227 (AM P. 28156); 2, AM 241 (AM P. 27871); 2, AM 386 (AM P. 28157); 1, AM 463 (AM P. 27857); 1, AM 464 (AM P. 27858); 1, AM 466 (AM P. 27859); 8, AM G. 6139; 1, AM P. 1441; 2, AM P. 2021; 3, AM P. 2022; 1, AM P. 2152; 1, AM P. 2347; 1, AM P. 3581; 2, AM P. 4497; 12, AM P. 4601; 3, AM P. 4602; 3, AM P. 4681; 1, AM P. 4839; 2, AM P. 5137; 1, AM P. 5356; 1, AM P. 6449; 2, AM P. 6468; 2, AM P. 6682; 3, AM P. 6710; 2, AM P. 7164; 2, AM P. 7463; 3, AM P. 7476; 6, AM P. 9068; 3, AM P. 12952; 4, AM P. 13558; 2, AM P. 13566; 4, AM P. 13576; 3, AM P. 13579; 4, AM P. 17923; 1, AM P. 19636; 4, BAU 5; 5, BAU 21; 7, BAU 59; 16, BAU 60; 4, BAU 61, 1 specimen each from CS 46, 47, 48, 49; 1, MM 178; 4, QM W 2241; 8, QM W 2242; 1, QM W 2243; 1, QM W 2244; 2, QM W 2245; 1, QM W 2247; 2, TM G 1348; 1, TM G 1349; 10, TM G 1359; 1, TM 12877/G51; 1, UQ 3; 1, UQ 9; 1, US 106164; 1, US 106165; 10, US 123603; 3, VM 14; 5, VM 15; 1, VM 27; 47, VM 34; 1, VM 36; 1, VM 935; 1, VM 956; 1, VM 962; 2, WM 294-65; 1, WM 295-65; 34, WM 10229; 27, WM 10199/10208 and 10229-34; 4, WM 10274; 7, WM 11664; 1, WM 11788; 1, WM 15057; 2, WM 15108/9; 2, WM 93/94-96; 2, WM 403/5-38; 6, WM 449/54-32; 1, WM 759-30; 1, WM 120-37; 1, WM 169-37; 1, WM 338-39; 1, WM 497-39; 1, WM 605-39; 2, WM 44-49; 1, WM 270-52; 6, WM 449/54-32.

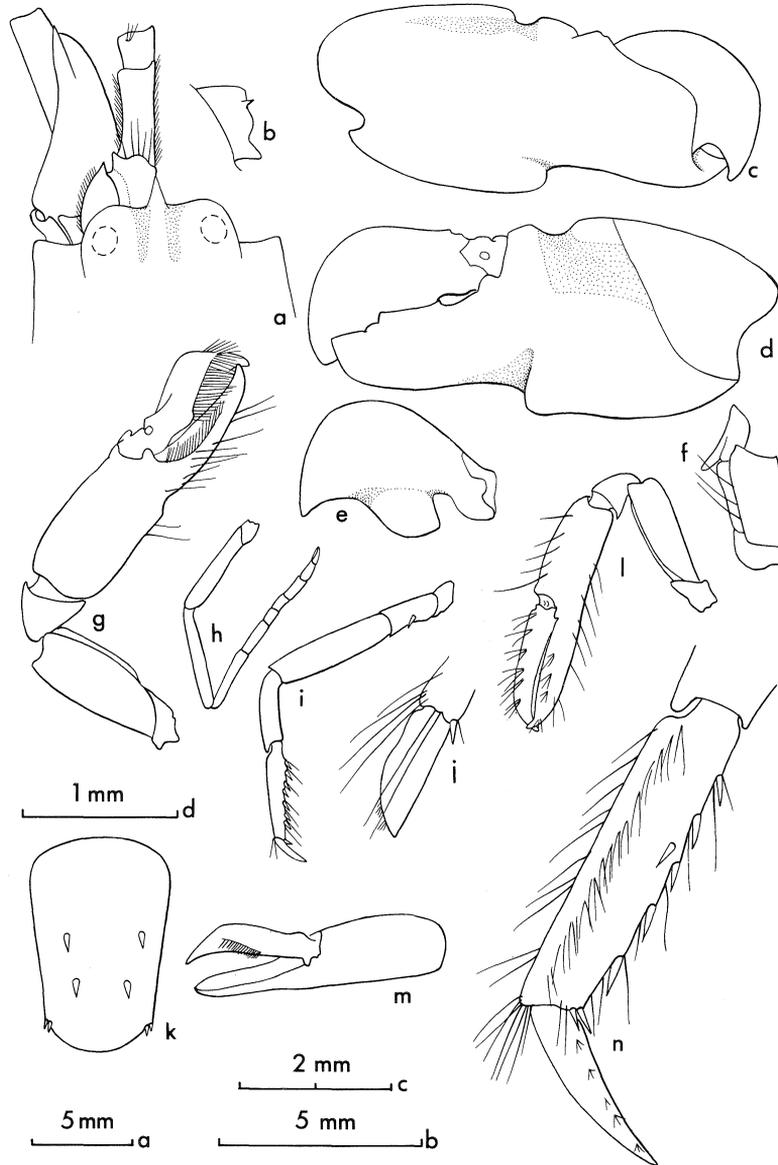


Fig. 74 *Alpheus euphrosyne richardsoni* Yaldwyn

45 mm male from AM P. 4497. **a.** Anterior region, dorsal view; **b.** basicerite, lateral view; **c.** large chela, medial face; **d, e.** large chela and dactylus, lateral face; **f.** merus large chela, lateral face; **g.** small cheliped, lateral face; **h.** second leg; **i, j.** third leg and dactylus; **k.** telson. 48 mm female from AM P. 4495; **l.** Small cheliped, lateral face. 30 mm male from AM P. 2021. **m.** Small chela with minimal balaeniceps development, lateral face. 45 mm male from AM 350. **n.** Enlargement of distal region of third leg. **c, d, e, f, g, h, i, l** scale a; **a, k, m** scale b; **n, b,** scale c; **j,** scale d.

TABLE 5
Separation of three subspecies of *Alpheus euphosyne*

| | <i>A. e. euphosyne</i> | <i>A. e. richardsoni</i> | <i>A. e. langi</i> |
|--|--|--|---|
| 1. Orbitorostral margin | Markedly concave | Slightly concave | Slightly concave |
| 2. Scaphocerite | Squamous portion broad, usually longer than lateral tooth, lateral margin straight to convex | Squamous portion only moderately broad, always shorter than lateral tooth, lateral margin slightly concave | Squamous portion usually broad, from longer to slightly shorter than lateral tooth, lateral margin straight |
| 3. Basicerite | Rarely with tooth | Always with tooth | Always with tooth |
| 4. Sculpturing of palm, small chela of males | Usually with strong superior saddle and inferior shoulder | Superior saddle obsolete; inferior shoulder of minimal development | Superior saddle moderate; inferior shoulder lacking |
| 5. Ecology and distribution | Tropical, in muddy estuaries and in mangrove swamps, Indonesia, Thailand and Northern Queensland | Temperate, in muddy estuaries and in mangrove swamps; New Zealand and southern waters of Australia (with one possible exception) | Tropical, in muddy estuaries and in mangrove swamps; mouth of Congo |

DIAGNOSIS: Rostrum acute, triangular, reaching past middle of visible part of first antennular article. Rostral carina slight, rounded, reaching to slightly past base of orbits; orbitorstral grooves minimal. Orbitorostral margin at most slightly concave. Ratio of antennular articles beginning with visible part of first article: 10:16:9, second article slightly more than 2 times as long as broad. Outer margins of antennular articles armed with short setiferous bristles. Stylocerite acute, reaching to last quarter of visible part of first antennular article, outer margins armed with short setiferous bristles. Outer margin of scaphocerite concave, lateral tooth longer than squamous portion which is moderately wide and reaches just beyond antennular peduncles. Carpocerite reaching almost length of third antennular article past that article.

Large chela 2.2 times as long as broad with fingers occupying the distal 0.4. Superior saddle deep, broadly "U"-shaped with both shoulders gradually rounded. Lateral palmar depression well defined, quadrangular, reaching to *linea impressa*. Medial palmar depression well defined, roughly triangular with apex reaching to proximal quarter of palm. Inferior shoulder heavy, lying at right angles to palm. Inferior notch continues into lateral face as a faint triangular depression, into medial face as small triangular depression extending proximally. Plunger of dactylus well developed and heavy. Merus 2.2 times as long as wide, with superior and inferointernal margins extended distally, but without teeth; inferointernal margin bearing a few long hairs.

Small chela sexually dimorphic. Male chela almost 3 times as long and broad with full balaniceps dactylus. Palm with vestigial superior saddle but relatively heavy inferior shoulder and notch; face of palm without sculpture. Merus 2.7 times as long as broad, unarmed. Small chela of female almost 4 times as long as broad, palm without trace of sculpture, fingers nearly cylindrical with slight knife edge on opposite faces.

Ratio of carpal articles of second leg: 10:6:2:2:3.

Ischium of third leg usually bearing short spine. Merus 4 times as long as broad, inermous. Carpus 0.5 as long as merus, superior margin projecting into rounded tooth, inferior margin not projecting. Propodus 0.7 as long as merus bearing on its inferior margin 6 spines and a pair distally; lateral and medial surfaces bearing parallel patches of setae similar to *A. e. euphrosyne*. Dactylus 0.4 as long as propodus, spatulate; superior surface with low crest and a few tufts of setae.

Telson 2 times as long as posterior margin is broad; anterior pair of dorsal spines just anterior to midline.

DISCUSSION: As pointed out under *A. euphrosyne*, that species is adapted for muddy, brackish water conditions such as are found in mangrove swamps and is found exclusively in such habitats in the tropics of the western Pacific. Two other forms, described as *A. richardsoni* by Yaldwyn and *A. langi* by Schmitt (as *Crangon langi*, 1926:20) are morphologically almost identical and live in similar habitats, but are geographically separated, *A. richardsoni* living in temperate Australia and New Zealand, usually living in estuarine conditions, and *A. langi* at the mouth of the Congo. Dr Yaldwyn has compared his specimens from New Zealand with specimens from Australia for us, and we have examined the type series of *A. langi* through the courtesy of the American Museum of Natural History in New York. We are combining the three species under *A. euphrosyne*, but are considering the two separately described forms as geographically isolated subspecies. There is a third form morphologically indistinguishable from *A. e. richardsoni*, but it was found in a markedly different environment that we also discuss below.

The three subspecies may be separated by the characterists given in Table 5.

The most consistent differences are in the nature of the squame and the sculpturing of the small chela of the males. We have found these differences quite consistent in our examination of the holotype and topotypic specimens from all three subspecies, as well as the extensive series of *A. e. euphrosyne* from Thailand and the more than 300 specimens of *A. e. richardsoni* listed above from Australia. Dr Yaldwyn agrees that his *A. richardsoni* is the same as the Australian form.

The form reported from sea grass beds in New South Wales by Hutchings and Recher as *A. euphrosyne* was identified by us before we had made the distinction between the two subspecies; it is actually *A. e. richardsoni*.

We are troubled by 4 specimens from Arlington Reef (BAU 21) and 5 specimens from intertidal reef flat on Green Island Reef (AM 227), both off Cairns, Qld. These were from neither silty nor brackish conditions, yet morphologically they could not be distinguished from *A. e. richardsoni*. Moreover, they were found 10° further north than the northernmost record of *A. e. richardsoni*. However, they were markedly smaller than *A. e. richardsoni*, for none, including 3 ovigerous females were over 25 mm in length while *A. e. euphrosyne* and *A. e. richardsoni* both reach 65 mm in length at maturity. It is also notable that in the numerous collections made elsewhere along the Great Barrier Reef no other specimens of this form were found. We suggest two possible explanations for the occurrence of these 9 specimens: First, they may have matured out of their natural range and have been stunted by adverse ecological conditions. Second, and more plausible, they are yet another subspecies of the nominate species that has adapted to living in other than mud and brackish water, but that in this adaptation the external morphology has not been modified. If this latter hypothesis is true, then this form can be distinguished from the other subspecies only by its ecological preferences, body size and possible physiological adaptations. We do not speculate further but leave the problem for Australian carcinologists and ecologists.

BIOLOGICAL NOTES: Yaldwyn's type series came from "Mangrove swamps and from intertidal and shallow water mudflats" on both coasts of the northern part of the North Island, New Zealand. Similarly, the Australian specimens, where the habitat was noted in the collection data, came from muddy or silty conditions, often apparently in brackish water. The deepest collection were dredged at 22-24 m from "soft, silty substrate" in Port Phillip Bay, Victoria*. The specimens ranged up to 65 mm long.

In her doctoral thesis Ms KhinKhin U (1977 — see also p. 24) devoted most of her studies to the biology of *A. e. richardsoni* (under the name of *A. richardsoni*) living intertidally on a mud flat at Margate, Tasmania (near Hobart). To our knowledge this is the most comprehensive study on the general biology of a species of alpheid shrimp — as opposed to special studies on behaviour or embryology, etc. — yet made. With her permission we summarize some of her findings.

On the mudflats she found the population extending high in the intertidal zone (to mean highwater level of spring tides?); she did not investigate its penetration into the subtidal zone. She also reported their collection along the northern, eastern and southeastern coasts of Tasmania as well as from Flinders Island. The environment was found to have marked seasonal variations, with the temperature of the surface water ranging from 6° to 28°C, and the salinities from 14‰ to about 35‰. Laboratory studies showed that shrimp could tolerate even greater spans, but that the winter-adapted shrimp had a broader tolerance than those summer-adapted.

*Diane Brown of the Australian Museum sent us a single specimen of this species collected in 225 fathoms (412m) at 33° 40'S, 151° 53'E (southeast of Broken Bay, N.S.W.) by the F. R. V. "Kapala" (Australian Museum register number P. 19636).

The largest specimen she reported upon was only 42 mm long, considerably shorter than some from the coasts of Australia proper. She presented a tabulation and a discussion of the variations in proportions she found which showed that, like many other species in the Edwardsii Group, the species is fairly consistent in most proportions. She did find that in all cohabiting pairs the male had a proportionally larger large chela than the female.

Like many other species in the Edwardsii Group she reported *A. e. richardsoni* was a burrowing form, constructing a rather elaborate set of chambers and passages up to 30 cm below the surface. The shrimp preferred to initiate their burrows under a rock laying on the surface, but could burrow through the silt to reach a subsurface rock. In making the burrows both members of the cohabiting pair worked together. The mud was loosened by action of the walking legs and then fanned out of the burrow by the beat of the pleopods; during the process the large chela was thrust into the substrate as a brace. Smaller particles of shell or sand were carried out of the burrow with the small chela; the large chela was used only to push larger objects and at times to push sand and mud away from the entrance of the burrow. In aquaria a cohabiting pair was observed to maintain the same burrow for months. She did not find any symbiotic relationship with fish in the burrow.

She found from observation and stomach contents the species to be an opportunistic omnivore, eating fragments of *Zostera* (eel grass), various foraminiferans, polychaetes, a few molluscs and many crustaceans, including its own species. Observations on feeding behaviour showed that the food was probably detected by both pairs of antennae and was transferred to the mouthparts either by the chelae of the second legs (for small pieces) or by the small chela (for larger pieces). She did not observe the use of the large chela in the feeding process either in the production of sound or for grasping. She presented some excellent scanning electron photomicrographs of the armature of the third maxilliped. She found that in the field the shrimp would remain confined to the burrows during daylight but at night would leave the burrows for foraging. If the wandering shrimp attempted to retreat to the wrong burrow, the burrow would be defended by its rightful inhabitants by the snapping of the large chela.

Ms U also reported upon reproduction. She did not observe copulation and offered no explanation of the function of the balaeniceps dactylus of the males. The females were in berry the year around, but she found the eggs hatching only during the (southern) summer; some individuals, at least, would have two broods hatching during a single summer. The number of eggs carried was roughly a function of the size of the female, ranging by actual count from 7 to 1019. In reference to those earlier workers who used egg size as differentiating characteristic between species, she found the newly laid eggs to be round and 0.7 mm in diameter, while mature eggs, ready to hatch, were ellipsoidal with the diameters of 1.2 x 0.8 mm. After the brood hatches, the female moulted. The larvae hatched in an early zoeal stage, but she was unable to rear the larvae past a stage III zoea, reached in about one week. She could not estimate the life span of an individual, but did report that in an aquarium, sexually mature individuals had lived for over two years.

Finally, Ms U reported the colour in life (p. 29); "Upper side of the carapace green, abdomen banded with green and brown. Tail fan is also green with a tinge of dark blue at the tip. Large chela green on upperside, underside is white, inner tips of the fingers yellow."

AUSTRALIAN DISTRIBUTION: Except for the 9 specimens discussed above from near Cairns, all records of this subspecies were from temperate Australian waters,

running from Moreton Bay at Brisbane southward with many records in New South Wales, continuing through Victoria, Tasmania, South Australia and to the large brackish rivers systems in Bunbury and Perth in Western Australia.

GENERAL DISTRIBUTION: Australia and New Zealand.

Alpheus inopinatus* Holthuis and Gottlieb

Fig. 75

Alpheus inopinatus Holthuis and Gottlieb, 1958:42, figs. 8, 9. Tirmizi and Kazmi, 1969:99, fig. 1.

Alpheus sp. Forest and Guinot, 1958:6, figs. 3-7.

SPECIMENS EXAMINED: 1 specimen from AM 5 (AM P. 27833); 7, AM 30 (AM P. 27467); 7, AM 36 (AM P. 27566); 1, AM 62 (AM P. 28158); 2, AM 66 (AM P. 27786); 1, AM 74 (AM P. 28159); 1, AM 237 (AM P. 27795); 1, AM 292 (AM P. 27808); 12, AM 408 (AM P. 27567); 2, AM P. 2006; 2, AM P. 2218; 2, AM P. 10125; 1, AM P. 28160; 48, BAU 6; 21, BAU 7; 1, BAU 74; 8, JC 18; 13, JG 13-73; 3, JG 14-73; 4, QM W 2237; 5, US 123602; 1, VM 29; 1, WM 102-65, 1, WM 130-65; 1, WM 214-65; 1, WM 256-65; 1, WM 272-65; 1, WM 276-65; 3, WM 286-65.

DIAGNOSIS: Rostrum narrow, acute, reaching past middle of visible part of first antennular article; tip tilted upward. Rostral carina sharp, slightly depressed between the eyes and terminating at base of eyes. Orbitorostral grooves moderately deep. Visible part of first and third antennular article equal, second article 1.4 times as long and almost twice as long as broad. Stylocerite acute, reaching to end of first antennular article. Scaphocerite with lateral tooth reaching beyond end of antennular peduncle, squamous portion narrow, reaching to end of antennular peduncle. Carpoperite stout, as long as lateral spine of scaphocerite.

Large chela stout, 2 times as long as broad with fingers occupying the distal 0.4, plunger of dactylus well developed. Superior saddle shallow, proximal shoulder gradually rounded. Lateral palmar depression well defined, quadrangular, reaching proximally to *linea impressa*. Medial palmar depression triangular, well defined, reaching to proximal third of palm. Inferior shoulder heavy, projecting slightly and rounded; both distal depressions triangular, that on lateral face smaller and better defined. Inferomedial margin of palm bearing long narrow groove from near proximal articulation almost to inferior shoulder. Merus 1.4 times as long as broad, distal margins inermous.

Small chela sexually dimorphic. Small chela of male balaeniceps, 3.0 times as long as broad, fingers and palm almost equal. Superior surface of palm with shallow, imperfectly defined superior saddle which runs proximally as a flattened area and is flanked on either side with heavy but low rounded crests. Palm with slight lateral depression, inferior shoulder strong. Strong tooth flanking dactylar articulation on medial side. Dactylus broadened with heavy fringe and strong proximal ridge, tip curved and crossing that of pollex, margins of pollex also bearing dense fringe of setae. Medial face of palm and pollex with scattered long hairs. Merus 2.0 times as long as broad, distal margins inermous, inferointernal margin bearing several setae. Small chela of female similar to male in proportions but dactylus not balaeniceps. Superior and inferior margins slightly notched proximal to dactylus. Medial face of fingers and distal portion of palm hirsute as in male. Merus similar to that of male.

Ratio of carpal articles of second leg: 10:7:3:3:5.

*(Note added in press). After a study of the variation found in a large collection of *A. lobidens* – *A. inopinatus* from the Red Sea we have come to the conclusion that the criteria set forth on p. 243 to separate the two nominal species are not valid and that *A. inopinatus* must be regarded as a junior synonym. The study also invalidated the separation of *A. lobidens* into two subspecies (see footnote, p. 252). We plan to publish the details of this study in a check-list of the alpheid shrimp of the Red Sea at some time in the future.



Fig. 75 *Alpheus inopinatus* Holthuis and Gottlieb
 35 mm male from AM P. 4229. **a, b.** Anterior region, lateral and dorsal view; **c.** large chela, lateral face; **d.** large cheliped, medial face; **e.** small cheliped, lateral face; **f, g.** small chela, medial and superior face; **h.** second leg; **i.** third leg; **j.** telson. 40 mm female from WM 286-65. **k, l.** Small cheliped, lateral and medial face; **a, b, j, l** scale a; **c, d, e, f, g, h, i, k** scale b.

Ischium of third leg unarmed. Merus 3.2 times as long as broad, also unarmed. Carpus 0.6 as long as merus; superodistal margin slightly projected but rounded. Margins bearing a few long setae. Propodus 0.7 as long as merus bearing 7 spines along inferior margin and a pair distally. Dactylus simple, 0.4 as long as propodus.

Telson 2 times as long as broad posteriorly. Posterior margin slightly arcuate and bearing a number of small spines in addition to the usual fringe of long setae.

DISCUSSION: Our specimens agree well with the original description. The scaphocerite is a little longer in relation to the antennular articles, but this type of variation is common in the genus *Alpheus*. The spinules on the posterior border of the telson are not always evenly placed as in the figure of Holthuis and Gottlieb, but often appear to have random placement and variable number and in some specimens they are very small or even absent.

We question the separation of this species from *A. lobidens lobidens* de Haan. It appears to be separated by the following differences:

(1) *A. inopinatus* has a much stronger lateral tooth and more concave lateral margin on the scaphocerite. (2) In the large chela the inferior shoulder is much heavier and projects slightly forward while in *A. l. lobidens* the inferior shoulder is at right angles to the chela. (3) The superior groove on the palm of the small chela of the male in *A. inopinatus* does not have the typical "U"-shaped transverse groove (superior saddle) found in *A. l. lobidens*, but bears a longitudinal groove bounded by a lateral ridge that when it terminates distally gives the appearance of an incomplete notch. (4) The medial faces of the fingers of the small chela of both sexes in *A. inopinatus* are much more hirsute than in *A. l. lobidens*. (5) Finally the inferointernal margin of the meri of the large and small chelae are unarmed distally except in very rare case in *A. inopinatus* while in *A. l. lobidens* they are usually armed. However, while "typical" *A. inopinatus* may be separated from "typical" *A. l. lobidens* by these differences, there are some specimens that lie intermediate in one or more of the characteristics. The two nominal forms co-exist in the same habitats, as well. We do not have enough specimens from the same habitats and localities to resolve the question and therefore must leave it to future workers.

Dr Forest of the Muséum National d'Histoire Naturelle in Paris has written us that he believes the specimen he and Guinot left unnamed in 1958 (*loc. cit.*) is of this species, therefore we are placing it in synonymy.

BIOLOGICAL NOTES: This species has been collected intertidally under rocks. It is often abundant as we collected over 50 specimens in two areas during a low tide at Yeppoon, Qld. In this collection were also some *A. l. lobidens*. It is a hardy species which according to Tirmizi and Kazmi, ". . . keeps well in small aquarium". Specimens reach 46 mm in length.

AUSTRALIAN DISTRIBUTION: This species was collected on the west coast from Perth to Gantheaume Bay, W.A.; in the north at Darwin and Thursday Island, and in eastern Australia from the Coral Sea to Grafton, N.S.W. Only one specimen was collected from the Great Barrier Reef and that was from the Low Isles.

GENERAL DISTRIBUTION: Mediterranean coast of Israel and the West Pakistan coast.

***Alpheus sudara* Banner and Banner**

Fig. 76

Alpheus sudara Banner and Banner, 1966b:153, fig. 59.

Alpheus crassimanus Tiwari, 1963:307, fig. 25, 26 (*partim*).

SPECIMENS EXAMINED: 2 specimens from AM 12 (AM P. 28133).

DIAGNOSIS: Rostrum short, not reaching to end of first antennular article; rostral carina sharp, but lying below level of orbital hoods in lateral view and extending to gastric region; carina terminated by slight protrusion in male specimen (protrusion lacking in female and in type series). Orbital hoods inflated, forming moderately deep grooves between carina and hoods. Second antennular article 2.5 times as long as broad, 2 times longer than visible part of first antennular article, third article subequal to first article. Stylocerite with lateral spine weak, but reaching almost to end of first antennular article. Scaphocerite with outer margins markedly concave, lateral spine reaching beyond antennular peduncle and well beyond narrow squamous portion which in turn reaches not quite to middle of third antennular article. Carpocerite equal in length to tooth of scaphocerite. Basicerite with strong lateral tooth.

Large chela stout, 2.4 times as long as broad, fingers occupying distal third. Proximal shoulder at right angles to, but not overhanging superior saddle; distal shoulder low and rounded; saddle broad. Lateral palmar depression quadrangular and well marked, extending to *linea impressa*; medial palmar depression a narrow triangle with apex extending to proximal quarter of palm. Inferior shoulder heavy and rounded; inferolateral depression "U"-shaped, narrow, deep and well defined; inferomedial depression roughly an equilateral triangle reaching about 0.4 breadth of palm bordered by low shoulder proximally that bears a few setae; distal margin indistinct. Pollex short and heavy, with distal oppositive margin on medial face lying at right angles to axis of palm and bearing dense fringe of long setae from dactylar articulation almost to short rounded conical tip. Plunger of dactylus of strong development. Merus 1.8 times as long as broad, without teeth on distal margins.

Small chelae showing sexual dimorphism. Small chela of male 3 times as long as broad, fingers 1.6 times as long as palm. Palm somewhat flattened on superior side, but without trace of superior saddle; inferior shoulder and notch strong. Dactylus articulated slightly laterally, medial side of articulation bearing moderate tooth. Dactylus bearing dense balaeniceps fringes of hair that meet on superodistal portion, but dactylus without the proximal expansion usually characteristic of balaeniceps condition; superior area set off by fringes with parallel sides except at tip. Superior crest of dactylus reaching almost to end of fringed area, but relatively low and rounded. Pollex also bearing rows of forward-sweeping dense setae longer than those of dactylus, meeting and overlapping dactylar setae. Tips of fingers hooked and crossing. Merus almost 2 times as long as broad with distal angles somewhat projecting but rounded. Small chela of females more slender, 2.8 times as long as broad and bearing only sparse hairs, tooth at dactylar articulation more acute than in male. Merus more slender and distal angles not as projecting.

Carpal articles of second leg with ratio: 10:7:3:3:4.

Ischium of third leg without spine, merus unarmed, 3 times as long as broad. Carpus 0.6 as long as merus, with neither margin distally projecting. Propodus 0.7 as long as merus, with 7 spines on inferior margin and a pair distally. Dactylus simple, 0.3 as long as propodus.

Telson 2.2 times as long as broad at posterior margin. Dorsal spines large.

DISCUSSION: The hair on the medial face of the dactylus and the pollex of the small chela of the male is much denser than in the specimens from Thailand, and also the

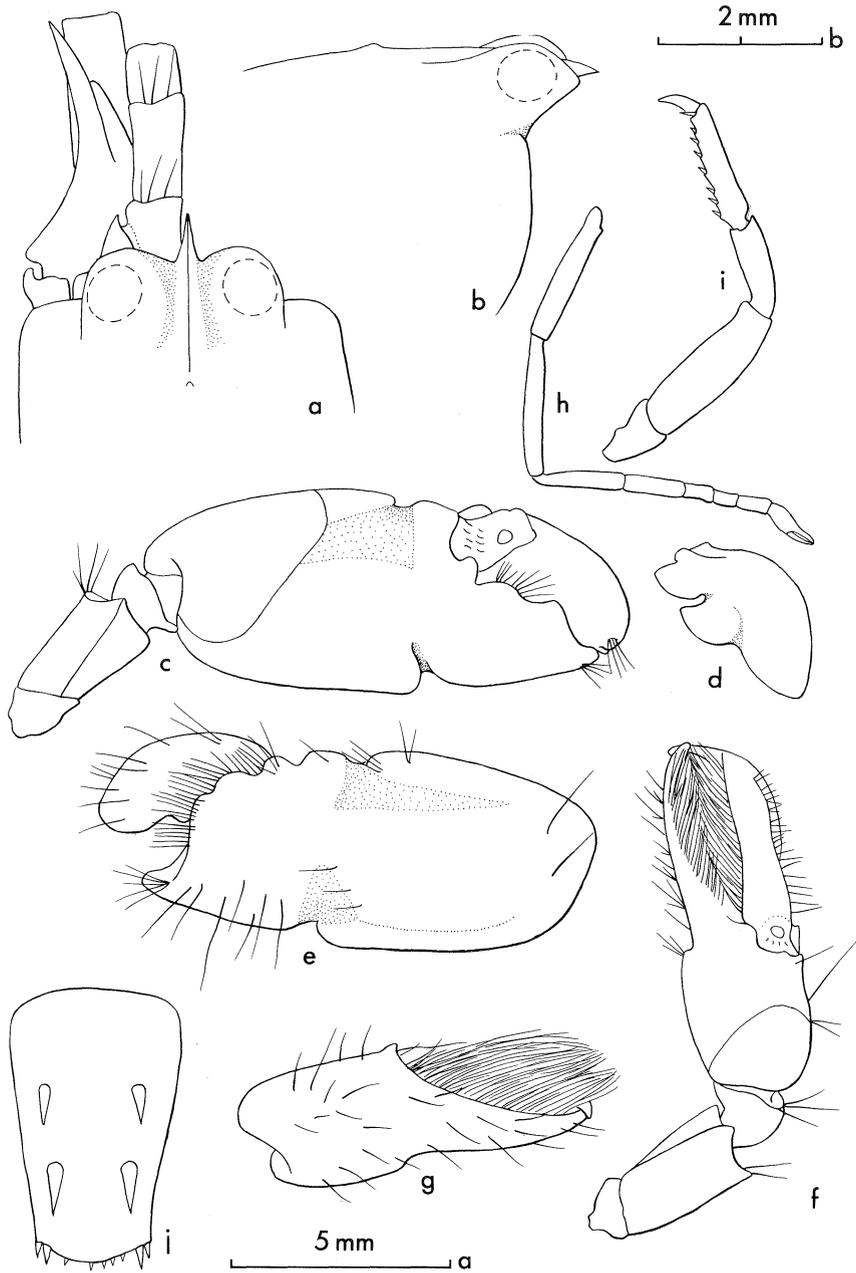


Fig. 76 *Alpheus sudara* B & B
 25 mm male from AM 112. **a, b.** Anterior region, dorsal and lateral view; **c, d.** large cheliped and dactylus, lateral face; **e.** large chela, medial face; **f, g.** small cheliped, lateral and small chela, medial face; **h.** second leg; **i.** third leg; **j.** telson. **c, d, e, f, g, h, i** scale **a**; **a, b, j** scale **b**.

superior groove on the palm of the large chela is broader. Finally, in both Australian specimens the rostral carina extends further posteriorly than in the Thai specimens and the posterior tubercle on the male carina was not seen before. With so few specimens and with their great similarity, we are considering these differences to be variation. However, when more specimens are examined, perhaps the Australian form may be considered to be a geographic race.

Tiwari (1963:307, figs. 25, 26) illustrates 2 specimens from Vietnam which he calls *A. crassimanus* (= *A. I. lobidens* De Haan). For remarks on the relationship of these specimens to *A. sudara* see discussion under *A. I. lobidens* (p. 252).

BIOLOGICAL NOTES: All specimens collected so far have come from the intertidal region or subtidally from coral heads. The larger specimen was 28 mm long; the Thai specimens reaching only 15 mm in length.

AUSTRALIAN DISTRIBUTION: Our specimens came from Port Curtis, Qld.

GENERAL DISTRIBUTION: Thailand and probably Vietnam.

***Alpheus leviusculus leviusculus* Dana**

Subspecies designated

Fig. 77

Alpheus edwardsii leviusculus Dana, 1852:543, pl. 34, figs 3a-f.

Alpheus leviusculus De Man, 1911:411, fig. 98. Banner and Banner, 1964:92, fig. 4.

Alpheus bouvieri bastardi Coutière, 1898b:133, fig. 1a.

Alpheus bastardi Coutière, 1905a:907.

Nec Alpheus leviusculus Bate, 1888:549, 98, fig. 1 (= *A. batesi* Banner and Banner, 1964:92, fig. 94).

Also discussed:

Alpheus leviusculus bouvieri Milne-Edwards, subspecies designated. *Alpheus bouvieri* Milne-Edwards 1878:231.

Alpheus hululensis Coutière, new combination. *Alpheus bouvieri hululensis* Coutière, 1905a:908, pl. 85, fig. 46.

SPECIMENS EXAMINED: 2 specimens from AM 64 (AM P. 28134); 4, AM 123 (AM P. 28135); 2, AM 226 (AM P. 28136); 2, BAU 35; 2, BAU 46; 3, BAU 54; 6, BAU 56; 1, US 123564; 4, WM 104-65.

DIAGNOSIS: Rostrum broadly triangular and short, not reaching beyond middle of visible part of first antennular article; margin lateral to rostrum slightly concave and continuing into the almost straight front of orbital hoods. Orbitorostral grooves shallow and broad, interorbital rostral crest slight and rounded. Orbital hoods slightly inflated. Second antennular article up to 1.3 times as long as broad, longer than visible part of first and third article. Stylocerite short, acute, tip reaching to end of first article. Basicerite with strong but short lateral tooth, slightly shorter than stylocerite. Lateral margin of

scaphocerite almost straight; lateral tooth slightly exceeding third article, varying from slightly longer than, to well past squame. Carpocerite thick, exceeding length of antennular peduncle by length of third article.

Large chela 2.6 times as long as broad, fingers occupying the distal third. Superior saddle "U"-shaped with distal shoulder gently rounded and proximal shoulder varying from gently rounded to forming a right angle to margin of palm. Medial palmar depression small and "U"-shaped, lateral palmar depression triangular with apex reaching *linea impressa*. Inferior shoulder low and rounded, not projecting; inferior notch small, extending as faint depression into both lateral and medial faces. Plunger of dactylus well developed. Merus 2 times as long as broad, inferoventral margin rounded, bearing 2-3 short spines.

Small chela of male 3.6 times as long as broad, fingers slightly shorter than palm with medial tooth flanking dactylar articulation. In most males the dactylus is balaeniceps-shaped with characteristic rows of setae on lateral and medial faces that meet on dorsal surface. In other males these crests of hair are imperfectly developed. Pollex also bearing a slight fringe of hairs proximally. The female chela is more slender sometimes bearing a slight fringe of setae on dactylus (fig. 77k) and in others (fig. 77 n,o) the fringe of setae is lacking and the dactylus bears only random patches of hairs. Merus similar to that of large chela.

Carpus of second leg with ratio of articles: 10:7:3:3:5.

Third leg usually without spine on ischium. Merus unarmed and distally rounded, varying from 3.5-4.5 times as long as broad. Carpus 0.45 as long as merus. Propodus 0.6 as long as merus and bearing on its inferior margin about 7 spines and a pair distally. Superodistal margin bearing either a few long setae or one or two spines. Dactylus simple, occasionally bearing on ventral surface a slight thickening suggesting a secondary unguis.

Telson 2.3 times as long as broad posteriorly, posterior border slightly arcuate.

DISCUSSION: The name *A. edwardsii leviusculus* was applied by Dana to a specimen collected at Wake Island in the Pacific. *A. bouvieri* was applied by Milne-Edwards to specimens collected from the islands of Cape Verde Archipelago in the central Atlantic. Bate in 1888 applied the name *A. leviusculus* to a specimen from the Challenger Expedition that all future workers decided was not similar to that described by Dana. Coutière dealt with the complex twice. First (1898b:133) he reported the extension of the range of *A. bouvieri* to the west coast of Africa, to Fernando de Noronha in the Western Atlantic and to the Pacific coast of Panama. In the same paper he also described a new variety, *A. bouvieri bastardi*, from Madagascar, Djibouti and Panama (presumably also in the Pacific coast). In his second paper (1898h:249) he stated that *A. edwardsii* of Dana was not that of Audouin, but was *A. bouvieri* Milne-Edwards, and that Dana's *A. e. leviusculus* was merely an *A. bouvieri* with an anomalous chela. In spite of his rejection of *A. leviusculus* in this paper, Coutière recognized *A. leviusculus* as well as *A. edwardsii* and *A. b. bastardi* as occurring at Djibouti (1899:486). In this listing it should be noted that Lockington in 1878 (p. 474) created a homonym (or near homonym) by naming *A. laeviusculus* from California; according to Coutière (1909:21) this species was actually in the genus *Synalpheus* and to it he applied the name *S. lockingtoni*.

Subsequent references to the species complex were rather rare: Coutière (1905a:907) said that he could find no differences between *A. bouvieri* from the Maldives and the Milne-Edward's type from the "Canaries" (*sic*), and he described *A. bastardi* more fully from the Maldives, and raised it to species level. In the same paper he described *A.*

b. hululensis as a new variety and stated (p. 915) "L'A. *leviusculus* Dana est probablement, comme le dit cet auteur, une simple variété de l'A. *Bouvieri* . . ." De Man recognized one specimen from the Siboga Expedition as *A. leviusculus* (raising it also to the species level) and suggested that while it was definitely separate from *A. bouvieri*, *A. bastardi* might be a synonym. Coutière (1921:427) listed both *A. bouvieri* and *A. bastardi* as being collected by the Percy Sladen Trust Expedition in the Indian Ocean. Edmondson (1925:15) lists *A. leviusculus* as being collected from Wake, Hult (1938:3) from the Galapagos, and Barnard (1950:740) from Mauritius. *A. bouvieri* was listed by Holthuis in the Atlantide Reports (1951:81), but the name of this form was subsequently changed to *A. holthuisi* by Ribiero (1964:1). Forest and Guinot (1958:9) gave a partial redescription of Milne Edward's type series. Finally, to conclude this period, Holthuis (1958:28) reported *A. leviusculus* from the Red Sea with the remarks: "It is doubtful whether the Indo-West Pacific specimens assigned by Coutière to *A. bouvieri* actually can be distinguished from *A. leviusculus*" and suggested that the separation between the three species being here discussed should be revised.

In the late 1950's as we launched our studies of the Pacific alpheids we discovered we had a collection of 45 reasonably intact specimens that we considered to be *A. leviusculus*, including 5 specimens from Wake Island, the type locality, and 5 specimens in better condition from Johnston Island already reported upon by Edmondson (1925:15). To clarify the definition of the species we selected a 9.8 mm male to be designated a neotype and redescribed the species, and then on the basis of the other specimens at hand we made a study of the extent of variation in the series of specimens. This entire series of specimens and some of our original notes upon them were destroyed in a laboratory fire late in 1961 (1962:238) so we could not designate a neotype. Fortunately the complete manuscript which gave the description and the discussion had been prepared and was lying unpublished at the Bishop Museum in Honolulu; it was subsequently published (B&B, 1964).

We should note in passing that we failed to report the collection localities from the specimens other than the 13 reported in the 1964 paper. In going over the fire-ravaged and water-stained original notes we discover that some, if not most of the 32 specimens came from the Marshall Islands, principally Bikini and Enewetak (old spelling, Eniwetok) and at least one collection from Western Samoa; some may have been collected in other archipelagoes.

In the 1964 paper we compared the variation in *A. leviusculus* to the reported differences between the Atlantic *A. bouvieri* and the Indian Ocean *A. bastardi*, and found that we could not distinguish between the nominal forms. We therefore placed the two younger names in synonymy; we reserved judgment on *A. bouvieri hululensis*. In 1966 we recorded and described the species from Thailand but did not discuss it further.

Also in 1964 Crosnier and Forest published their preliminary notes on the collections of the Calypso made in tropical eastern Atlantic, and stated that the specimens reported under the name of *A. bouvieri* from the Indo-Pacific were probably a different species. In their final report on the collections they gave excellent descriptions and figures of *A. bouvieri* and *A. bouvieri hululensis* (1966:273, 282 *et seq.*); they also gave a table separating seven species and forms they considered to be closely related, but they did not mention *A. leviusculus*. They gave 3 criteria that would separate *A. bastardi* from *A. bouvieri*: *A. bastardi* has a shorter rostrum with a more rounded and shorter carina, a broader and more rounded squame on the scaphocerite and finally *A. bastardi* has spines on the ischia of the third and fourth legs which are lacking in *A. bouvieri*. They suggested that Coutière's report of *A. bastardi* from Panama should be confirmed.

Chace (1972:63) recorded 26 specimens of *A. bouvieri* from various parts of the Caribbean and gave certain differences he found between our description and the range of variation we had given for *A. leviusculus* and the Caribbean specimens. These were:

| | <i>A. leviusculus</i> | <i>A. bouvieri</i> |
|--|-----------------------|------------------------------------|
| Large cheliped, merus palm, length/breadth | small tooth 1.90 | rounded 1.48-1.80; average 1.66 |
| Small cheliped, male | rarely balaeniceps | always balaeniceps |
| Tooth of dactylar articulation | sharp | subrectangular or bluntly acute. |
| Second legs, carpus, ratio of 2nd to 5th article | second shorter | second 0.98 to 1.6 times fifth |
| Third legs, spine on ischium | present | absent |

Chace also discussed some specimens from the Galapagos and Clipperton Island which he felt lay between *A. leviusculus* and *A. bouvieri*, and concluded ". . . it seems best for the time being to treat all forms (including the Eastern Pacific forms) as separate species."

We wish again to discuss these separations. We have some notes preserved of our original study on the 45 specimens, the 16 specimens listed above, approximately 10 specimens from Madagascar (some fragmentary) and one each from the Philippines, the Maldives and Hong Kong. We also examined specimens from the West Indies at the Smithsonian Institution.

ROSTRUM: Again we have found in the Australian specimens variation that encompasses the supposed differences set forth, with some specimens from the Coral Sea (AM 64 and AM 226) corresponding to the condition reported for *A. bastardi*, while some of the specimens from Heron Island (BAU 54) are similar to Coutière's figure for *A. bouvieri*. Most of the specimens again were intermediate.

SCAPHOCERITE: The variation in the breadth of the squamous portion and the curvature and length of the lateral spine in the Australian specimens again was like that reported in 1964, and encompasses the differences cited by other authors.

LARGE CHELIPED: In our original tabulation of the 45 specimens we measured only the total length-breadth ratio of the chela, not the length-breadth ratio of the palm, but our figures give an indication of the variation: of 36 specimens with the chelae intact, the average length-breadth ratio was 2.63, but the range was 2.1-3.0. In the figure we drew of the "neotype-to-be" the length-breadth ratio of the entire hand was 2.76 and that of the palm 1.88. If we are to presume that the other 35 specimens had the same relative finger lengths (which, of course, they would not have), then the average palmar ratio would have been 1.78 and the range would have been 1.43-2.05. This average is within 0.12 of Chace's average and the range extends on either side beyond Chace's range. Similar variation was found in the Australian specimens, but they were not measured.

The small tooth on the merus usually was present in the central Pacific and Australian specimens, but it varied in size and at times was lacking; in one pair, probably cohabiting (AM 64), the end of the merus in the female was rounded while it had an acute tooth in the male.

SMALL CHELA: The male Australian specimens showed a greater range of variation in the degree of the balaeniceps condition than did those originally studied. For example, 2

males from the Coral Sea had a definite balaeniceps-type fringe of setae, but did not have the great lateral expansion found in other specimens, while none of the 5 males with small chelipeds present collected from Heron Island bore more than short setiferous crests as described for the Wake Island specimens.

In our notes about the original 45 specimens we wrote "spine at (dactylar) articulations somewhat blunt, sometimes sharp, always present". We are not sure whether this means any were "subrectangular", but it does overlap Dr Chace's "bluntly acute".

CARPUS, SECOND LEGS: We did not measure the relative lengths of the second and fifth carpal articles in our initial study, but we did measure the relative lengths of the first two articles in 36 specimens with these legs intact. Here the ratio was 10:4.4. to 10:6.3 with the average of 10:5.7. It is worthy to note that Crosnier and Forest stated that they found the first article to be 1.65-2.5 as long as the second in *A. bouvieri*, which if converted to the ratio we are using, it would be 10:4.0-10:6.1. We measured the second to fifth articles of 5 Australian specimens taken at random and found the second articles to be equal to the fifth in 2 specimens and 1.06, 1.15 and 1.19 times as long in the other three — thus the Australian specimens have a longer second article than the one drawn from Wake. In six specimens from the Caribbean studied at the Smithsonian, 3 had the second and fifth articles equal, two had the ratio of 1.1 and one had an anomalous 1.46.

A re-examination of the original data showed another interesting thing: 6 specimens collected in Western Samoa (BBS6) all had markedly shorter second articles when compared to the first: their ratios ran from 10:4.4-10:5.8, with an average of 10:4.8, and if these were removed from the 36 previously averaged, the average would be 10:5.9. This may indicate a geographically distinct race but we would be loathe to consider it of taxonomic importance.

ISCHIUM OF THIRD LEGS: Both Crosnier and Forest and Chace regard the presence of a spine on the ischium in *A. leviusculus* or *A. bastardi*, and its absence in *A. bouvieri* as important; indeed, Chace stated that the characteristic is "perhaps of most importance". Unfortunately, we did not consider this in our original study and we now do not know how consistently the specimens in the Central Pacific were in the characteristic. The specimens we drew from Thailand lacked the spine. In 13 randomly selected specimens from Australia, 5 carried ischial spines, 8 did not.

Thus again we find that there are no firm characteristics to differentiate the specimens from the Atlantic and from the Indo-Pacific. Yet it is inconceivable that in recent geological time this species, like other circumtropical species of non-pelagic marine life could have been able to maintain a common gene pool. One of us (DMB) after examining the specimens from the Caribbean at the Smithsonian, was struck with subtle differences between these and the familiar Indo-Pacific specimens and wrote in her working notes "Think FC (Fenner Chace) is right about the species from the Caribbean." Thus, we conclude that *A. leviusculus* should be divided into at least two geographically separate subspecies, *A. leviusculus leviusculus* and *A. leviusculus bouvieri* which probably can be distinguished by differing norms in distribution curves of variable characteristics, but not by any single firm difference.

In 1964 we renamed as *A. batesi* the specimen from the Philippines that Bate had listed in the Challenger Report as *A. leviusculus*; it evidently has not been collected since that time. In the same paper we suggested that *A. bouvieri hululensis* might be a species separate from *A. leviusculus*. Since that time, through the courtesy of the Muséum National d'Historie Naturelle of Paris, we were able to examine Coutière's holotype from

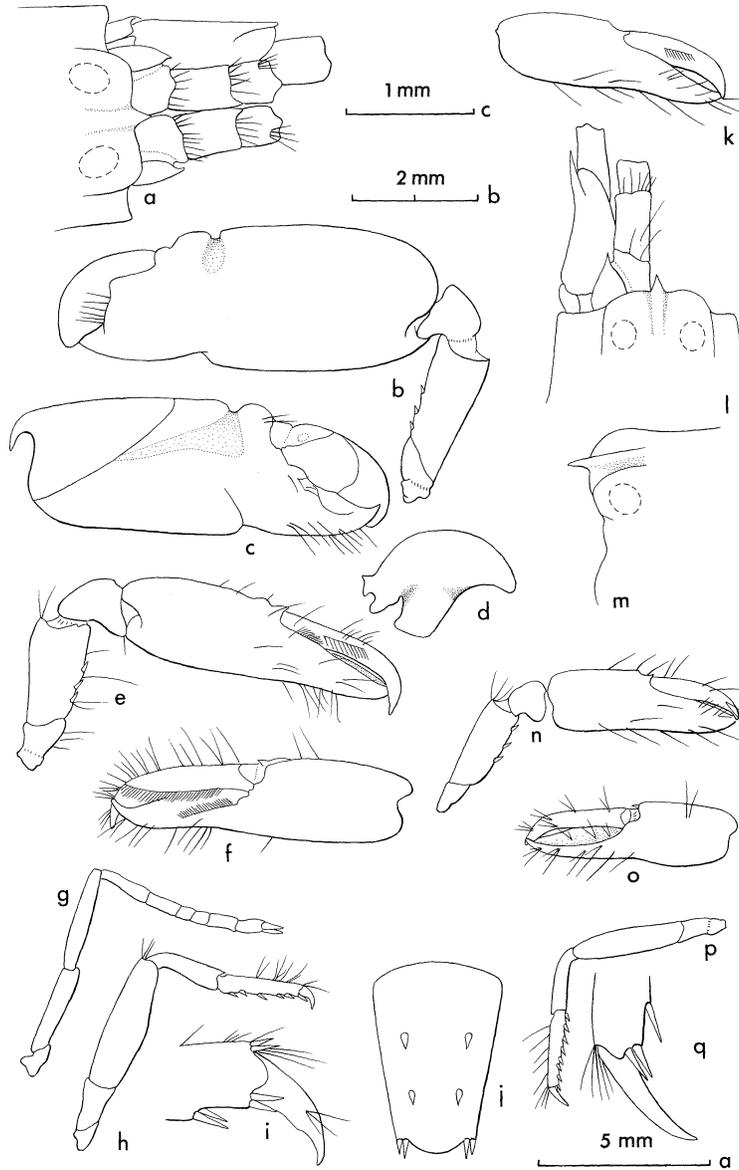


Fig. 77 *Alpheus leviusculus leviusculus* Dana

25 mm male from AM 226. **a.** Anterior region, dorsal view; **b.** large cheliped, medial face; **c, d.** large chela and dactylus, lateral face; **e, f.** small cheliped, medial and lateral face; **g.** second leg; **h, i.** third leg and dactylus enlarged; **j.** telson. 20 mm female from AM 226. **k.** Small chela, medial face. 24 mm female from BAU 54. **l, m.** Anterior region, dorsal and lateral view; **n, o.** small cheliped, medial and lateral face; **p, q.** third leg and dactylus enlarged. **b, c, d, e, f, g, h, k, n, o, p** scale a; **a, j, l, m** scale b; **i, q** scale c.

the Maldives, and now can say definitely that his description and figures of the anterior body region were accurate and not within the range of *A. leviusculus*. Also different were the ratios of the first two carpal articles; the difference in the small chela of the male is less reliable. (The holotype was also well figured by Crosnier and Forest, 1966:fig. 25a, b). Therefore we raise *A. hululensis* to specific level. We have not seen specimens of this species in any of our collections to date. Finally, we take no action on the possibly separate subspecies from the far eastern Pacific that was discussed by Chace.

BIOLOGICAL NOTES: Crosnier and Forest emphasized that *A. l. bouvieri* is intertidal and found under rocks on beaches of sand or gravel. Chace for the same subspecies, reported it both under rocks and in dead coral at or near the low tide level. The specimens in the collection we have studied, where the collection data is adequate, are similar in ecology. Most are reported from under stones, but some are from dead coral. In retrospect, some we personally collected from dead coral, as BAU 54, the specimens may have come from the fronds of the dead coral buried in the sandy substrate and not from the exposed portion of the head. All appeared to be intertidal or immediate subtidal. Yaldwyn notes that two specimens from the Coral Sea had "narrow green bands on abdomen, green on hands, green egg mass". The specimens ranged up to 28 mm long.

AUSTRALIAN DISTRIBUTION: The specimens were collected from Diamond Islet in the Coral Sea south to Heron Island in the Capricorn Group.

GENERAL DISTRIBUTION: The subspecies *A. leviusculus leviusculus* has been reported under one or another of its three names from the Red Sea, the islands of the central Indian Ocean, on to the islands of the central Pacific. While it reaches Wake Island, about 1000 km to the west south-west of Hawaii it does not reach the main Hawaiian Islands. The specimens reported (again under various names) from Clipperton, Panama and Galapagos, may not be of this subspecies.

Alpheus lobidens lobidens* De Haan

Fig. 78

Alpheus lobidens De Haan, 1850:179. Ortmann, 1890:474, pl. 36, fig. 13. Coutière, 1897e:199.

Alpheus lobidens lobidens Banner and Banner, 1974: fig. 31.

Alpheus crassimanus Heller, 1865:107, pl. 10, fig. 2. Bate 1888:554, pl. 99, fig. 2. De Man, 1902:880, pl. 27, fig. 62, 62a. Kemp, 1915:299. Barnard, 1950:756, fig. 144. Banner, 1959:147, fig. 11. Banner and Banner, 1966b:138, fig. 52. Forest and Guinot, 1958:6, fig. 1, 2. Tiwari, 1963:307, fig. 25, (*Partim*).

Crangon crassimanus Banner, 1953:134, fig. 49.

Nec Alpheus crassimanus Fourmanoir, 1958:119, fig. 5 (= *Alpheus edwardsii* (Audouin)).

Previous Australian record:

Bate *loc. cit.* Cape York (as *A. crassimanus*).

SPECIMENS EXAMINED: 4 specimens from AM 7 (AM P. 27541); 4, AM 13 (AM P. 27527); 2, AM 23 (AM P. 27556); 2, AM 93 (AM P. 27891); 2, AM 124 (AM P. 27809); 1, AM 198 (AM P. 27552); 1, AM 206 (AM P. 27540); 10, AM 213 (AM P. 28161); 14, AM 223 (AM P. 27892); 2, AM 234 (AM P. 27539); 1, AM 244 (AM P. 27564); 1, AM 250 (AM P. 27787); 2, AM 255 (AM P. 27810); 5, AM 277 (AM P. 27537); 6, AM 278 (AM P. 27457); 5, AM 291 (AM P. 27538); 4, AM 304 (AM P. 27925); 1, AM 305 (AM P. 27774); 1, AM 345 (AM P. 27811); 11, AM 350 (AM P. 28162); 1, AM 391 (AM P. 27763); 1, AM 393 (AM P. 27856); 2, AM 404 (AM P.

**A. lobidens* is no longer to be separated into two subspecies and *A. inopinatus* Holthuis and Gottlieb is to be considered a synonym — see footnote on p. 241.

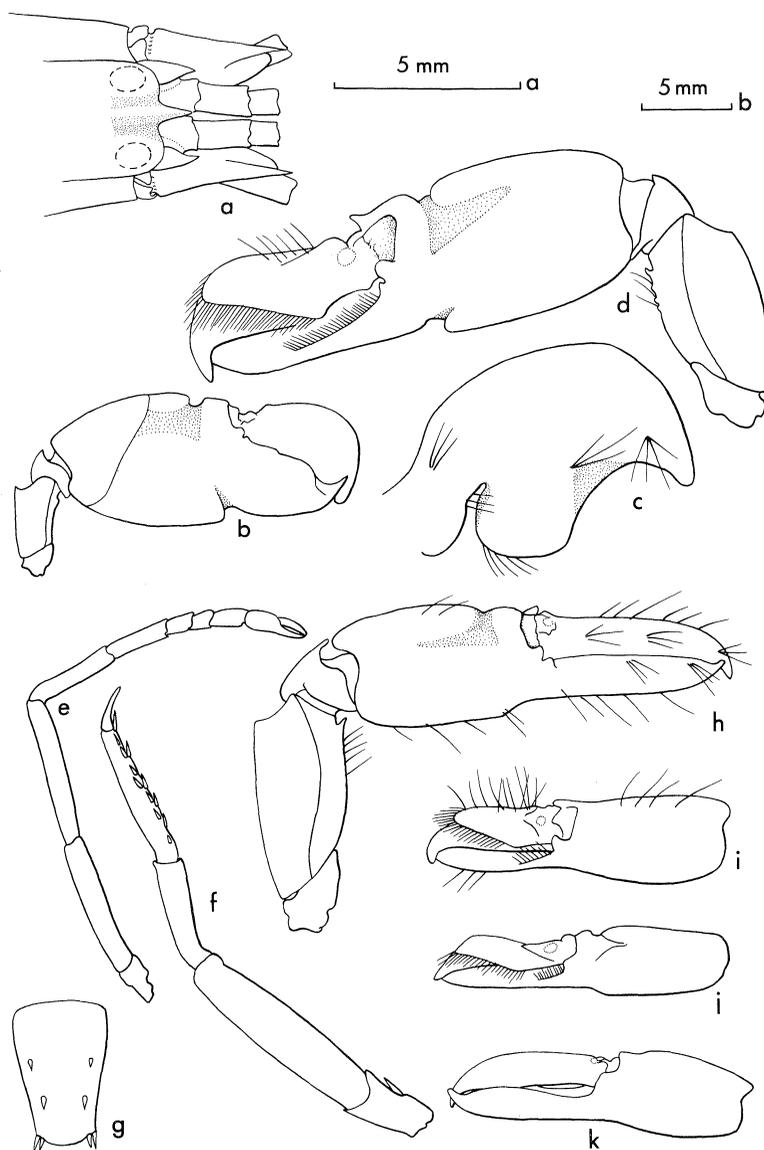


Fig. 78 *Alpheus lobidens lobidens* De Haan
 40 mm male from AM 213. **a**. Anterior region, dorsal view; **b**, **c**. large cheliped, enlarged dactylus, lateral face; **d**. small cheliped of male, lateral face; **e**. second leg; **f**. third leg; **g**. telson. 38 mm female from AM 213. **h**. Small cheliped of female, lateral face. Small chela, lateral face; **i**. 24 mm male from BAU 36, showing lack of palmar grooves; **j**. 26 mm male from US 123567, showing minimal grooves; **k**. 31 mm female from AM 13 showing very slight sculpturing. **a**, **c**, **d**, **e**, **f**, **g**, **h** scale **a**; **b**, **i**, **j**, **k** scale **b**.

27893); 5, AMP. 3127; 2, AMP. 5215; 4, AMP. 8009; 3 AMP. 13561; 2, AMP. 13569; 1, AMP. 27452; 13, BAU 2; 12, BAU 8; 19, BAU 9; 1, BAU 23; 1, BAU 25; 7, BAU, 26; 34, BAU 34; 2, BAU 36; 8, BAU 41; 13, BAU 45; 4, BAU 46; 8, BAU 59; 3, BAU 72; 5, BAU 73; 4, BAU 74; 13, BAU 75; 6, JB 1; 2, JC 1; 6, JC 2; 2, JC 9; 2, JC 13; 1, JC 19; 2, JC 21; 1, JC 26; 3, JC 27; 9, JG 6-73; 1, JG 7-73; 3, JG 10-73; 1, JG 17-73; 4, MM 72; 2, QM W 1224; 3, QM W 2234; 4, QM W 2240; 15, QM W 2391; 1, UQ 21; 3, UQ 23; 1, UQ 27; 1, US 106163; 1, US 106166; 2, US 123567; 6, US 123568; 1, US 123602; 20, US 123603; 1, WM 36-65; 1, WM 142-65; 7, WM 275-65.

DIAGNOSIS: Rostrum acute, triangular, varying from 1.1 to 1.7 times as long as broad reaching almost to end of first antennular article. Orbitorostral grooves shallow and rounded. Second antennular article usually about 2 times as long as broad and varying from 1.3-2.0 times length of first; third varying from 0.6 to equal length of first. Stylocerite acute, reaching to end of first antennular article. Scaphocerite with lateral tooth reaching just beyond antennular peduncle; squamous portion reaching end of antennular peduncle. Tip of carpopocerite reaching to end of lateral tooth of scaphocerite.

Large chela similar to *A. australiensis* sp. nov. (see below p. 256).

Small chela sexually dimorphic. Male chela balaeniceps, varying from 3.1 to 4.7 times as long as broad. In fully mature specimens the palm usually bears sculpturing similar to that of large chela but reduced; in smaller males sculpturing is greatly reduced and may be almost entirely absent. Female chela not balaeniceps, varying from 3.5-4.7 times as long as broad. Sculpturing on palm varying with maturity of female, with larger specimens bearing superior indentation and inferior shoulder strong but less developed than in large males while in smaller females all sculpturing may be lacking.

Ratio of carpal articles of second legs varying as indicated: 10:(6-8):(3-4):(3-4):(4-5).

Ischium of third leg usually with movable spine. Merus inermous, varying from 3.5-5.0 times as long as broad. Distal margins of carpus not produced into acute processes. Propodus usually with about 10 spines. Dactylus simple, slightly curved.

Telson 2.3 times as long as posterior margin is wide, spines on upper surface small.

DISCUSSION: After examining topotypes of *A. lobidens* we found *A. crassimanus* to be a junior synonym. Then, examining collections of *A. lobidens* from the Indo-Pacific area, including Australia, we separated the species into two geographic subspecies: *A. l. lobidens* and *A. l. polynesica* (1974:429). The principal difference between the two rested in the sculpturing of the small chela of the mature males. In *A. lobidens* the superior margin of the palm proximal to the dactylar articulation is notched similar to that of the large chela and opposite this on the inferior margin is a strong shoulder with the groove extending into the medial face. In *A. l. polynesica* these grooves are only slight constrictions in the outlines. However, the smaller males of *A. l. lobidens* are similar in sculpturing to *A. l. polynesica*. *A. l. lobidens* occurs in the western Pacific and Indian Ocean, *A. l. polynesica* has only been collected in the central Pacific. This same type of variability was described by us for specimens of *A. e. euphrosyne* from Thailand (B&B, 1966b:130).

In this paper we are describing a new species, *A. australiensis* (p. 256), as closely related to *A. l. lobidens* and we are questioning the separation of *A. inopinatus* Holthuis and Gottlieb from *A. l. lobidens* (p. 241).

In a group of 11 specimens from near Brisbane, Qld. (AM 350) the inferointernal margin of the merus of the large cheliped was inermous distally. However, as they resembled in every other character *A. l. lobidens*, we interpret this as a variation.

Tiwari (1963:307) described 2 males as *A. crassimanus* which we believe are two different species. The "short male" he described exactly agrees with *A. sudara*, a species we described from Thailand (1966b:153, fig. 59; see also p.372 above). In his plates, figures 25a, d and 26b, c, d, e are figures of *A. sudara*. The "long male" he describes is probably the true *A. l. lobidens* and is represented in his plates by figures 25b, 25c and 26f. Fourmanoir (1958:118, fig. 5) records on some specimens as *A. crassimanus* from Nosy Bé Madagascar. He figures the large chela with the distal margin of the grooves on both the superior and inferior margins as being projected and subacute, a condition that never occurs in *A. lobidens*. We feel these specimens were, in all probability, *Alpheus edwardsii* (Audouin).

BIOLOGICAL NOTES: Barnard (1950:758) remarks on the colour of his live specimens, "Greeny-brown, olive green, or smoky-grey, anterior parts of abdominal segments often white (producing a banded appearance), with or without longitudinal stripes (a median and 2 lateral) on each segment, the lower lateral stripe runs along the lower margins of the pleura and is often edged with black, a black spot in middle of the side on segments 2 and 4; telson and uropods apically blackish; chelae greeny-orange or greeny-brown, finger and thumb of large chela orange, tips dull violet, palm with a more or less brilliant cobalt-blue patch on inner (upper) surface; other legs dull pinkish" Kemp (1915:301) also remarked on the black spots on each side of the second and fourth abdominal segments.

Kemp (*loc. cit.* p.300) found in his specimens from Chilka Lake that the species has an adaptability to extreme salinity changes. He found that although the species lives under rocks it does not produce an elaborate burrow, but simply makes a horizontal tunnel not more than a few inches in length. Farrow (1971:482), on the other hand, reports that at Aldabra the burrows in the carbonate sand are elaborate with the main tunnel lying horizontal 8-13 cm below the sand and with several sets of dichotomously branched entrance burrows reaching to the surface. He does not give the length of the horizontal portion of the burrow, but if one estimated from an approximately 10 cm depth in his figure 17a, the burrow is near a half metre long. McNae (1957:361) reports in South Africa they inhabit radiating burrows to the depth of 25 cm. Farrow, McNae and others have reported that this species lives in association with gobiid fish (see also discussion on p. 182).

Almost all our specimens were collected intertidally, but we do have 4 specimens that were captured in a prawn trawl at 14 fathoms in the Gulf of Carpentaria (AM 13), presumably they had been living in the mud on the bottom. This species is also occasionally found in the bases of dead coral heads. Our largest specimen attained the length of 44 mm but Barnard (1950:758) reports on specimens up to 55 mm in length.

AUSTRALIAN DISTRIBUTION: Our specimens have come from all warmer parts of Australia: Houtman Abrolhos, Darwin, Gulf of Carpentaria, Torres Straits and on down the east coast to Sydney, N.S.W. We also have 17 specimens from Lord Howe Island.

GENERAL DISTRIBUTION: This species ranges throughout the entire Indo-Pacific area from the Red Sea to Hawaii, but the subspecies does not occur in the central Pacific area. Forest and Guinot (1956:102) reported the species under *A. crassimanus* from Tunisia; it may have reached the Mediterranean via the Suez Canal.

***Alpheus australiensis* sp. nov.**

Fig. 79

HOLOTYPE: 33 mm male from Caloundra, Qld., collected by A. A. Livingstone 14/8/22. (AM P. 6352).

ALLOTYPE: 26 mm female from the same locality as the type. (AM P. 27264).

PARATYPES: 1 specimen from AM 46 (AM P. 27205); 11, AM 126 (AM P. 27221); 2, AM 144 (AM P. 27220); 1, AM 150 (AM P. 27202); 4, AM 167 (AM P. 27222); 3, AM 216 (AM P. 27203); 1, AM 349 (AM P. 27201); 10, AM 350 (AM P. 27248); 2, AM 406 (AM P. 27204); 1, AM P. 10980; 1, AM P. 27254; 13, AM P. 27255; 16, BAU 63.

DESCRIPTION: Rostrum conical, about as long as wide at base, reaching somewhat past middle of visible part of first antennular article. Rostral carina rounded, extending posteriorly to base of eyes. Orbital hoods not markedly inflated with frontal margin somewhat convex; orbitorostral grooves moderate. Ratio of antennular articles beginning with visible part of first antennular article 10:13:10; second antennular article 1.4 times as long as broad. Stylocerite acute, reaching to end of first antennular article. Squamous portion of scaphocerite moderately wide, reaching end of antennular peduncle; lateral tooth a little longer, outer margin straight. Carpocerite reaching length of third antennular article past that article. Basicerite with acute lateral tooth.

Ratio of articles of third maxilliped: 10:4:6. Second article bearing only long hairs on inner face.

Large chela 2.4 times as long as broad, fingers occupying the distal 0.4. Superior saddle broad and relatively shallow, proximal shoulder usually gently rounded but at times almost abrupt, distal shoulder always gently rounded. Medial palmar depression a well-marked triangle whose apex reaches half the distance from saddle to proximal end of palm. Lateral palmar depression quadrangular, reaching to *linea impressa*. Inferior shoulder heavy and rounded; inferior notch broadly "U"-shaped, continuing on lateral face of palm as a well-defined but small triangular depression with rounded apex, and on medial face as a longer, broader, but less well-defined depression. Plunger pronounced. Merus a little longer than broad, bearing no teeth distally on inferoventral margin.

Small chela of male 3.0 times as long as broad, dactylus balaeniceps, fingers only slightly shorter than palm, both superior and inferior margins of palm with shallow, rounded indentations proximal to fingers. Medial side of dactylar articulation bearing acute tooth. Superior margin of dactylus with a slight subacute carina that disappears where the crest of hairs meet on the superior surface. Merus 1.7 times as long as broad with distal margins inermous. Small chela of female similar to male, 3.4 times as long as broad with fringe of setae well developed on medial and lateral margins of dactylus, but not reaching beyond two-thirds length of dactylus and not meeting at crest. Merus similar to male but 2.3 times as long as broad.

Ratio of carpal articles of second leg: 10:9:3:4:4.

Ischium of third leg armed with spine. Merus inermous 4.3 times as long as broad. Carpus 0.5 as long as merus; superior and inferior margins slightly projected distally. Propodus 0.7 as long as merus bearing 7 spines on inferior margin and a pair distally. Dactylus simple, slightly curved, 0.3 as long as propodus.

Telson 2.5 times as long as posterior margin is broad. Dorsal spines of moderate size.

DISCUSSION: It is with considerable reluctance that we are naming this as a species separate from *A. lobidens lobidens* De Haan and *A. lobidens polynesica* Banner and

Banner (1974:429). We separated the nominate species from the subspecies on the basis of the small chelae of mature males which carry heavy sculpturing in the nominate species that is entirely lacking in the subspecies. The two subspecies are geographically separated, with the nominate form being found in the far western Pacific (including Australia) to the Red Sea and *A. l. polynesica* being confined to the archipelagoes of the central Pacific. The central Pacific subspecies never reaches the large size at maturity attained by the western subspecies.

A. australiensis can be firmly separated from the two subspecies of *A. lobidens* only by the characteristics of the small chelae of the males and females. Like *A. l. polynesica*, the males of mature size lack the sculpturing on the small chela, and unlike both subspecies the chelae of the females show balaeniceps development. These and other characteristics of less reliability are set fourth in Table 6.

This separation appears rather subtle and questionable, but in the more than 350 specimens of both sexes of *A. l. lobidens* and more than 60 specimens of *Alpheus australiensis* from Australia we have examined, never did we find mature males or females that were intermediate in the form of the small chelae. Moreover, never did we collect the two species together. It initially appeared to us that in those collections where sufficient ecological data was given, they showed a definitely ecological separation, with *A. l. lobidens* occurring in burrows in cleaner sand and more saline waters, and with *A. australiensis* occurring in more muddy sand and less saline conditions. This recalls the ecological separation of *A. heeia* B&B and *A. l. polynesica* in Kaneohe Bay in Hawaii (*op. cit.*) where the former species lives in the cleaner more saline sand and the latter lives in the more muddy estuarine conditions. If we could have established such ecological separation the two forms could have been regarded as other than sympatric, for a difference in ecological requirements might impose a more effective separation of gene pools than would a geographic separation by thousands of kilometres, especially to species with planktonic larvae. If such a separation could be established, then *A. australiensis* should be considered a subspecies of *A. lobidens*.

However, there were too many records, especially of *A. l. lobidens*, for which we had no ecological data, only a broad geographic designation. In addition the records of *A. l. lobidens* from our personal collections in the Darwin area (BAU 72-75 incl.) seemed to range from "typical *lobidens* grounds" as in BAU 73 to "typical *australiensis* grounds", a muddy estuarine flat bordered by mangroves, in BAU 75.

It is therefore with doubts that we are describing this form, so obviously related to the two subspecies of *A. lobidens*, as a separate species and we suggest that Australian workers in the future try to determine, possibly through studies on breeding or behaviour, whether this form is a true species, subspecies or merely an ecological variant.

In spite of its close relationship to *A. l. lobidens*, it might be well to contrast this subspecies to other species in which the small chela of the female may approach a balaeniceps condition. From *A. s. strenuus* Dana and *A. pareuchirus imitatrix* De Man it differs by the lack of sculpturing on the small chela of the male and the lack of distal teeth on the meri of the chelipeds. *A. edwardsii* (Audouin), according to Coutière, may have slight setiferous crests on the dactylus of the female (Coutière, 1905a:914 as *A. audouini*), but here at least the meri of the chelipeds of the male are always armed with teeth. *A. heeia* B&B also bears a trace of the setiferous crests, but in that species the inner faces of the second articles of the third maxillipeds bear spines, not setae.

The holotype, allotype and some paratypes will be placed in the Australian Museum,

TABLE 6
Difference between 2 subspecies of *A. lobidens* and *A. australiensis*

| | <i>A. l. lobidens</i> | <i>A. l. polynesica</i> | <i>A. australiensis</i> |
|---|-----------------------|-------------------------|-------------------------|
| 1. Length/breadth second antennular article | 2.0 | 2.0 | 1.1-1.7 |
| 2. Small chela, mature male, palmar sculpture | Pronounced | Slight to absent | Slight to absent |
| 3. Small chela, female dactylus | Not balaeniceps | Not balaeniceps | Sub-balaeniceps |
| 4. Distal tooth on inferointernal margin of meri of chelipeds | Usually present | Present | Lacking |

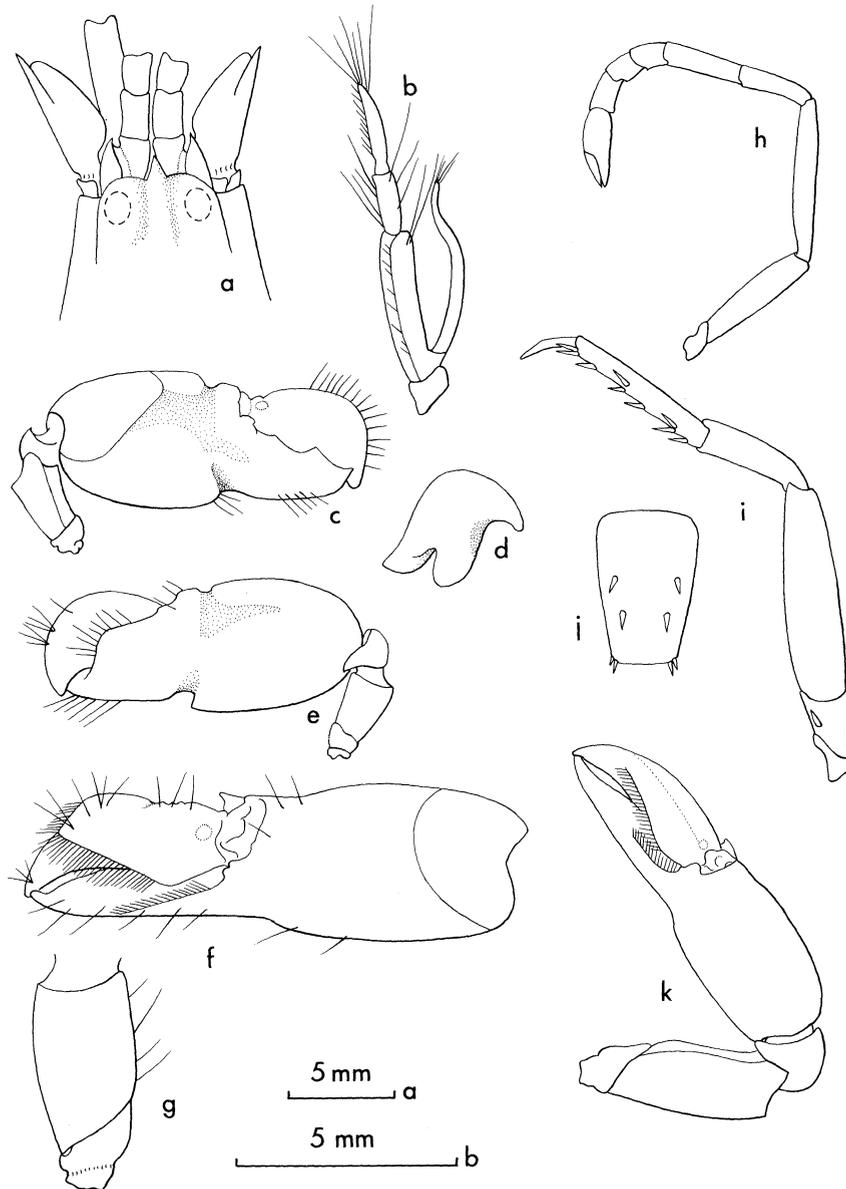


Fig. 79 *Alpheus australiensis* sp. nov.

Holotype (male) **a**. Anterior region, dorsal view; **b**. third maxilliped, lateral face; **c**, **d**, **e**. large cheliped medial and lateral face and dactylus; **f**, **g**. small chela and merus, lateral face; **h**. second leg; **i**. third leg; **j**. telson; Allotype (female) **k**. small cheliped, lateral face. **c**, **d**, **e** scale **a**; **a**, **b**, **f**, **g**, **h**, **i**, **j**, **k** scale **b**.

Sydney, N.S.W. Paratypes will also be placed in the National Museum of Natural History, Washington D.C., U.S.A.

BIOLOGICAL NOTES: These specimens were all collected intertidally, usually in estuarine conditions. They were found under rocks relatively free of mud and also in sandy-muddy conditions such as collection we made at the mouth of the Wilson River, at Pt. Macquarie (BAU 63). Our field notes state: "Plus 2.6 tidal level and above. In very soft muddy sand in eel grass beds. Substrate of such a consistency as to cause us to sink in 4-6" deep with each step. Burrow entrance in depression of surface, often concealed under short eel grass. Burrows not over 6" deep. Initially at an angle of 45° to surface and possibly extending horizontally, at times small gobys were found in the excavation. These alpheidids are at times used for fish bait and are called popularly 'nippers'." In two collections colour notes indicate that the specimens were dark olive green and were not transversely banded as *A. l. lobidens* and *A. l. polynesica* are found to be. The specimens reached up to 35 mm in length.

AUSTRALIAN DISTRIBUTION: The 67 specimens were collected in about 1600 km of coastline reaching from the Whitsunday Group, Qld. to Sydney, N.S.W.

***Alpheus papillosus* sp. nov.**

Fig. 80

HOLOTYPE: 28 mm male from Sandgate, Moreton Bay, Qld., 25/6/44. From J. S. Hynd collection. AM 114 (AM P. 27233).

ALLOTYPE: 31 mm ovigerous female from same collection as holotype. (AM P. 27232).

PARATYPES: 1 specimen from AM 13 (AM P. 27230); 13, AM 56 (AM P. 27212); 25, AM 70 (AM P. 27213); 2, AM 114 (AM P. 27231); 1, AM 147 (AM P. 27215); 4, AM 133 (AM P. 27218); 1, AM 142 (AM P. 27238); 1, AM 165 (AM P. 27219); 3, AM 168 (AM P. 27216); 2, AM 175 (AM P. 27223); 1, AM 219 (AM P. 27239); 1, AM 227 (AM P. 27217); 1, AM 256 (AM P. 27240); 2, AM 390 (AM P. 27237); 4, AM 391 (AM P. 27241); 2, AM 403 (AM P. 27224); 2, AM 445 (AM P. 27225); 1, AM 446 (AM P. 27242); 5, AM 450 (AM P. 27243); 1, AM 461 (AM P. 27227); 3, AM 462 (AM P. 27229); 1, AM 465 (AM P. 27228); 1, AM P. 836; 1, AM P. 5116; 1, AM P. 7234; 1, AM P. 8255; 1, AM P. 8695; 2, AM P. 9076; 3, AM P. 10770; 1, AM P. 11416; 1, AM P. 11440; 2, AM P. 11451; 1, AM P. 13563; 3, AM P. 13567; 1, AM P. 27262; 2, AM P. 27875; 1 specimen each from CS IIA3, IIIB1, IIID1, IIIE2; 3, QM W 835; 3, QM W 838; 3, QM W 1052; 1, US 106167; 5, US 123562; 2, US 123579; 1, US 123602; 1, UQ 4; 1, UQ 6; 1, UQ 11; 24, UQ 21; 1, WM 34-65; 6, WM 49-65; 1, WM 205-65; 2, WM 239-65.

DIAGNOSIS: Rostrum acute, triangular, almost twice as long as broad at base, reaching almost to end of first antennular article; lateral margin bearing a few short setae. Rostral carina rounded; orbitorostral grooves moderately shallow, disappearing at base of eyes; anterior margin of orbital hoods evenly rounded. Second antennular article 2 times as long as broad, 1.5 times as long as visible part of first article, third article a little shorter than visible part of first article. Anterior margins of antennular articles beset with strong setae. Stylocerite acute, reaching to end of first antennular article; scaphocerite with squamous portion moderately narrow, reaching past end of antennular peduncle, lateral spine reaching past squame by half the length of third antennular article. Carpcerite reaching half length of third antennular article beyond that article. Lateral spine of basicerite slender, acute, shorter than stylocerite.

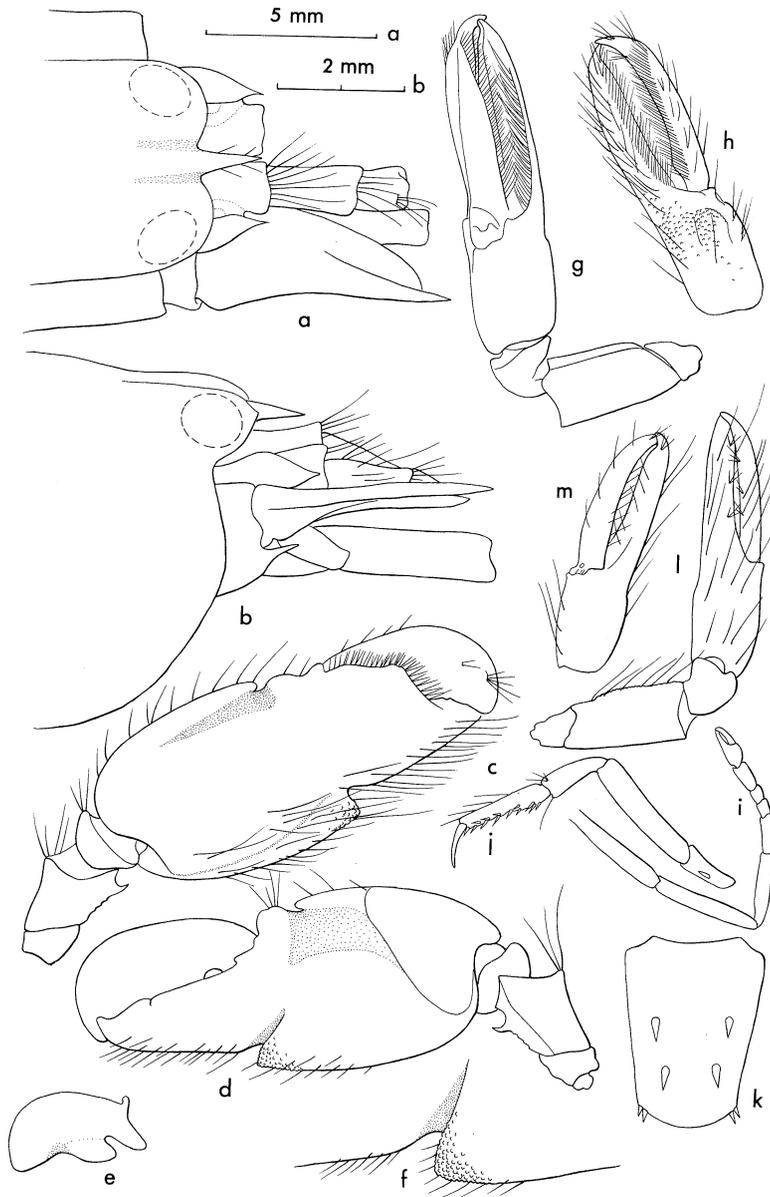


Fig. 80 *Alpheus papillosus* sp. nov.

Holotype (male). **a, b.** Anterior region dorsal and lateral view; **c, d.** large cheliped, medial and lateral face; **e, f.** large chela, dactylus, and enlargement of inferior midsection, lateral face; **g, h.** small cheliped, lateral face, and small chela, medial face; **i.** second leg; **j.** third leg; **k.** telson. Allotype (female) **l, m.** Small cheliped, medial and lateral face. **c, d, e, g, h, i, j, l, m** scale a; **a, b, f, k** scale b.

Articles of third maxilliped with ratio: 10:3:7. Inferior face of second article beset with fine setae.

Large chela compressed, 2.4 times as long as broad, fingers occupying the distal 0.4. Plunger of dactylus of moderate development. Superior saddle well defined, proximal shoulder overhanging, but not acute, and lying close to floor of saddle. Distal shoulder of saddle prominent, gradually rounded. Lateral palmar depression well defined, quadrangular, continued proximally to *linea impressa*. Medial palmar depression well defined, a narrow triangle with apex reaching to proximal quarter of chela. Inferior shoulder heavy, directed distally, in profile appearing as a heavy truncate lobe; inferodistal portion of lobe covered with papillae. Inferolateral depression well defined, continuing up lateral face for 0.3 total height. Medial face of palm bearing faint, narrow longitudinal groove from near proximal articulation to inferior notch. Chela bearing long, forward directed setae on face near inferior margin; setae continuing to region of pollex. Hirsute section of chela slightly papillose. Merus almost 2.0 times as long as broad; superodistal margin obtuse, inferointernal margin armed with strong acute tooth subterminally and setae proximally.

Dactylus of small chela of male balaeniceps, chela almost 4.0 times as long as broad, fingers 0.6 of total length. Superior surface of palm not rounded distally but appearing as a triangular flattened area demarked laterally by slight rounded ridge and medially by a low rounded crest that terminates before dactylar articulation; this development seen only in larger males. Medial face with long setae and low papillae; bearing slight tooth at dactylar articulation; lateral surface nearly smooth. Both fingers with dense rows of setae on margins of opposite faces that cross at midpoint; setiferous crests of dactylus joining across superior margin near distal end. Dactylus bearing low, thin tooth on cutting surface near dactylar articulation. Inner face of chela bearing long fine setae, increasing towards proximal end, setae directed distally. Merus inermous, 2.2 times as long as broad. Dactylus of small chela of female not balaeniceps. Fingers 1.6 times as long as palm with short fine setae on opposite surfaces that cross in the middle, inner face also beset with long, distally-directed setae similar to those of male chela. Surface of chela almost smooth. Merus 2.7 times as long as broad, inferointernal margin inermous but bearing a few setae along its entire margin.

Carpal articles of second legs with ratio: 10:5:2:2:3.

Ischium of third leg with spine. Merus inermous, 4.8 times as long as broad. Carpus 0.4 as long as merus, bearing a few setae distally and without extension of distal angles. Propodus 0.7 as long as merus, bearing approximately 14 spines, more or less in pairs, along inferior border. Dactylus simple, slender, 0.4 as long as propodus.

Telson almost twice as long as broad at posterior margin. Anterior margin 1.4 times as broad as posterior margin. Spines on upper surface prominent with anterior pair arising slightly anterior to middle. Spines on posterolateral angles small, posterior margin slightly arcuate.

DISCUSSION: This species more closely resembles *Alpheus pacificus* Dana than any other species in the Edwardsii Group. It differs in the following characters: (1) *A. pacificus* does not have a balaeniceps dactylus in the male small chela and the palm does not bear a shoulder on the medial face. (2) In *A. pacificus* the surface of the inferior shoulder of the large chela is smooth while in this species it is papillose. (3) The plunger of the dactylus on the large chela is much longer in *A. pacificus* than in this species. (4) The inferodistal margin of the merus of the large chela of *A. pacificus* is inermous while in this species it carries a pronounced subterminal tooth.

This species is also related to other members of the Edwardsii Group in which the small chela of the male is balaeniceps and the female is not; the male chela is less than 5 times as long as broad; the rostrum is not flattened above; the depression on the superointernal surface of the large chela is triangular instead of "U"-shaped; and the merus of the large cheliped is armed distally on the inferior margin. These species include *A. edwardsii* (Audouin), *A. chiragricus* Milne-Edwards, *A. lobidens lobidens* De Haan, *A. pareuchirus pareuchirus* Coutière, *A. leptochirus* Coutière, and *A. leptochiroides* De Man. It can be separated from all of these by the papillose shoulder on the inferior margin in the large chela, the papillose palm of the small chela in the male and the swelling near the superior margin proximal to the dactylar articulation.

This species is not subject to a great deal of variation. We have found that the ratio of the first two articles of the second leg varies from 10:5 to 10:8. In the young specimens the papillae of the chelae are not as numerous and also in the smaller male specimens the swelling on the medial face near the superior margin of the small chela is scarcely discernible.

The species of *Alpheus* that Hutchings and Recher (1974) placed under the designation *Alpheus* species B and C (table 2, 6) are *A. papillosus*.

The name *papillosus* refers to the papillae on the inferior shoulder of the large chela. The holotype and allotype will be placed in the Australian Museum, Sydney, N.S.W. The paratypes will be returned to the institutions that loaned them to us.

BIOLOGICAL NOTES: The habitat of this species is similar to that of *A. pacificus*, largely intertidal, under stones. However, it has been dredged as deep as 10 fathoms and was frequently taken in the prawn trawls of Moreton Bay. A colour note in the collection from US 106167 states "Abdomen with white stripe down side. Reddish to grey-green and white." We have specimens ranging from 22-40 mm.

AUSTRALIAN DISTRIBUTION: The specimens on the west coast came from Cockburn Sound and Exmouth Gulf. Four of the specimens came from the Gulf of Carpentaria. Five of the specimens came from near Kangaroo Is., South Australia. The rest of the specimens ranged on the east coast from Cairns, Qld. to Careel Bay, N.S.W. At present, the species is known only from Australian waters.

***Alpheus bisincisus* De Haan**

Fig. 81

Alpheus bisincisus De Haan, 1850:179, pl. 45, fig. 3 (in text as *A. avarus* Fabricius, on plate as *A. bisincisus*). Pearson, 1911:182. Tiwari, 1963:304, fig. 23.

Alpheus bisincisus malensis Coutière, 1905a:910, pl. 86, fig. 48.

Alpheus bisincisus stylirostris Coutière, 1905a:911, pl. 86, fig. 49.

Alpheus bisincisus variabilis De Man, 1909a:109; 1911:406, fig. 95 a-e.

SPECIMENS EXAMINED: 1 specimen from AM E. 3159; 2, AM P. 7050; 2, AM P. 7711; 1, UQ 36; 1, WM 93-65; 1, WM 144-65; 1, WM 185-65.

DIAGNOSIS: Rostrum reaching almost to end of first antennular article; varying from 1.8-3.0 times as long as broad at base. Rostrum flattened dorsally with margins overhanging deep orbitorostral grooves and disappearing well posterior to eyes. Orbitorostral margin varying from slightly to abruptly concave. Visible part of first antennular article a little longer than third article, second article 1.5 times longer than

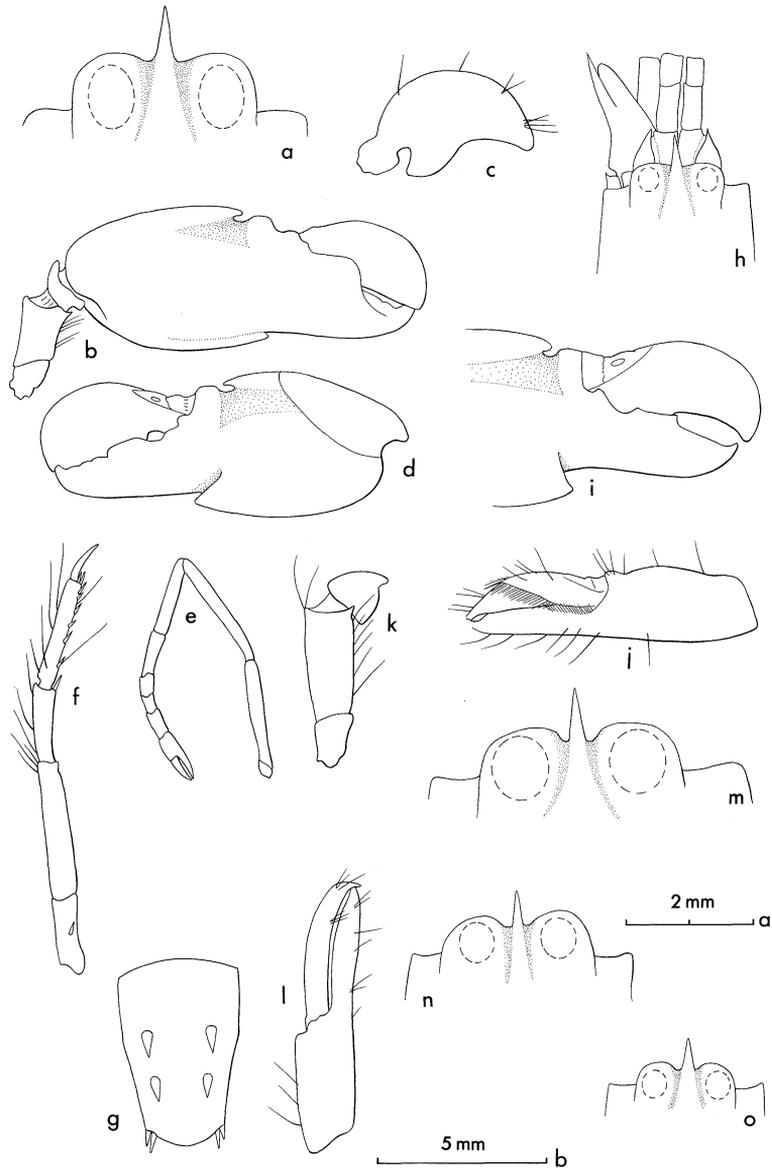


Fig. 81 *Alpheus bisincisus* De Haan

28 mm male from WM 144-65. **a.** Anterior region, dorsal view; **b, c.** large cheliped and dactylus medial face; **d.** large chela, lateral face; **e.** second leg; **f.** third leg; **g.** telson. 30 mm male from AM P. 7711. **h.** Anterior region, dorsal view; **i.** distal end of large chela, lateral face; **j, k.** small chela, lateral face, merus, medial face. 25 mm female from UQ 36. **l.** Small chela, medial face. 31 mm male from AM E. 3159. **m.** Anterior region, dorsal view. 34 mm male from AM P. 7050. **n.** Anterior region, dorsal view. 30 mm female from WM 185-65. **o.** Anterior region, dorsal view. **a, g, m, n** scale a; **b, c, d, e, f, h, i, j, k, l, o** scale b.

visible part of first antennular article and 2.0 times as long as wide. Stylocerite reaching to end of first antennular article. Scaphocerite with outer margin concave, lateral tooth extending well beyond narrow squamous portion and as long as antennular peduncle. Carpocerite as long as antennular peduncle.

Large chela 2.4 times as long as broad, fingers occupying distal 0.4. Palm broader than fingers. Plunger of dactylus of strong development. Proximal shoulder subacute, markedly overhanging superior saddle; distal shoulder gradually rounded. Lateral palmar depression shallow and quadrangular, extending to *linea impressa*. Medial palmar depression triangular, apex disappearing in the proximal third of chela. Inferior notch well marked; inferior shoulder strong, subacute, continuing 0.3 the distance up lateral face, with margin well defined. Near inferior margin of medial face is a narrow longitudinal groove that extends from inferior notch to proximal half of palm. Merus 1.6 times as long as broad, bearing long hairs and a strong tooth distally on inferointernal margin.

Small chela sexually dimorphic with that of male *balaeniceps* varying from 2.3 to 4.0 times as long as broad, fingers and palm almost equal in length. Superior margin of palm bearing shallow transverse groove proximal to dactylus. Fringes of setae on dactylus meeting on superior surface at distal third. Pollex bearing a fringe of short hairs extending from near point of articulation to middle. Merus 2.4 times as long as broad, bearing an acute tooth distally on inferointernal margin. Female chela not *balaeniceps*, 4.5 times as long as broad, fingers a little longer than palm. Merus 3.3 times as long as broad with tooth similar to that of males.

Carpal articles of second legs with ratio of: 10:7:2:2:3.

Third leg with spine on ischium. Merus inermous, 5 times as long as broad. Carpus 0.5 as long as merus, superodistal margin projected as a small rounded tooth; inferodistal margin bearing a slender acute spine. Propodus 0.8 as long as merus bearing 7 spines with a pair distally on inferior margin. Dactylus simple, 0.4 as long as propodus.

First four abdominal sterna of male bearing small flat processes extending posteriorly.

Telson 2 times as long as broad at posterior margin. Posterior margin slightly arcuate; dorsal spines large.

DISCUSSION: In addition to De Haan's original species, 3 varieties have been described; the criteria used in their separation are given in Table 7. The two varieties (*malensis* and *stylirostris*) described by Coutière were considered by Pearson in 1911 on the basis of variation he found in 10 specimens from Ceylon; he evidently did not have De Man's 1909a and 1911 publications for he did not mention *A. b. variabilis* of that author. He stated that the variation he found in his specimens encompassed the differences Coutière had set forth to separate the three forms. However, the rostrums in his specimens varied from 1.88 to 2.77 times as long as broad, none reaching the 3.5 ratio given by Coutière for his *A. b. stylirostris*, and he did not remark upon the lack of the *balaeniceps* development in the male of that variety.

In addition to the specimens from Australia, listed above, we were loaned 3 males and 3 females from Japan by Dr Miya of Nagasaki University; four came from near Amakusa which is near the presumed locality for De Haan's species, and two were from Sagami Bay near Tokyo. The variation we found in these specimens is listed also in table 7, with the variation in the Japanese specimens listed in parentheses after the figures deduced from De Haan's original description and plates.

TABLE 7
Criteria for the separation of described forms of *A. bisincisus* compared
to range of variation in Japanese and Australian specimens
 (Figures taken from texts and plates)

| | <i>A. bisincisus</i> | <i>A. b. malensis</i> | <i>A. b. stylirostris</i> | <i>A. b. variabilis</i> | Australian specimens |
|--|----------------------|-----------------------|---------------------------|-------------------------|----------------------|
| Length/breadth of rostrum | 1.5(1.5-2.6)* | 1.5 | 3.5 | 3.0 | 1.8-3.0 |
| Proportion between height of palm and fingers, large chela | 1.34 (1.1-1.2) | 1.6 | 1.34 | 1.54 | 1.1-1.4 |
| Small chela of male: | | | | | |
| balaeniceps | yes (yes) | yes | no | yes | yes |
| total length/breadth | ? (3.5-4.3) | 4.7 | 4.85 | 4.2 | 3.2-4.2 |
| length palm:length fingers | ?(0.9-1.4) | 0.7 | 1.0 | 0.8 | 0.9-1.0 |
| Ratio of first and second carpal articles of second leg | 10:7 (10:5-10:7) | 10:6 | 10:7 | 10:5 | 10:5-10:7 |

*Figures in parentheses are from specimens from Japan; see text.

The comparison shows that variation in these specimens studied encompasses the three varieties except for the narrowness of the rostrum and the lack of a sexually modified small chela in *A. b. stylirostris*. However, we believe that the range of variation of the rostral length to breadth of the measured or described specimens, which runs from the ratio of 1.5 to 3.0, could easily be extended to Coutière's described 3.5 where more specimens are examined. The balaeniceps condition of the small chela of the male like other sexually dimorphic characteristics, is a function of size and sexual maturity. Coutière does not give the size of his sole specimen of *A. b. stylirostris*, but he does give a drawing (fig. 30a) of the small chela and its magnification. If the magnification (30x) is correct, then the chela itself is only 2 mm long, while the mature chela of *A. b. malensis* in fig. 31b is magnified by a factor of 12x and would therefore measure 4.8 mm. The shortest balaeniceps type chela present in our collection measures 8 mm. We believe that Coutière had a sexually immature male and that its small size might also be reflected in the narrowness of the rostrum; therefore we do not recognize any named varieties in De Haan's species, *A. bisincisus*.

This species is remarkably close to *A. chiragricus* Milne-Edwards and is only separated by the flattened rostrum that overhangs the rostral grooves and the subacute lobes that overhang the grooves on the large chela in this species.

BIOLOGICAL NOTES: This species has been collected intertidally and from mud and sand bottoms as deep as 25 fathoms. It has not been reported from dead coral heads. The specimen from Port Dennis (AM P. 7050) was hand netted in "weeds" and the specimen from Dampier Archipelago (WM 144-65) was inhabiting a sponge. Our specimen range up to 35 mm in length.

AUSTRALIAN DISTRIBUTION: We have specimens from northwest Australia, the Gulf of Carpentaria and southern Queensland.

GENERAL DISTRIBUTION: South Africa, Maldive and Laccadive Archipelagoes, Ceylon; Indonesia, Singapore and Japan.

***Alpheus chiragricus* Milne-Edwards**

Fig. 82

Alpheus chiragricus Milne-Edwards, 1837:354. De Man, 1911:415.

*Alpheus Edwardsii** De Man, 1882b:266; 1897:745, pl. 36, fig. 64e; 1898b:312, pl. 4, fig. 1; 1902:880, pl. 37, figs. 62b, c (*passim*). Coutière, 1905a:912, pl. 86, fig. 50 (*passim*).

SPECIMENS EXAMINED: 4 specimens from AM 3 (AM P. 27821); 4, AM 42 (AM P. 28163); 1, AM 45 (AM P. 27832); 3, AM 114 (AM P. 27548); 1, AM 156 (AM P. 28102); 1, AM 193 (AM P. 27547); 1, AM 194 (AM P. 27546); 1, AM 200 (AM P. 27818); 1, AM 232 (AM P. 27588); 2, AM 280 (AM P. 27460); 5, AM 306 (AM P. 27461); 1, AM 312 (AM P. 27545); 1, AM 391 (AM P. 27764); 1, AM P. 9670; 5, AM P. 13550; 1, AM P. 13564; 1, JC 28; 2, JC 29; 1, JC 33; 2, JG 14-73; 4, QM W 1265; 1, WM 24-65; 2, WM 53-65; 2, WM 196-65; 1, WM 210-65.

DESCRIPTION: This species cannot be distinguished from the following *A. edwardsii* (Audouin) (p.404) except for three differences discussed below.

DISCUSSION: In 1972 we established a neotype for *A. edwardsii* and at that time we pointed out how Coutière had confused the characteristics of the species when he established *A. audouini* (1905a:911). Coutière in the same publication reduced *A. chiragricus* of Milne-Edwards to a varietal name under *A. edwardsii*. In our 1972 report we

*The spelling of this name with *i* or *ii* has been rather informal — thus De Man in 1911 used *A. Edwardsi* in most references, but in his discussions on pp.411, 416 and in his index, p.461, he used *A. Edwardsii*. We will refer to the species only as *A. edwardsii* in this discussion. See also footnote on p. 132.



Fig. 82 *Alpheus chiragricus* Milne-Edwards

30 mm male from AM 42. **a.** Anterior region, dorsal view; **b, c.** large cheliped and dactylus, lateral face; **d.** large chela, medial face; **e.** small cheliped, medial face; **f.** second leg; **g.** third leg; **h.** telson. 28 mm female from AM 42. **i.** Small chela, medial face. "*Alpheus edwardsii*" Coutière, 1905a (*nec* Audouin) (= *A. chiragricus*) from Madras. **j.** Dactylus of large chela; **k.** small chela, lateral face. Drawings from photographs made by Dr Forest of Museum National d'Histoire Naturelle of Paris of the holotype of *A. chiragricus*. **l.** Large cheliped, lateral face; **m.** large cheliped, medial face; **n.** small cheliped, lateral face.

All figures except l, m and n same scale.

placed *A. audouini* in synonymy and again accepted, as De Man had in 1911, *A. chiragricus* as a valid species.

On the basis of 45 specimens of *A. chiragricus* and more than 100 specimens of *A. edwardsii*, all from Australia, and the neotypic series of *A. edwardsii* from the Suez, we believe that the following characteristics (listed in order of decreasing importance) will serve to separate *A. edwardsii* and *A. chiragricus*:

1. The development of the "shoulders" on the large chela. In *A. edwardsii* the shoulder proximal to the superior groove overhangs the groove but is obtuse; the inferior shoulder projects somewhat and is rounded (figs. 83 b, c). In *A. chiragricus* both shoulders project as acute, almost spiniform teeth (fig. 82b). This characteristic of *A. chiragricus* was initially confirmed by Dr Forest of the Muséum national d'Histoire naturelle of Paris who kindly sent us photographs of the large and small chela of the holotype of *A. chiragricus* which are reproduced as the drawings in Figures 82 l, m, n; subsequently we have examined the holotype ourselves.

2. The proportions of the large chela: If the shoulder proximal to the superior saddle or groove is taken as the dividing point of the chela then in *A. edwardsii* the portions proximal and distal to this point are approximately equal in length, while in *A. chiragricus* the distal portion is usually 1.3-1.4 times the length of the proximal.

3. The shape of the rostrum: In *A. edwardsii* the rostrum is broader, being 1.4-2.0 times as long as broad at the base, while in *A. chiragricus* it runs from 2.0 to 3.0 times as long as broad. While the characteristics cannot be quantified, the rostral carina is round and the orbitorostral grooves are shallow and rounded in *A. edwardsii* with the grooves usually disappearing at the base of the eyes, while in *A. chiragricus* the carina is more abrupt and sharper, the grooves more narrow and deep, and they extend further posteriorly.

Coutière made several mistakes in 1905 when he attempted to separate these two species into three forms. He had evidently decided from Savigny's figures of the species that Audouin was to name *A. edwardsii*, that the outstanding characteristic was a slender rostrum. He found a specimen in the museum, collected by Henderson from Madras, that corresponded "très exactement" to this form. This specimen he therefore took to be representative of *A. edwardsii* and figured its large chela with spinose shoulders as typical of the species (figures 50a, 50a' and 50a''). As the *A. chiragricus* of Milne-Edwards had similar shoulders, he demoted that species to a varietal name, *A. edwardsii chiragricus*; while he did not distinguish between the two forms in his text, to judge from his figures (figs. 50, 51) he was attempting to separate them on the basis of the narrowness of the rostrum. In our interpretation of Savigny's figures the rostrum is broad and the shoulders of the chelae are not spinose, and these features certainly characterize our neotype of *A. edwardsii*. Therefore, Coutière's *A. edwardsii* is what we accept as *A. chiragricus*, and the apparent difference in rostral form between his "*A. Edwardsii*" and his "*A. Edwardsii chiragricus*" falls within the range of rostral variation we have found in our Australian specimens of *A. chiragricus*. As previously pointed out, the form he described as *A. audouini* is actually *A. edwardsii* as we redescribed it.

Two further minor corrections to Coutière's work: First, Audouin placed the species *edwardsii* in the genus *Athanas*, not *Athanasus* (Coutière, 1899:10, and 1905a:911). Second, neither *A. edwardsii* nor *A. chiragricus* reach from "*Nlle Zeland aux iles Sandwich*" (=Hawaiian Islands).

The specimens discussed by De Man in 1911 as *A. chiragricus* appear to be correctly identified, and his specimens of *A. audouini* are likely to be *A. edwardsii*.

BIOLOGICAL NOTES: This species has been collected under rocks intertidally and has been dredged as deep as 11 fathoms. It has been collected in heads of dead coral. It has also been found in the fouling growth on navigational buoys. Yaldwyn reported that a specimen from the Gulf of Carpentaria was found in a "cow-udder sponge" and another specimen from Townsville was reported as living in association with a giant anemone (JC-28). Our specimens range in size from 10-50 mm.

AUSTRALIAN DISTRIBUTION: In western Australia it was collected from Cockburn Sound, Port Hedland, Broome and off Cape Jaubert; in northern Australia from Darwin and the Gulf of Capentaria; and in eastern Australia from the Coral Sea to Port Curtis, Qld.

GENERAL DISTRIBUTION: "Mers d'Asie" (M-Ed), Indonesia, Mergui Archipelago.

Alpheus edwardsii* (Audouin)

Fig. 83

(Without name) Savigny, 1809, pl. 10, fig. 1.

Athanas Edwardsii Audouin, 1827:274.

Alpheus edwardsii Guérin Menéville, 1829-44, 2:pl. 21, fig. 5, 3:15. Miers, 1874:4, pl. 4, fig. 3. (*A. neptunus* on plate).

Alpheus audouini Coutière, 1905a:911, fig. 52.

Alpheus edwardsi Banner and Banner, 1973:1142, 1 fig. (Neotype established).

Nec A. edwardsii Bate, 1888:542, pl. 97, fig. 1 (= *A. leviusculus* Dana).

Previous Australian records**

Miers, 1874:4. Port Essington; 1884:285. Port Curtis, Port Molle, Port Dennison, Thursday Is., Darwin and Rockhampton.

Haswell, 1882b:188. Port Essington.

Kingsley, 1882:120 Port Essington.

Etheridge, 1889:35.

Whitelegge, 1889:224.

Ortmann, 1894:13. Thursday Is.

Grant and McCulloch, 1907:156. Norfolk Is.

Rathbun, 1914:654. Monte Bello Is. (as *Crangon edwardsii*).

Balss, 1921:9. Cape Jaubert.

McNeill, 1926:302. Queensland; 1937:263. Middleton Reef.

Hale, 1927b:308. Kangaroo Is.; 1929:68. Dirk Hartog Is. (as *C. edwardsi*).

Pope, 1949:327. Darwin. (as *C. edwardsii*).

Stephenson, Endean and Bennett, 1958:268. Low Isles.

Gillett, McNeill, 1959:123. (Sound production).

SPECIMENS EXAMINED: 1 specimen from AM 9 (AM P. 27824); 3, AM 13 (AM P. 27555); 1, AM 27 (AM P. 27837); 2, AM 28 (AM P. 27550); 2, AM 33 (AM P. 27813); 1, AM 40 (AM P. 27814); 1, AM 57 (AM P. 27830); 2, AM 60 (AM P. 27836); 1, AM 62 (AM P. 27919); 2, AM 79 (AM P. 27561); 4, AM 102 (AM P. 27529); 1, AM 113 (AM P. 27462); 2, AM 129 (AM P. 27838); 5, AM 150 (AM P. 27839); 1, AM 154 (AM P. 27531); 1, AM 160 (AM P. 27799); 1, AM 169 (AM P. 27532); 1, AM 180 (AM P. 27549); 1, AM 183 (AM P. 27533); 1, AM 184 (AM P.

*For explanation of spelling see footnote, p. 132.

**The correctness of the identifications listed below is questionable, as we pointed out in our 1972 paper. However, we were able to examine some specimens of *A. edwardsii* from Monte Bello Is. at the British Museum (Natural History) which were correctly identified.

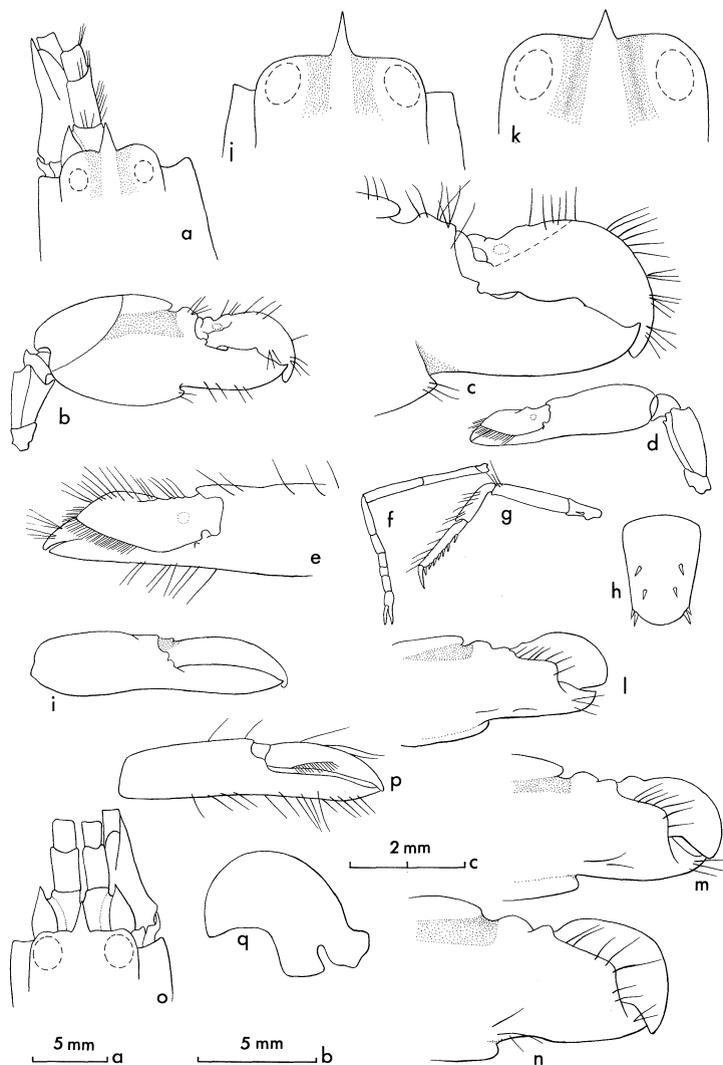


Fig. 83 *Alpheus edwardsii* (Audouin)

32 mm male from AM 217. **a**. Anterior region, dorsal view; **b**, **c**. large cheliped and enlargement of distal region, lateral face; **d**, **e**. small cheliped and enlargement of distal region, lateral face; **f**. second leg; **g**. third leg; **h**. telson. 30 mm female from AM 217. **i**. Small chela, lateral view. 27 mm male from AM P. 2577. **j**. Anterior region, dorsal view. 30 mm female from AM P. 6355. **k**. Anterior region, dorsal view. Three neoparotypic specimens from the Suez Canal. **l**, **m**, **n**. Distal region of large chelipeds (after B & B, 1972: figs. l, e, m and n). 15 mm female from JG 12-73. **o**. Anterior region, dorsal view; **p**. small chela, lateral view; **q**. dactylus, large chela. **b**, **d**, **f**, **g**, **l**, **m**, **n** scale a; **a**, **c**, **e**, **h**, **i**, **q** scale b; **j**, **k**, **o**, **p** scale c.

27920); 1, AM 188 (AM P. 27534); 4, AM 190 (AM P. 27815); 1, AM 200 (AM P. 27817); 2, AM 208 (AM P. 27816); 2, AM 217 (AM P. 27840); 1, AM 242 (AM P. 27850); 1, AM 254 (AM P. 27851); 1, AM 265 (AM P. 27796); 3, AM 280 (AM P. 27459); 11, AM 281 (AM P. 28104); 4, AM 285 (AM P. 27797); 1, AM 292 (AM P. 27807); 1, AM 300 (AM P. 27458); 1, AM 301 (AM P. 27803); 1, AM 308a (AM P. 27554); 1, AM 309 (AM P. 27455); 1, AM 312 (AM P. 27544); 1, AM 382 (AM P. 27835); 1, AM 422 (AM P. 27852); 1, AM 448 (AM P. 27565); 1, AM G. 5782; 4, AM P. 1418; 3, AM P. 6354; 2, AM P. 6355; 4, AM P. 6605; 1, AM P. 7902; 2, AM P. 9481; 2, AM P. 11730; 2, AM P. 11779; 3, AM P. 11882; 8, AM P. 27430; 1, AM P. 27789; 1, AM P. 28164; 9, BAU 6; 2, BAU 10; 1, BAU 20; 2, BAU 36; 2, BAU 40; 1, BAU 43; 5, BAU 50; 1, BAU 72; 19, BAU 73; 1, CS 37; 1, CS 40; 2, JB 1; 1, JC 5; 1, JC 6; 2, JC 7; 4, JC 11; 1, JG 7-73; 1, JG 12-73; 3, JG 16-73; 5, QM W 1265; 2, QM W 1296; 1, UQ 3; 1, UQ 5; 1, UQ 7; 1, UQ 10; 1, UQ 14; 2, UQ 21; 2, UQ 24; 1, UQ 25; 1, US 123590; 2, VM 19; 1, WM 42-65; 1, WM 48-65; 2, WM 53-65; 1, WM 60-65; 1, WM 98-65; 1, WM 106-65; 1, WM 161-65; 1, WM 165-65; 1, WM 167-65; 2, WM 168-65; 1, WM 169-65; 2, WM 170-65; 1, WM 179-65; 2, WM 191-65; 1, WM 210-65; 7, WM 243-65; 5, WM 251-65; 1, WM 252-65; 2, WM 278-65; 2, WM 279-65; 4, WM 286-65; 1, WM 10876.

DIAGNOSIS: Following is the description of the neotype (Banner and Banner, 1972:1142); "Rostrum 1.4 times as long as wide at base, reaching to near end of first antennular article. Broad, moderately deep orbitorostral grooves disappearing at posterior margin of orbits. Visible part of first antennular article 0.8 as long as second antennular article which is 2 times as long as broad; third antennular article 0.5 as long as second. Stylocerite acute, reaching to end of first antennular article. Scaphocerite with squamous portion reaching nearly to end of third antennular article, lateral tooth a little longer. Carpocerite reaching well past end of third article. Lateral tooth of basicerite small, acute.

"Large chela 2.3 times as long as broad, fingers occupying 0.3 total length. Superior margin bearing transverse groove proximal to dactylus. Proximal edge of groove obtuse, never acute, overhanging floor of groove; distal margin of groove rounded; groove continued on inner face as poorly defined triangular depressed area, the apex of which reaches to proximal quarter of chela; groove continued on outer face as well defined quadrangular depression, proximal portion reaching *linea impressa* and inferiorly extending 0.3 width of palm. Deep notch on inferior margin directly opposite superior groove, demarked proximally by heavy shoulder with tip slightly projected but not acute; distal margin of groove rounded. Inferior groove extends as a slightly depressed triangular area only 0.2 into outer face of palm. Merus 2 times as long as broad, bearing an acute tooth distally on inferointernal margin; superior and inferoexternal margins not projecting.

"Small chela sexually dimorphic. Male chela 3.8 times as long as broad with fingers 0.6 as long as palm. Superior margin of palm bearing small groove proximal to dactylus that is extended slightly into outer face; inferior margin with only slight trace of concavity comparable to groove and shoulder of large chela. Dactylus proximally broadened into a triangular area demarked by fringes of short stiff setae which line margins near articulation of dactyl and curve to meet on superior surface proximal to tip; this is the usual "balaeniceps" development, Female chela 4.4 times as long as broad with fingers and palm almost equal. Chela with traces of large chela sculpturing, but even less developed than male, and without fringe of setae on dactyl. Meri of both male and female small chelipeds similar, 2.2 times as long as broad and bearing an acute tooth distally on inferointernal margin. External and superior margins not projecting distally.

"Carpal articles of second leg with ratio: 10:6:3:3:5.

"Ischium of third leg bearing strong spine. Merus of third leg 5 times as long as broad, inermous. Carpus 0.5 as long as merus, superodistal margin projecting into a tooth. Propodus almost 0.8 as long as merus, bearing 6 inferior spines and 2 distal spines. Dactylus simple and slightly curved, 0.3 as long as propodus.

"Telson 2 times as long as posterior margin is broad; spines on dorsal surface small; outer pair of terminal spines as long as dorsal spines, inner spines a little longer".

DISCUSSION: In 1972 we used a number of Australian specimens to determine the extent of the range in the characters of *A. edwardsii*. We repeat our findings here:

"1. The rostrum varied from 1.4-2.0 times as long as broad at the base.

"2. The ratio of the first and second article of the antennular peduncles varied from 10;13-10:16; the ratio of the visible part of the first to third antennular article varied from 10:6-10:10.

"3. (The shoulders proximal to both the superior and inferior grooves of the large chela were found to vary independently from right angles, with rounded edges, to blunt rounded projections (illustrated but not described in original discussion).)

"4. The small chela varied in males from 3.4-4.4, and in the females from 3.8-5.4 times as long as broad.

"5. The first two carpal articles of the second leg varied from 10:5-10:8.

"6. The merus of the third leg varied from 4.3-5.3 times as long as broad."

We have a 15 mm female specimen from Moreton Bay (JG 12-73, see fig. 83p) in which the dactylus of the small chela has a slight fringe of hair on the lateral and medial face instead of being totally lacking. This condition in the females of species of the *Edwardsii* Group with sexually dimorphic small chelae has been noted before (Banner and Banner, 1966a:185). In addition, in this specimen the orbitorostral margin is straight rather than concave. As in all other characteristics this specimen easily falls within the range of variation we have found for this species, we are treating it as another variation.

We have examined the holotype and sole specimen of *A. minor* de Haan at the Rijksmuseum van Natuurlijke Historie, Leiden, which is a female; as the name was preoccupied, the species was renamed *A. haanii* by Ortmann (1890:472). In all characteristics this specimen falls within the ranges we have found for *A. edwardsii*, but the synonymy cannot be confirmed until the small chela of a male is examined. We suggest that when specimens are obtained from Nagasaki, Japan, the probable type locality of *A. haanii* (see Banner and Banner, 1974:431), the question of possible synonymy be resolved. We also wish to report that the figures given for *A. haanii* by Yokoya (1939:266) do not compare well with the holotype, and that the slender large chela and the acute overhanging shoulder on its superior and inferior margins are similar to *A. japonicus* Miers.

BIOLOGICAL NOTES: This species is largely intertidal, living under rocks in sandy, muddy conditions. It has been dredged from as deep as 14 fathoms and has been collected on navigational buoys and beacons. One specimen was reported from a clump of live coral, but probably it was taken from the dead part near the base. We have specimens ranging in size up to 40 mm.

AUSTRALIAN DISTRIBUTION: Specimens that we have examined have been collected on all the coasts of Australia.

GENERAL DISTRIBUTION: As pointed out in our 1972 paper this binomen has been so confused in its use that we cannot trace out the distribution of the species in the Indo-Pacific. On the basis of our collections we can report it from the Red Sea, Australia, Thailand and the Philippines. It probably extends widely through the Indian Ocean, into

Southeast Asia, but it is not known on the islands of the Central Pacific nor from New Zealand.

Alpheus polyxo De Man
Fig. 84

Alpheus polyxo De Man, 1909a:108; 1911:423, fig. 104.

SPECIMENS EXAMINED: 1 specimen from AM 91 (AM P. 27517); 1, AM 118 (AM P. 27558); 2, AM 143 (AM P. 27570); 1, AM 165 (AM P. 27562); 2, AM 186 (AM P. 27328); 1, AM 257 (AM P. 27522); 2, AM 280 (AM P. 28165); 1, AM 309 (AM P. 27454); 1, AM 409 (AM P. 28166); 2, AM 410 (AM P. 27523); 1, AM P. 3544; 1, AM P. 27435; 1, AM P. 27439; 3, AM P. 27790; 3, AM P. 27791; 1, AM P. 28124; 1, BAU 28; 3, BAU 37; 2, BAU 38, 1, BAU 40; 2, BAU 44; 2, BAU 47; 5, BAU 48; 2, BAU 50; 2, BAU 53; 1, BAU 58; 1, UQ 11; 1, WM 79-65; 1, WM 91-65; 1, WM 186-65; 1, WM 189-65; 4, WM 274-65.

DIAGNOSIS: Rostrum 1.8 times as long as wide at its base, reaching to end of first antennular article, bearing a marked but rounded carina reaching from tip posteriorly to well behind eyes and bearing a number of upstanding hairs. Margins of orbital hoods rounded laterally, medially extending as flattened prominences. Second antennular article 2.5 times as long as broad, 1.8 times longer than visible part of first, 2.0 length of third. Antennular articles bearing on distal margins as well as superior surface a small number of long hairs. Stylocerite reaching slightly beyond end of first antennular article. Scaphocerite with outer margins concave, squamous portion narrow, lateral spine reaching to end of carpocerite and beyond squame by 0.6 length of third antennular article. Carpocerite slender, 6 times as long as wide, reaching just beyond end of antennular peduncle.

Large chela heavy, 2.1 times as long as broad, fingers occupying distal 0.35. Superior saddle deep, somewhat narrow, proximal shoulder rounded and overhanging saddle, distal shoulder prominent, gradually rounded. Lateral palmar depression well defined, quadrangular, extending to *linea impressa*. Medial palmar depression well defined, triangular, reaching proximally to middle of palm. Inferior shoulder rounded, only moderately heavy, not extended. Inferior notch shallow. Inferolateral depression shallow, extending as a shallow "U"-shaped groove that reaches to middle of palm, with rounded apex directed proximally. Inferomedial depression lacking. Plunger of dactylus low and confluent with distal margin. Merus 2.3 times as long as broad, bearing on its inferodistal margin a small sharp tooth, superodistal margin slightly projected.

Small chela sexually dimorphic with dactylus balaeniceps in males only. Male chela 3.7 times as long as broad with fingers 0.4 total length. Superior margin bearing a slight transverse groove proximal to dactylus. Merus 2.1 times as long as broad with small acute tooth terminally on inferointernal margin. Female chela 4.0 times as long as broad, fingers as long as palm, tapering. Palm bearing a slight depression proximal to dactylus.

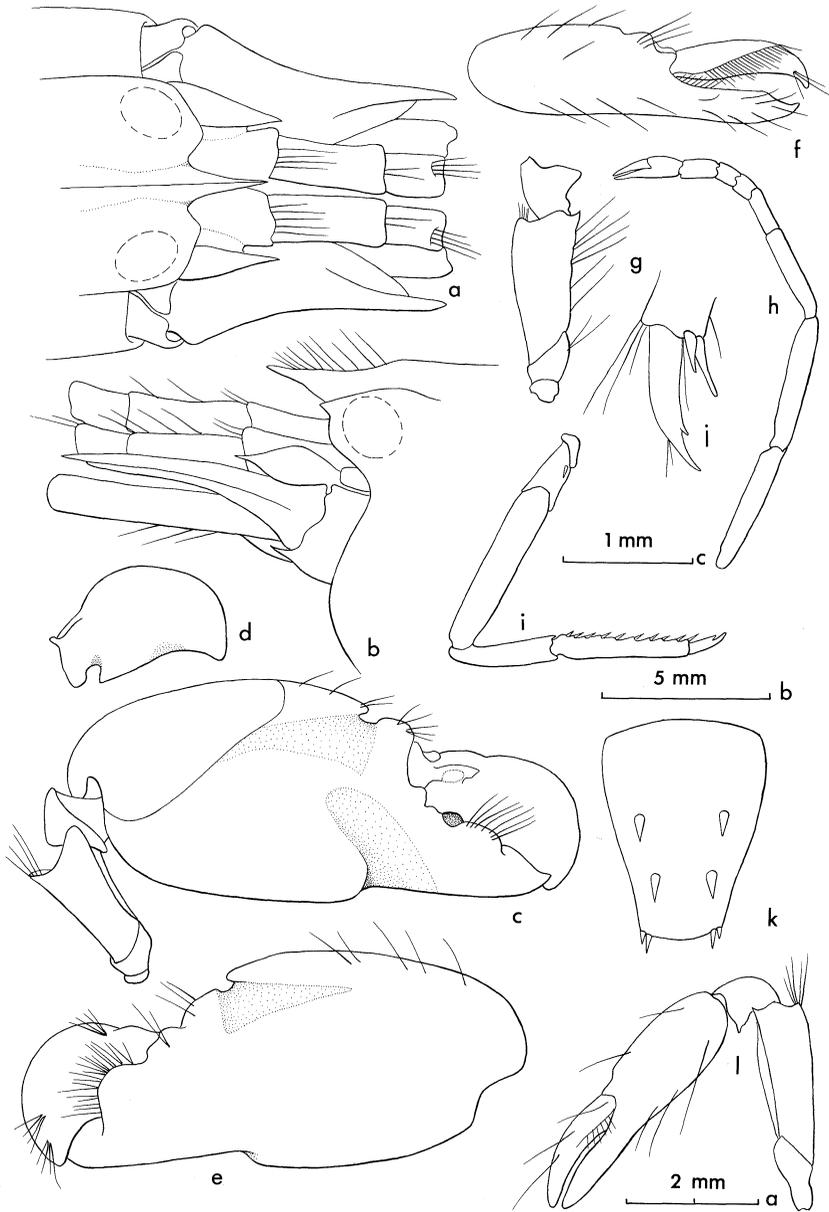


Fig. 84 *Alpheus polyxo* De Man
 32 mm male from AM 280. **a, b.** Anterior region, dorsal and lateral view; **c, d.** large cheliped and dactylus, lateral face; **e.** large chela, medial face; **f, g.** small chela, merus and carpus, medial face; **h.** second leg; **i, j.** third leg and enlarged dactylus; **k.** telson. 32 mm female from AM 280. **l.** Small cheliped, medial face. a, b, k scale a; c, d, e, f, g, h, i, l scale b; j scale c.

Dactylus bearing short fringes of setae only on proximal portion of margins. In some specimens, fringe of setae lacking on one or both faces of dactylus. Carpus cup shaped bearing a sharp tooth distally near inferior margin of palm.

Ratio of carpal articles of second leg: 10:5:2:2:4.

Ischium of third leg with small spine. Merus 5 times as long as broad, inermous. Carpus 0.5 as long as merus, inferodistal margin bluntly produced. Propodus 0.8 as long as merus, carrying about 10 spines on inferior margin. Dactylus 0.3 as long as propodus, slightly curved, and biunguiculate with inferior unguis less than 0.3 length of superior and located one-quarter length of dactylus from tip.

Telson 2.3 times as long as posterior margin is broad, anterior margin 1.8 times wider than posterior margin. Posterior margin evenly rounded.

DISCUSSION: We have examined the male holotype and female allotype of *A. polyxo* at the Zoologisch Museum in Amsterdam. De Man mentioned the rounded prominences of the inner margins of the orbital hoods but his figure 104 does not show them; they are on the types. Also, while he mentioned the secondary unguis on the dactylus of the third leg his figure 104e does not show it; the types also have this structure. He stated that the dactylus of the small chela of the male bore a fringe of setae on the inner face, but that the outer face was glabrous. This is true of the holotype. The small chela of the female is lacking as are the large chelipeds for both specimens.

We find our specimens agree well with De Man's with two notable exceptions. In most of the males in our collection the fringes of setae on the dactylus are on both faces and extend to the superior surface, the typical balaeniceps condition. However, there are a few in which the fringes of setae are much reduced, similar to De Man's. This does appear to be somewhat related to size as we find the specimens with the reduced fringes of setae are smaller than 25 mm. However, we have a male specimen of 18 mm in length that is fully balaeniceps. De Man's male was 22 mm in length. The second exception is that all of our specimens carried several upstanding hairs on the rostral carina as well as the distal margins of the antennular articles (e.g. fig 84b). De Man's specimens carry the long hairs on the antennular articles, but the carina is glabrous.

These two characteristics may be of subspecific worth in separation of the Australian form from De Man's Indonesian form, but until more specimens and complete specimens are collected from the type locality the separation would be questionable.

BIOLOGICAL NOTES: Specimens we collected personally came from dead coral in water up to 10 ft. deep; others were dredged as deep as 71 fathoms. The specimens ranged in size from 12-35 mm.

AUSTRALIAN DISTRIBUTION: In western Australia the specimens were collected between Shark Bay and Bedout Is; in northern Australia from Thursday Is., and in eastern Australia between Cairns and Stradbroke Is., Qld.

GENERAL DISTRIBUTION: This is the first time this species has been reported since De Man described it from Banda in Indonesia.

Alpheus pareuchirus pareuchirus Coutière Subspec. designated
Fig. 85a-k

Alpheus pareuchirus Coutière, 1905a:906, pl. 84, fig. 43. De Man, 1911:418, fig. 101.

Alpheus pareuchirus var. *leucothea* De Man, 1911:420, fig. 102.

SPECIMENS EXAMINED: 1 specimen from AM E. 3190; 1, AM P. 28137; 1, QM W2249; 2, WM 275-65.

DIAGNOSIS: Rostrum slender, 2 times as long as wide at base, acute, reaching slightly past middle of first antennular article. Visible part of first antennular article a little longer than third; second article almost twice as long as broad and 1.6 times longer than third article. Stylocerite reaching to end of first antennular article. Lateral spine of scaphocerite as long as carpocerite and antennular peduncle; squamous portion of scaphocerite a little shorter. Basicerite with acute lateral tooth.

Large chela 2.4 times as long as broad, fingers occupying the distal 0.4. Superior saddle well developed; proximal shoulder projecting above saddle but rounded; distal shoulder rounded. Lateral palmar depression almost triangular with rounded proximal apex lying almost in proximal third of palm; medial palmar depression narrow and acutely triangular, slightly longer than lateral depression. Medial face with a narrow longitudinal groove near inferior margin that extends proximally from near articulation of carpus to inferior notch. Inferior notch slight, not continued into faces of palm as depressions; inferior shoulder low and rounded. Plunger of minimal development. Merus a little longer than broad, bearing strong acute tooth distally on inferointernal margin.

Small chela sexually dimorphic. Chela of male 3.7 times as long as broad, with fingers only slightly shorter than palm and with dactylus of typical balaeniceps development, laterally expanded with crests of hairs meeting on superior surface proximal to tip; proximal half of both margins of pollex with crests of hair. Palm with marked superior saddle, with proximal shoulder slightly overhanging groove and with medial and lateral palmar depressions long and triangular. Merus 2.0 times as long as broad, bearing distally on inferointernal margin a small acute tooth. Female chela simple, 3.6 times as long as broad, with simple conical fingers almost equal in length to palm; palm without sculpturing, 2.4 times as long as broad. Merus similar to that of male, but more slender, 4.0 times as long as broad (as we lacked a female with a small chela Fig. 85k is a female from the Siboga Expedition, St. No. 51).

Carpal articles of second legs with ratio: 10:9:3:3:5.

Ischium of third leg with strong spine. Merus inermous, 6.5 times as long as broad. Carpus 0.5 as long as merus, distal angles slightly projecting. Propodus 0.8 as long as merus, bearing on its inferior margin 10-12 small spines and a pair distally. Dactylus simple, 0.4 as long as propodus.

Telson 2.5 times as long as broad posteriorly. Anterior pair of dorsal spines definitely anterior to middle. Inner spines of posterolateral pair of little more than twice length of outer.

DISCUSSION: The inferior shoulder of the large chela in our specimens is distinct but rounded while in both Coutière's and De Man's specimens it is less pronounced and the margin merely appears to be sinuous. We have examined the type series from Hulule Male Atoll at the Muséum National d'Histoire Naturelle in Paris (there are 3 males and 2 ovigerous females). Of the five specimens all lack the small cheliped and there are only 3 large chelipeds lying loose in the vial. In one of the chela the inferior margin which Coutière described as "*Simplement sineux*" has a more abrupt inferior shoulder than the one figured (1905a:fig. 43a). This appears to be a variable character that may be influenced by size of the specimen.

The merus of the third leg was described by Coutière as being 7 times as long as

broad; this is slightly more slender than in our specimens, but De Man, with a larger number of specimens at hand, pointed out that the third legs in the larger specimens were heavier. The inferodistal margin of the merus in Coutière's type was angular while in our specimens it is rounded; this also appears to be a variable characteristic. De Man remarked that Pearson's specimen from Ceylon (1905:86) probably was not *A. pareuchirus*; this appears likely since the merus of the large chela bore no tooth on the inferointernal margin, distally.

De Man described a variety from his Siboga material which he called *A. p. leucothea*. For comparison with our specimens, the Zoologisch Museum of Amsterdam loaned us 18 specimens of *A. p. pareuchirus* and 3 specimens of *A. p. leucothea* from the Siboga material which De Man himself had identified. De Man separated his variety *leucothea* on the basis of 3 characters.

1. In *A. p. pareuchirus* the proximal margin of the superior groove of the large chela markedly overhangs the floor of the groove while in *A. p. leucothea* it does not. We found this to be variable both in the Siboga specimens and in ours. The proximal margin varies from right angles to the floor of the groove to overhanging the groove. This does not appear to be a reliable character.

2. In the typical *A. p. pareuchirus*, according to Coutière, the merus of the third leg "A son apex inférieur distal il se termine par un bord nettement aigu, mais non épineux..." while in *A. p. leucothea*, according to De Man, the distoinferior margin is rounded. We found this character subject to variation. It is true in some of the Siboga specimens the distoinferior margin was sharp, but in others it was rounded; in our specimens all were rounded. Again this does not appear to be a well-defined difference.

3. In *A. p. pareuchirus* the merus of the third leg is more slender, varying from 6-7 times as long as broad while in *A. p. leucothea* De Man states it is "around 5.3 times as long as broad". In two of our specimens the merus is 5 times as long as broad, and in another 6.3 and in 2 others 6.5. One of the specimens did not have any third legs. From our experience with the Edwardsii Group this range of variation is to be expected.

Thus the slight differences that are supposed to separate the variety from the nominate species appears to be within the normal range of variation and we are placing the variety into synonymy.

The variety *A. p. imitatrix* (De Man, 1911:426) in which both the male and female bear the *balaeniceps dactyli* on the small chela (see fig. 85l) appears to be valid and we are raising it to subspecific rank (see following).

BIOLOGICAL NOTES: All specimens of this subspecies reported so far have been dredged from at least 15 metres deep except the several specimens in our own collections from the Philippines which came from no more than 10 ft. deep. The specimens range in size up to 30 mm.

AUSTRALIAN DISTRIBUTION: Three specimens were collected near Percy Isles, S. E. Qld., and 2 from Port Hedland in Western Australia.

GENERAL DISTRIBUTION: Madagascar; Maldives; Indonesia; Philippines.

***Alpheus pareuchirus imitatrix* De Man**
Fig. 85 l

Alpheus pareuchirus var. *imitatrix* De Man, 1909a:106; 1911:426.

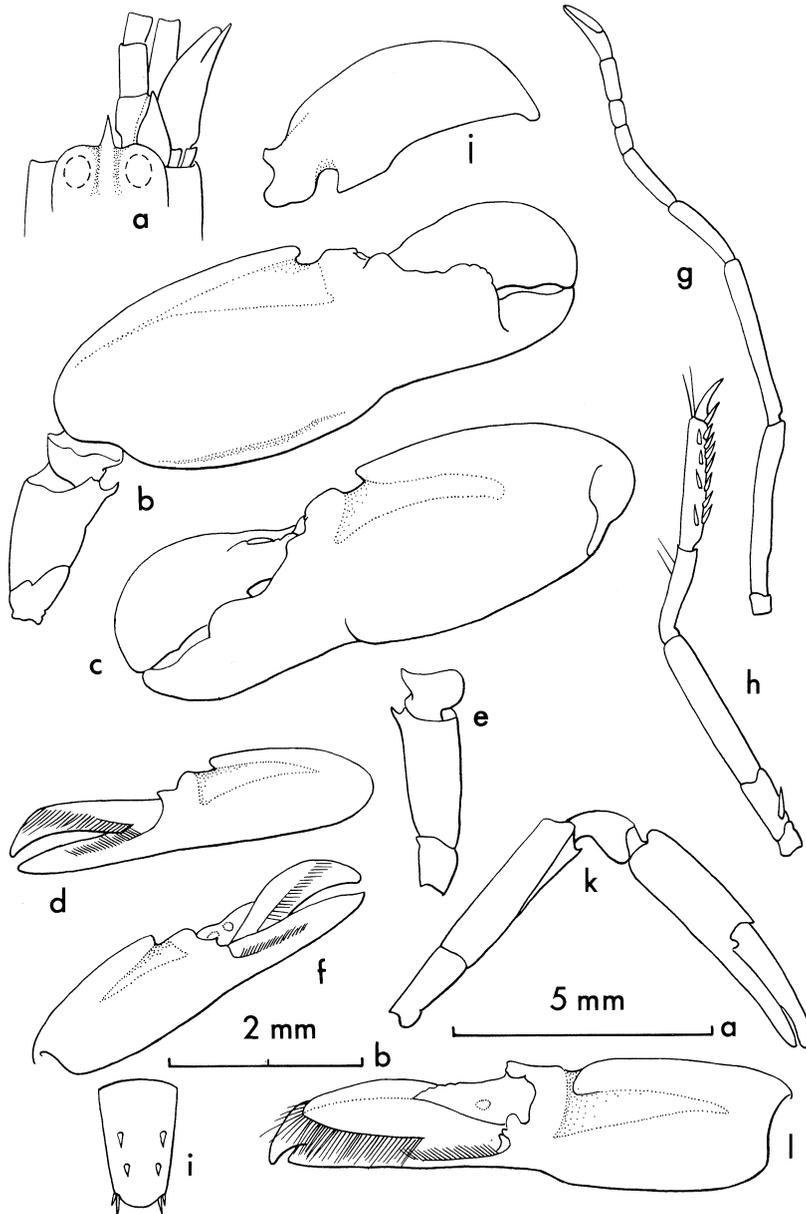


Fig. 85 *Alpheus pareuchirus pareuchirus* Coutière
 24 mm male from AM E. 3190. **a.** Anterior region, dorsal view; **b, c.** large cheliped, medial face and chela, lateral face; **d, e.** small chela and merus, medial face; **f.** small chela, lateral face; **g.** second leg; **h.** third leg; **i.** telson. 30 mm male from WM 275-65. **J.** Dactylus of large chela. 18 mm female from Siboga station No. 51. **k.** Small cheliped, lateral face.

Alpheus pareuchirus imitatrix De Man
 30 mm female from AM 280. **1.** Small chela, lateral face. **a, b, c, d, e, f, g, h, i, j, l** scale **a**; **k** scale **b**.

SPECIMENS EXAMINED: 1 specimen from AM 160 (AM P. 28138); 1, AM 280 (AM P. 28139); 1, MM 434.

DIAGNOSIS: See *A. p. pareuchirus* Coutière preceding for diagnosis except for the small chela of the female.

DISCUSSION: *A. pareuchirus* var. *imitatrix* was separated from the nominate subspecies only by the development of a balaeniceps dactylus on the small chela of the female. Two of our female specimens (AM 160 and AM 280) resemble the nominate species exactly except for the small chela which is the same as the male. The grooving on the palm is quite similar except the inferior shoulder is more pronounced (see fig. 85l). The merus of the third legs of the 3 specimens (including MM 434) was 5.0 times as long as broad, a little heavier than the nominate subspecies. The specimen from Torres Straits (MM 434) is questionable as it lacks the small cheliped, but as stated above the merus of the third leg was stout, typical of the subspecies *imitatrix*.

BIOLOGICAL NOTES: One of the specimens came from the growth on a pearl oyster shell and another was dredged at 12 fathoms. De Man's specimens were dredged as deep as 141 metres. Our specimens reached up to 30 mm in length.

AUSTRALIAN DISTRIBUTION: One specimen came from Van Diemens Gulf, near Darwin, and one was from the Torres Straits; the third was dredged off Port Curtis, Qld.

GENERAL DISTRIBUTION: De Man's specimens came from Indonesia and this is only the second report of collection of the subspecies.

Genus **Metalpheus** Coutière

Alpheus sp. ? *Metalpheus* n. gen. Coutière, 1908a:213, 1921:419, pl. 62, fig. 15.

Metalpheus Chace, 1972:78

TYPE SPECIES: *Alpheus rostratipes* Pocock

DIAGNOSIS: General body form similar to *Alpheus*, eyes normally covered by orbital hoods but may be exposed through rough handling.

Antennular peduncle short and relatively heavy. Basicerite and carpcerite of antennal peduncles also massive; squame may be reduced.

Labrum enlarged and protruding. Incisor process of mandible expanded and enclosing labrum; margin with numerous teeth. Epipodite of second maxilliped a soft-walled triangular lobe. Basal article of endopod of third maxilliped flattened in section, not trigonal, mediolaterally expanded and curving to enclose more anterior mouthparts; basal article longer than sum of following two.

First chelipeds like *Alpheus*, with both large and small chelipeds varying in form with sex and maturity; large chela with at most slight to moderate sculpturing. Second legs may be short and massive; carpus of 5 articles. Third to fifth legs with propodi somewhat curved, dactyli biunguiculate.

Appendix masculina of endopod of second male pleopod greatly elongate, reaching beyond tips of both rami. Third to fifth pleopods of females with *appendix interna* large and arising in distal third of endopod, with tip reaching to end or near end of that ramus.

Distal articulation of outer branch of uropods not straight but curving to form several lobes. Inner branch bearing spines on distolateral margin. Telson similar to *Alpheus*, with anal tubercles.

Branchial formula including 5 pleurobranchs, 1 arthrobranch and epipodites, usually with the last mastigobranch on the third legs and the last setobranch on the fourth.

DISCUSSION: This genus, now containing three or possibly four species (see below), has a somewhat confused history. In 1908 Coutière described two specimens from the Percy Sladen Trust Expedition to the Indian Ocean (exact locality not specified; description repeated with figures in 1921). He suggested that they might or might not be of the same species as Pocock described in 1890 as *Alpheus rostratipes* from Fernando de Noronha in the Atlantic. He also suggested that these one or two species might constitute a separate genus for which he advanced (with a question mark) the name *Metalpheus*. As only one chela was present in both his and Pocock's specimens, Coutière deferred final decision on the validity of the new genus until both chelae had been studied from both oceans.

As pointed out by Chace (1972:78), Shelford (1909:2631) listed the genus in the *Zoological Record* and designated *A. rostratipes* as the type species.

The species, now recognized as *M. rostratipes*, thereafter appeared in the literature under a confusing series of names (see synonymy under that species p. 429) and was finally and definitely established with complete synonymy in the work of Crosnier and Forest (1966:246); however, those authors retained it in the genus *Alpheus*. Only in 1972 was the generic name *Metalpheus* revived by Chace (*loc. cit.*) for this species and for *Alpheus paragracilis* Coutière. In 1974 (p. 424) we re-examined the holotype of *Alpheus hawaiiensis* (Edmondson) and found it, too, met the criteria established by Chace.

There may be a fourth species in this genus. In 1900 Borradaile (p. 417) described *Alpheus aglaopheniae* on the basis of a single incomplete female specimen "found living in the branches of a hydroid polyp of the genus *Aglaophenia*" from the "Engineer Group, British New Guinea". Through the courtesy of the University Museum of Zoology at Cambridge, England, we were able to examine Borradaile's holotype. When described by Borradaile the specimen was incomplete; since then all of the pereopods have been lost. We found his illustrations to be accurate. On the basis of the protrudent mouthparts, the expanded proximal endopodal article of the third maxillipeds (we did not try to dissect the underlying mouth parts on this sole specimen), the heavy antennular and antennal peduncles and especially the highly modified pleopods, this species plainly belongs to the genus *Metalpheus*. There is nothing in the original description nor in the remains of the holotype that could be used to separate this species from Coutière's *M. paragracilis* named three years earlier. In spite of this, we have decided to let the species stand on the basis of its habitat, for neither *M. paragracilis* nor any other alpheid, for that matter, has been recorded as living in hydroid colonies. This may indicate a degree of specialization that could be reflected by its morphology if a complete specimen were available.

The genus is very close to *Alpheus* on one hand and to *Pomagnathus* Chace (1937:124) on the other. From *Alpheus* it is separated by the enlargement of the labrum, the expansion of the incisor process on the mandibles, the modification of the epipodite of the second maxillipeds, the somewhat opercular development of the proximal endopodal article of the third maxillipeds, and the modification of the pleopods in both the male and female. The loss of the last setobranch and mastigobranch normally found in *Alpheus* is also distinctive, although there may be variation in this character (B & B 1964:90). In quick examination the species of *Metalpheus* stand out from *Alpheus* in the relative heaviness of the antennular peduncles and the massive and protruding mouthparts. The nature of the articulation on the outer branch of the uropods has not been remarked upon before although it is plainly shown by Crosnier and Forest (1966:fig. 12f); however, as this articulation is not usually studied, we do not know how valid this

criterion may be to separate this from other genera.

The genus *Pomagnathus* Chace (1937:124) is yet more closely related, but Chace (1972:78) separates it as follows: "*Pomagnathus* agrees with *Metalpheus* in the form of the front and mouthparts (although the incisor process of the mandible is armed with longer and sharper teeth, and the antepenultimate segment of the third maxilliped is even more expanded than in *M. rostratipes*), but it differs in lacking epipods on all of the pereopods and in having an appendix masculina that is even shorter than the appendix interna rather than abnormally elongate."

KEY TO THE KNOWN SPECIES OF THE GENUS METALPHEUS

(*M. aglaopheniae* not included; see discussion below)

1. Large chela with inferior shoulder abrupt; squamous portion of scaphocerite as long as, or longer than, antennular peduncle; second carpal article of second legs about twice as long as broad; merus of third leg with strong tooth.....*M. paragracilis* p. 282
2. Inferior shoulder of large chela represented by only a slight, rounded depression; squamous portion of scaphocerite reaching to near end of third antennular article; second carpal article about as broad as long; merus of third leg with rounded projection or slight tooth *M. hawaiiensis** p. 281
3. Inferior margin of large chela without trace of shoulder or depression; squame reaching slightly beyond end of second antennular article; second carpal article about as broad as long; merus of third leg distally rounded. . *M. rostratipes* p. 285

*Known only from Lisianski Island, leeward Hawaiian chain.

***Metalpheus paragracilis* (Coutière)**

Fig. 86

Alpheus paragracilis Coutière, 1897b:303; 1905a:883, pl. 76, fig. 22.

Metalpheus paragracilis Chace, 1972:78.

Crangon paragracilis Banner, 1953:96, fig. 33.

Previous Australian Records:

Coutière, 1900:404. Murray Island

O'Loughlin, 1969:37. Houtman Abrolhos.

SPECIMENS EXAMINED: 2 specimens from AC C-28; 3, AM 74 (AM P. 27504); 30, AM 109 (AM P. 27506); 1, AM 214 (AM P. 27560); 1, AM 339 (AM P. 27505); 2, BAU 21; 2, BAU 31; 1, BAU 32; 4, BAU 33; 2, BAU 48; 3, BAU 57; 2, BAU 58; 1, WM 62-65; 2, WM 225-65; 1, WM 235-65; 1, WM 209-57.

DIAGNOSIS: Rostrum acute, reaching to end of first antennular article; lateral margins with a few setae. Rostrum with slight rounded carina. Orbitorostral grooves shallow, extending only to base of eyes. Orbitorostral margin deeply indented. Margins of orbital hood subacute. Antennular articles nearly equal, second article as broad as long. Stylocerite acute, reaching to middle of second antennular article; outer margin of scaphocerite slightly concave, lateral tooth strong, reaching well past end of antennular peduncle, squamous portion reaching to end of third article. Carpocerite as long as lateral spine of scaphocerite. Basicerite heavy, with lateral tooth reaching almost to end of second antennular article.

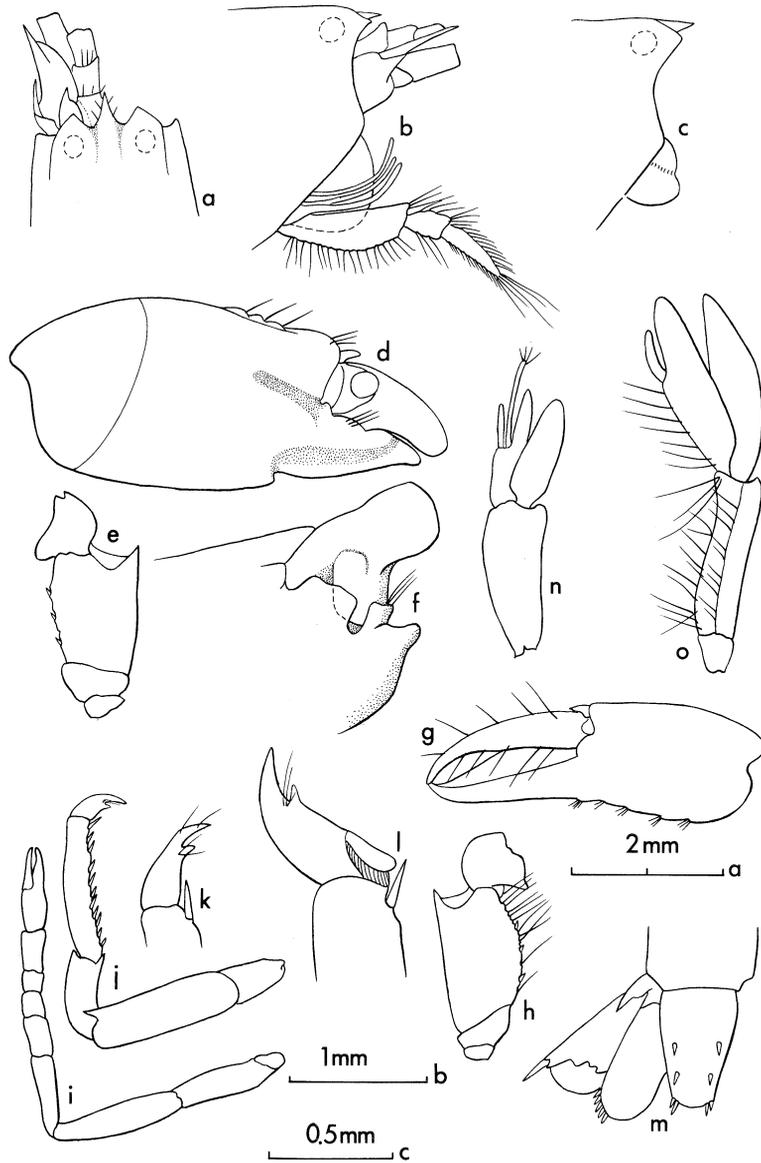


Fig. 86 *Metalpheus paragracilis* (Coutière)

14 mm male from BAU 58. **a, b.** Anterior region, dorsal and lateral view; **c.** anterior region of carapace showing labrum; **d, e.** large chela, lateral face and merus, medial face; **f.** large chela, distolateral face and detail of dactylus; **g, h.** small chela, lateral face and merus, medial face; **i.** second leg; **j, k.** third leg and dactylus enlarged; **l.** dactylus of third leg showing "heel" sclerite; **m.** telson and uropods; **n.** second pleopod. 14 mm female from BAU 58. **o.** Second pleopod. a, b, c, d, e, g, h, i, j, m scale a; f, k, n, o scale b; l scale c.

Mouthparts protrudent as normal in genus. Basal article of endopod of third maxilliped 3 times as long as wide in middle and 1.4 times length of two distal articles.

Large chela compressed, 2.3 times as long as broad, fingers occupying distal third; axis of fingers rotated about 30° to proximal portion of palm. Lateral face with 2 shallow grooves, one extending proximally from dactylar articulation, the other proximally from distal third of propodal finger; both reaching near level of inferior shoulder on palm. Inferior shoulder abrupt; groove from inferior notch confluent with lower groove. Medial face carrying 3 rounded protrusions below superior crest, each with a few setae. Superior margin with slight longitudinal ridge that continues obliquely from plaque crest to near *linea impressa*. Tip of dactylus rounded in immature-males and in females, acute in larger males. Plunger of dactylus large and continued distally as rounded crest; crest fitting neatly into narrow gap in distal margin of propodal "socket" (fig 86f). Merus 1.5 times as long as broad with superior margin distally projecting and acute; inferoventral margin bearing 3-5 small spines, distally rounded.

Small chela without sexual dimorphism, about 0.75 as long as large chela, 3 times as long as broad, fingers and palm equal. Dactylar articulation flanked by acute tooth medially. Inferior margin of palm with 5 slight notches bearing tufts of short stiff setae. Merus similar to that of large chela.

Carpal articles of second leg with ratio: 10:5:3:3:5; first article 3.6 times as long as broad distally and second article 1.7-2.0 times as long as broad.

Ischium of third leg unarmed. Merus 3.2 times as long as broad, distally armed with an acute tooth on inferodistal angle. Carpus 0.5 as long as merus; superodistal margin somewhat projecting, inferior distal angle an acute tooth. Propodus nearly as long as merus, slightly arched, bearing on its inferoventral margin about 9 slender spines and a pair distally. Dactylus 0.4 as long as propodus and biunguiculate. Secondary unguis inferior and 0.3 length of superior. Propododactylar articulation bearing small extra sclerite, a "heel" that is exposed when dactylus is so extended as to make an oblique or right angle to superior surface of propodus (fig. 86l).

Second pleopod of male with elongate *appendix masculina*, 1.5 times as long from base as adjacent lobe of endopodite and more than twice as long as *appendix interna*; *appendix interna* of second pleopod of female 0.2 length of endopod and originating at 0.6 length of ramus, not reaching to endopodal tip.

DISCUSSION: We have previously described an extra sclerite at the propododactylar articulation in *M. rostratipes* (1959:139); in the same paper we pointed out the form of the chelae in that species varies with age and sex.

BIOLOGICAL NOTES: This species occurs largely in dead coral, calcareous algae and under rocks inter- and sub-tidally. One of Coutière's specimens came from an abandoned teredo hole in a piece of wood. It has been dredged as deep as 11 fathoms. It is not a large species with our largest specimen being 18 mm.

AUSTRALIAN DISTRIBUTION: *M. paragracilis* has been collected on the west coast from Houtman Abrolhos to Dirk Hartog Island; in the north from Murray Island in the Torres Straits; and on the east coast from Diamond Islands in the Coral Sea south to Cape Moreton, Qld.

GENERAL DISTRIBUTION: This species extends from the Red Sea and Madagascar across the Indo-Pacific to Hawaii and the Societies. Chace (1966:627) found that specimens collected at St. Helena Is. in the Atlantic were indistinguishable from specimens from Hawaii. So the species must be circumtropical, although it is strange it

has not been found in other more extensive Atlantic collections.

Metalpheus rostratipes (Pocock)

Fig. 87

Alpheus rostratipes Pocock, 1890:522.

Metalpheus rostratipes Chace, 1972:78. (see also *Alpheus* sp, *Metalpheus*, n. gen.? Coutière, 1908a:213; 1921:419, pl. 62, fig. 15.)

Alpheus rostratipes Crosnier and Forest, 1965b:605; 1966:246, figs. 12-14.

Crangon hawaiiensis clippertoni Schmitt, 1939:11.

Alpheus clippertoni Chace, 1962:609. Banner and Banner, 1964:89.

Crangon nanus Banner, 1953:90, fig. 30. (Nec *Crangon nanus* Krøyer, 1842:231).

Alpheus huikau Banner, 1959:139, fig. 5.

SPECIMENS EXAMINED: 4 specimens from BAU 33; 2, BAU 47.

DIAGNOSIS: Rostrum acute, short, hardly reaching past orbital margins, without distinct carina, separated from orbital hoods by shallow rounded concavities. Orbital hoods projecting but rounded. Antennular peduncle stout, with second article a little broader than long. Visible part of first antennular article equal in length to second; third slightly longer. Stylocerite with acute tip reaching beyond first antennular article. Scaphocerite with squamous portion broad, reaching to near middle of third antennular article; lateral tooth prominent, reaching to end of antennular peduncle. Lateral tooth of basiscerite strong, reaching to middle of second antennular article.

Third maxilliped with ratio of articles: 10:2.5:4.2; basal article 2.7 times as long as broad in midsection.

Large chela strongly compressed laterally, twice as long as broad. Superior margin with ill-defined ridge extending distally from *linea impressa* obliquely to crest for palmar adhesive plaque. Distal section of palm twisted slightly laterally. Lateral face of palm with 2 shallow grooves, superior arising near point of articulation of dactylus; inferior arising on propodal finger near socket for dactylar plunger. Neither reaching to middle of palm. Superior margin of dactylus rounded, not sharply carinate, tip rounded to acute and reaching beyond pollex. Plunger and socket similar to that of *M. paragracilis*. Merus almost as long as broad, bearing on its inferointernal margin 4 small spines; rounded distally. Superodistal margin not projected.

Small chela variable with maturity and sex. Small chela of male 2.7 times as long as broad, fingers and palm almost equal, dactylus slender with acute tip reaching beyond tip of pollex. Inferior margin of propodus opposite articulation of dactylus with strong concavity, and bearing proximally 4-5 spines. Chelae of females and immature males without elongation of dactylus and often without spines on inferior margin. Merus often heavier than that of mature males.

Second leg stout, with ratio: 10:5:4.3:2.9:7. Second to fourth articles as broad as, or broader than, long.

Ischium of third leg unarmed. Merus unarmed and flattened, 2.2 times as long as broad, medial face slightly concave. Carpus 0.5 as long as merus, slightly curved, superodistal angle projecting but rounded. Propodus slightly shorter than merus, curved and bearing on inferior margin about 5-6 spines with a pair distally. Dactylus 0.3 as long as

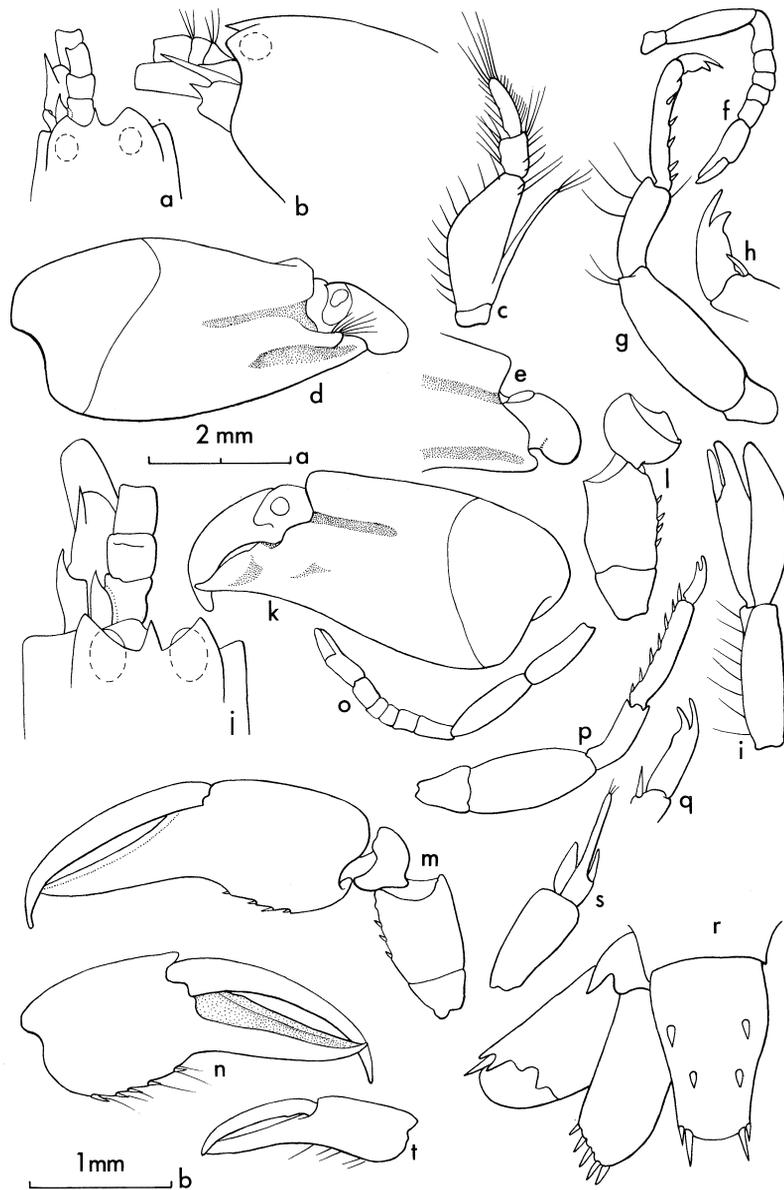


Fig. 87 *Metalpheus rostratipes* (Pocock)

15 mm female from BAU 47. **a, b.** Anterior region, dorsal and lateral view; **c, d, e** large chela, lateral face and detail of dactylus; **f, h.** second leg; **g, h.** third leg and enlarged dactylus; **i** second pleopod. 12 mm male from BAU 47. **j.** Anterior region, dorsal view; **k, l.** large chela, lateral face and merus, medial face; **m.** small cheliped, medial face; **n.** small chela, lateral face; **o.** second leg; **p, q.** third leg and dactylus; **r.** telson and uropods; **s.** second pleopod. 9 mm female from Hawaii. **t.** Small chela, lateral face. **a, b, c, d, e, f, g, j, k, l, m, n, o, p, r, t** scale a; **h, i, q, s** scale b.

propodus, biunguiculate, inferior unguis almost as long as superior. Inferior margin bearing swelling proximal to base of inferior unguis. Propododactylar articulation bearing extra sclerite as a "heel" when dactylus is extended to form right angle with a superior propodal surface.

Endopods of 2-4 pleopods of female with *appendix interna* arising in distal half, broadened and reaching to near end of endopod proper. *Appendix masculina* of second pleopod of male 2.5 times length of adjacent *appendix interna*.

Telson 2.5 times as long as posterior margin is broad. Inner spine of posterior pair 2 times as long as dorsal spines. Distolateral margin of inner uropod bearing about 5 strong spines.

DISCUSSION: This species has a long history of separate descriptions and names from various parts of the world which were finally synonymized by Crosnier and Forest (1966:*loc. cit*) as *Alpheus rostratipes*. They also present a complete description and illustrations. We have in the collection from Australia only 6 specimens. The specimens agree well with those descriptions presented heretofore. As Banner (1959) points out, the females and the smaller males (under the name *A. huikau*) have rounded tips to the dactyli of the large and small chelae, while in the larger males the dactyli are longer, more gradually curved with the tips more acute. This dimorphism was found in the two complete Australian specimens (see figs. 87d, k). In the same publication Banner described the extra "heel" sclerite on the walking legs.

We have sought the specimens that Coutière discusses from the Percy Sladen Trust Expedition as *Alpheus* sp? to see if we could confirm their identity and also to discover where the expedition collected it in the Indian Ocean. However, these, like some other specimens from the same expedition could not be found in any of the museums where Coutière deposited his material (Paris, Amsterdam, Leiden, London and Cambridge). We agree with Crosnier and Forest (1966:250) that on the basis of the published description and figures, there was no basis for the separation of Coutière's *Alpheus* sp? from *M. rostratipes* despite Coutière's doubts.

BIOLOGICAL NOTES: This species is small, not over 15 mm in length. It has been collected from the intertidal zone down to 15 m from under rocks, from dead coral and from calcareous algae.

AUSTRALIAN DISTRIBUTION: Two of the specimens were collected intertidally at Heron Island in the Capricorn Group, the others were collected off Port Douglas in 6-10 ft of water.

GENERAL DISTRIBUTION: This is a circumtropical species. In the Indo-Pacific we have yet unreported specimens from Madagascar and from there it ranges to the Hawaiian and Tuamotuan Archipelagoes. In the Eastern Pacific realm it is known from Clipperton Island. In the western tropical Atlantic, it has been reported from the Caribbean and Fernando de Noronha (the type locality), and in the eastern Atlantic from the Gulf of Guinea.

Family Ogyrididae

Ogyridae Hay and Shore, 1918:388

Ogyrididae Holthuis, 1955a:93.

DIAGNOSIS: Carapace without cardiac notch. Anterior margin with small rostrum, with 1 or more movable spines along midline posterior to rostrum. Pterygostomial angle produced, rounded. Abdominal pleura rounded; pleura of sixth abdominal segment not articulated. Telson with posterior margin markedly produced beyond posterolateral spines, tip rounded or slightly acute, sides sinuate. No transverse articulation on posterior section of outer uropods.

Eyestalks uncovered, elongate, cylindrical, pubescent and reaching at least to end of antennular peduncles; corneal surfaces reduced.

Antennular peduncles slender; flagella not bifurcate. Stylocerite with 2 strong acute teeth. Scaphocerite with squamous portion confluent with lateral tooth.

Mandible with incisor process reduced; palp of two articles. Following mouthparts similar to those of *Alpheus* (Coutière, 1899:333). Ultimate article of third maxilliped much shorter than penultimate.

First legs smaller than second, feeble, symmetrical with chela shorter than carpus. Second legs chelate, carpus having 4 or 5 articles.

Posterior thoracic sterna may bear a thelycum-like structure in both males and females. In some species the *appendix masculina* of second pleopods reduced or absent.

DISCUSSION: The familial relationship of the sole genus *Ogyrides*, for which the family was created, has been subject to discussion and several changes since Stimpson first described the genus (as *Ogyris*) without designation of family in 1861. Coutière in 1899 decided that it was close to the genus *Automate* and therefore placed it in the Alpheidae. Hay and Shore placed the genus in this separate family in 1918 as Ogyridae and suggested it lay between the families Alpheidae (then Crangonidae) and Hippolytidae. They were not aware that Stebbing in 1914 had found the name *Ogyris* occupied and had changed it to *Ogyrides*, thereby placing the extra syllable also in the family name. Armstrong (1949) rejected the family of Hay and Shore and placed the genus in the Hippolytidae, as had Ortmann in 1893. In his comprehensive review of the caridean and stenopodidean shrimp Holthuis (1955a:93) maintained Hay and Shore's family, but combined it with Alpheidae, Hippolytidae and Processidae into the superfamily Alpheoidea. Since that date there has been no further discussion of the family relationships. We accept Holthuis's determinations, but we have included the family in this work merely because it was included by Coutière and De Man in their important publications.

We agree with Hay and Shore that the presence of the thelycum-like structure, the small size of the first chelipeds, and the elongate and exposed eyestalks warrants the separation of this genus from the family Alpheidae and we accept Holthuis' erection of the superfamily Alpheoidea.

The exact morphology of the thelycum-like structure on the specimens at hand is difficult to determine because of their small size and poor condition, but we do suggest that it may not be homologous nor analagous to the well-studied thelycum of the penaeids. In the penaeids the structure between the fourth and fifth legs is an outgrowth of the sternal plates of the female alone and is considered to be for the reception of the spermatophores. As others have remarked, in *Ogyrides*, both the males and females carry comparable structures. In the genus the main structure, a deeply notched — forwardly-directed plate lying in the midline, appears to be derived from the coxae of the fourth legs as well as the sternum (Pl. 1, and see Kemp, 1915:fig. 30d). In addition in the species *O. delli* (but not remarked upon for other species) the coxae of the last thoracic legs of the males carry two setiferous lobes which in the females unite to form a low,

continuous setiferous process reaching from leg to leg (fig. 88q). It is probable that these unique structures play some role in reproduction, but until copulation is observed it is difficult to imagine how they may be used. To speculate further, the hair-like structures that appear upon all coxae and other associated parts, but especially on the coxae of the fourth legs, as shown in Plate 1, are reminiscent of the sensilla shown in the SEM photograph of a calanoid copepod given by Fleminger (1973, fig. 2). Fleminger reported that the copepods he studied were almost blind, and suggested that these sensilla with the associated integumentary glands were part of the species-specific pheromonal system for detecting members of the opposite sex for reproduction.

Genus **Ogyrides** Stebbing

Ogyris Stimpson, 1861:36. (Junior synonym of: "*Ogyris* Westwood, 1851, in: Doubleday and Westwood, Gen. diurn. Lep.: pl. 75 (Lepidoptera)" see Holthuis, 1955a:93).

Ogyrides Stebbing, 1914:31.

TYPE SPECIES: *Ogyris orientalis* Stimpson, 1861:36.

This genus has the characteristics given for the family. Within the genus are 11 species, 5 of which have been reported for various parts of the Indo-Pacific, with two known from Australian waters. Where the habitat has been described for the various species, it has always been a muddy sandy substrate in waters of varying depth.

KEY TO THE SPECIES OF THE GENUS OGYRIDES IN AUSTRALIAN WATERS.

1. Carpus of second leg of 5 articles, but with first articulation faint and probably vestigial; with 4-8 movable spines on midline of anterior carapace ..*O. delli* (p. 289)
 Carpus of second leg of 4 articles; with 3-4 movable spines on midline of anterior carapace*O. mjobergi* (p. 294)

Ogyrides delli Yaldwyn

Fig. 88, 89

Ogyrides n. sp. Richardson and Yaldwyn, 1958:36, fig. 31.

Ogyrides delli Yaldwyn, 1971:89.

SPECIMENS EXAMINED: 1 specimen from AM P. 20709; 4, AM P. 21599; 1, AM P. 21872; 1, AM P. 21873. (All Australian specimens males; females found in paratypic series from New Zealand loaned by the National Museum of New Zealand through the courtesy of Dr J. C. Yaldwyn).

DESCRIPTION: Rostrum triangular, subacute at tip, as long as broad at base and as long as extracorneal teeth. Extraorbital teeth rounded, infracorneal teeth shorter than extracorneal, but acute. Pterygostomial angle projected but rounded. Posterior to rostrum carapace not carinate, but bearing in midline 4-7 heavy movable spines directed forward. Carapace covered with a light pubescence. Eyestalks reaching to end of antennular peduncles, thicker at base and tapering towards slightly expanded cornea. Cornea occupying only small proportion of stalk. First antennular article 1.4 times length of second when measured from base of rostrum; third article 0.7 as long as second, second article 2 times as long as broad. Stylocerite with 2 strong teeth, superior tooth reaching end of first antennular article and inferior tooth a little longer. Squamous

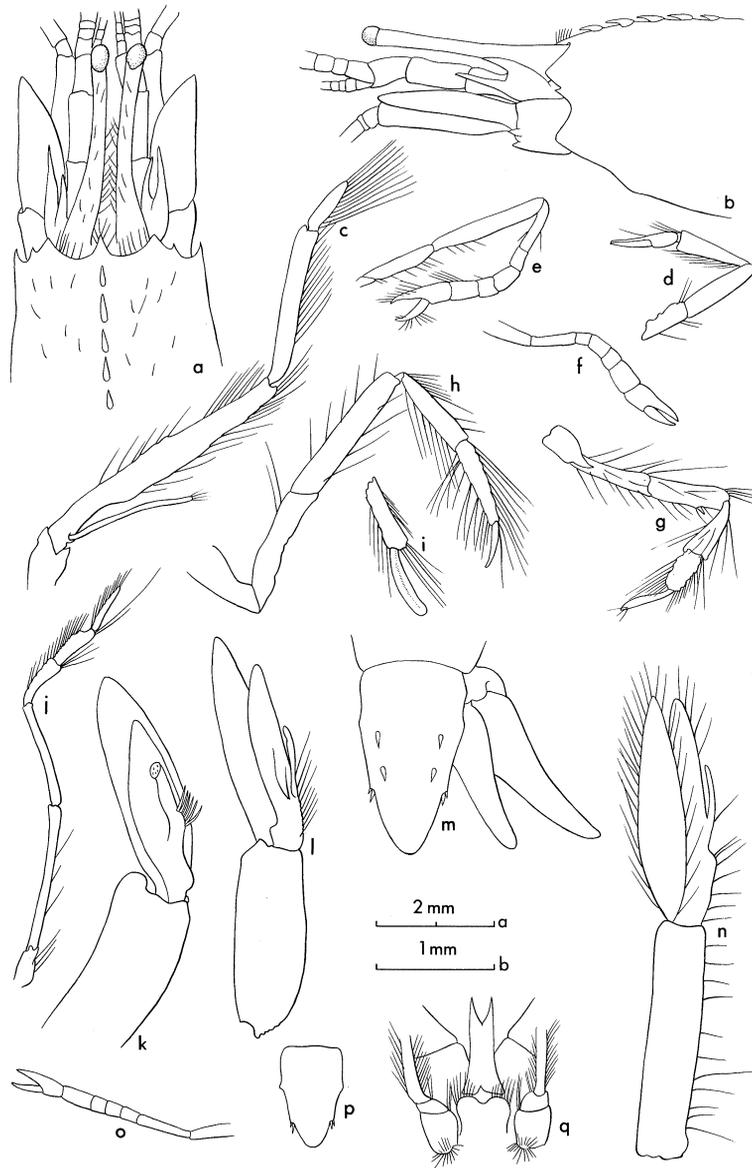


Fig. 88 *Ogyrides delli* Yaldwyn

22 mm male from AM P. 21599. **a, b.** Anterior region, dorsal and lateral view; **c.** third maxilliped; **d.** first leg; **e.** second leg; **f.** second leg, cleared; **g.** third leg; **h, i.** fourth leg and inferior view of dactylus; **j.** fifth leg; **k, l.** two views of second pleopod; **m.** telson and uropods. 28 mm ovigerous female paratype from New Zealand. **n.** Second pleopod. 18 mm paratype from New Zealand. **o.** Second leg, cleared; **p.** telson; **q.** "thelycum"-like structure. **a, b, c, d, e, f, g, h, i, j, m, o, p, q** scale a; **k, l, n** scale b.

portion of scaphocerite broad, lanceolate, lateral tooth of minimal development, often absent, reaching past middle of third antennular article. Carpocerite as long as antennules. Distoinferior margin of basicerite bearing 2 small acute teeth.

Third maxilliped much longer than antennules. Ratio of articles: 10:5:2. Inner faces of article carrying rows of setiferous bristles with those of last article the longest.

First chelipeds 0.4 as long as third maxilliped, symmetrical. Ischium 0.5 length of merus, bearing rounded protrusion on inferior margin. Merus 3.5 times as long as broad. Carpus 3 times as long as broad distally, with distal end twice as broad as proximal and bearing setiferous bristles on lower margins. Chela not as long or as broad as carpus, with fingers 1.6 times length of palm.

Carpal articles of second legs five, of variable length, with the approximate ratio of 10:3:4:3:5. (Note: the articulation between first and second carpal articles difficult to see — see DISCUSSION).

Third leg with ischium unarmed, nearly as long as merus, but slightly more slender. Merus 3.5 times as long as broad, bearing massive spine subterminally on inferior margin. Carpus 0.7 as long as merus, greatly broadened distally, and bearing many long forward-sweeping setiferous bristles on its surfaces. Propodus stout, 2 times as long as broad, with margins beset with strong setae, bases of which form a serrated edge. Dactylus spatulate, a little longer than propodus. Fourth leg of more normal form and slender. Ischium 0.8 as long as merus. Merus over 6 times as long as broad, inermous, but bearing long setiferous bristles on inferior and superior margin. Carpus 0.6 as long as merus. Propodus slightly longer than carpus and tapered distally. Inferior and superior margin of both carpus and propodus bearing long forward-sweeping setiferous bristles. Dactylus spatulate and curved, 0.5 as long as propodus. Fifth legs very slender, ischium 1.4 times as long as merus; merus 7 times as long as broad; carpus, propodus and dactylus of approximately equal length, each about half length of merus and each bearing long setiferous bristles; dactylus spatulate.

Thelycum-like structure of males a narrow, elongate process, lying between coxae of fourth legs (seventh thoracic segment) and ventral to sternal plates; anteriorly reaching to base of third legs; anterior margin with "V"-shaped cleft; lateral margins slightly concave; posterior margins apparently attached to coxae of legs and to sternum. Coxae of last thoracic legs bearing slight setiferous lobes pointing forward and attached at approximately the same point as in the "thelycum" of fourth legs. "Thelycum" of females similar to males, but with the setiferous lobes of the coxae of the fifth legs joining as a flap or lobe of thoracic sterna and becoming a low continuous and setiferous, flap-like process reaching from leg to leg.

Endopod of second pleopod carrying only *appendix interna* in both sexes; that of female shorter and attached slightly distal to middle; that of male longer and attached about one-quarter of length from base. Male *appendix interna* also with heavy setae on rounded lobe (probably vestige of *appendix masculina*) near articulation of *appendix*. Basipodite of male 2.8 times as long as broad while in female it is 4.0.

Total length of telson 2.5 times breadth measured at posterolateral spines; tip of telson extended and arcuate, part beyond posterolateral spines representing 0.3 of total telson length. Lateral margins bearing broad, low rounded projection just anterior to middle. Outer spines of posterolateral pairs very small; length of inner pair variable, at times half as long as median projection. Anterior pair of dorsal spines placed slightly anterior to middle, posterior pair well back. Outer uropod longer than telson, lanceolate in shape, tip rounded, without distal articulation.

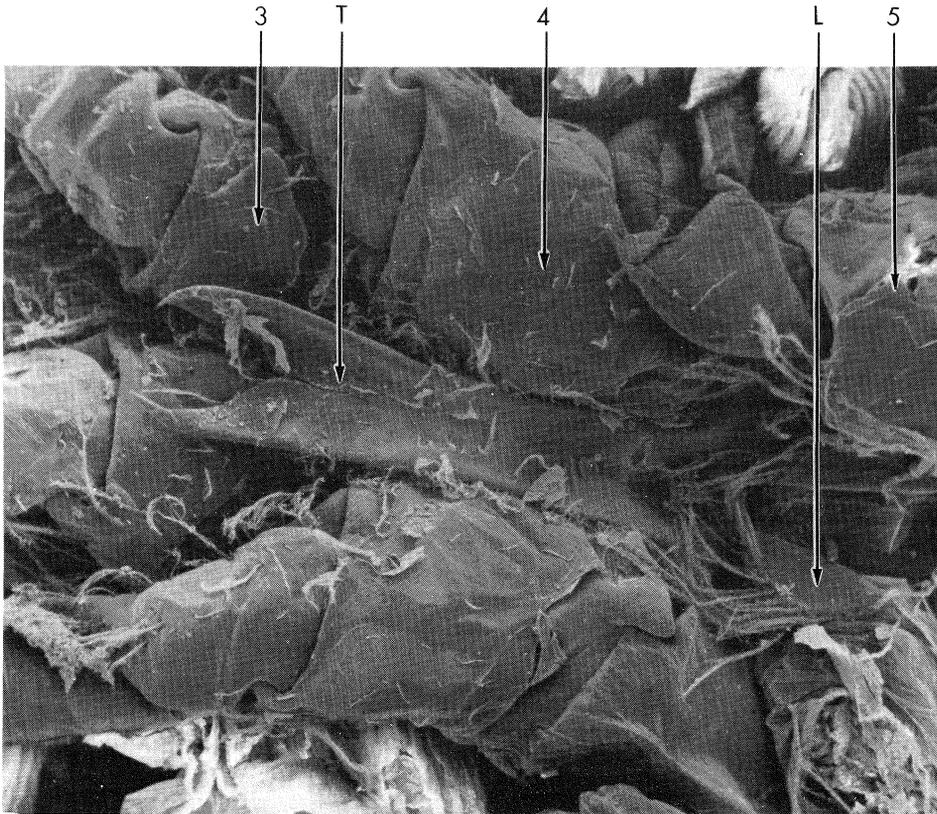


Fig. 89. *Ogyrides delli* Yaldwyn
20 mm male specimen from AM P. 21599. Scanning electron microscope photograph of ventral side, posterior thoracic segments. 3, 4, 5 bases of thoracic legs, as numbered; T, notched plate of thelycum-like structure, L, setiferous lobe. SEM photography made by Dr Arthur N. Popper, Department of Zoology, University of Hawaii, Honolulu, Hawaii.

DISCUSSION: An important characteristic within this genus is the number of carpal articles of the second legs. *O. orientalis* Stimpson may have 3 — see p. 294. The rest have been described with four articles except the following three species: *O. saldanhae* Barnard (described as: “Wrist of second legs with 4 jointlets, but the basal one often with marginal notch indicating incomplete division (five jointlets)” Barnard, 1950:726); *O. rarispina* Holthuis (described as “the carpus is divided into five jointlets . . . (in some the proximal articulation is less distinct than the distals)” Holthuis, 1951:133) and *O. delli*. *O. saldanhae* and *O. rarispina* come from the Atlantic; *O. orientalis* and *O. delli* from the Pacific. When we first examined the Australian specimens we did not detect more than 4 articles with at times a “bump” on the initial article and when we examined the paratypes from New Zealand we could find no more of an indication of the articulation than we did in the Australian. It was only after we cleared the exoskeleton of the appendage in sodium hypochlorite solution (household bleach), stained it lightly with Fast Green and mounted it in Euparal that the proximal articulation was clearly visible. However, the articulation appears to be degenerate and possibly non-functional as there does not seem to be any indentation nor other clear separation on the superior margin where the two subarticles join, and very little separation on the inferior margin. It is certainly not as heavy and well-formed as are the distal articulations. The New Zealand and Australian specimens show similar development (see figs. 88 f and o).

There is a slight difference in the number of dorsal spines on the carapace between the Australian and New Zealand forms. They were described by Yaldwyn as 6 to 8 in number, and in the 10 Australian specimens the number varied from 4 to 5. However, we counted the spines on 29 specimens from a single dredge haul from New Zealand and found 6 specimens with 5 spines, 13 specimens with 6 spines and 10 specimens with 7 spines. No apparent specific nor subspecific value should be placed upon this characteristic; this also reduced the value placed by Yaldwyn (1971:89) upon the use of this characteristic to separate the species from *O. rarispina*. The separation of the 3 species with the reported 5 carpal articles then rests upon the characteristics of the telson, a structure we have not studied in detail.

The Australian specimens were found to vary in their rostrums, which at times were somewhat shorter to somewhat longer than extracorneal teeth; in width of the scaphocerite, but which was always lanceolate; the length of the scaphocerite, which varied from reaching to the end of the second antennular article to reaching to the middle of the third; and in the length of the eyes, which varied from a little shorter to a little longer than the carpocerite.

We were able to compare the Australian specimens with 2 specimens of *O. orientalis* (Stimpson) collected from near the type locality of Kagoshima Bay, Japan and loaned by Dr Yasuhiko Miya of Nagasaki University, Japan. On these the carpus of the second legs was apparently of four articles as described by Stimpson (see p.294) and later workers (we did not remove the legs and clear them), and there was one other difference between them and the specimens from Australia, possibly of importance. The Japanese male specimen carried an *appendix masculina*, similar to the one discussed and figured by Fujino and Miyake (1970:255, fig. 6B) while in all 10 male specimens from Australia the process was lacking and its site was marked by only a slight lobe that carried strong and slightly curved setae (fig. 88 k,l). Otherwise the Australian and Japanese specimens were very similar.

BIOLOGICAL NOTES: This species apparently is a burrowing form in sand bottoms and has been collected both from bare sand and sea grass beds in shallow water; one specimen was dredged near Sydney at 30 fathoms. Yaldwyn reported (*loc. cit.*) that in New Zealand specimens the colour in life was transparent with prominent transverse

bands of red posteriorly on each abdominal segment.

AUSTRALIAN DISTRIBUTION: Specimens have been collected in Moreton Bay, Qld, and from near Sydney, N.S.W.

GENERAL DISTRIBUTION: The species is known only from Australia as indicated, and from the North Island, New Zealand.

Ogyrides mjobergi (Balss)

Fig. 90

Ogyris Mjöbergi Balss, 1921:7, figs. 1, 2.

Ogyrides mjobergi Holthuis and Gottlieb, 1958:48, fig. 10. Ledoyer. 1968:75, pl. 11, fig. 1A-11A; 1970:128.

DIAGNOSIS: "The rostrum is triangular and somewhat shorter than the extraorbital teeth; on the carapace behind it lies 3 teeth (spines) in a straight line; there is no crest. The orbits (the eye sockets) are rounded and there is barely an indication of an antennal (infracorneal) tooth. The pterygostomial angle is obtuse. The abdominal pleura have rounded margins. The shape of the telson is similar to those of *Ogyris Sibogae*: it carries on the middle of the lateral margins a prominence (an obtuse but definite angular protuberance), on the end of the sides a spine and the posterior margin is rounded oval.

"The outer uropods are pointed and are longer than the telson, the inner somewhat shorter than the outer.

"The eyestalks are longer than the antennular peduncle and about the same length as the antennular peduncle; the stylocerite has two points and the outer tooth is somewhat longer than the inner. The antennal squame reaches about to the end of the second antennular article; it is blunt at the end and carries on the outer margin a clear tooth.

"The terminal article of the third maxillipeds is lacking.

"The first chelae are symmetrical and similar to those of *Ogyris Sibogae*.

"Also the second chelae are built similarly to those of *Ogyris Sibogae*; the carpus is of four articles. The following thoracic legs are lacking.

"Measurement: Length of the carapace 5 mm, of the abdomen 14 mm." (Translated from the German by the authors.)

DISCUSSION: Balss separated this species from *O. sibogae* De Man (1911:135, fig. 1), which he considered to be very close, on the basis of three characteristics: the rostrum was shorter than the extra-orbital teeth instead of longer; the antennal scale was truncate instead of pointed; and the carapace carried three movable spines instead of four. He also suggested that the smaller specimen that De Man discusses under the same name (from Siboga station 313, *loc. cit.*) may be identical with *O. mjobergi*; Holthuis and Gottlieb (*loc. cit.*) agree. Ledoyer (*loc. cit.*) remarked upon the variation he has found in specimens from Madagascar that he identified as *O. mjobergi* and suggested that the species may be found to be a synonym of *O. sibogae* but continued the separation based on the shape of the tip of the antennal squame.

In separation action, first Yokoya (1927:171, pl. 7, fig. 1-16) pointed out that *O. sibogae* did not differ materially from a specimen from Japan probably identical with *O. orientalis* (Stimpson) (1861:105) if one interpreted Stimpson's description of the carpus of the second legs as "*triarticulatus*" to mean with three articulations and four articles*.

*Dr. Fenner A. Chace, Jr. has pointed out to us that Stimpson used the same word "*triarticulatus*" to describe the carpus of his genus *Virbius* on the preceding page, and *Virbius* carries 2 secondary articulations and 3 articles (personal communication).

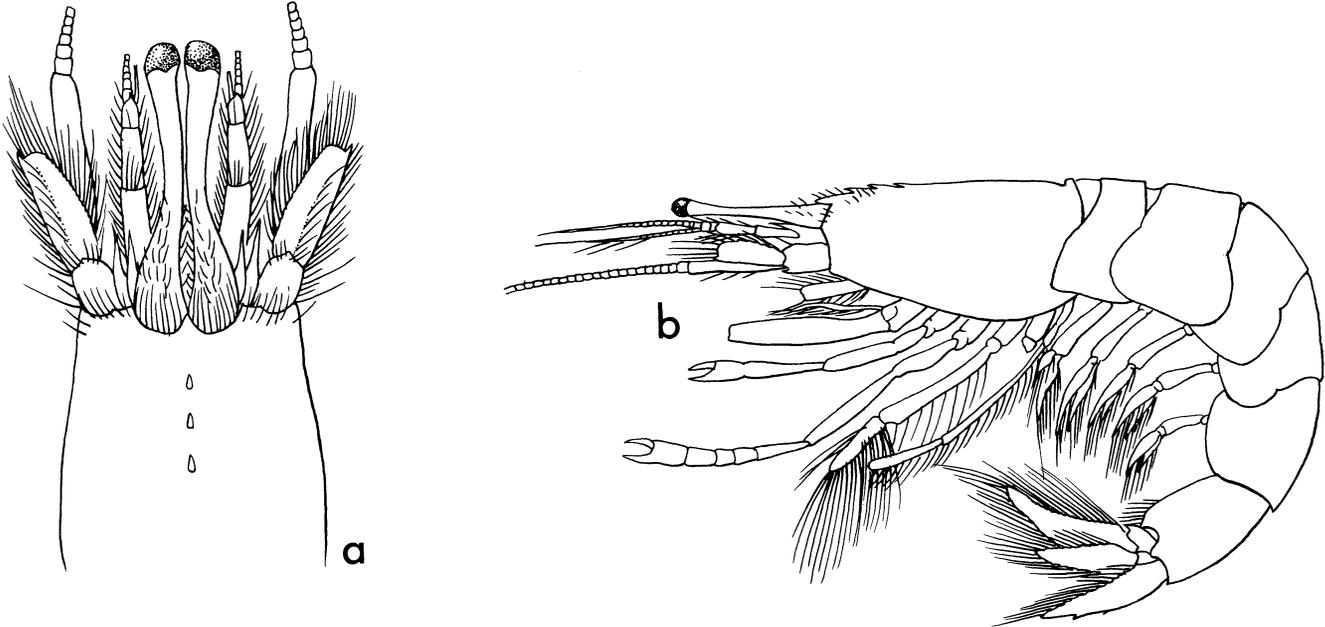


Fig. 90 *Ogyrides mjobergi* (Baiss)
a. Anterior region dorsal view; b. whole animal, lateral view. (Figs. after Baiss).

Yokoya stopped short of declaring *O. sibogae* to be a synonym. However, Fujino and Miyake (1970:255) with 2 specimens from the East China Sea did list *O. sibogae* as a junior synonym of *O. orientalis*. Therefore, if *O. mjobergi* is indeed a synonym of *O. sibogae*, the proper name for it would be *O. orientalis*.

We do not enter the discussion of synonymy at this time as we have no specimens we can identify as *O. mjobergi*. We would like to point out, however, that if the previous workers overlooked the first and vestigial articulation of the carpus of the second leg, it is possible that *O. delli*, as discussed above, its also a synonym of *O. orientalis*.

BIOLOGICAL NOTES: Ledoyer records the species being dredged from fine to muddy sand and depths from 6.5 to 37 m., but reports the workers on Madagascar did not collect it from the "sables grossiers" nor from beds of sea grasses.

AUSTRALIAN DISTRIBUTION: Balss' specimen came from 45 miles WSW from Cape Jaubert at a depth of 54ft.

GENERAL DISTRIBUTION: Mediterranean coast of Israel (Holthuis and Gottlieb (*loc. cit.*), suggest it reached the Mediterranean Sea via the Suez Canal); Madagascar. (If the species is found to be a synonym of *O. orientalis*, the known distribution will be greatly extended).

Appendix I

TWO NEW SPECIES, NOTES AND ADDITIONAL RECORDS OF GENERA COVERED IN PARTS I AND II

Since the publication of Parts I and II of this study we have received many additional specimens for study from Australia. These collections contained two species that we recognize as new, two species previously unknown from Australian waters, together with many additional records of previously reported species, some of which are extensions of the ranges given in Parts I and II. Through examination of the type specimens we are able to settle the affinities of *S. haddoni*, questioned in Part II. All are reported in this appendix. References under *Additional Records* are to the earlier parts published.

NEW SPECIES

***Synalpheus tijou* sp. nov.**

Fig. 91

HOLOTYPE: 14 mm female from Tijou Reef, Lizard Island, Great Barrier Reef. Living commensally with a crinoid. Collected by R. A. Birtles and L. P. Zaan, 11/11/73. (JC 42). (AM P.30809).

DIAGNOSIS: Dorsal surface of carapace entirely smooth without ridges or grooves. Anterior carapace greatly projecting, one third lying anterior to eyes; acute tip of rostrum reaching to near end of antennular peduncles. Orbital teeth suppressed, being low obtuse angles confluent with anterior margins of carapace and concave sides of rostrum. Pterygostomial angle rounded. Orbitorostral process lacking. First antennular article when viewed through the carapace 3 times as long as broad, 3 times as long as second,

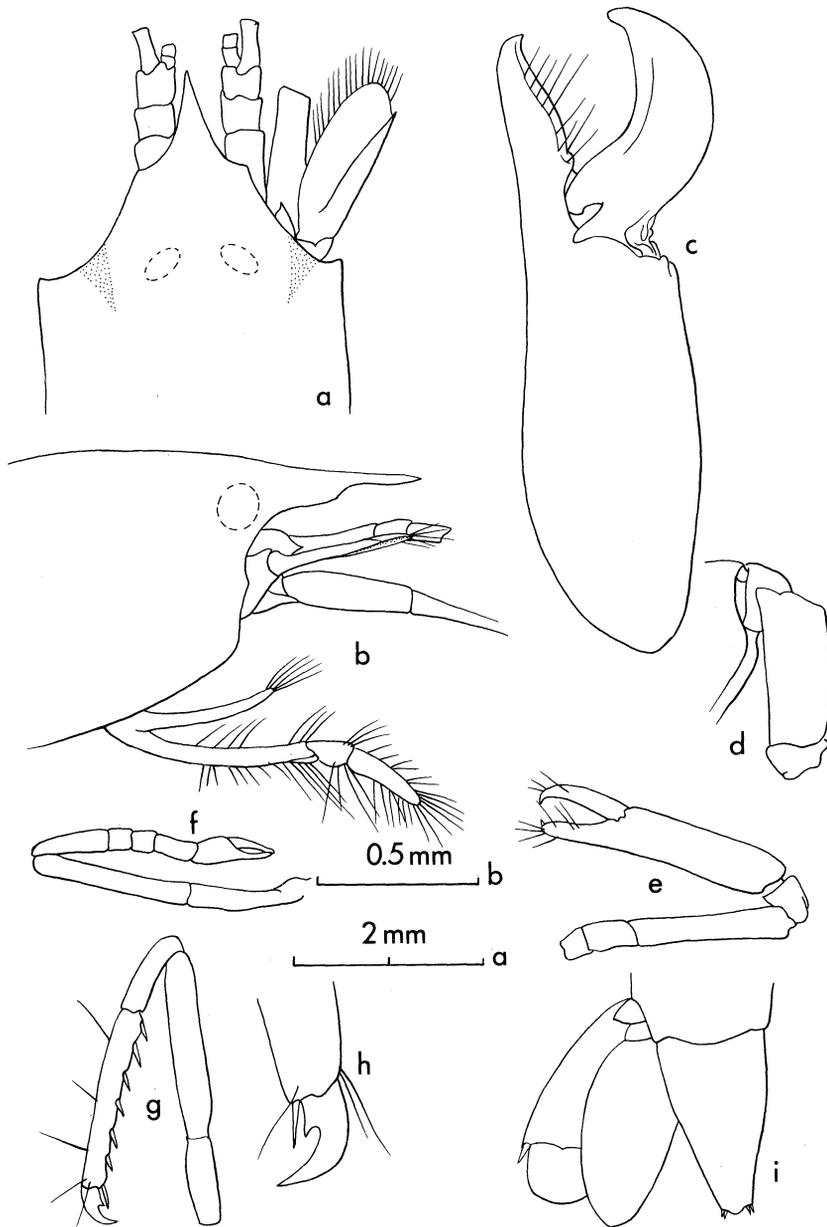


Fig. 91 *Synalpheus tijou* sp. nov.

Holotype (female). **a, b.** Anterior region, dorsal and lateral view; **c, d.** large chela and merus, lateral face; **e.** small cheliped, medial face; **f.** second leg; **g, h.** third leg and dactylus, enlarged; **i.** telson and uropods. **a, b, c, d, e, f, g, i** scale **a**; **h,** scale **b**.

second as broad as long and equal in length to third. Stylocerite minimal in size, reaching only 0.5 length of first antennular article. Statoliths plainly visible beneath the stylocerite. Squamous portion of scaphocerite broad, reaching near end of antennular peduncle, lateral tooth acute but markedly shorter than squame. Carpocerite 5 times as long as broad when viewed laterally, not reaching end of antennular peduncles. Basicerite without teeth.

Ratio of articles of third maxilliped: 10:2.4:5.1. Third article with a few heavy setae distally.

Large chela 3.2 times as long as broad, surface wrinkled from desiccation, but normal chela is undoubtedly without grooves and may be thicker. No tooth on palm flanking dactylar articulation. Fingers 0.3 as long as entire chela. Plunger well developed. Merus 2 times as long as broad and without inferior and distal teeth. Small chela 5 times as long as broad, palm 2 times as long as fingers. Dactylus not broadened, tips of fingers acute, somewhat hooked and crossing when closed. Merus unarmed, slender, 6 times as long as broad in middle.

Second legs with only 4 carpal articles. Ratio of carpal articles: 10:3:3:5.

Ischium of third legs inermous, almost half as long as merus. Merus also inermous, 5 times as long as broad. Carpus 0.48 as long as merus, distal angles rounded and not projecting. Propodus as long as merus, bearing on its inferior margin 6 strong spines and a pair distally. Dactylus biunguiculate, 0.14 as long as propodus, tip curved at right angles to axis of propodus; inferior unguis arising in basal third of dactylus. Superior unguis 4.5 times as wide at the base as the inferior unguis and 4 times as long.

Telson 4.6 times as long as broad posteriorly and almost 4 times as broad anteriorly as posteriorly; posterior margin convex. No spines visible on superior surface; posterolateral spines small. Outer uropod with a distinct articulation.

DISCUSSION: The lack of orbitorostral process, the anterior region of the carapace advanced so far distal to the eyes, the markedly curved superior unguis of the dactylus of the thoracic legs and its association with a crinoid places this species firmly within the Comatularum Group of the genus *Synalpheus*. From all species within the group it differs by the extreme length of its rostrum and the great reduction of the orbital teeth; by the slender and elongate palm of the small chela; by the presence of 4 articles in the carpus of the second legs (if this is an adult condition); by the form of the dactylus of the third legs; and by the shape of the telson with its extreme taper and narrow tip. It may be separated from other species by other specific characteristics, as by the lack of a tooth on the base of the propodal finger of the large chela as found in *S. odontophorus* de Man, or the lack of a hooked dactylus of the small chela as in *S. comatularum* (Haswell), but the major differences listed above are more than sufficient. It appears to us that the species may be related most closely in the group to *S. stimpsonii* (de Man) but that species always has strong and distinct orbital teeth.

This specimen was evidently ready to moult or had recently moulted for the integument was soft and transparent, permitting one to see through it in places. Visible were slightly more pronounced orbital teeth and possibly one pair of dorsal spines on the telson. The soft exoskeleton had also caused the palms of both chelae to wrinkle, so that they may be more plump in a fully hardened specimen. The presence of four articles in the carpus of the second legs may be an indication of immaturity in the specimen (see discussion in B&B, 1975:298), but in no other members of the genus does one find immature traits in a 14 mm long specimen.

This species may be inserted into the key to *Synalpheus* by deleting the name *S. stimpsonii* from dichotomy 5 on p.279 (1975) and inserting the following:

- 5A (5) Rostrum not reaching near end of second antennular article; orbital teeth prominent and acute; carpus of second legs of 5 articles... *S. stimpsonii* II: 292
- Rostrum reaching near end of third antennular article; orbital teeth reduced to low obtuse angles; carpus of second legs of 4 articles... *S. tijou*

This species may also be inserted in the key to the alpheids known to inhabit crinoids (1975:389) by converting the dichotomy under 6 to a trichotomy with the addition of:

- Rostral carina absent; tip reaching to near end of third article *S. tijou*

The name is derived from the type locality.

The holotype will be placed in the Australian Museum, Sydney N.S.W.

***Synalpheus paralticeps* sp. nov.**

Fig. 92

HOLOTYPE: 10 mm female from Rudder Reef, off Port Douglas, Qld. From outer reef flat, 200 yards from reef edge. Reef subject to heavy surf with S. E. winds. (BAU 30) (AM P.30810).

ALLOTYPE: 9 mm male from same collection. (AM P.30811).

DIAGNOSIS: Rostrum slender, 1.8 times as long as broad, reaching to last quarter of visible part of first antennular article, tip rounded. Orbital teeth as long as broad at base and almost as long as rostrum. Tip of rostrum and orbital teeth bearing a few short stiff setae. Rostral base with orbitorostral process. Second antennular article slightly longer than wide, 0.8 as long as visible part of first, and 1.5 times longer than third. Stylocerite reaching near middle of second antennular article. Scaphocerite with very narrow squame reaching to end of second antennular article, lateral tooth reaching nearly length of third article past that article. Carpocerite 5.6 times as long as broad, viewed laterally, and reaching well past end of lateral tooth of scaphocerite. Inferior tooth of basicerite reaching near end of second antennular article and superior tooth as long as orbital teeth.

Ratio of the articles of third maxilliped 10:1:6. Distal tip beset with a cirlet of short spines.

Large chela cylindrical, 2.6 times as long as broad, with fingers occupying distal 0.3. Tip of dactylus abruptly rounded. Palm bearing one obtuse tubercle above dactylar articulation. Merus twice as long as broad, bearing a small acute tooth on superodistal margin. Small chela 2.8 times as long as broad with fingers 0.4 as long as palm. Dactylus bears 2 rounded curved teeth distally; pollex terminating in a single acute tooth flanked by two abrupt shoulders lying at right angles to axis of tooth. Merus 2.8 times as long as wide, unarmed. Carpus cup-shaped, 0.3 as long as chela.

Carpal articles of second legs with a ratio: 10:2:2:2:5; middle articles broader than long.

Ischium of third leg over half length of merus, unarmed. Merus 3 times as long as broad and bearing two small spines on inferior margin in distal third with a few hairs proximally. Carpus 0.4 as long as merus with superodistal margin bearing obtuse projection and inferodistal margin a small spine. Propodus 0.7 as long as merus, inferior margin with 6 pairs of spines interspersed with a few hairs. Dactylus biunguiculate, inferior unguis a little less than half as long as superior; apex of notch subacute.

Telson 3 times as long as tip is broad, 2.2 times as wide anteriorly as at tip. Anterior

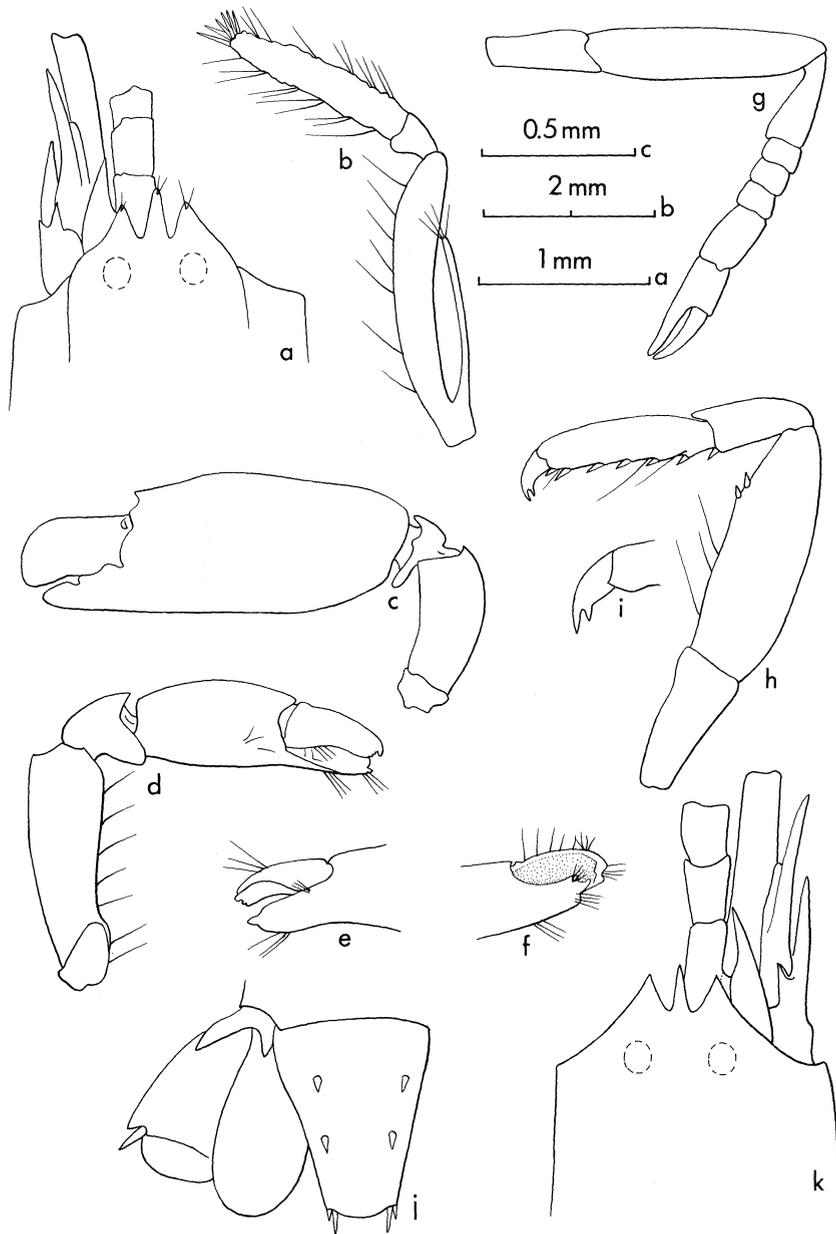


Fig. 92 *Synalpheus paralaticeps* sp. nov.

Holotype (female). **a.** Anterior region, dorsal view; **b.** third maxilliped; **c.** large cheliped, medial face; **d.** small cheliped, lateral face; **e, f.** distal region of small chela, medial and inferior face; **g.** second leg; **h, i.** third leg and enlarged dactylus; **j.** telson and uropods. Allotype (male). **k.** Anterior region, dorsal view. a, b, g, h, j, k scale a; c, d, e, f scale b; i, scale c.

pair of dorsal spines placed well anterior to middle. Outer uropod with an articulation.

DISCUSSION: This species is similar to a compact group of three Australian members of the genus, *S. quadriarticulatus* B&B, *S. pescadorensis* Coutière, and *S. sciro* B&B (1975:297, 301, 304). The four species have similar development of the orbital teeth and rostrum, a reduced squame and long teeth on the basicerite of the antennae, a broadened and denticulate dactylus of the small chela, and a heavy carpus of the second legs with the middle articles broader than long; of these, the fingers of the small chela are the most outstanding characteristic. However, none of the three previously recorded species have the orbitorostral process and the articulation of the tip of the outer uropod. In addition, *S. paralaticeps* may be separated by other specific characteristics, such as the presence of spines on the merus of the third legs, the five articles of the carpus of the second legs as opposed to four in *S. quadriarticulatus*, the lack of a strong tooth flanking the dactylar articulation which is found in *S. pescadorensis* the longer teeth on the basicerite and the more slender merus of the third legs as found in *S. sciro*.

This species is close to the form from the southern Philippines we have interpreted to be *S. laticeps* which Coutière described from the Maldives (we have been unable to find the two type specimens of Coutière in the museums at Paris or Cambridge, and we will describe and figure our Philippine specimens in a later paper). These *S. laticeps* also have the orbitorostral process. The two species can be distinguished by the length of the first carpal article of the second legs — only twice its width in *S. paralaticeps* and about 3.5 times its width in *S. laticeps* — and in the third leg in which the merus is broader and carries 2 spines and the propodus carries fewer and heavier spines in the Australian species.

S. paralaticeps may be inserted in our key to the genus (B&B; 1975:280) by the modification of the dichotomy under 10 to read:

10. (9) Merus of third legs bearing two to many spines; dactylus of small chela with 2 or more teeth at tip, pollex with either several teeth or a single tooth flanked with abrupt shoulders10A
- Merus of third legs unarmed; pollex of small chela tapering to single acute tip.....11
- 10A. (10) Small cheliped short and heavy, with merus less than twice as long as broad and palm curved, 1.3 times as long as broad*S. harpagatrus* (II:311).
- Small cheliped of more usual proportions with merus 2.8 times as long as broad, palm 1.8 times as long as broad, and straight not curved*S. paralaticeps*

The specific name refers to the possible close relationship of this species to *S. laticeps* (see footnote p. 72).

The specimen will be deposited in the Australian Museum, Sydney, N.S.W.

NEW RECORDS

Athanas polynesia Banner & Banner Fig. 93

Athanas polynesia Banner and Banner, 1966a:152, fig. 4.

SPECIMENS EXAMINED: 1 specimen from AM P. 25161; 3, 75-LIZ I (AM P. 28140); 2, 75-LIZ T (AM P. 28141); 2, 75-LIZ V (AM P. 28142).

DIAGNOSIS: Rostrum usually reaching to near end of second antennular article, usually acute at tip with slight carina, outer margins at times slightly flattened. Ventral side of rostrum with slight notch near tip bearing a stiff seta. Supracorneal teeth prominent, a little less than half as long as rostrum, rounded at tip; extracorneal teeth slender, reaching end of first antennular article. Rostrum and supracorneal teeth curving upwards. Antennules stout, visible part of first antennular article 2 times as long as second; second broader than long; third article 1.13 times longer than second article. Stylocerite reaching near end of second antennular article. Outer flagellum of 5 articles. Squamous portion of scaphocerite broad, reaching to end of antennular peduncle; lateral tooth a little longer. Carpocerite reaching end of antennular peduncle. Basicerite with small rounded lateral tooth.

Labrum enlarged, hemispherical. Mandible with *pars incisiva* expanded, fitting over labrum, with finely serrate cutting edge; palp large; *pars molaris* reduced. Maxillule with expanded middle lobe. Third maxilliped with ratio of article 10:3:5; superodistal margin of second article and superior side and tip of third article with groups of long setae; tip of third article narrow; medial face of second article with one, third article with six, rows of stiff bristles.

Chelipeds sexually dimorphic, but with propodal finger carried in superior position in both sexes. In males, chelipeds of similar general form but differing in size, both very flattened and evidently folding back on themselves so as to produce a broad flattened anterior surface. Large chela about twice as long as broad, very flattened and becoming lamellar towards margins, outer surface convex, inner surface concave except where muscles are placed; distal margins of palm and proximal portion of propodal finger serrate and carrying long setae. Finger 0.3 length of chela, propodal finger heavy at base, about 3 times as wide as adjacent dactylus; oppositional surfaces of both fingers carrying a low irregular dentition, teeth not meshing; tips hooked and crossing. Ischium and merus broadened and flattened. Ischium heavy, 0.7 as long as merus, distally expanded and bearing spines and setae. Merus less than 0.5 length of palm, over twice as broad distally as proximally, 1.5 times as long as broad distally, unarmed. Carpus on inner face 1.3 times length of merus, proximally very thin rapidly expanding in proximal third and at end of expansion medial face marked by strong rounded tooth; distal portion with nearly parallel sides; superior margin convex, inferior margin concave, with medial margin of concavity lamellar. Small chela essentially like large chela, but only about 0.5 as long in each of its articles. Only one cheliped of female is known. It is conventional in shape, not flattened. Ischium 0.6 as long as merus, unarmed; merus twice as long as broad, unarmed; carpus distally expanded, 2.5 times as broad distally as proximally and 1.3 times as long as broad distally. Chela cylindrical in section, 2.8 times as long as broad, with fingers occupying distal third.

In the few specimens with second legs intact the ratios of the carpal articles varied: 10: (5-9): (4-5): (9-12).

Ischium of third leg without spine. Merus inermous, 4 times as long as broad. Carpus 0.5 as long as merus, not projected distally, but inferodistal margin bearing short spine. Propodus a little shorter than merus, bearing 5 spines on inferior margin with a pair distally. Dactylus simple 0.4 as long as propodus. Fourth leg more slender. Merus of fifth leg 2 times as long as broad, and 1.2 times longer than ischium, without spines or projections; propodus 2 times longer than merus, slightly arched and bearing only 3 spines near distal portion; dactylus as long as carpus.

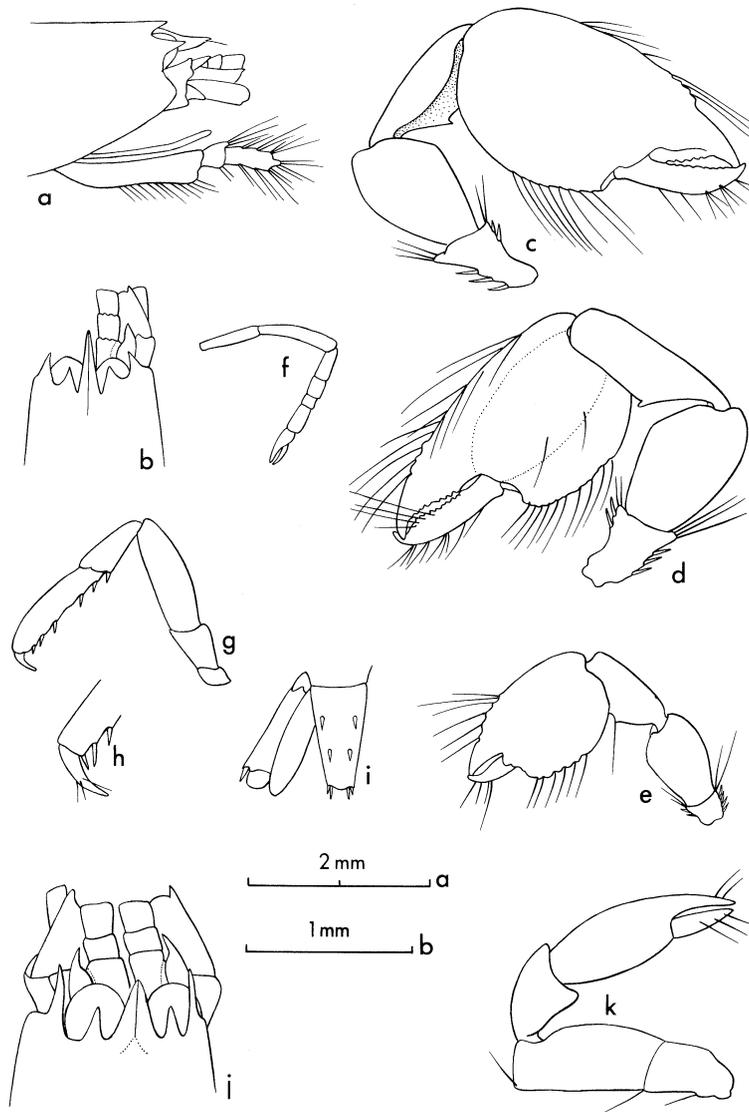


Fig. 93 *Athanas polynesia* B&B

8 mm male from AM P. 25161. **a, b.** Anterior region, lateral and dorsal view; **c, d.** large cheliped, lateral and medial face; **e.** small cheliped, lateral face; **f.** second leg; **g, h.** third leg and enlarged dactylus; **i.** telson and uropod. 8 mm female from 75-LIZ-V. **j.** Anterior region, dorsal view; **k.** cheliped, lateral face. **a, b, c, d, e, f, g, i** scale a; **h, j, k** scale b.

Telson 3.7 times as long as posterior margin is broad. Posterior margin arcuate, anterior pair of dorsal spines placed anterior to middle. Uropods elongate with outer uropod distally bearing articulation. Sympodite with two teeth, outer longer and broader than inner.

DISCUSSION: Unfortunately, most of these specimens are fragmentary. The seven specimens with the "LIZ" collection records are especially bad, with only 4 walking legs and one cheliped remaining attached; the male specimen from AM P. 25161, also from Lizard Island, is however complete. Extra appendages in the "LIZ" bottles agreed with the appendages that were attached.

There was only one female cheliped in the entire collection and females of this species have not been previously described. We suggest that the females probably have symmetrical chelae as has been reported in related species.

The rostrum in one specimen is short and somewhat distorted (fig. 92j); we suggest that it may be a malformation from heredity or accident, as we reported in a specimen of *A. borradailei* (Coutière) from Samoa (1966a:152). Otherwise in the intact parts only minor variation was noted, such as the range in the relative lengths of the carpal articles reported above. The specimens agree well with the specimens we described from Samoa; the similarities in the male chelae are especially striking.

There is a group of four nominal species that lie intermediate between the old genera of *Athanas* and *Arete*; they are *A. borradailei* (Coutière), *A. ghardagensis* (Ramadan), *A. verrucosus* B&B, and this species. All carry the chela in an inverted position, with the dactylus in inferior orientation; in all males the palm is greatly widened and compressed, with associated modification of the merus and carpus to permit flexion; in all the bases of the antennules and antennae are heavy and in all of these species the mouthparts are greatly protrudent (the mouthparts for *A. ghardagensis* have not been described, but we have specimens of it as yet unreported in our collections from Madagascar and the Red Sea). The only species that can be firmly separated from the others is *A. verrucosus*, for it has 5 carpal articles in the second leg rather than four. The other species, described on the basis of one or few specimens, often partially fragmentary, are separated by more subtle and variable characteristics and should be reviewed when a larger series of intact specimens are available (as we pointed out in 1960:149 and in 1966a:152). This compact group of species also should be considered in their generic relationship. In 1960 we considered them as intermediate between the previously separated genera of *Athanas* and *Arete*, so we combined the two genera. On the other hand, it may be more useful to consider them to be a separate genus, yet to be designated, which would permit the two previous genera to stand. With the present collections, however, nothing further can be done.

This species may be inserted into our key to the genus *Athanas* (B&B, 1973:303) by substituting the following for dichotomy 10:

- "10 (1) With supracorneal spines; dactylus of third to fifth legs simple
*A. polynesia*
 — Without supracorneal spines; dactylus of third to fifth legs
 biunguiculate11"
 and renumbering the present dichotomy from 10 to 11.

BIOLOGICAL NOTES: All of these specimens were reported as coming from areas largely covered with encrusting coralline algae in water from 6-20 ft deep.

AUSTRALIAN DISTRIBUTION: These Lizard Island specimens are the only ones

known from Australia.

GENERAL DISTRIBUTION: Samoa.

Salmoneus sibogae* (De Man)
Fig. 94

Jousseamea sibogae De Man, 1910b:303; 1911:158, fig. 9.

SPECIMENS EXAMINED: 1, 14 mm male and 1, 10 mm ovigerous female from North Reef, Heron Island, Capricorn Group. Coll. A. J. Bruce, 4/1/77.

DIAGNOSIS: Surface of carapace finely granulate, bearing a slight pubescence of short stiff setae. Rostrum triangular, with somewhat concave margins, 1.3 times as long as broad at base, tip reaching to middle of third antennular article; carina slight extending posteriorly from tip to level of middle of eyes. Extracorneal teeth triangular, about one-fifth as long as rostrum, with inner margins parallel to medial plane of body. Margin between extracorneal teeth and rostrum narrow but rounded. Antennular peduncle stout, with second antennular article slightly broader than long; antennular articles nearly equal in length. Stylocerite with acute tip reaching slightly beyond end of second antennular article. Scaphocerite with squamous portion broad, reaching just past antennular peduncle; outer margin straight; lateral tooth as long as squamous portion. Carpocerite stout, reaching just past end of second antennular article. Lateral tooth of basicerite broad and acute, reaching to level of tips of extracorneal teeth. Pterygostomial angle produced but rounded.

Large chela 3.0 times as long as broad, with fingers occupying distal 0.4, rotated about 90° with fingers opening laterally. Palm somewhat quadrangular but rounded in section without excavations, with heavy proximal shoulder and notch at carpal articulation, distally constricting opposite dactylar articulation. Fingers compressed, bearing 11 teeth that mesh exactly when closed; tips hooked and crossing. Carpus bearing 2 strong teeth on lower (medial) side, otherwise projecting in a cyathiform manner. Merus 8.3 times as long as broad in inferior view, unarmed; inferior face broadened, flattened to excavate, and curved to accommodate palm when carpal articles are flexed. Ischium about 0.4 length of merus (in female specimen; that of male broken).

Small cheliped of minimal size, when all articles are extended it is about 0.9 length of large chela proper, not showing sexual dimorphism. Ischium unarmed, 0.6 as long as merus. Merus 6 times as long as broad; carpus 0.8 as long as merus, almost 3 times as broad distally as proximally. Chela 0.7 as long as merus, with fingers a little shorter than palm.

Second leg with ratio of carpal articles: 10:5:3:2:5.

Ischium of third leg with 2 spines, merus 5.8 times as long as broad. Carpus 0.8 as long as merus, not projected distally; propodus 0.7 as long as merus bearing on its inferior margin 5 spines and a pair distally. Superior margin bearing a slender spine distally. Dactylus simple, 0.3 as long as propodus, bearing on its dorsal surface near the tip a small notch from which protrudes 2 fine hairs.

Telson 4 times as long as posterior margin is broad; posterior notch narrow, V-shaped, with depth equal to 0.5 breadth of tip. With usual posterolateral pairs of spines and long plumose setae arising in middle. Inner part of spines as long as outer (in female, spines on male telson missing). Anterior pair of dorsal spines set posterior to middle.

DISCUSSION: It is the 14 mm male that is the basis of this description unless *This name will be reduced to a synonym of *S. serratidigitus* (Coutière, 1896b) in a forthcoming paper on the alpheid shrimp of the Red Sea and Gulf of Aden.

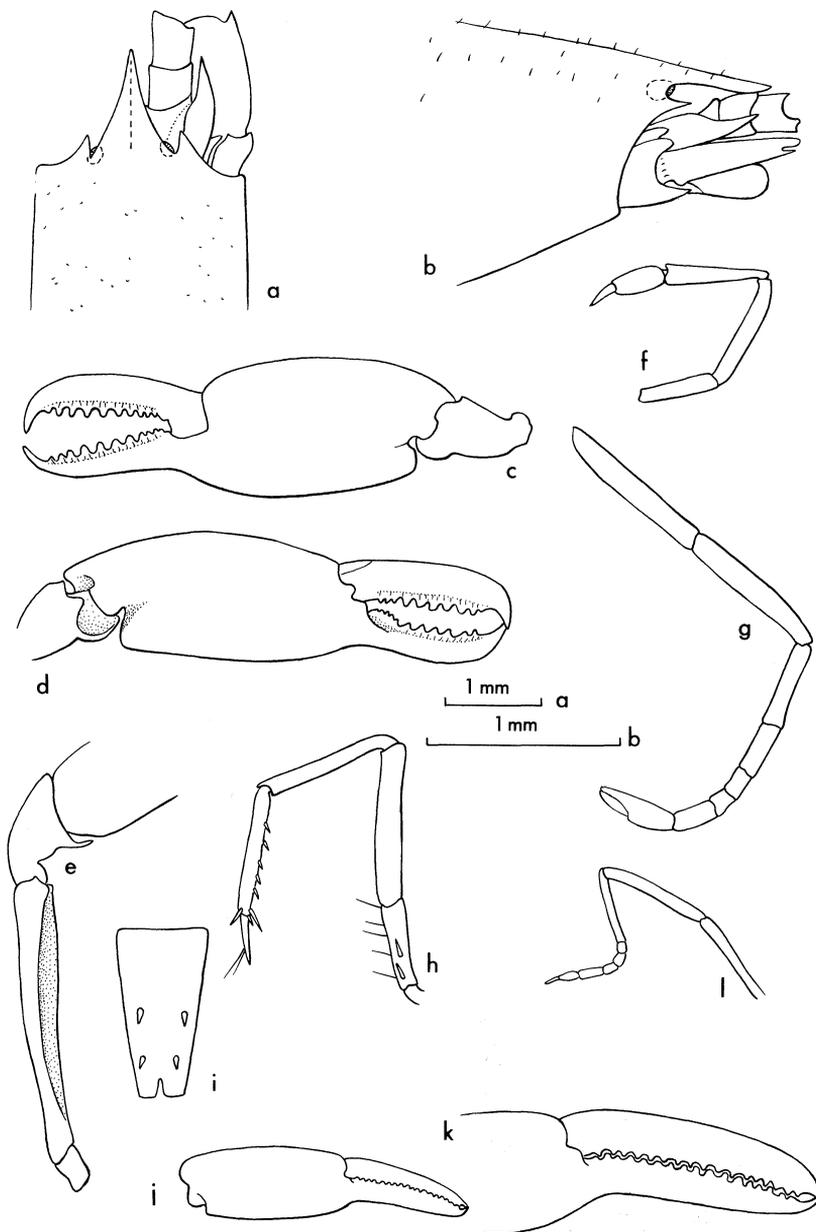


Fig. 94 *Salmoneus sibogae* De Man

14 mm male from Heron Island. **a, b.** Anterior region, dorsal and lateral view; **c, d.** large chela, medial and superolateral face; **e.** merus, lateral face (ischium broken); **f.** small cheliped; **g.** second leg; **h.** third leg; **i.** telson (distal spines missing). 10 mm female from Heron Island. **j, k.** Large chela and enlarged distal region, lateral face; **l.** second leg. All figure scale a, with the exception of k which is scale b.

otherwise noted. We are not certain that these two specimens are of the same species and that either is actually *S. sibogae*. We have examined De Man's holotype and only specimen and found his descriptions and figures to be very accurate; on the basis of the holotype we have identified a series of 15 more or less intact specimens from the Red Sea (not as yet reported upon) as this species.

In general form of the body and appendages both of the Australian specimens resemble each other and conform well both to De Man's holotype and to the Red Sea specimens. In the Red Sea specimens some variation was noted which cover some of the minor differences between the Australian specimens and De Man's specimen — for example in the angle of the inner margin of the orbital teeth which varies from parallel to the axis of the body, as found in the Australian specimens, to lying at an angle to the axis as found in the holotype; also in the slight pubescence of the carapace, which in some Red Sea specimens approaches the condition found in these specimens, and yet others are glabrous.

Our doubts are primarily upon the ratio of the carpal articles of the second legs in the 14 mm male and the large chela of the 10 mm female. In the male the first carpal article of the second legs is only 0.7 the length of the sum of the following articles, instead of equal to or longer than the sum, as in all other specimens including the type and the Red Sea specimens. However, this specimen had only one second leg and that was loose in the vial (but must have come from the specimen as the specimen was alone in the vial); thus, it could have been an anomalous development, possibly even from regeneration. In the 10 mm female the chela was more slender and had more teeth than any other specimen, being 3.8 times as long as broad and bearing about 17 teeth. Most of the specimens, including the Australian male, were 3.0-3.2 times as long as broad and usually carried about 10 teeth, with the most slender specimen among the Red Sea specimens being 3.6 times as long as broad, and another specimen from the Red Sea carrying 14 teeth on the dactylus (but the last three did not meet corresponding teeth on the pollex).

We do not know how to evaluate these differences but suspect that they may lie within extremes of variation in Australian populations. We therefore have assigned these two specimens to this species, but advise future workers to study the range of variation before accepting our determination.

The species can be distinguished from the other known Australian species of *Salmoneus*, *S. tricristatus* Banner (B&B 1:334) by the absence of strong keels on the carapace. The records of capture given above do not appear in Appendix II.

BIOLOGICAL NOTES: Most, if not all, of the specimens we have available of this species were collected intertidally; it is a small species, with the largest we have seen being only 16 mm long (from the Red Sea). Dr Bruce's field notes indicate these specimens were of translucent white with an orange "liver"; we reported that the specimens from the Marshall Islands were "usually bright yellow to muddy white in colour while the eggs were red." (1968:270). In the Marshall Islands the specimens were collected under rocks intertidally with worms of the genus *Eurythoe* ("fire worms") and the shrimp *Alpheus strenuus strenuus* Dana and *S. tricristatus* Banner.

DISTRIBUTION: This appears to be a rather wide-spread species in spite of the fact that it has previously been reported only three times, the holotype by De Man from the Lucipara Islands (in the middle of the Banda Sea), and by ourselves from Canton Is. in the Phoenix Group and from Enewetak in the Marshall Islands. However, we have specimens in our present study collections, as yet unreported, from the Philippines, Madagascar and the Red Sea.

ADDITIONAL NOTES

In Part II of this paper (p.341) we listed *Synalpheus haddoni* on the basis of Coutière's record of a species from Torres Straits and expressed a little confusion by his two different names and two different assignments to subgeneric groups. In his earlier publications (1900:411) he named it *S. laevimanus Haddoni*, making the point that it was the first time that this species (or any member of the *Laevimanus* Group, a group that was to be established later) had been found in the Pacific. In his second publication (1909:10) he raised the subspecies to species level and transferred it to the *Biunguiculatus* Group. (The group names now have been changed to *Gambarelloides* and *Coutierei* Groups, respectively — see B&B, 1975:274). One of the characteristics of the *Gambarelloides* Group is the presence of a thick brush of setae on the dactylus of the small chela, but this characteristic was not mentioned or figured by Coutière.

We have since had the opportunity to examine the large holotype and the smaller allotype of Coutière's species at the British Museum (Natural History). We found that Coutière's description of the holotype was accurate, but that the specimen lacked the small cheliped. This appendage was found on the smaller allotype, however, and we found it lacked the brush of setae characteristic of the *Gambarelloides* Group. Therefore, his 1909 assignment was correct. As in our key to the species of *Synalpheus* we had presumed the dactylus carried the tuft of setae (1975:280, dichotomy 17), the placement of the species is incorrect. With this characteristic known, it now keys out to *S. streptodactylus* Coutière under dichotomy 25. These two species can be easily separated as the tip of the telson in *S. haddoni* is very narrow with the longer posterolateral spines almost two-thirds as long as the tip is broad, while the tip in *S. streptodactylus* is broad, almost 2.5 times as broad as the spines are long (contrast fig. 17e and 25g, *op. cit.*).

ADDITIONAL RECORDS (arranged alphabetically)

- Alpheopsis trispinosus* (Stimpson) (I:337): 1 specimen from TM G1538; 8, WM 94-65; 1, WM 161-65. The range of this species has been extended from southern Australia westward and northward to include Shark Bay, W.A.
- Athanas dimorphus* Ortmann (I:313): 1 specimen from JG 6-73; 1, JG 9-73; 2, US 123608.
- Athanas dorsalis* (Stimpson) (I:324): 2 specimens from AM 460a; 1, WM 98-65; 1, WM 119-65; 1, WM 163-65; 1, 208-65. The range in western Australia has been extended northward to include Exmouth Gulf.
- Athanas sibogae* De Man (I:321): 3 specimens from UQ 12. The range in eastern Australia has been extended southward to include Moreton Bay, Qld.
- Automate dolichognatha* De Man (I:299): 2 specimens from US 123609.
- Synalpheus carinatus* De Man (II:283): 1 specimen from JC 44; 2, JC 50. The range in eastern Australia has been extended northward to Cooktown, Qld.
- Synalpheus comatularum* (Haswell) (II:289): 2 specimens from JC 43; 2, JC 45; 2, JC 47; 1, JC 51; 3, WM 95-65. The range in eastern Australia has been extended southward to off Cooktown, Qld.
- Synalpheus coutierei* Banner (II:343): 2 specimens from WM 30-65. The range in Western Australia has been extended southward to include the Dampier Archipelago.

- Synalpheus gracilirostris* De Man (II:372): 2 specimens from 75 LIZ-L; 2, 75 LIZ-V. This species was previously known from one specimen from Hayman Island, Qld (about 20°S); these came from Lizard Island, Qld. (about 14°40'S).
- Synalpheus neomeris* (De Man) (II:357): 1 specimen from AM 397; 1, JC 55; 2, WM 226-65. The range in western Australia has been extended northward to Cape Jaubert.
- Synalpheus neptunus neptunus* Dana (II:317): 14 specimens from WM 60-65; 2, WM 10380.
- Synalpheus pescadorensis* Coutière (II:301): 1 specimen from 75 LIZ-M. This extends the range northward to Lizard Island, Qld.
- Synalpheus quadriarticulatus* B&B (II:297): 1 specimen from 75 LIZ-G. This extends the range southward on the Queensland coast to Lizard Island, Qld.
- Synalpheus stimpsonii* (De Man) (II:292): 1 specimen from AM 443; 2, JC 47; 1, JC 49; 2, JC 53; 2, JC 56; 1, JC 57; 1, WM 79-65; 1, WM 226-65 2, 75 LIZ-14.
- Synalpheus streptodactylus* Coutière (II:362): 7 specimens from SM 4; 1, WM 97-65; 1, 75 LIZ-1.
- Synalpheus tumidomanus* (Paulson) (II:377): 4 specimens from AM P. 5276; 1, AM P. 8706; 2, AM P. 13487; 30, BAU 3; 1, BAU 37; 1, TM G1514; 2, TM G1529; 5, TM G1538; 4, VM 32N; 7, VM 33S; 9, VM 41N; 1, WM 176-65; 4, WM 153-176; 2, 75 LIZ-I; 2, 75 LIZ-I; 3, 75 LIZ-Q.

APPENDIX II

ADDITIONAL LOCALITY LISTS FOR ALPHEID COLLECTIONS

The following collections were received after the preparation of the locality list for Part I (1973:353), and contain specimens referred to in Parts II and III. The same alphameric system has been followed and the lists are arranged alphabetically by the key letters. (We should note here and in Part I that in general the date notation, other Americans follow their system of month/day/year, while we and the Australians follow the British system of day/month/year. If the century is not indicated in the year date, it is of the current century — *i.e.* "/50" is "/1950".)

AQUINAS COLLEGE

| | |
|-----------------|---|
| AC 1, 3, 4. | Northern reef of island north of Rolland Passage, Easter Group Houtman Abrolhos Island. Coll. M. Yates and J. Unkovich, 30/7/72. From crinoid. Same as above. From coral on shallow reef. |
| 7 | Same as above. From coral on shallow reef. |
| 15, 16, 17, 18. | North of Leo Island, Easter Group. Coll. M. Yates and J. Unkovich, 31/7/72. From coral reef. |
| 29, 30, 35. | North of Leo Island, Easter Group. Coll. M. Yates and J. Unkovich, 2/8/72. From coral reef in lumps of dead coral at 6 ft. |
| 38, 39. | Easter Group. Coll. M. Yates and J. Unkovich, 2/8/72. From crinoid. |

The collections listed below were from the North Island in Houtman Abrolhos Islands off Western Australia. They were collected during the Aquinas College Seventh Abrolhos Expedition in 1974 and were collected by P. Bannon and G. Davis with the exceptions of AC 40 which was collected by A. Sasche, and AC 61 and 62 which were collected by P. Bannon, G. Davis and M. Minotti.

- AC 40, 42. Section 7, reef. 5 ft. 27/8/74. Found in coral which was loose on top of reef.
41. Same as AC 40. Found in coral rock near reef.
- 43, 44. Same as AC 40. 18-24 inches. Found in loose coral rock.
45. Same as AC 43. 6ft.
46. Section 4. 10ft. 29/8/74. Found in loose coral.
48. Same as AC 46. 30 inches.
- 52, 54. Section 9, 15 ft. 29/8/74. Found in loose coral rock.
53. Same as AC 52. 4 ft. found in coral.
55. Same as AC 52. 10 ft.
57. Same as AC 52. 30/8/74.
- 58, 65, 71, 72, 73, 74. Section 9. 3 ft. Found in loose coral rock. Habitat was on slope of a reef which dropped off quickly.
- 59, 62, 69. Same as AC 58. 4 ft. Found in loose coral.
- 60, 70. Section 9. 15 ft. 30/8/74. Found in *Montipora* coral which was still attached to the reef.
63. Same as AC 59. 3 ft.
64. Same as AC 59. 15 ft.
66. Same as AC 59. 1 ft. Found in sponge.
67. Same as AC 59. 3 ft.
68. Section 9. 9 ft. 30/8/74. Found in loose coral rock. Habitat was on the slope of a reef which dropped off quickly.
- 76, 78, 79, 81. Section 5. 5 ft. 30/8/74. Found on flat bottom in loose coral.
77. Same as AC 76. 35 ft.
82. Section 8. 20 ft. 31/8/74. Found on side of reef which sloped off sharply. Living in dead coral.
- C-54. East side of Jubilee Island. Pelsart Group. 4 inches, in coral. 7/1/67.

THE AUSTRALIAN MUSEUM

(See also LIZ listings)

- AM 460. Torres Straits, Qld. Coll. P. C. Black. In weed.
- 460a. Pt. Peron, near Fremantle. W.A. Coll. H. Butler, —/6/59.
461. Careel Bay, Pittwater, N.S.W. Coll. P. Hutchings, 11/12/73. From *Posidonia*.
- 462, 463. Same as AM 461. 30/7/73. From *Zostera*.
464. Same as AM 461. 27/2/72. In mud, sandy, adjacent to *Zostera* beds.

465. Same as AM 461. 11/12/73.
466. Same as AM 461. 10/6/73. Upper *Zostera*.
467. North Is., Capricorn Group, Qld. Coll. M. Ward and W. Boardman. July 1929.
- AM E.4496. South Australia, rec. 1913.
- AM P.1542, 3. Port Jackson, N.S.W. Received 1908.
13566. Middle Harbour, Port Jackson, N.S.W. Coll. A. R. McCulloch. Under stones.
17923. Wallis Lake, near Forester, N.S.W. Between Godwin Is. and Wallis Island in *Zostera*. 2 ft. Coll. W. F. Ponder, K. G. O'Gower and P. Dixon. 17/4/71. Soft mud, in *Zostera*.
19636. South east of Broken Bay, N.S.W. 33°44'S; 151°54-50'E. 225 fms. Coll. N.S.W. State Fisheries on F. R. V. Kapala 1/8/72.
20709. Belmont Beach, north end, near Terrigal, N.S.W. 15 m. Coll. J. Laxton, 18/3/76. Shipek grab.
21599. Off Richmond River Mouth, N.S.W. 28-30 fms. COLL. J. C. Yaldwyn on Swains Reef Expedition, 7/10/62. Prawn Trawl.
21872. Tangalooma, Moreton Bay, Qld. Loc: 101(1). Sample 1323. High tide — 2.37 m. Coll. CSIRO, Moreton Bay Survey 5/1/73. Bare Sand.
21873. Tangalooma, Moreton Bay, Qld. Loc: 102B. Sample No. 1324. Coll . CSIRO Moreton Bay Survey, 5/3/73. Among sea grasses, *Halophila ovalis* and *H. spinulosa*.
25161. S. end Coconut Beach, Lizard Is., Qld. Rotenone Station. 2-7 m. Bottom, coral and sand. Collected by Fish Dept. 24/11/75.
27254. Same as AM P. 2006.
27255. Same as AM P. 6354
27256. Same as AM E. 4496.
27257. Same as AM E. 4499.
27258. Same as AM P. 1418.
27259. Same as AM P. 13580.
27260. Same as AM P. 13583.
27261. Same as AM E. 3180.
27262. Same as AM E. 3180.
27264. Same as AM P. 6352.
27407. Same as AM P. 8565.
27408. Same as AM P. 10038.

| | |
|-------------|----------------------|
| AM P.27409. | Same as AM P. 10038. |
| 27430. | Same as AM P. 2577. |
| 27431. | Same as AM P. 2577. |
| 27432. | Same as AM P. 2577. |
| 27433. | Same as AM P. 2577. |
| 27434. | Same as AM P. 2578. |
| 27435 | Same as AM P. 2579. |
| 27436. | Same as AM P. 2577. |
| 27439. | Same as AM E. 3147. |
| 27452. | Same as AM P. 2006. |
| 27569. | Same as AM P. 7027. |
| 27765. | Same as AM P. 5572. |
| 27766. | Same as AM P. 8028. |
| 27767. | Same as AM P. 7982. |
| 27783. | Same as AM P. 7521. |
| 27789. | Same as AM P. 3566. |
| 27790. | Same as AM P. 3566. |
| 27791. | Same as AM E. 3180. |
| 27874. | Same as AM P. 1418. |
| 27875. | Same as AM P. 2152. |
| 27877. | Same as AM P. 1695. |
| 27878. | Same as AM P. 11730. |
| 27884. | Same as AM E. 4499. |
| 27885. | Same as AM E. 4500. |
| 27936. | Same as AM E. 6274. |
| 28122. | Same as AM P. 7982. |
| 28123. | Same as AM P. 8028. |
| 28124. | Same as AM P. 8028. |
| 28125. | Same as AM P. 14960. |
| 28137. | Same as AM P. 3574. |
| 28155. | Same as AM P. 11882. |
| 28160. | Same as AM P. 4229. |
| 28164. | Same as AM E. 3180. |

A. H. AND D. M. BANNER

- BAU 63. Wilson River Mouth, Port Macquarie, N.S.W. 2.6 tidal level and above 10/2/64. In very soft muddy sand in eel grass beds. (Note: BAU 64-71, incl. contained no alpheid).

C. R. SMALLEY

- CS 37. Exmouth Gulf, W.A. Coll. C. Smalley 22-23/10/70. Trawled, in sponges.

JAMES COOK UNIVERSITY

These collections were made by R. A. Birtles and L. P. Zaan from the School of Biological Sciences. (The data given below for these collections in the two series are all that is presently available).

- JC 34. Bowling Green Bay, near Townsville, Qld. 5 m. From *Solenocaulon* sp.
35. From approximately 60 km E. of Townsville, Qld. 40 m. Trawled, from sponge.
36. Halifax Bay, north of Townsville, Qld. From soft coral.

These collections were made by R. A. Birtles and L. P. Zaan from the northern Great Barrier Reef and the Torres Straits.

- JC 37. F4. SS004 and SS005. Pelorus on C006. 4/5/74.
38. F5. Wheeler Is. 9/10/74.
39. F6. Lizard Is. 15/11/73. From crinoid.
40. F7. Lodestone Reef. 6 m. 11/1/74.
41. F8. Lizard Is. 25 m.
42. F9. Tijou Reef. 11/11/73. Crinoid 10.
n.b. the numbered crinoids have not yet been identified.
43. SS034. Northwest Reef, Torres Strait. 14 m. On crinoid C036.
44. SS009-010. Tijou Reef. 7 m. On crinoid C034.
45. SS030. Thursday Is. Torres Straits. 76 m. On crinoid C034.
46. 35022-023. Tijou Reef. On crinoid C027.
47. SS036. Northwest Reef, Torres Straits. 14 m. On crinoid C038.
48. SS104-105. Lizard Is. 10 m. On crinoid C000.
49. SS040. Sue Island, Torres Straits. On crinoid.
50. SS025-026. Tijou Reef. 8 m. On crinoid C028.
51. SS031-032. Thursday Is., Torres Straits. 6 m. On crinoid C035.
52. SS027. Thursday Is., Torres Straits. 6 m. On crinoid C033.
53. SS109-110. Lizard Is. 18 m. On crinoid C176.
54. SS072-73. Murray Is., Torres Straits. On Crinoid C076.
55. SS074. Murray Is., Torres Straits.
56. SS118-119. McGilvray Cay, Lizard Is., 20 m. On crinoid C000.
57. SS108. Lizard Is. On crinoid C164.

JOHN GARTH

These collections were made personally by Dr John Garth of the Allan Hancock Foundation, Los Angeles, California while Zoologist in Residence at the University of Queensland, Brisbane. We are prefacing his collection numbers with JG.

- JG 6-73. Dunwich, Stradbroke Island, Moreton Bay, Qld. 11/6/73. Collecting on sandy mud flats with well-spaced turnable rocks encrusted with dead oysters at higher level and live mussels at lower level. 0.2 m. tide at 1533. With Stephen Cook.
- 7-73. Connecting reef between Goat and Bird Islands, Moreton Bay, Qld. 7/5/73. Collecting on sand flats with matted *Zostera*. Turnable rocks, live oysters and mussels, dead coral slabs at lowest level. 0.2 m. tide at 1423. With Stephen Cook from speedboat "Scylla".
- 9-73. Dunwich, Stradbroke Island, Moreton Bay, Qld. 9/5/73. Same locality as Sta. 6-73. From speedboat "Scylla". 0.2 m tide at 1638. Temperature 75°F. With Stephen Cook and Stephen Newlands.
- 10-73. Wellington Point, Moreton Bay, Qld. 6/5/73. Collecting along sandy bar leading to a small island, with mud flats on either side having turnable rocks encrusted with oysters and mussels. 0.3 m tide at 1808.
- 12-73. From S. of jetty on W. side of St. Helena Island, Moreton Bay, Qld. to Beacon off N. point of island. 23/5/73. Dredging from speedboat "Scylla". 1-3 fms. Bottom mud, broken shell, sponge and algae. 0930-1230 hrs. With Stephen Cook.
- 13-73. Tannum Sands, S. of Gladstone, Qld. 29/5/73. Collecting on rocky reef with sandy substrate. No turnable rocks, but beach rock could be pried apart along cleavage lines. Orange sponge with many small xanthids. 0.2 m tide at 1201.
- 14-73. Eimeo Beach, N. of Mackay, Northern Qld. 30/5/73. Turnable rocks on sand and cobble substrate at outlet of estuary. 0.5 m tide at 1523.
- 16-73. Picnic Cove, Magnetic Island, off Townsville, Northern Qld. 2/6/73. Collecting on shore with sandy substrate. 0.0 m tide at 1536. With Shirley Trefz.
- 17-73. West along S. shore of Jetty, Peel Island, Moreton Bay. 15/6/73. Beach rock with turnable slabs, some rubble, some sandy beach, some dead corals. 0.2 m tide at 1456. With Stephen Cook.
- 20-73. Brammo Bay, Dunk Island, Northern Qld. 8/6/73. Collected by Shirley Trefz. On and under small granite boulders on mud flats at low tide. *Ocypode* on sand.
- 21-73. Lizard Is., N. of Cooktown, Northern Qld. 26/6/73. Collecting in lagoon from mangroves and on sand flats with small, turnable oyster-encrusted rocks. 0.5 m tide at 1211. With D. P. Abbott.
- 22-73. Low Isles, off Port Douglas, Northern Qld. 27/6/73. Collecting on reef flat S. of Sand Cay (with lighthouse). Turnable pieces of dead coral over coral rubble. 0.4 m. tide at 1243. With John Lucas. Additional specimens collected further seaward by Shirley Trefz.

J. E. RANDALL

Personal collections made by Dr John E. Randall, Bernice P. Bishop Museum,

Honolulu, in connection with a study of an alpheid-goby association; specimens speared with a "feather-duster"-type piano wire spear. The collection designations are ours.

- JR 1. One Tree Is. 2 m. 1/18/73. Lives with an elongate pale pink barred goby with a small black spot behind the eye.
2. Same locality. Lagoon, 2 m. 1/19/73. Chelae with irregular bands of purple, antennae red.
3. Same locality. 2 m. 1/18/73. Living with yellow green goby, lagoon near patch reef.
4. Same Locality. 1-1.5 m. 1/12/73. Living with *Cryptocentroides maculosus*, a gobiid fish.
9. Same locality. 2 m 1/17/73. Lagoon, near patch reef in vicinity of artificial reefs. Some sand and coral rubble. Caught by hand near burrow.
12. Carter Reef, near Lizard Is., Great Barrier Reef. 60 ft. 6/25/73. Outside reef, rubble and sand. Living with *Cryptocentrus guttatus*, a gobiid fish.

"LIZ" COLLECTIONS
(Australian Museum)

These collections were made by Dr Patricia Hutchings of the Australian Museum from Lizard Island, Qld. (14°40'S: 145°27'E). The alphanumeric code designations are the registration numbers of the Australian Museum. A description of the types of habitat in which these alpheids were collected will appear in Hutchings and Weate (in press).

- 75 LIZ 1. Second reef off Station Beach, 8-10 ft. at high tide. 6/1/75. Exposed to N. W. winds. Dead *Pocillopora*, very hard solid reef rock.
3. Transect off point north of Crystal Beach. 35 ft. 4/14/75. Exposed to S. E. winds Habitat with high percentage of live coral.
4. Transect off point to north of Crystal Beach. 60 ft. 15/1/75. Exposed to S. E. winds. Solid reef rock, encrusted with brown algae, soft coral, little live coral and filamentous algae.
7. Reef off Point to north of Coconut Beach. 50 ft. 17/1/75. Solid reef habitat, heavily encrusted with algae etc.
8. Same as above. 20 ft. 17/1/75. Exposed to S. E. winds. Solid with large surface area, heavily encrusted with coralline algae *Lithothamnion*.
14. Pichon's N. E. transect on N. E. face of Lizard Island from slope. 6/1/75. Habitat with high percentage of coral *Diplostrea* sp.
- C. Bommie on inner Yonge Reef. 7/1/75. Exposed to N. W. winds. Flat, horizontal plates of what was originally tabular *Acropora*. Habitat of large surface area and easily broken up.
- G. Outer Yonge Reef (steep sloping reef from 20-40 ft). 80 ft. 10/1/75. Rich diverse area. Coral rubble covered with algae *halimeda*, but loose rubble in between reef rock. Habitat with high percentage

of live coral.

- 75 LIZ H. Same as above. Habitat with large surface area and easily broken up.
- I. Outer Yonge Reef. 20 ft. 10/1/75. Very little *Halimeda*, mainly coralline algae. Solid reef habitat.
- L. Same as above. 60 ft. 1/1/75. Solid reef habitat with limited algae growth, inside coral cave.
- M. Same as above. 80 ft. 12/1/75. Just outside cave. Habitat with large surface area and easily broken up, with much *Halimeda*.
- Q. Same as above. 10 ft. 13/1/75. Exposed to N. W. winds. Fairly large surface area, but covered with pink coralline algae rather than filamentous algae. Solid reef habitat.
- R. Inner Yonge Reef. Reef flat (very compact, and narrow zone). 6ft. (high tide). 19/1/75. Exposed to N. W. winds. Halfway from reef crest to outer reef. Heavily encrusted with *Lithothamnion*, coralline algae. Habitat with large surface area and easily broken up.
- S. Same as above. Dead Staghorn, heavily encrusted coralline algae, brown and green filamentous algae. Dead branching coral habitat.
- T. Same as above. Flat horizontal cemented, originally table top *Acropora*. Habitat with high percentage of coral.
- U. Inner Yonge Reef—bommie on reef flat. 20 ft. (high tide). 20/1/75. Exposed to N. W. winds. Some coralline algae, alcyonarians, green filamentous algae. Habitat with large surface area and easily broken up.
- V. Same as above. 6 ft (high tide). 20/1/75. Hard cemented *Lithothamnion*. Relatively large surface area, coralline algae and bits of *Halimeda*. Solid reef habitat.

MACLEAY MUSEUM

- MM 108. Cape Grenville, Qld.
260. Sue Islet, Torres Straits, Qld.

QUEENSLAND MUSEUM

- QM W 2241. Dunwich, Moreton Bay, S. E. Qld. Coll. F. C. Vohra 5/2/62.

SOUTH AUSTRALIAN MUSEUM

- SM C 514 Queenscliffe, Kangaroo Is., S. A. Collected by Capt. Brown, 1886.

SHIRLEY TREFZ

Personal collections made by Dr Shirley Trefz, Leeward Oahu Community College, Honolulu, while on leave. The collection designations are ours.

- ST 1. Low Isles, Great Barrier Reef. 5/27/73.

- ST 2. Same locality. 6/11/73.
 3. Dunk Island, Qld. 7/7/73. Under granite rock and on mud flat.

TASMANIAN MUSEUM AND ART GALLERY

The North-West Acid Plant Survey and Wesley Vale Offshore Survey were carried out by the Department of Agriculture, Sea Fisheries Division. The area covered by the North-West Acid Plant Survey lies offshore between Burnie and Penguin, N. W. Tasmania. That covered by the Wesley Vale Offshore Survey lies between Devonport and Port Sorell, N. W. Tasmania.

- TM G1348. Midway Point, Tasmania. Coll. G. Prestedge, 14/6/71.
 G1349. Same locality. 5/9/71.
 G1359. Same locality. 23/10/71.
 G1461. Western Port, Victoria. Coll. J. R. Penprace, 20/2/72.
 G1482. Sta. 3 of North-West Acid Plant Survey. 2½ miles off Burnie, Tasmania.
 G1509. Sta. 7 of Wesley Vale Offshore Survey. N.N.W. of Moorland Point, Tasmania. 7-11/6/71.
 G1510. Sta. 22 of Wesley Vale Offshore Survey. North of Pardoe Beach, N. W. Tasmania. 10 fms. 7-11/6/71.
 G1511. Sta. 18. Same as above.
 G1514. Darlington Beach, Maria Island, Tasmania. Collected by Turner and Dartnall, 16/4/67. In kelp holdfast.
 G1528. West of Cape Barren Is., Bass Strait, Tasmania. 16 fms. 14/10/50.
 G1529. Same as above.
 G1538. Marion Bay, S.E. Tasmania. Collected by Mrs E. Turner and A. J. Dartnall, 6/1/71.

UNIVERSITY OF QUEENSLAND

- UQ 35. 27°10'S., 153°21'E. 8 fms. 1/5/72.
 36. Gulf of Carpentaria 15°23'S., 137°E. Coll. Moore on "Clan Nellie"

NATIONAL MUSEUM OF VICTORIA

The stations below were collected by the Marine Pollution section of the Fisheries and Wildlife Department of Victoria as part of some zoobenthic studies in Western Port Bay. They were taken from the Crib Point area.

- VM Sta. 23N. Coarse gravel, some sand, much broken shell. 34 ft.
 25N. Sand, little mud, worm tubes. 36 ft.
 25S. Sand, mud, broken shell, sponges, etc. 28 ft.
 26S. Sand, with medium-sized pieces of old shell. 26/2/65. 32 ft.
 31N. Fine sand and mud. 48 ft.

- VM 31S. Same as the above.
32N. Sandy gravel. 21/2/69. 38 ft.
32S. Muddy sand and gravel, some shell. 2/2/69. 43 ft.
33S. Heavy reef with large stones, sponges, tunicates. 29/10/73. 42 ft.
41N. Fine gravel and sand with mud, heavy stones, etc. 1965, 1973, 52 ft.

Other Victoria Museum collections:

- VM 37. N.S.W. Coll. Mr Brown, July, 1872.
VM Sta. 918. Beaumaris, Port Phillip Bay, Victoria. 23/8/71. Sandy sediment. (See VM 924, B&B 1973:376).
Sta. 984. Sorrento, Port Phillip Bay, Victoria. 5 m. 24/11/72. With tunicate on sandy substrate. (See VM 924, B&B 1973:376).

WESTERN AUSTRALIAN MUSEUM

- WM 287-65. N. E. side Rosemary Is., Dampier Archipelago. Coll. B. R. Wilson and G. W. Kendrick, 27/8/61.
251-78-32. Cottesloe. Coll. L. Glauert, July, 1932.
131-76. Cockburn Sound, S.W.A. Coll. A. J. Santich, Feb., 1976.

APPENDIX III

Species of alpheids listed in the literature as from Australia under other than current names

| As previously listed | Reference | Present Name | Discussed in |
|--|--|---|---------------|
| <i>Alpheus alope</i> White | White, 1847:75; Miers, 1874:5 | <i>Nomen nudem</i> | B&B, 1977:281 |
| <i>A. avarus</i> Fabricius* | Heller, 1865:108; ? Bate, 1888:544 | ? <i>Alpheus strenuus</i> Dana | See footnote |
| <i>A. comatularum</i> Haswell | Haswell, 1882a:762 | <i>Synalpheus comatularum</i> (Haswell) | II:289 |
| <i>A. crassimanus</i> Heller | Bate, 1888:554 | <i>Alpheus lobidens</i> de Haan | III:252 |
| <i>A. crinitus</i> Dana | Coutière, 1900:413 | <i>Alpheus bucephalus</i> Coutière | III:120 |
| <i>A. doris</i> White | White, 1847:75; Miers, 1874:5 | <i>A. strenuus strenuus</i> Dana | B&B, 1977:281 |
| <i>A. doto</i> White | White, 1847:75; Miers, 1874:5 | <i>A. socialis</i> Heller | B&B, 1977:282 |
| <i>A. galathea</i> White | White, 1847:75; Miers, 1874:5 | <i>Nomen nudem</i> | B&B, 1977:282 |
| <i>A. gracilidigitus</i> Miers | Nobili, 1899:233 | <i>A. pacificus</i> Dana | III:217 |
| <i>A. insignis</i> Heller | ? Nobili, 1899:233 | <i>A. diadema</i> Dana | III:140 |
| <i>A. laevis</i> Randall | Heller, 1865:107; Haswell, 1882b:191 | <i>A. lottini</i> Guérin | III:65 |
| <i>A. neptunus</i> White | White, 1847:74; Miers, 1874:4 | ? <i>A. edwardsii</i> (Audouin) | B&B, 1977:280 |
| <i>A. paraculeipes</i> Coutière | Green, 1972:67 | <i>A. spongiarum</i> Coutière | III:116 |
| <i>A. rapax miersi</i> | Coutière, 1898d:166 | <i>A. miersi</i> Coutière | III:168 |
| <i>A. richardsoni</i> Yaldwyn | Yaldwyn, 1971:88 | <i>A. euphrosyne richardsoni</i> Yaldwyn | III:235 |
| <i>A. thetis</i> White | White, 1847:75; Miers, 1874:5 | <i>A. lottini</i> Guérin | B&B 1977:282 |
| <i>A. ventrosus</i> Milne-Edwards | Coutière, 1900:413; Patton, 1966:282; McNeill, 1968:15 | <i>A. lottini</i> Guérin | III:65 |
| <i>Betaeus trispinosus</i> Stimpson | Stimpson, 1861:32; Haswell, 1882b:192; Whitelegge, 1889:224 | <i>Alpheopsis trispinosus</i> (Stimpson) | I:337 |
| <i>Betaeus microstylus</i> Bate | Bate, 1888:566 | <i>Alpheus microstylus</i> (Bate) | III:319 |
| <i>Cheirothrix parvimanus</i> Bate | Bate, 1888:533 | <i>Batella parvimanus</i> (Bate) | III:16 |
| <i>Crangon bucephalus</i> var. (Coutière) | Rathbun, 1914:654 | <i>Alpheus bucephalus</i> Coutière | III:120 |
| <i>C. edwardsii</i> (Audouin) | Rathbun, 1914:654; Hale, 1927b:308 Pope, 1949:327 | <i>A. edwardsii</i> (Audouin) | III:270 |
| <i>C. novae-zealandiae</i> (Miers) | Hale, 1927a:47; 1927b:308 | <i>A. novaezealandiae</i> Miers | III:145 |
| <i>C. praedator</i> (De Man) | Hale, 1927a:47; 1927b:308 | <i>A. bidens</i> (Olivier) | III:136 |
| <i>C. strenuus</i> (Dana) | Pope, 1949:326 | <i>A. strenuus strenuus</i> Dana | III:225 |
| <i>C. villosus</i> (Olivier) | Hale, 1927a:46; 1927b:407; 1941:265 | <i>A. villosus</i> (Olivier) | III:49 |
| <i>Ogyris mjobergi</i> Balss | Balss, 1921:7 | <i>Ogyrides mjobergi</i> (Balss) | III:294 |
| <i>Palaemon bidens</i> Olivier | Olivier, 1811:663 | <i>Alpheus bidens</i> (Olivier) | III:136 |
| <i>P. brevirostris</i> Olivier | Olivier, 1811:664 | <i>A. brevirostris</i> (Olivier) | III:170 |
| <i>P. diversimanus</i> Olivier | Olivier, 1811:663 | <i>A. villosus</i> (Olivier) | III:49 |
| <i>P. villosus</i> | Olivier, 1811:664 | <i>A. villosus</i> (Olivier) | III:49 |

APPENDIX III, continued

| | | | |
|--|--|------------------------------------|--------|
| <i>Paralpheus diversimanus</i> (Olivier) | Bate, 1888:568 | <i>A. villosus</i> (Olivier) | III:51 |
| <i>Synalpheus bakeri stormi</i> De Man | Hale, 1941:265 | <i>Synalpheus fossor</i> (Paulson) | II:335 |
| <i>S. biunguiculatus</i> (Stimpson) | Ortmann, 1894:14; Coutière, 1900:411 | <i>S. coutierei</i> Banner | II:343 |
| <i>S. brucei</i> Potts | Potts, 1915:76; Clark, 1921:624 | <i>S. stimpsonii</i> (De Man) | II:292 |
| <i>S. falcatus</i> Bate | Bate, 1888:574 | <i>S. comatularum</i> (Haswell) | II:289 |
| <i>S. laevimanus haddoni</i> Coutière | Coutière, 1900:411 | <i>S. haddoni</i> Coutière | II:341 |
| <i>S. latastei</i> Coutière | Coutière, 1909:26 (listed with question) | (Evidently in error) | II:278 |
| <i>S. maccullochi</i> Coutière | ? Coutière, 1908a:13; Hale, 1927a:48; 1927b:308 | <i>S. tumidomanus</i> (Paulson) | II:377 |
| <i>S. neomeris pococki</i> Coutière | Coutière, 1898d:167 | <i>S. pococki</i> Coutière | II:366 |

*It should be noted that Heller in 1865 (p. 108) reported *A. avarus* from Sydney Harbour without further description or figures; he cited *A. strenuus* Dana as a synonym. Except for Bate (*loc. cit.*) who attempted to place a number of presently accepted species in synonymy with *A. avarus*, Fabricius' name has been almost unused in the last century (it was used by Heilprin, 1889a, b, and Gee, 1925) as the original description is faulty and without figures and the type specimen is evidently lost. While the name is still available it is a *nomen dubium* and probably should be officially suppressed; however, according to Holthius (1955:89) *A. avarus* is the type species for the genus. Heller's reference to Dana's work indicated his specimen belonged to the Edwardsii Group at least and possibly is the species presently recognized as *A. strenuus* Dana.

APPENDIX IV

ZOOGEOGRAPHIC SUMMARY

Distribution of alpheids and ogyridids in the faunal provinces of Australia.

In their summary of distribution and relationships of Australian decapod crustaceans, Griffin and Yaldwyn (1968:164) showed that these crustaceans could be divided into two major groups on the basis of their distribution: the tropical species of northern Australia and the temperate species from southern Australia. They reported that the two faunas met and overlapped along the east and west coasts. We have found the same type of division. However, as a device to separate better the distributional patterns we have used the zoogeographic provinces used by other authors (for a review, see Endean, 1957:234). The provinces are:

Solanderian: The cleaner waters of the Great Barrier Reef and most non-continental islands associated with it from the western edge of the Torres Straits (set at 141°30'E) to the Queensland-New South Wales border (at 28°S) (for convenience, 2° further south than the limit of Endean).

Banksian: The more turbid waters along the continental margins and the close-in continental islands within the same limits as the Solanderian Province; we have included in this province the islands of the Torres Straits.

Peronian: The temperate waters from 28°S along the southeast coast of Australia to the Bass Straits and eastern Tasmania; the westward limit we have set at 146°E.

Flinderian: Western Tasmania and the western section of Bass Straits (from 146°E) along the south coast of Australia and up the west coast to about Geraldton, with the limit set at 29°S.

Dampierian: Along the west, northwest and north coasts of Australia from 29°S. to west of the Torres Straits, 141°30'E.

We should caution that our distinction between the Solanderian and Banksian provinces is dulled by the lack of specific information on many of the older museum specimens for their locality labels would merely state "Cooktown, Qld." or "Cairns" and not state whether the specimens were collected along the shores or from off-shore reefs. Another lack of precise distinction lay in the continental islands like the Whitsunday Group which are definitely continental islands in the Banksian province, but in places have reefs similar to those found in the Solanderian province. Because of this confusion of labels and zones, some Solanderian species may have been added to the Banksian lists, thereby making that province by our figures the richest in number of species (fig. 94).

As shown by Griffin and Yaldwyn (*op. cit.*) and as pointed out in the following discussion, the arbitrary delimitations of the provinces are not recognized by the species themselves, and a typical Peronian species may invade the southern Banksian province and *vice versa*. What is actually found, then, is a broad zone of mixing between the adjacent provinces rather than a sharp line.

We should remind the reader that the coasts of Australia are not uniformly sampled, with the bulk of collections being in areas where active research units exist, for example around Heron Island in the Solanderian province, Brisbane in the Banksian, Sydney in the Peronian, and Melbourne and Perth at the margins of the Flinderian. From our records it appears that the Dampierian province has been visited largely by special expeditions or occasional itinerant individuals, and that almost no collections have been made at all in the Great Australian Bight that covers so much of the Flinderian province.

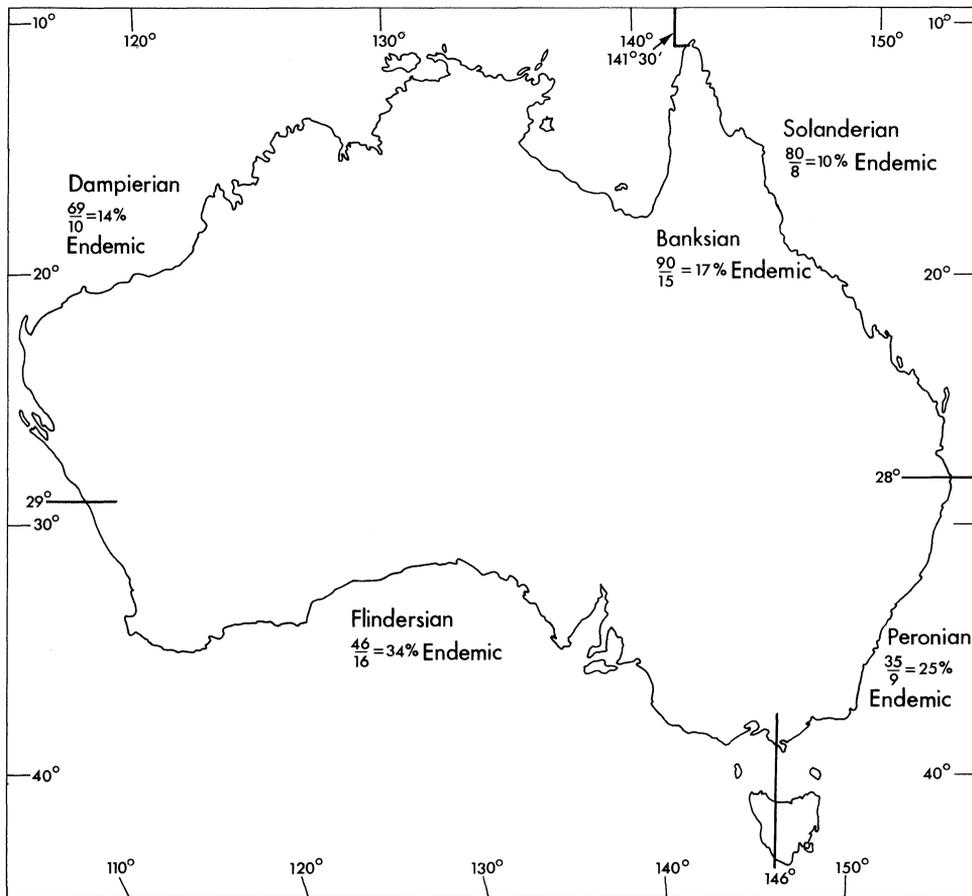


Fig. 95

Australia (sinusoidal projection), showing faunal provinces and percentages of endemism of alpheid and ogyridid shrimp. The location of the boundaries is discussed in the text, as well as the distinction between the Solanderian and Banksian provinces; in the figures, the numerator is the total number of species reported for the province, the denominator is the total number of endemic species found in the province, and the quotient is the percentage of endemism.

Finally, in fig. 95 and Table 8, we have treated the subspecies found in Australia as equal to the species, have considered the unnamed form *Alpheus* sp., as a separate species, and were forced to leave out *A. brevirostris* (Olivier) because there is no indication as to where it was collected in half the perimeter of Australia (see p.226). The two species of *Ogyrides* are also included in the computations.

As to be expected, the tropical fauna is best found in, but not confined to, the Dampierian, Solanderian and Banksian provinces. Many species penetrate further south than the Tropic of Capricorn. Along the east coast we find species especially of the Banksian province, which are species typically not associated with coral reefs, reaching as far south as Sydney, N.S.W. The limits of the tropical fauna on the west coast are more difficult to delimit both by the lack of large numbers of collections, and by the lack of extensive coral reefs. However, as we found that 7 tropical species had reached the Houtman Abrolhos slightly north of 29°S, these islands should be near the zone of transition. This is further north than Griffin and Yaldwyn found for the majid crabs (*op. cit.*, map 1). The large number of species shared by the Solanderian, Banksian and Dampierian provinces (see Table 8) would indicate that if the same habitats were found in the three provinces, they could be expected to have much the same species composition.

The temperate fauna of the Peronian and Flinderian provinces have many fewer species (fig. 94) and like the tropical fauna, many of these species reach into the adjacent parts of other provinces. For example, a number of species that appear to have arisen in the temperate fauna and are endemics (see below) reach up to Moreton Bay in the east and to Shark Bay in the west; two species, at least, reach from the south to the Gulf of Carpentaria.

Faunal Affinities and Endemism

As Griffin and Yaldwyn found for all decapods, almost all species found in the Dampierian, Banksian and Solanderian provinces are of Indo-Pacific relationship, with 101 of the 142 species and subspecies tabulated appearing elsewhere in the Indo-Pacific tropics. The group listed as "Indo-Pacific" included only those which were known to occur both in the Pacific north or east of Indonesia and in the Indian Ocean; the number of species in this group is likely to increase when more extensive collections are made in the western Pacific that are comparable to the collections made from the Maldives and Laccadives in the Indian Ocean. The number of species shared only between Indonesia and Australia is what one would expect considering, first, that most zoogeographers have found the great shallow-water triangle between Indonesia and the southern Philippines to be the richest area in species in the entire Indo-Pacific with many species that apparently have not spread far from the triangle, and, second, considering that the Indonesian shelf area is bridged by a tight island chain to the shelf area between New Guinea and northern Australia.

Some of the non-Australian distributional patterns shown in Table 8 and listed in the text under the distribution of each species appear to be sharply discontinuous. However, the discontinuities may be those of collection, not distribution. For example, the species shown as shared alone between Japan and the Dampierian province is *Athanas japonicus* Kubo, a species that was collected intertidally under rocks on mud-flats in southern Japan and in a mangrove swamp near Darwin, N.T. We are quite certain that if similar habitats were searched in the Philippines and Indonesia, the species would also be found there.

We also believe that the large number of apparent endemics in the tropical waters of Australia is also a reflection of the intensity of collection. Most appear in the extensive Australian collections as a single or several specimens; presumably if collections as exhaustive were made elsewhere in the Indo-Pacific, these species might be found there

Table 8. Faunal Relationships of Australian Alpheids and Ogyrids.

| Australian Distribution General Distribution | Total Number of Species | Australian Distribution | | | | | General Distribution | | | | | General Distribution | | | | | All Zones | | | | | | |
|---|-------------------------|-------------------------|----------|----------|------------|------------|----------------------|-----------|------------|-------------|--------------|----------------------|--------------|---------------------|--------------------|---------------------|-----------|----------------------|--------------------|----------------------------|--------------------------|--------------------------|----------------------------|
| | | Solanderian | Banksian | Peronian | Flinderian | Dampierian | Sol + Banks | Sol + Per | Sol + Damp | Banks + Per | Banks + Damp | Per + Flind | Flind + Damp | Sol + Banks + Flind | Sol + Banks + Damp | Banks + Per + Flind | | Banks + Flind + Damp | Per + Flind + Damp | Sol + Banks + Flind + Damp | Sol + Banks + Per + Damp | Sol + Per + Flind + Damp | Banks + Per + Flind + Damp |
| ENDEMIC | 36 | 4 | 7 | 1 | 8 | 4 | 2 | | | 2 | 1 | 2 | 1 | | | | | 1 | | | | 3 | |
| NON-ENDEMIC | | | | | | | | | | | | | | | | | | | | | | | |
| New Zealand only | 4 | | | 1 | | | | | | 1 | | | | | 1 | | | | | | | | 1 |
| Indonesia only | 14 | 1 | 4 | | | | 1 | | | | 2 | 1 | | 2 | | | 1 | | | 1 | | | 1 |
| Indonesia & Indian O. | 14 | 1 | 1 | | | | 1 | 2 | | | 3 | | | | 1 | 1 | | | 1 | | | | 3 |
| Indonesia & W. Pacific O. | 2 | | | | | | | | | | | | | 1 | | | | | 1 | | | | |
| Indonesia & Pacific O. | 6 | 1 | | | | | 2 | | | | | | 1 | 1 | | | | | | | | | 1 |
| Indian O. | 4 | 1 | | | | 1 | | | | | 1 | | | | | | | | | | | | 1 |
| Japan only | 1 | | | | | 1 | | | | | | | | | | | | | | | | | |
| Pacific O. | 2 | 2 | | | | | | | | | | | | | | | | | | | | | |
| Indo-Pacific | 52 | 9 | 2 | | | 3 | 9 | | 2 | 1 | 2 | | | 1 | 11 | | | | 3 | 2 | 1 | 1 | 5 |
| Indo-Pacific & E. Pacific | 3 | 1 | | | | | | | | | | | | | | | | | | | | | 2 |
| Circumtropical | 4 | 2 | | | | | | | | | | | | 1 | | | | | | | | | 1 |
| TOTAL NON-ENDEMIC | 106 | 18 | 7 | 1 | 0 | 5 | 13 | 2 | 2 | 2 | 8 | 0 | 1 | 2 | 16 | 2 | 1 | 1 | 6 | 2 | 1 | 1 | 15 |
| TOTAL SPECIES | 142 | 22 | 14 | 2 | 8 | 9 | 15 | 2 | 2 | 4 | 9 | 2 | 2 | 2 | 16 | 2 | 1 | 2 | 6 | 2 | 1 | 4 | 15 |

as well. An excellent example is the rare *Prionalpheus triarticulatus* B&B — it was until now “endemic” to the Fijian Archipelago, but if that sole specimen from Fiji had not been captured, the two specimens from Lizard Island on the Great Barrier Reef would have been “endemic”.

It is quite different with the endemics of the southern Australian waters. All except *Betaeus australis* Stimpson appear to be derived from tropical forms moving into colder waters, finding new ecological niches and being modified to suit these niches. Some of these modifications are great enough that we can recognize them as separate species or subspecies. Thus did the widespread Indo-Pacific *Synalpheus neptunus* (Dana) give rise to *S. n. germanus* B&B found only in the Flinderian province, and the even more widespread *Alpheus strenuus* Dana gave rise to *A. s. cremnus* B&B that is found in all Australian provinces except the Solanderian. We suspect there are other modifications, possibly minor in morphology, but greater in ecological requirements, behaviour and physiology, to be found in the large group of nominal species that penetrate far south of their normal coral reef habitats. These subtle changes may in the future be recognized as a basis for the specific separation of the temperate from the tropical races.

None of the species of alpheids save *Betaeus australis* appear to show relationship to other southern temperate faunas, although these faunas are poorly known (for New Zealand, see below). The exact affinities of *B. australis* are uncertain, but the members of the genus are typically temperate water forms in both the northern and southern hemispheres (the species that De Man named *Betaeus indicus* from Indonesia has been placed by Yaldwyn (1971:88) in his new genus *Betaeopsis*). Species from the genus have been reported both from southern South America and southern Africa; inasmuch as we have seen none of these southern species, we cannot postulate possible relationships.

The invasion of temperate waters by tropical species has given rise to the greatest regional endemism found for the family anywhere. Table 8 shows that all eight of the species found only in the Flinderian province are endemic, and of those confined to the Peronian and Flinderian provinces, 11 of the 12 are endemic. For the total Australian alpheid fauna, the figure is 25 per cent endemism, but as we pointed out above, we have doubts about the true endemism of some tropical species. In contrast, in Hawaii which is not contiguous with the other Indo-Pacific fauna as is southern Australia, but separated by about 3000 km of ocean from the closest archipelagoes, only 24 per cent of the species appear to be endemic (and that includes deep water forms that were not searched for elsewhere).

No definitive studies have yet been published of the New Zealand alpheids, but at least 4 species are endemic to Australia and New Zealand (thus, if these are lumped with the endemics confined to Australia alone, the total number of non-endemics is decreased to 102 and the number of endemics increased to 40). Two of these are confined to the Peronian and Flinderian provinces, one penetrates as far north as Moreton Bay, Qld., and one occurs in all Australian provinces.

The collections from Norfolk and Lord Howe Islands are too small to justify any conclusions, but the few species we have seen from the two islands are interesting. Eight species have been found on the two islands, 6 of which are Indo-Pacific species with wide distribution in Australia; of these 6, only one was collected from both islands, 3 were collected from Lord Howe alone and 2 from Norfolk. The other two species are among those endemic to the Australian-New Zealand waters: *A. socialis* Heller is known in Australia only from the Peronian province, while the other, *A. novaezealandiae* Miers, is found in all Australian provinces.

APPENDIX V

ERRATA

The following errors have been detected in the previously published portions; the errors and corrections are underscored.

Part I

- P. 298. Change diagnosis of Family Alpheidae dealing with the mandible to read "Mandible with molar and incisor process except in *Prionalpheus* and with palp of two articles except in *Prionalpheus* and *Batella*".
- P. 304. In dichotomy to "*A. dorsalis* (p. 327)" should read "p. 324".
- P. 316. The correct spelling of "*Athanas haswelli*" is "*A. hasswelli*" (cf. III: 132. fn.).
- P. 326. *A. mascarinicus* line 2 should read *A. mascarenicus*. Under *Biological notes*, the reference "Hipeau-Jacquotte, 1965:47" should read "1965:247".
- P. 327. Under *Specimens examined*, the reference "RG451" should read "RG 541".
- P. 330 et seq. *Aretopsis aegyptica* should read *Aretopsis aegyptiaca*.
- P. 337. The reference in synonymy, "*Alpheopsis trispinosus* Coutière . . . 3:382" should read ". . . 2(8):382".

Footnote. The name "*A. garrick*" should read "*A. garricki*".

- P. 352. Under *Biological notes*, *Galexia* should be spelt *Galaxea*.
- P. 355. Under AM 22, eliminate the last statement, "Commensal on urchin *Heliocidaris tuberculata*."
- P. 357. Under AM 156, "Same as AM 43" should read "AM 13".
- P. 358. Under AM 177 "Cape Varquar" should read "Cape Farquar".
- P. 362. Under AM 439, "Same as AM 103" should read "AM 13".
- P. 363. AM P. "2071-2" (listed below AM P.3014) should read "3071-2".
- P.365 AM P. "8565-67, 77" should read "8565-67, and 8677". Collecting information the same for all numbers.

Part II

- P. 292. The correct spelling of "*Synalpheus stimpsoni*" is "*S. stimpsonii*" (cf. III:132,fn.)
- P. 295. Table 2. Due to inadvertent error, the last 5 lines from Table 3 (p. 339) were copied instead of the correct 3 last lines of Table 2. Printed on the following separate page is a full and correct Table 2; it is recommended that this be removed and placed over the erroneous table in Part II, p. 295. (Table 3 is correct as printed.)
- P. 326. "*S. triunguiculatus* Paulson" in the third paragraph should read "*S. triunguiculatus* (Paulson)".
- P. 341. Under the paragraph entitled "Original description, our translation:" line 18 from top should read "the carpocerite, on the typical specimens . . ." instead of "the antennular peduncle, on the typical specimens . . ."
- P. 362. Under *Specimens examined*, citation "WM 94-65" should read "97-65".
- P. 369. *Synalpheus prolificus* should read *Alpheus prolificus*.
- P. 389. Add to dichotomy 3(2) "Distosuperior margin of merus . . ."

Corrected Table 2, for insertion in Banner and Banner 1975. The Alpheid Shrimp of Australia, Part II: The genus *Synalpheus*. *Rec. Aust. Mus.* 29(12):295

Table 2. Species reported in the *S. stimpsonii* complex

| Characteristic | <i>S. stimpsonii</i> | <i>S. amboinae</i> | <i>S. brucei</i> | <i>S. striatus</i> | Australian species |
|---|------------------------------|--|------------------------------|----------------------------|---|
| Tip of rostrum to second antennular article | To middle | Slightly past end | To end | To end | From distal quarter of first to beyond end of second |
| Length, orbital teeth to rostrum | 0.3 | Less than half | 0.3 | 0.4 | 0.3-0.6 |
| Length, orbital teeth to first antennular article | To middle | Past middle (De Man) | To middle | To middle | From middle almost to end |
| Length, visible part first antennular article to following articles | Longer than sum of following | Equal to sum of following | Same as <i>S. stimpsonii</i> | Same as <i>S. amboinae</i> | Length of first varying with angle it makes to carapace |
| Tip of stylocerite to antennular article | End first | Same | Same | 0.3 of second | From shorter to definitely longer than first |
| Relative length, teeth of basicerite | Teeth subequal | Inferior markedly longer than superior | Same as <i>S. amboinae</i> | Same as <i>S. amboinae</i> | Varying from condition in <i>S. stimpsonii</i> to condition <i>S. amboinae</i> |
| Length, carpocerite to antennular peduncle | Reaching to end | Same | Same | Same | A little shorter to a little longer than antennular peduncle |
| Length, squame to antennular peduncle | Equal | Slightly longer | Same as <i>S. amboinae</i> | Same as <i>S. amboinae</i> | From slightly shorter to slightly longer (lateral spine always longer, incurved or not) |
| Tooth above dactylar articulation, large chela | Slight | Slight | Absent | Slight | From strong and acute to absent; most slight to moderate |
| Length-breadth ratio large chela | 3.5 | 3.3 | 3.2 | 3.2 | 2.8-3.6 |

REFERENCES — Parts I-III*

*The actual date of publication does not always correspond to the official date used on the volume and in library cataloguing. Thus, our paper in *Pacific Science* 29(4):423-437 bears the date of the volume for 1974, but the next issue of the journal states that vol. 29 no. 4 was actually published under the definition by the *International Code of Zoological Nomenclature* in May, 1975. As the priority of names under the code and the actual date of publication is of primary importance, we have used this date where we have had evidence that it differs from the volume date; however, to facilitate the search for publications in libraries, we have included the volume date in parenthesis — thus, the case cited would be 1975 (1974). We discover at this time (October, 1977) that we have not been consistent in using the actual date of publication either in this now completed manuscript of Part III or in our previous publications, and we regret the confusion that will arise for future workers caused by differences in the texts between the cited dates in the texts and the two dates given in this bibliography.

- Alcock, A. and A. R. Anderson, 1899. An account of the deep-sea Crustacea dredged during the surveying-season of 1897-98. XLIII. Natural history notes from H. M. Royal Indian Marine Survey Ship 'Investigator', Commander T. H. Heming, R. N., commanding. Series III, No. 2. *Ann. Mag. nat. Hist.* VII. 3(16):278-292. (Alpheidae: pp. 283-284).
- Anonymous (White, A.), 1847. List of specimens of Crustacea in the collections of the British Museum. Printed by order of the Trustees, London, 1847, pp. i-viii, 1-143. (Alpheidae: pp. 74, 75).
- Armstrong, J. C., 1941. The Caridea and Stomatopoda of the second Templeton Crocker-American Museum expedition to the Pacific Ocean. *Am. Mus. Novit.* (1137):1-14, 4 figs. (Alpheidae: pp. 3-10, fig. 1-3).
- 1949. New Caridea from the Dominican Republic. *Am. Mus. Novit.* (1410):1-27, 9 figs. (Ogyrididae: pp. 1-8, fig. 1; Alpheidae: pp. 8-26, figs. 2-9).
- Audouin, V., 1827. Description de l'Égypt ou recueil des observations et des recherches qui ont été faites en Égypt pendant l'expédition de l'armée française. Ed. 2, 22:249-290. (cf. J. C. Savigny, 1809). (Alpheidae: pp. 274-275).
- Balss, H., 1921. Stomatopoda, Macrura, Paguridea and Galatheaidea. In Results of Dr E. Mjöberg's Swedish Scientific Expeditions to Australia 1910-1913. XXIX. K. *Svenska Vetensk. Akad. Handl.* 61(10):1-24, 12 figs. (Alpheidae: pp. 7-10).
- 1927. Bericht über die Crustacea Decapoda (Natantia und Anomura). In: Zoological results of the Cambridge Expedition to the Suez Canal, 1924. *Trans. zool. Soc. Lond.* 22(2):221-227. (Alpheidae: p. 222).
- Banner, A. H., 1953. The Crangonidae or snapping shrimp of Hawaii. *Pacif. Sci.* 7(1):1-147, 50 figs.
- 1956. Contributions to the knowledge of the alpheid shrimp of the Pacific Ocean. Part I. Collections from the Mariana Archipelago. *Pacif. Sci.* 10(3):318-373, 23 figs.
- 1957. *Op. cit.* Part II. Collections from Arno Atoll, Marshall Islands. *Pacif. Sci.* 11(2): 190-206, 5 fig.
- 1958. *Op. cit.* Part III. On a small collection from Onotoa, Gilbert Islands. *Pacif. Sci.* 12(2):157-169, 4 figs.
- 1959. *Op. cit.* Part IV. Various small collections from the central Pacific area, including supplementary notes on alpheids from Hawaii. *Pacif. Sci.* 13(2):130-155, 13 figs.
- Banner, A. H. and D. M. Banner, 1960a. Contributions to the knowledge of the alpheid shrimp of the Pacific Ocean. Part V. The Indo-Pacific members of the genus *Athanas*. *Pacif. Sci.* 14(2):129-155, 6 figs.
- 1960b. *Op. cit.* Part VI. *Prionalpheus*, a new genus of the Alpheidae. *Pacif. Sci.* 14(3):292-298, 2 figs.
- 1962. *Op. cit.* Part VIII. Losses of specimens in the fire of the Hawaii Marine Laboratory. *Pacif.*

- Sci.* 16(2):238-240.
- 1964. *Op. cit.* Part IX. Collections from the Phoenix and Line Islands. *Pacif. Sci.* 18(1):83-100, 5 figs.
- 1966a. *Op. cit.* Part X. Collections from Fiji, Tonga, and Samoa. *Pacif. Sci.* 20(2):145-188, 20 figs.
- 1966b. The alpheid shrimp of Thailand. *Siam Soc. Mono.* No. 3, pp. v+168, 62 figs.
- 1967. Contributions to the knowledge of the alpheid shrimp of the Pacific Ocean. Part XI. Collections from the Cook and Society Islands. *Bishop Mus. Occ. Pap.* 23(12):253-286, 5 figs.
- 1968. *Op. cit.* Part XII. Collections from the Marshall and Caroline Islands. *Micronesica* 4(2):261-294, 1 fig.
- 1971. *Op. cit.* Part XIV. A review of *Prionalpheus* (Decapoda, Alpheidae) with the description of two new species. *Crustaceana* 20(3):263-270, 2 figs.
- 1973 (1972). The establishment of a neotype for *Alpheus edwardsi* (Audouin). *Bull. Mus. natn. Hist. nat.*, Paris, III, 67(88):1141-1146, 1 fig.
- 1975 (1974). Contributions to the knowledge of the alpheid shrimp of the Pacific Ocean. Part XVII. Additional notes on the Hawaiian alpheids: new species, subspecies, and some nomenclatorial changes. *Pacif. Sci.* 28(4):423-437, 5 figs.
- 1977. Notes on the alpheids in White's 'List of the specimens of Crustacea in the collections of the British Museum' (1847). *Bull. Br. Mus. nat. Hist. (Zool.)* 31(6):279-283.
- Banner, D. M., 1970. Alpheid shrimp from the Line Islands, pp. 160-162. In K. E. Chave (ed.), Fanning Island Expedition, January 1970. *Hawaii Inst. Geophysics Publ.* HIG-70-23, pp. iv + 202.
- Banner, D. M. and A. H. Banner, 1972. Contributions to the knowledge of the alpheid shrimp of the Pacific Ocean. Part XV. The relationship of *Synalpheus neptunus* (Dana, 1852) to *Synalpheus theano* De Man, 1911, and the establishment of a neotype for *Synalpheus neptunus* (Decapoda, Alpheidae). *Crustaceana* 23(1):20-27, 3 figs.
- 1973. The alpheid shrimp of Australia. Part I. The lower genera. *Rec. Aust. Mus.* 28(15):291-382, 19 figs.
- 1975. *Op. cit.* Part II. The genus *Synalpheus*. *Rec. Aust. Mus.* 29(12):267-389, 29 figs.
- Banner, D. M. and C. R. Smalley, 1969. Contributions to the knowledge of the alpheid shrimp of the Pacific Ocean. Part XIII. Two species of alpheid shrimp, one new, common in the prawn trawls of Moreton Bay, Queensland, Australia. *Proc. R. Soc. Qd.* 81(3):43-50, 3 figs.
- Barnard, K. H. 1946. New species of South African decapod Crustacea (with notes on synonymy and new records). *Ann. Mag. nat. Hist.* XI, 13:361-392. (Alpheidae: pp. 387-390).
- 1950. Descriptive catalogue of South African decapod Crustacea (crabs and shrimps). *Ann. S. Afr. Mus.* 38:1-837, 154 figs. (Alpheidae: pp. 724-762, figs. 136-144. Ogyrididae: pp. 725-728, fig. 135).
- 1955. Additions to the fauna list of South African Crustacea and Pycnogonida. *Ann. S. Afr. Mus.* 43:8-107, 53 figs. (Alpheidae: pp. 45-46, fig. 22).
- 1958. Rediscovery of the genus *Racilius* Paulson. *Ann. Mag. nat. Hist.* XII, 10(118):752.
- Barry, C. K. 1965. Ecological study of the decapod crustaceans commensal with the branching coral *Pocillopora meandrina* var. *nobilis* Verrill. M. S. thesis, University of Hawaii, Honolulu, Hawaii.
- Bate, C. Spence, 1888. Report on the Crustacea Macrura dredged by H.M.S. Challenger during the years of 1873-76. In the voyage of H.M.S. *Challenger*, Zoology 24: xc+942 (157 pls. in separate vol.). Eyre & Spottiswoode, London. (Alpheidae: pp. 528-576, pls. 96-103).

- Boone, L., 1935. Crustacea and Echinodermata. Scientific results of the world cruise of the yacht *Alva*, 1931, William K. Vanderbilt, commanding. *Bull. Vanderbilt mar. Mus.* 6:1-263, 96 pls. and 13 text figs. (Alpheidae: pp. 119-150, pls. 31-37, text figs. 9-11).
- Borradaile, L. A., 1898. On some crustaceans from the South Pacific. Part III. Macrura. *Proc. zool. Soc. Lond.* 1898:1000-1015, pls. 63-65. (Alpheidae: 1011-1014, pl. 65).
- 1899, (1900). On the Stomatopoda and Macrura brought by Dr. Willey from the South Seas. In A. Willey (ed.), Zoological results based on material from New Britain, New Guinea, Loyalty Islands and elsewhere collected during the years 1895, 1896, 1897. Part IV., No. 20, pp. 395-428, pls. 36-39. University Press, Cambridge, England. (Alpheidae: pp. 415-418, pl. 38, 39).
- Bowers, R. L. 1970. The behavioral ecology of *Alpheus clypeatus* Coutière (Decapoda, Alpheidae). Ph.D. thesis, University of Hawaii, Honolulu, Hawaii.
- Brooks, W. K. and F. H. Herrick. 1891. IV. The metamorphosis of *Alpheus*. Pp. 361-369, pl. I, II, IV, XVI-XXIV. In W. K. Brooks, and F. H. Herrick (eds.), The embryology and metamorphosis of the Macroura. *Mem. natn. Acad. Sci.* 5:(321)-576, 57 pls.
- Bruce, A. J., 1969. *Aretopsis amabilis* de Man, an alpheid shrimp commensal of pagurid crabs in the Seychelle Islands. *J. Mar. biol. Ass. India* 11 (1&2):175-181, 4 figs.
- 1972. On the association of the shrimp *Racilius compressus* Paulson (Decapoda, Alpheidae) with the coral *Galaxea clavus* (Dana). *Crustaceana* 22(1):92-93.
- Calman, W.T. 1939. Crustacea:Caridea. In scient. Rep. John Murray Exped. 6:183-224. British Museum (Natural History). (Alpheidae: pp. 208, 209).
- Castro, P. 1971. The natantian shrimps (Crustacea, Decapoda) associated with invertebrates in Hawaii. *Pacif. Sci.* 25(3):395-403. (Alpheidae: pp. 399-400).
- Chace, F. A., Jr., 1937. The Templeton Crocker Expedition. VII. Caridean decapod Crustacea from the Gulf of California and the west coast of Lower California. *Zoologica*, N.Y. 22:109-138, 9 figs. (Alpheidae: pp. 118-126, figs. 4, 5).
- 1955. Notes on shrimps from the Marshall Islands. *Proc. U.S. natn. Mus.* 105(3349):1-21, 8 pls. (Alpheidae: pp. 13-21, pls. 7, 8).
- 1962. The non-brachyuran decapod crustaceans of Clipperton Island. *Proc. U.S. natn. Museum.* 113(3466):605-635, 7 figs. (Alpheidae: pp. 608-614).
- 1966. Decapod crustaceans from St. Helena Island, South Atlantic. *Proc. U.S. natn. Mus.* 119(3536):623-661, 15 figs. (Alpheidae: pp. 627-629, fig. 2).
- 1972. The shrimps of the Smithsonian-Bredin Caribbean Expeditions with a summary of the West Indian shallow water species. (Crustacea: Decapoda: Natantia). *Smithson, Contr. Zool.*, 1972(98):i+179, 61 figs. (Alpheidae: pp. 53-105, figs. 16-39. Ogyrididae: pp. 105-106).
- Chace, F. A., Jr. and J. Forest, 1970. Henri Coutière: son oeuvre carcino-logique, avec un index pour son Mémoire de 1899 sur les Alpheidae. *Bull. Mus. natn. Hist. nat.*, Paris, 11, 41(6):1459-1486.
- Clark, A. H. 1921. A monograph of the existing crinoids. *Bull. U.S. natn. Mus.* 82, 1(2):1-795, 57 pls., 949 text figs. (Alpheidae: pp. 623-627, text figs. 943, 944).
- Coutière, H. 1896a. Note sur un nouvel Alphéidé, *Betaeus Jousseumei* (Crust.). *Bull. Soc. ent. Fr.* 1896(13):313-317, 1 fig.
- 1896b. Note sur quelques genres nouveaux ou peu connus d'alphéidés. formant la sous-famille des alphéopsides. *Bull. Mus. Hist. nat.*, Paris, 2(8):380-386.
- 1897a. Note sur quelques alphéidés nouveaux ou peu connus rapportés de Djibouti (Afrique Orientale). *Bull. Mus. Hist. nat.*, Paris, 3(6):233-236.
- 1897b. Note sur un nouveau genre d'alphéidés. *Bull. Mus. Hist. nat.*, Paris, 3(7):301-303.

- 1897c. Note sur quelques alphéés nouveaux. *Bull. Mus. Hist. nat.*, Paris, 3(7):303-306.
- 1897d. Notes biologiques sur quelques espèces d'alphéidés observés à Djibouti. *Bull. Mus. Hist. nat.*, Paris, 3(8):367-371.
- 1897e. Note sur quelques espèces du genre. *Alpheus* du Musée de Leyde. *Notes Leyden Mus.* 19(23):195-207.
- 1898a. Note sur *Alpheus Talismani* n. sp. et *A. macroskeles* (Alcock et Anderson (Crust.)). *Bull. Soc. ent. Fr.* 1898(3):31-33, 4 figs.
- 1898b. Note sur quelques formes nouvelles d'alphéidés voisins de *A. Bouvieri* A. M. — Edwards (Crust.) *Bull. Soc. ent. Fr.* 1898(5):131-134, 5 figs.
- 1898c. Note sur quelques alphéidés nouveaux de la collection du British Museum (Crust.). *Bull. Soc. ent. Fr.* 1898(6):149-152, 2 figs.
- 1898d. *Op. cit.* *Bull. Soc. ent. Fr.* 1898(7):166-168, 3 figs.
- 1898e. Sur quelques variétés de *Synalpheus laevimanus* Heller (Crust.). *Bull. Soc. ent. Fr.* 1898(8):188-191, 4 figs.
- 1898f. Note sur *Alpheus villosus* Olivier (Crust.). *Bull. Soc. ent. Fr.* 1898(9):204-206.
- 1898h. Note sur quelques cas de régénération hypotypique chez *Alpheus* (Crust.). *Bull. Soc. ent. Fr.* 1898(12):248-250, 8 figs.
- 1898i. Notes sur la faune des récifs madréporiques de Djibouti. *Bull. Mus. Hist. nat.* Paris 4(4):195-198.
- 1899. Les "Alpheidae" morphologie externe et interne, formes larvaires, bionomie. Thèses présentées à la Faculté des Sciences de Paris . . . Sér. A, No. 321 No. d'ordre 980. 559 pp. 409 text figs., 6 pls. Masson et Cie, Paris. (Also in: *Ann. Sci. Nat.*, VIII, Zool. 9:1-560). (For index see: Chace and Forest, 1970).
- 1900. Note sur une collection d'Alpheidae provenant détroit de Torrès. *Bull. Mus. Hist. nat.*, Paris, 6(8):411-414, 4 figs.
- 1902. Sur quelques espèces nouvelles du genre *Automate* de Man. *Bull. Mus. Hist. nat.*, Paris, 8(5):337-342.
- 1903. Note sur quelques Alpheidae des Maldives et Laquedives. *Bull. Soc. philomath.* Paris IX, 5(2):72-90, 38 figs.
- 1904. Note sur le commensalisme de *Arete dorsalis* var. *Pacificus* H. Coutière, d'après les notes de M. L. Seurat, naturaliste, à Rikitea (Iles Gambier). *Bull. Mus. Hist. nat.*, Paris, 10(2):58-60.
- 1905a. Les Alpheidae. In J. S. Gardiner (ed.), The fauna and geography of the Maldive and Laccadive Archipelagoes. Vol. 2(4):852-921, pl. 70-87, text figs. 127-139. University Press, Cambridge, England (Vol. dated 1906).
- 1905b. Note sur quelques Alpheidae recueillis par M. G. Seurat à Marutea (Iles Gambier). *Bull. Mus. Hist. nat.*, Paris, 11(1):18-23, 1 fig.
- 1908a. Sur quelques nouvelles espèces d'Alpheidae. *Bull. Soc. philomath.* Paris, IX, 11(5):191-216. (Pagination in reprint from 1-26, without indication of journal pagination; we have used reprint pagination).
- 1908b. Sur les synalphees Americaines. C. r. hebd, séanc. Acad. Sci. Paris, 146:710-712.
- 1909. The American species of the snapping shrimp of the genus *Synalpheus*. *Proc. U.S. natn. Mus.* 36(1659):1-93, 54 figs.
- 1921. Les espèces d'Alpheidae rapportées de l'Océan Indien par M. J. Stanley Gardiner.

Trans. Linn. Soc. Lond. II Zool., 17(4):413-428, pls. 60-64. (Also titled: Reports of the Percy Sladen Trust Expedition to the Indian Ocean in 1905, 6(10):413-428).

- Cowles, R. P. 1913. The habits of some tropical Crustacea. *Philipp. J. Sci.* 8D:119-124, 1 pl. 3 text figs.
- Crosnier, A. and J. Forest, 1965a. Remarques sur quelques espèces ouest-Africaines d'Alpheidae (Decapoda Macrura). Description d'*Alpheus blachei* sp. nov. *Bull. Mus. natn. Hist. nat.*, Paris, II, 36(3):355-367, 5 figs.
- 1965b (1964). Note préliminaire sur les Alpheidae recueillis par la Calypso dans l'Atlantique Oriental tropical. *Bull. Mus. natn. Hist. nat.*, Paris, II, 36(5):602-610, 3 figs.
- 1966. Crustacés décapodes: Alpheidae. In Campagne de la Calypso dans le Golfe de Guinée et aux îles princepe, São Tomé et Annobon (1956), et campagne aux îles du Cap Vert (1959). XXVII (Fasc. 7). *Ann. Inst. Ocean.* 44:199-314. (Masson et Cie, Paris).
- Dakin, W. G., 1952. Australian Seashores. Angus and Robertson, Sydney, London. pp. i+372, 98 pls. 23 text figs. (Alpheidae: pp. 177-179, 352, 353, text fig. 18).
- Dana, J. D., 1852. Crustacea*. In United States Exploring Expedition, during the years 1838, 1839, 1840, 1841, 1842 under the command of Charles Wilkes, U.S.N. 13:viii +685. C. Sherman Philadelphia. (Alpheidae: pp. 541-561).
- 1855. *Op. cit.* Folio atlas 13:1-27, pls. 1-96. (Alpheidae: pl. 34, 35).
- Drouet, F., 1968. Revision of the classification of the Oscillatoriaceae. Monograph No. 15. *Proc. Acad. nat. Sci. Philad.* 370 pp, 131 figs.
- Edmondson, C., 1925. Crustacea. Marine Zoology of tropical central Pacific. (Tanager Expedition Publ. 1). *Bull. Bernice P. Bishop Mus.* 27:3-62, 4 figs. (Alpheidae: pp. 9-18, figs. 1-3).
- Ekman, S., 1953. Zoogeography of the Sea. Sidgwich and Jackson, London. pp. xiv + 417.
- Endean, R., 1957. The biogeography of Queensland's shallow-water echinoderm fauna (excluding Crinoidea), with a rearrangement of the faunistic provinces of tropical Australia. *Aust. J. mar. Freshwat. Res.* 8(3):233-273, 5 figs.
- Estampador, E. P., 1937. A checklist of Philippine crustacean decapods. *Philipp. J. Sci.* 62(3):465-559. (Alpheidae: pp. 479-482).
- Etheridge, R., 1889. The general zoology of Lord Howe Island; containing also an account of the collections made by the Australian Museum collecting party, Aug. — Sept., 1887. *Mem. Aust. Mus.* 2:1-42. (Alpheidae: pp. 35, 36).
- Fabricius, J. C. 1775. Systema entomologiae sistens insectorum classes ordines, genera, species adiectis synonymis, locis, descriptionibus, observationibus. Flensburgi et Lipsiae (Flensburg and Leipzig.) Pp. 1-832. (Alpheidae: p. 415).
- 1798. Supplementum entomologiae systematicae, Hafniae (Copenhagen). Pp. 1-572. (Alpheidae: pp. 404-406).
- Farrow, G. E., 1971. Back reef and lagoonal environments of the Aldabra Atoll distinguished by their crustacean burrows. In D. R. Stoddard and M. Yonge (eds.), Regional Variation in Indian Ocean Coral Reefs. *Symp. zool. Soc. Lond.* 28:455-500.
- Fishelson, L., 1966. Observations on the littoral fauna of Israel. V. On the habitat and behaviour of *Alpheus frontalis* H. Milne-Edwards (Decapoda, Alpheidae). *Crustaceana* 11(1):98-104, 3 figs.

*While we have referred to this publication of Dana in our text, it should be noted that his "Conspectus Crustaceorum . . . Conspectus of the Crustacea of the Exploring Expedition under Capt. Wilkes, U.S.N." *Acad. nat. Sci. Philad., Proc.* 6:6-28 actually appeared in May, 1852, while the major work appeared sometime before December, 1852 according to Dr. L. B. Holthuis — see discussion in Banner, 1956:372. Therefore, the Conspectus should be used for questions of priority.

- Fleminger, A., 1973. Pattern, number, variability and taxonomic significance of the integumental organs (sensilla and glandular pores) in the genus *Eucalanus* (Copepoda, Calanoida). *Fish. Bull. U.S. Dept. Commerce* 71(4):965-1010, 22 figs.
- Forest, J. and D. Guinot, 1956. Sur une collection de crustacés décapodes et Stomatopodes des mers Tunisiennes. *Bull. Stn. oceanogr. Salammbó* (53):24-43. (Alpheidae: pp. 29-30).
- 1958. Sur une collection de crustacés décapodes des côtes d'Israel. *Bull. Sea Fish. Res. Stn. Israel* (15):4-16, 9 figs. (Alpheidae: pp. 6-10, figs. 1-7).
- Fourmanoir, P., 1958. Crevettes alpheides de Nosy-Be. *Naturaliste malgache* 10(1-2):115-127, figs. 1-15.
- Fujino, T. and S. Miyake, 1970. Caridean and stenopodidean shrimps from the East China and Yellow Seas. (Crustacea, Decapoda, Natantia). *J. Fac. Agric., Kyushu Univ.* 16(3):237-312, 25 figs. (Ogyrididae: pp. 255-257, fig. 6).
- Gee, N. G. 1925. Tentative list of Chinese Decapod Crustacea including those represented in the collections of the United States National Museum (marked with an *) with localities at which collected. *Lingnaam agric. Rev.* 3:156-163. (Not seen).
- Gillett, K. and F. McNeill, 1959. The Great Barrier Reef and adjacent isles. Coral Press, Pty. Ltd. Sydney. Pp. 1-194. (Alpheidae: p. 123, pl. 123, text fig. 2).
- Gillett, K. and J. Yaldwyn, 1969. Australian Seashores in Colour. A. H. & W. A. Reed, Sydney, Melbourne, Wellington, Auckland, 112 pp., 52 pls. (Alpheidae: p. 70, fig. 41).
- Grant, F. E. and A. R. McCulloch, 1907. Decapod Crustacea from Norfolk Island. *Proc. Linn. Soc. N.S.W.* 32:151-156. (Alpheidae: p. 156).
- Gravely, F. H., 1930. The Alpheidae of Krusadai Island. *Bull. Madras Govt. Mus. new ser. (Nat. Hist.)* 1(2):77-79, pl. 1.
- Green, A. 1972. A report of the fifth expedition to the Easter and Pelsart Group of Houtman's Abrolhos, Aug. 22-28, 1970 made by the students of Aquinas College, Manning, W.A. 80 pp., 52 figs. (Alpheidae: p. 67).
- Griffin, D. J. and J. Yaldwyn, 1968. The constitution, distribution and relationships of the Australian decapod Crustacea. A preliminary review. *Proc. Linn. Soc. N.S.W.* 93(1):164-183, 5 figs., 7 tables.
- Guérin-Ménéville, F. E., 1829-44. Iconographie du règne animal de G. Cuvier, ou représentation d'après nature de l'une des espèces les plus remarquables et souvent non encore figurées, de chaque genre d'animaux. Avec une texte descriptif mis accourant de la science. Ouvrage pour servir d'atlas a tous les traités de zoologie. Vol. 2, Planches des animaux invertébrés, pls. 1-104; Vol. (?) 3, Crustacés, pp. 1-48. J. B. Baillière, Paris, London. (Alpheidae: Vol. 2, pls. 21, 22; Crustacés, pp. 15, 16).
- 1838 (1830 on title page). Crustacés, arachnides et insectes. In L. I. Duperrey (M. Lesson on title page) (ed.), Voyage autour du monde, exécuté par ordre du Roi sur la corvette de Sa Majesté, La Coquille, pendant les années 1822, 1823, 1824 et 1825 . . . Zoology (T. II, Part II, Ire Div., Chapt. II): xii + 9-319. Arhus Bertrand, Paris. (Plates published earlier, with Pl. 3 in 1829; see Holthuis, 1961:168).
- Guinot, D., 1977. Propositions pour une nouvelle classification des Crustacés Décapodes Brachyours. *C.R. Acad. Sci. Paris* 285D (10):1049-1052.
- Gurney, R. 1927. Report on the larvae of the Crustacea Decapoda. In Zoological results of Cambridge Expedition to the Suez Canal, 1924. *Trans. zool. Soc. Lond.*, 22(2):231-286. (Alpheidae: pp. 261-264, figs. 63-65).
- 1938. The larvae of decapod Crustacea. Palaemonidae and Alpheidae. In *Scient. Rep. Gt.*

- Barrier Reef Exped.* 6(1):1-60, 165 text figs. British Museum (Natural History). (Alpheidae: pp. 44-59, figs. 193-265).
- Haan, W. de (1850). Crustacea. In P. F. de Siebold, *Fauna Japonica sive descriptio animalium, quae in itinere per Japoniam, jussu et auspiciis superiorum, qui summum in India Batava Imperium tenent, suscepto, annis 1823-1830 collegit, notis observationibus; et adumbrationibus illustravit*, pp. i-xvii, i-xxxi, 1-244, pls. 1-55, A-Q, 1, 2. Lugduni, Batavorum. (Alpheidae: pl. 45, issued in 1844; pp. 176-180, issued in 1849).
- Hale, H. M., 1927a. The Crustaceans of South Australia. Part I. pp. 1-201, 202 figs. Government Printer, Adelaide, S.A. (One of the Handbooks of the Flora and Fauna of South Australia, issued by the British Science Guild (South Australian Branch.)) (Alpheidae: pp. 44-48, figs. 36-39).
- 1927b. The fauna of Kangaroo Island, South Australia. No. 1 — Crustacea. *Trans. R. Soc. S. Aust.* 51:307-321, 7 figs. (Alpheidae: pp. 307-308).
- 1929. Notes on the fauna of Dirk Hartog Island, South Australia. No. 4. Crustacea. *Trans. R. Soc. S. Australia.* 53:67-70, pl. 5. (Alpheidae: p. 68).
- 1941. Decapod Crustacea. In H. Johnston (ed.), *Rep. B.A.N.Z. antarct. Res. Exped. Series B*, vol. 4(9):257-286, pl. 3. 16 text figs. B.A.N.Z.A.R. Expedition committee, Adelaide, S.A.
- Harada, E., 1969. On the interspecific association of a snapping shrimp and gobioid fishes. *Publ. Seto mar. biol. Lab.* 16(5):315-334, 10 figs.
- Haswell, W.A., 1882a (1881). Description of some new species of Australian Decapoda. *Proc. Linn. Soc. N.S.W.* 6(4):750-763. (Alpheidae: 762-763).
- 1882b. Catalogue of the Australian stalk- and sessile-eyed Crustacea (Catalogue No. 5). Australian Museum, Sydney. Pp. xxiv + 324, 4 pls. (Alpheidae: pp. 186-192).
- Hay, W. P. and C. A. Shore, 1918. The decapod crustaceans of Beaufort, N. C., and the surrounding region. *Bull. U.S. Bur. Fish.* 35:369-476, pls. 25-39, 20 text figs. (Alpheidae: pp. 382-389, p. 26, text figs. 5-12; Ogyrididae: pp. 388-389, pl. 26, 27, text figs. 11, 12).
- Healy, A. and J. Yaldwyn, 1970. Australian Crustaceans in Colour. A. H. & A. W. Reed, Sydney, Australia. 112 pp., 52 pls. (Alpheidae: p. 40, pl. 18).
- Heilprin, A., 1889a, (1888). Contributions to the natural history of the Bermuda Islands. *Proc. Acad. nat. Sci. Philad.* 1888:302-328. (Alpheidae:321-322).
- 1889b. The Bermuda Islands. A contribution to the physical history and zoology of the Somers Archipelago. With an examination of the structure of coral reefs, pp. 1-231, pls. 1-17, 11 pls. in the text. (Not seen).
- Heller, C. 1862, (1861). Beiträge zur crustaceen-fauna des Rothen Meeres. *Sbr. Akad. Wiss., Wien* 44(2):241-295, 3 pls. (Alpheidae: pp. 267-274, pl. 3).
- 1862. Beiträge zur näheren Kenntniss der Macrouren. *Sbr. Akad. Wiss., Wien* 45(1):389-426, pls. 1, 2. (Alpheidae: pp. 400-406, pl. 1).
- 1865. Crustacea. In *Reise der Österreichischen Fregatte Novara um die Erde in den Jahren 1857, 1858, 1859 unter den Befehlen des Commodore B. von Wüllerstorff-Urbair*. Zool. Thiel. Vol. 2 (3):1-280, pls. 1-25. (Government Printers) Wien. (Alpheidae: pp. 106-108, pl. 10).
- Henderson, J. R. 1893. A contribution to Indian carcinology. *Trans. Linn. Soc. Lond.* 11, 5(10):325-458, pls. 36-40. (Alpheidae: pp. 434-436, pl. 40).
- Hendrix, G. Y. 1971. A systematic study of the genus *Alpheus* (Crustacea: Decapoda: Alpheidae) in South Florida. Ph.D. thesis, University of Miami, Coral Gables, Florida.
- Herrick, F. H. 1891. V. *Alpheus* A study in the development of Crustacea, pp. 370-461, pls. 25-57. In W. K. Brooks and F. H. Herrick (eds.). *The embryology and metamorphosis of the Macrourea*. *Mem. natn. Acad. Sci.* 5:321-576, 57 pls.

- Hilgendorf, F. 1879, (1878). Die von Hr. W. Peters in Moçambique gesammelten Crustaceen, (bearbeitet von Hr. Dr. F. Hilgendorf.) *K. Akad. Wiss. Berlin Mbr.* 25:782-851, 4 pls. (Alpheidae: pp. 829-835, pl. 4).
- Hipeau-Jacquotte, R. 1965. Notes de faunistique et de biologie marines de Madagascar. III — Un nouveau decapode nageur (Pontoniinae) associe aux oursins dans la region de Tuléar. *Tuleariocaris holthuisi nov. gen. et nov. sp. Rec. trav. Stn. mar. Endoume.* Bull. 37, fasc. 53, pp. 247-259, 5 pls.
- Holmes, S. J. 1900. Synopsis of California stalk-eyed Crustacea. *Occ. Pap. Calif. Acad. Sci.* 7:1-262, 4 pls., 6 text figs. (Alpheidae: pp. 181-192, pl. 2, 3).
- Holthuis, L. B. 1951. The caridean Crustacea of tropical West Africa. In A. F. Bruun. (ed.), *Atlantide Rep. No. 2*, pp. 7-187, 34 figs. Danish Science Press, Copenhagen. (Alpheidae: pp. 69-119, figs. 14-24; Ogyrididae: pp. 119-124, fig. 25).
- 1952. The Crustacea Decapoda Macrura of Chile. Reports of the Lund University Chile Expedition 1948-49. *K. fysiogr. Sällsk. Lund Förh.* NF 62(10):1-110, 18 figs. (Also entitled: *Lunds Universitets Årsskr.* N. F. Avd. 2, Bd. 47., Nr. 10). (Alpheidae: pp. 23-49, figs. 5-9).
- 1955a. The recent genera of the caridean and stenopodidean shrimps (class Crustacea, order Decapoda, supersection Natantia) with keys for their determination. *Zool. verh. Leiden* (26):1-157, figs. A, B + 105. (Alpheidae: pp. 82-93, figs. 56-63; Ogyrididae: p. 93, fig. 64).
- 1955b. Proposed addition to the "Official List of Generic Names in Zoology" of the name of one hundred and two genera of Caridae . . . *Bull. zool. Nom.* 11(7):204-228. (Alpheidae: 219-221; Ogyrididae: p. 213).
- 1958. Contributions to the knowledge of the Red Sea. No. 8. Crustacea Decapoda from the northern Red Sea (Gulf of Aqaba and Sinai Peninsula). I. Macrura. *Bull. Sea Fish. Res. Stn., Israel* No. 17, pp. 1-40, 15 figs. (Alpheidae: pp. 14-32, figs. 5-12).
- 1961. On the dates of publication of the crustacean plates in Duperry's "Voyage Autour du Monde . . . sur . . . La Coquille". *Crustaceana* 3(2):168-169.
- 1969. Thomas Say as a carcinologist. In: Thomas Say. An account of the Crustacea of the United States. (A reprint of Say's original work). *Historiae Naturalis Classica* 73:V-XV. J. Cramer, Lehre (Germany).
- Holthuis, L. B. and E. Gottlieb, 1958. An annotated list of the Decapod Crustacea of the Mediterranean coast of Israel, with an appendix listing the Decapoda of the Eastern Mediterranean. *Bull. Res. Coun. Israel* 7B(1-2):1-126, 3 pls, 14 text figs. (Alpheidae: pp. 27-48, figs. 2-9; Ogyrididae: pp. 48-51, fig. 10).
- Hult, J., 1938, (1939). Crustacea Decapoda from the Galapagos Islands collected by Mr Rolf Blomberg. *Ark. Zool.* 30A(5):1-18, 4 text figs., 1 pl. (Alpheidae: pp. 3-5).
- Hutchings, P. A. and H. F. Recher, 1974. The fauna of Careel Bay with comments on the ecology of mangrove and sea-grass communities. *Aust. Zool.* 18(2):99-128, 6 tables, 9 figs. (Alpheidae: pp. 106, 120, tables 2,6).
- Hutchings, P. A. and P. B. Weate. *In press*. The distribution and abundance of cryptofauna of Lizard Island, Great Barrier Reef. *Indones. J. Zool.*
- Hyman, L. H. 1959. The Invertebrates. V: Smaller coelomate groups, Chaetognatha, Hemichordata, Pogonophora, Phoronida, Ectoprocta, Brachiopoda, Sipunculida the coelomate Bilateria. McGraw-Hill, N.Y., London, Toronto. Pp. viii + 782, 240 figs.
- International Commission of Zoological Nomenclature, 1955. (Francis Hemming, ed.). Opinions and declarations rendered by the International Commission on Zoological Nomenclature. Opinion 334. Validation under plenary powers, of the generic names *Crangon* Fabricius 1798 and *Alpheus* Fabricius 1798 (Class Crustacea, Order Decapoda) 10(1):44.

- International Congress of Zoology, 1961. International Code of Zoological Nomenclature adopted by the XV International Congress of Zoology. (N. R. Stoll, R. Ph. Dollfus, J. Forest, N. D. Riley, C. W. Sabrosky, C. W. Wright, R. V. Melville, eds.) Pp. xviii + 176. International Trust for Zoological Nomenclature, London.
- 1964. (Same title, same editors as 1961). Pp. xix + 175. (Same publisher). (Some revisions of the 1961 Code).
- 1974. Report of special session held at Usaoset, Norway, September, 1973. *Bull. zool. Nom.* 31(2):65-102. (Further revision of the 1961 Code and revisions of the 1964 revisions).
- Jacquotte, R. 1964. Notes de faunistique et de biologie marines de Madagascar. II. Decapodes nageurs associes aux echinodermes dans la region de Tulear. *Rec. Trav. Stn. mar. Endoume Bull.* 32, fasc. 48, pp. 179-181.
- Johnson, D. S. 1962a, (1961). A synopsis of the Decapoda Caridea and Stenopodidea of Singapore, with notes on their distribution and a key to the genera of Caridea occurring in Malayan waters. *Bull. natn. Mus. St. Singapore* 30:44-79, pl. 2. (Alpheidae: pp. 49-54).
- 1962b. Commensalism and semi-parasitism amongst decapod Crustacea in Singapore waters. In Proceedings of the first Regional Symposium of Scientific Knowledge of Tropical Parasites, Univ. Singapore pp. 282-288. UNESCO, Paris. (Alpheidae: pp. 282-284).
- 1965. A review of the brackish water prawns of Malaya. *Bull. natn. Mus. St. Singapore* 33(2):7-11. (Alpheidae: p.9).
- Karplus, I., M. Tsurnamal and R. Szlep, 1972. Analysis of the mutual attraction in the association of the fish *Cryptocentrus cryptocentrus* (Gobiidae) and the shrimp *Alpheus djiboutensis* (Alpheidae). *Mar. Biol.* 17:275-283, 5 tables, 9 figs.
- 1974. The burrows of alpheid shrimp associated with gobiid fish in the northern Red Sea. *Mar. Biol.* 24(3):259-268, 6 figs.
- Kemp, S. 1915. Crustacea Decapoda, Fauna of the Chilka Lake. *Mem. Indian Mus.* 5(3):199-326, pls. 12, 13, text figs. 1-38. (Alpheidae: pp. 289-307, pl. 13, text figs. 32, 33; Ogyrididae: pp. 284-289, text fig. 31).
- Kensley, B., 1970. A small collection of decapod Crustacea from Mozambique. *Ann. S. Afr. Mus.* 57(5):103-122, 14 figs. (Alpheidae: pp. 118-121, figs. 12-14).
- Kingsley, J. S., 1878. (Art. VII.) A synopsis of the North American species of the genus *Alpheus*. *Bull. U.S. Geol. and Geogr. Surv. Territories* 4(1):189-199.
- 1882. Carcinological notes: Number V. *Bull. Essex Inst.* 14:105-132, pls. 1, 2. (Alpheidae: pp. 109-127, pl. 2).
- Knowlton, R. and J. M. Moulton, 1963. Sound production in the snapping shrimps *Alpheus (Crangon)* and *Synalpheus*. *Biol. Bull. mar. biol. Lab., Woods Hole.* 125(2):311-331, 20 figs.
- Krøyer, H., 1842. De Hidtil bekjendte nordiske Krangon-Arter. *Naturh. Tidsskr.* 4:217-276, table 4,5.
- Kubo, I., 1936. A description of a new alpheoid shrimp from Japan. *J. Imp. Fish. Inst., Tokyo.* 31(2):43-46, pl. 13.
- 1938. A new snapping shrimp belonging to the genus *Synalpheus*. *Annotnes zool. jap.* 17(1):89-92, 2 figs.
- 1940a. On some littoral shrimps collected from Micronesia. *J. Imp. Fish. Inst., Tokyo.* 34(1):77-99, 15 figs. (Alpheidae: pp. 87-95, figs. 10-13).
- 1940b. Notes on the Japanese shrimps of the genus *Athanas* with a description of one new species. *Annotnes zool. jap.* 19(2):99-106, 5 figs.
- 1942. On a snapping shrimp *Athanas kominatoensis*. *Zool. Mag., Tokyo (Dobutsugaku*

Zasshi) 54:82-85, 2 figs.

- 1951. Some macrurous decapod Crustacea found in Japanese waters, with descriptions of four new species. *J. Tokyo Univ. Fish.* 38(2):259-289, 16 figs. (Alpheidae: pp. 265-268, figs. 5, 6).
- Lanchester, W. F., 1901. Part I. — Brachyura, Stomatopoda and Macrura. 2. On the Crustacea collected during the "Skeat" Expedition to the Malay Peninsula, together with a note on the genus *Actaeopsis*. *Proc. Zool. Soc. Lond.* 2:534-574, pls. 33, 34. (Alpheidae: pp. 563-565, pl. 34).
- Leach, W. E. 1814. Crustaceology. In D. Brewster (ed.), *Edinburgh Encyclopedia*, vol. 7:383-437, pl. 221. Blackwood, Edinburgh.
- 1815. XXXI. A tabular view of the external characters of four classes of animals, which Linné arranged under Insecta; with the distribution of the genera composing three of these classes into orders, etc. and descriptions of several new genera and species. *Trans. Linn. Soc. Lond.* 11(2):306-400. (Alpheidae: pp. 336, 347, 349).
- Lebour, M. V., 1938. Decapod Crustacea associated with the ascidian *Herdmania*. *Proc. zool. Soc. Lond. Ser. B*, 108(27):649-653, pl. 1, 2. (Alpheidae: pp. 651-653, pl. 2).
- Ledoyer, M. 1968. Les Caridea de la frondaison des herbiers de phanérogames de la région de Tuléar. *Ann. Univ. Madagascar (Sci. Nat. Math.)*, 6, 1968:65-115, 19 pls. (Ogyrididae: p. 75, pl. 11; Alpheidae: pp. 74, 75, pl. 10, 11).
- 1970. Etude systématique et remarques écologiques sur les Caridea recueillis principalement dans les biotopes de substrat meuble régions de Tuléar et de Nosy-Be. *Ann. Univ. Madagascar (Sci. Nat. Math.)* 7, 1970:121-157, 25 pls. (Alpheidae: pp. 125-133, pls. 10-19, 23, 24. Ogyrididae: pp. 128-133, pls. 20, 25).
- Lenz, H. 1905. Ostrafrikanische Dekapoden und Stomatopoden gesammelt von Herrn Prof. Dr A. Voeltzkow. In A. Voeltzkow (ed.), *Wissenschaftliche Ergebnisse der Reisen in Madagaskar und Ostafrika in den Jahren 1889-95. Vol. III. Abh. senckenb. naturforsch. Ges.* 27(4):341-392, pls. 47, 48. (Alpheidae: pp. 383-385).
- Lewinsohn, C. and L. B. Holthuis, 1964. New records of decapod Crustacea from the Mediterranean coast of Israel and the eastern Mediterranean. *Zoöl. Meded.* 40(8):45-63, 5 figs. (Alpheidae: pp. 47-52, figs. 1-3).
- Lockington, W. N., 1878. 53 — Remarks on some new alpei, with a synopsis of the North-American species. *Ann. Mag. nat. Hist.* V, 1(53):465-480.
- Luther, W. 1958a. Symbiose von Fischen (Gobiidae) mit einem Krebs (*Alpheus djiboutensis*) im Roten Meer. *Z. Tierpsychol.* 15:175-177.
- 1958b. Symbiose von Fischen mit Korallentieren und Krebsen im Roten Meer. *Natur Volk* 88(5):141-146, 3 figs.
- McNae, W. 1957. The ecology of the plants and animals in the intertidal regions of Zwartkops estuary near Port Elizabeth, S. Africa. Part II, *J. Ecol.*, 45(2):361-387.
- Magnus, D.B.E. 1967. Zur Ökologie Sedimentbewohnender *Alpheus* Garnelen (Decapoda, Natantia) des Roten Meeres. *Helgoländer wiss. Meeresunters* 15:506-522, 7 figs.
- Man, J. G. de 1888a. Bericht über die im Indischen Archipel von Dr J. Brock gesammelten Decapoden und Stomatopoden. *Arch. Naturgesch.* 53(1):215-600, pls. 7-22a. (Alpheidae: pp. 497-532, pl. 21-22. In separate: pp. 285-320, pl. 15-16).
- 1888b. Report on the podopthalmous 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. *J. Linn. Soc.* 22:1-312, pls. 1-19, (Alpheidae: pp. 261-274, pl. 17).
- 1890. Carcinological studies in the Leyden Museum. No. 4. *Notes Leyden Mus.* 12:49-126, pls. 3-6. (Alpheidae: pp. 116-120, pl. 6).

- 1892. Decapoden des Indischen Archipels. In M. Weber (ed.), Zoologische Ergebnisse einer reise in Niederländisch Ost-Indien. *Zool. Ergebn.* vol. 2:265-527, pls. 15-29. E. J. Brill, Leiden. (Alpheidae: pp. 404-407, pl. 25).
- 1897. Bericht über die von Herrn Schiffscapitän Storm zu Atjeh, an den westlichen Küsten von Malakka, Borneo und Celebes sowie in der Java-See gesammelten Decapoden und Stomatopoden. Fünfter theil. *Zool. Jb. syst.* 9:725-790, pl. 12-14. (Alpheidae: pp. 726-761).
- 1898a. *Op. cit.* Sechster theil. *Zool. Jb. syst.* 10:677-708, pl. 28-38. (Alpheidae: pl. 34-36).
- 1898b. Note sur quelques espèces du genre *Alpheus* Fabr. appartenant à la section dont *l'Alpheus Edwardsi* Aud. est le représentant. *Mém. Soc. Zool. Fr.* 11:309-325, pl. 4.
- 1899. On *Alpheus hippothoë*, De M. var. ?. *Notes Leyden Mus.* 20(30):210.
- 1902. Die Von Herrn Professor Kükenthal im Indischen Archipel gesammelten Dekapoden und Stomatopden. (In W. Kükenthal (ed.), Ergebnisse einer zoologischen Forschungreise in den Molukken und Borneo.) *Abh. Senckenb. naturforsch. Ges.* 25(3):467-929, pls. 19-27. (Alpheidae: pp. 861-893, pl. 26, 27).
- 1907. On a collection of Crustacea, Decapoda and Stomatopoda, chiefly from the Inland Sea of Japan; with descriptions of new species. *Trans. Linn. Soc. Lond.* II, 9:387-454, pls. 31-33. (Alpheidae: 427-432, pl. 33).
- 1908. Diagnoses of new species of macrurous decapod Crustacea from the "Siboga-Expedition". III. *Notes Leyden Mus.* 30(14):98-112.
- 1909a. *Op. cit.* IV. *Tijdschr. ned. dierk. Vereen* II, 11(2):99-125.
- 1909b. Note sur quelques espèces du genre *Alpheus* Fabr. appartenant au Groupe Brevirostris de M. *Mém. Soc. Zool. Fr.* 22:146-164, pls. 7, 8.
- 1909c. Description of a new species of the genus *Alpheus* Fabr. from the Bay of Batavia. *Proc. zool. Soc. Lond.* 1909:663-666, pl. 70.
- 1910a. Ueber eine neue Art der Gattung *Arcte* Stimps. *Arch. Naturgesch.* 76(1):25-27, 6 figs.
- 1910b. Diagnoses of new species of macrurous decapod Crustacea from the "Siboga Expedition". V. *Tijdschr. ned. dierk. Vereen.* II, 11(4):287-319.
- 1911. The Decapoda of the Siboga Expedition. Part II. Family Alpheidae. *Siboga-Expeditie* 39a'(2):133-465. (Livre 60). 1915. *Op. cit.* Supplement... Explanation of plates of Alpheidae. *Siboga-Expeditie* 39a'(2):23 pls. (Livre 74). E. J. Brill, Leiden.
- 1920. Diagnoses of some new species of Penaeidae and Alpheidae with remarks on two known species of the genus *Penaeopsis* A. M. -Edw. from the Indian Archipelago. *Zool. Meded., Leiden.* (5(3):103-109. (Alpheidae: pp. 106-109).
- 1922. The Decapoda of the Siboga Expedition. Part V. On a collection of macrurous decapod Crustacea of the Siboga Expedition, chiefly Penaeidae and Alpheidae. *Siboga Expeditie* 39a'(5):1-51, 4 pls. (Livre 93). E. J. Brill, Leiden. (Alpheidae: pp. 16-43, pls. 2-4; Ogyrididae: pp. 14-15, pl. 2).
- 1924. On a collection of macrurous decapod Crustacea, chiefly Penaeidae and Alpheidae from the Indian Archipelago. *Arch. Naturgesch.* 90(1): 1-60, 20 figs. (Alpheidae: pp. 34-52).
- 1926. Beschreibung zweier arten von Decapoda Macrura von der Insel Buka (Salomoninseln). *Mitt. zool. Mus. Berl.* 12(2):339-345. (Alpheidae: pp. 341-343).
- 1929. On a collection of decapod and stomatopod Crustacea from Pulau Berhala, an islet situated in the Straits of Malacca. *Bijdr. Dierk.* 26:1-26, 3 pls. (Alpheidae: pp. 23-26, pl. 3).
- Mayr, E. 1960. Principles of Systematic Zoology. McGraw-Hill, N. Y., etc. Pp. x + 428.
- McNeill, F. A. 1926. The biology of North-West Islet, Capricorn Group. (I) Crustacea. *Aust. Zool.*

- 4(5):299-318, text figs. 1, 2, pl. 41. (Alpheidae: p. 302).
- 1937. The Crustacea. In G. P Whitley (ed.). The Middleton and Elizabeth Reefs, South Pacific Ocean. *Aust. Zool.* 8(4):199-273, pls. 13-17. (Alpheidae: p. 263).
- 1968. Crustacea, Decapoda & Stomatopoda. In *Scient. Rep. Gt. Barrier Reef Exped.* 7(1):1-98, 2 pl, 2 text figs. British Museum (Natural History), London. (Alpheidae: pp. 15-18).
- Miers, E. J. 1874. Crustacea. In: The zoology of the voyage of H.M.S. Erebus & Terror, under the command of Captain James Clark Ross, R.N., F.R.S. during the years 1839 to 1843. Vol. 2:1-5, pls. 1-4. J. Murray, London. (Alpheidae: pp. 4, 5, pl. 4).
- 1875. On some new or undescribed species of Crustacea from Samoa Islands. *Ann. Mag. nat. Hist.* IV, 16(95):341-344. (Alpheidae: p. 343).
- 1876. Descriptions of some new species of Crustacea chiefly from New Zealand. *Ann. Mag. nat. Hist.* IV, 17(99): 218-229. (Alpheidae: pp. 224-225)
- 1881. On a collection of Crustacea made by Baron Hermann-Maltzan at Goree Island, Senegambia Macrura. *Ann. Mag. nat. Hist.* V, 8 (47): 364-377, pls 13-16 (Alpheidae: pp. 365-367, pl. 16)
- 1884. Crustacea. In: Report of the zoological collections made in the Indo-Pacific Ocean during the voyage of H.M.S. "Alert", 1881-2, pp. 178-322, 513-575, pls. 18-35, 46-52. Printed by order of Trustees of the British Museum (Natural History), London. (Alpheidae: collections from Melanesia, pp. 284-291; collections from Western Indian Ocean, pp. 561-562.)
- Milne-Edwards, A., 1873. Description de quelques crustacés nouveaux ou peu connus provenant du Musée de M. C. Godeffroy. *J. Mus. Godeffroy* 1:77-88, pls. 12, 13. (Alpheidae: p. 87.)
- 1878 (1879-1880). Description de quelques espèces nouvelles de crustacés provenant du voyage aux îles du Cap-Vert de MM. Bouvier et de Cessac. *Bull. Soc. philomath.* Paris VII, 4:225-232. (Alpheidae: p. 229-231.)
- Milne-Edwards, H., 1837. Histoire naturelle des crustacés, comprenant l'anatomie, la physiologie et la classification de ces animaux, 2:1-532, Atlas, pp. 1-32, pls. 1-42. Roret, Paris. (Alpheidae: pp 349-357, pl. 24).
- Miya, Y., 1972. The Alpheidae (Crustacea, Decapoda) of Japan and its adjacent waters. Part I. *Publ. Amakusa mar. biol. Lab., Kyushu Univ.* 3(1):23-101, pls. 1-14.
- 1974. *Op. cit.* Part II. *Publ. Amakusa mar. biol. Lab., Kyushu Univ.* 3(2):103-195, pls. 15-31.
- Miya, Y. and S. Miyake, 1968a. Revision of the genus *Athanas* of Japan and the Ryukyu Islands, with a description of new species (Crustacea, Decapoda, Alpheidae). *Publ. Amakusa mar. biol. Lab., Kyushu Univ.* 1(2):129-162, 13 figs.
- 1968b. Redefinition of the genus *Batella* (Crustacea, Decapoda, Alpheidae), with description of a new species from Kyushu, Japan. *Occ. Pap. zool. Lab., Fac. of Agric., Kyushu Univ.,* 1(5):113-120, 4 figs.
- 1969. Description of *Alpheus bellulus* sp. nov. associated with gobies from Japan (Crustacea, Decapoda, Alpheidae). *Publ. Seto mar. biol. Lab.* 16(5):307-314, 2 figs.
- Miyake, S. and Y. Miya, 1966. On a new species and a new record of alpheid shrimps from Japan. *J. Fac. Agric. Kyushu Univ.* 14(1):133-141, 2 figs.
- 1967. A rare alpheid shrimp *Aretopsis amabilis* de Man from the Ryukyu Islands (Decapoda, Crustacea). *J. Fac. Agric. Kyushu Univ.* 14(2):267-273, 2 figs.
- Moehring, J. L. 1972. Communications system of a goby-shrimp symbiosis. Ph. D. thesis, University of Hawaii, Honolulu, Hawaii.
- Moikeha, S. N. and G. W. Chu, 1971. Dermatitus-producing alga *Lyngbya majuscula* Gomont in Hawaii. II. Biological properties of the toxic factor. *J. Phycol.* 7(1):8-13.

- Moulton, J. M., 1967. On collection of alpheid shrimp from Queensland. *N. Qd. Nat.* 34(143):7.
- Nobili, G., 1899. Contribuzioni alla conoscenza della fauna carcinologica della Papuasie, delle Molucche e dell'Australia. *Ann. Mus. Stor. nat. Genova* 40:230-282. (Alpheidae: p. 233)
- 1901. Decapodi e stomatopodi Eritrei del Museo Zoologico dell'Universita di Napoli. *Annuar. R. Mus. zool. R. Univ. Napoli N. S.*, 1(3):1-20. (Alpheidae: pp. 2-3).
- 1903. Crostacei di Singapore. *Boll. Mus. Zool. Anat. comp. Torino* 18(455):1-39, 1 pl. (Not seen).
- 1906a. Fauna carcinologique de la Mer Rouge. Décapodes et stomatopodes. *Annls. Sci. nat.* IX, 4:1-347, 12 text figs., 11 pls. (Alpheidae: pp. 31-33).
- 1906b. Diagnoses préliminaires de crustacés, décapodes et isopodes nouveaux recueillis par M. le Dr. G. Seurat aux îles Tuamotou. *Bull. Mus. Hist. nat.*, Paris 12(5):256-270. (Alpheidae: pp. 256-257).
- 1906c. Crustacés décapodes et stomatopodes. Mission J. Bonnier et Ch. Pérez (Golfe Persique, 1901). *Bull. scient. Fr. Belg.* 40:13-159, 3 text figs., pls. 2-7. (Alpheidae: pp. 24-35, text fig. 1).
- 1907. Ricerche sui crostacei della Polinesia. Decapodi, stomatopodi, anisopodi e isopodi. *Mem. Accad. Sci. Torino II*, 57:351-430, pls. 1-3. (Alpheidae: pp. 353-358, pl. 1).
- Olivier, A. G. 1811. Palémon. Palaemon. In Diderot & d'Alembert (premiers) (eds.), *Encyclopédie méthodique, ou par ordre de matières... Histoire naturelle. Insectes...*, vol. 8:652-667. Chez Panckonshe... Paris. (Alpheidae: pp. 663-664).
- O'Loughlin, P. M. 1969. Aquinas College third and fourth expeditions to the Pelsart Group of Houtman's Abrolhos, August 24-September 1, 1966 and January 2-12, 1968. pp. 1-39, 20 figs. Aquinas College, Manning, W. A. (Alpheidae: pp. 36-37).
- Ortmann, A. E., 1890. Die Unterordnung Natantia Boas. Theil I. Die Decapoden-Krebse des Strassburger Museums, mit besonderer Berücksichtigung der von Herrn Dr Döderlein bei Japan und bei den Liu-Kiu-Inseln gesammelten und z. Z im Strassburger Museum aufbewahrten Formen. *zool. Jb. Syst.* 5(1):437-542, pls. 36, 37. (Alpheidae: pp. 469-490, pl. 36).
- 1893. Decapoden und Schizopoden. In *Ergebnisse der Plankton-Expedition der Humboldt-Stiftung*. vol. 2Gb:1-120, pls. 1-10. Lipsium & Tischer; Kiel und Leipzig. (Alpheidae: pp. 44-45; Ogyrididae: pp. 45-46, pl. 3).
- 1894. Crustaceen. In R. Semon (ed.), *Zoologische Forschungsreisen in Australien und dem Malayischen Archipel mit Unterstützung des Herrn Dr Paul von Ritter ausgeführt in den Jahren 1891-93*. Denkschr. med. naturw. Ges. Jena 8:3-80, pls. 1-3. (Alpheidae: pp. 12-15, pl. 1).
- Patton, W. K., 1966. Decapod Crustacea commensal with Queensland branching corals. *Crustaceana* 10(3):271-295, 4 tables, 3 figs. (Alpheidae: pp. 281-282).
- Paulson, O., 1875. Studies of the Crustacea of the Red Sea with notes regarding other seas, Part I. Podophthalmata and Edriophthalmata (Cumacea). Pp. xiv + 144, pls. 1-21. S. V. Kul'zhenko, Kiev. (In Russian). (English translation by Francis D. Por with above title, 1961, issued by Israel Program for Scientific Translations and available from Office of Technical Services, U. S. Department of Commerce, Washington D. C. 164 pp.) (Note: pagination of translation not corresponding to original.) (Alpheidae in Paulson: pp. 101-108, pl. 13, 14; in Por: pp. 107-114, pl. 13-14).
- Pearson, J., 1905. Report on the Macrura collected by Professor Herdman, at Ceylon in 1902. In W. A. Herdman, (ed.), *Report to the government of Ceylon on the pearl oyster fisheries of the Gulf of Manaar*. Vol. 4(24): 65-92, 2 pls. Royal Society, London. (Alpheidae: pp. 82-88, pl. 2).
- 1911. Ceylon Crustacea. Part 1. Notes on the Alpheidae. *Spolia Zeylan.* 7:169-186, pls. 5-7.
- Pocock, R. I., 1890. Crustacea. In H. N. Ridley (ed.), *Notes on the zoology of Fernando Noronha*. *J. Linn. Soc.* 20:473-526. (Alpheidae: pp. 518-523).

- Pope, E. C., 1949. Crangon — the noisy pistol prawn. *Aust. Mus. Mag.* 9(10):326-328, 3 figs.
- Potts, F. A., 1915a. The colour variations of fauna associated with crinoids. *Proc. Camb. phil. Soc. biol. Sci.* 18:59-62, 1 fig.
- 1915b. The fauna associated with the crinoids of a tropical coral reef: with especial reference to its colour variations. *Pap. Dep. mar. Biol. Carnegie Instn Wash.* 8:73-96, 7 text figs. 1 pl. (Alpheidae: pp. 75-81, 96, text figs. 1-3, pl. 1).
- Ramadan, M. M., 1936. Report on a collection of Stomatopoda and Decapoda from Ghardaqa, Red Sea. *Bull. Fac. Sci. Egypt. Univ.* No. 6, pp. 1-43, pls 1, 2. (Alpheidae: pp. 12-22, pls. 1, 2).
- Randall, J. R., 1968. Caribbean Reef Fishes. 318 pp., 324 figs. T. F. H. Publications, Jersey City, N. J.
- Randall, J. W., 1839. Catalogue of the Crustacea brought by Thomas Nuttall and J. K. Townsend, from the west coast of North America and the Sandwich Islands, with descriptions of such species as are apparently new, among which are included several species of different localities, previously existing in the collection of the Academy. *J. Acad. nat. Sci. Philad.* 8(1):106-147, pls. 3-7. (Alpheidae: pp. 140-141, pl. 5).
- Rathbun, M. J., 1904. Some changes in crustacean nomenclature. *Proc. biol. Soc. Wash.* 17:169-172.
- 1914. Stalk-eyed crustaceans collected at the Monte Bello Islands. *Proc. zool. Soc. Lond.* 1914:653-664, pls. 1, 2. (Alpheidae: pp. 654-655).
- Ribeiro, A., 1964. Sobre uma espécie nova de *Alpheus* Fabricius, 1798, do Arquipélago de Cabo Verde, *Alpheus holthuisi* n. sp. *Notas mimeogr. Centro Biol. Piscat. Lisboa*, no. 42, pp. 12-14, figs. 1-11. (Not seen).
- Richardson, L. R. and J. C. Yaldyn, 1958. A guide to the natant decapod Crustacea (shrimps and prawns) of new Zealand. *Tuatara* 7(1):17-41, 47 figs. (Alpheidae: pp. 36-37, figs. 33-36; Ogyrididae: p. 36, fig. 31).
- Richters, F., 1880. Decapoda. In K. Möbius (ed.), *Beiträge zur Meeresfauna der Insel Mauritius und der Seychellen bearbeitet von K Möbius, F. Richters und E. von Martens nach Sammlungen, angelegt auf einer Reise nach Mauritius.* vi + 352, 25 pls. Gutmann, Berlin. (Alpheidae: pp. 164-165, pl. 17).
- Ritzmann, R., 1973. Snapping behaviour of the shrimp *Alpheus californiensis* *Science* 181(4098):459-460 (issue of 3 Aug., 1973).
- Sankarankutty, C., 1962. On the occurrence of *Athanas dorsalis* (Stimpson) (Decapoda-Alpheidae) in the Gulf of Mannar. *J. mar. biol. Ass. India* 4(2):167-171, 1 table, 2 figs.
- Savigny, J. C., 1809. Crustacés. Description de l'Égypte, ou recueil des observations et des recherches qui ont été faites en Egypt pendant l'expédition de l'armée française, atlas Crust., pl. 1-13. (Alpheidae: pl. 9, 10).
- Sayce, O. A., 1902. Dredging in Port Phillip. *Victorian Nat.* 18(10):149-155. (Alpheidae: p. 155).
- Schenkel, E., 1902. Beitrag zur Kenntnis der dekapoden Fauna von Celebes. *Verh. naturf. ges. Basel.* 13:485-585, pls. 7-13. (Alpheidae: pp. 566-568, pl. 13).
- Schmitt, W. L., 1924. The macruran, anomuran and stomatopod Crustacea. Bijdragen tot de kennis der fauna van Curaçao. Resultaten eener reis van Dr C. J. van der Horst in 1920. *Bijdr. Dierk.* 23:61-81, text figs. 1-7, pl. 8. (Alpheidae: pp. 64-68).
- 1926. The macruran, anomuran, and stomatopod crustaceans collected by the American Museum Congo Expedition, 1909-1915. With field notes by Herbert Lang and James P. Chapin. *Bull. Am. Mus. nat. Hist.* 53:1-67, 9 pls., 75 text figs. (Alpheidae: pp. 19-23, fig. 63).
- 1939. Decapod and other Crustacea collected on the presidential cruise of 1938. *Smithson. misc. collns* 98(6):1-29. (Alpheidae: pp. 3-5 (collection data); pp. 11, 12, 24, 26, 28; Ogyrididae: p. 9).
- Sendler, A. 1923. Die Decapoden und Stomatopoden der Hanseatischen Südsee Expedition. *Abh. senckenb. naturforsch. Ges.* 38(1):21-47, 3 text figs., pl. 5, 6. (Alpheidae: p. 46).
- Shelford, R., 1909. Crustacea. *Zool. Rec.* 45(10):2598-2632. (Alpheidae: 2631).
- Sivertsen, E., 1934. Littoral Crustacea Decapoda from the Galapagos Islands. Part VII. In The

- Norwegian Zoological Expedition to the Galapagos Islands, 1925, conducted by Alf Wollebaek. *Nyt. Mag. Naturvid.* 74:1-23, 4 pls., 1 text fig. (Alpheidae: pp. 2-4, pl. 1).
- Sollaud, E., 1932. Sur un alphéidé d'eau douce, *Alpheopsis Monodi n. sp.*, recueilli par M. Th. Monod au Cameroun. *Bull. Soc. zool. Fr.* 57:375-386, figs. 1, 2.
- Stebbing, T. R., 1914. South African Crustacea (Part VII of S. A. Crustacea for the marine investigations in South Africa). *Ann. S. Afr. Mus.* 15:1-53, pl. 1-12, (of Vol. 15 and pl. 65-76 of Crustacea). (Ogyrididae: pp. 31-32).
- 1915. *Op. cit.* (Part VIII.) *Ann. S. Afr. Mus.* 15:57-104, pls. 8-25 (of vol. 15, and pl. 77-89 of Crustacea). (Alpheidae: pp. 79-88, pls. 20-23 of vol. 15; pls 84-87 of Crustacea).
- 1919. Some Crustacea of Natal. *Ann. Durban Mus.* 2(3):119-125, pls. 18-20. (Alpheidae: pp. 122-124, pl. 20).
- Steinitz, H., 1967. A tentative list of immigrants via the Suez Canal. *Israel J. Zool.* 16:166-169. (Alpheidae: p. 167).
- Stephenson, W., R. Endean, and I. Bennett, 1958. An ecological survey of the marine fauna of the Low Isles, Queensland. *Aus. j. mar. Freshwat. Res.* 9(2):261-318, 9 figs. (Alpheidae: p. 268).
- Stephenson, T. A., A. Stephenson, G. Tandy and M. Spender, 1931. The structure and ecology of Low Isles and other reefs. In *Scient. Rep. Gt. Barrier Reef Exped.* 3(2):72-112, 27 pls., 15 text figs. British Museum (Natural History), London. (Alpheidae: pp. 43, 73).
- Stimpson, W., 1860 (Proc. for 1860, title page states "Printed ... 1861") Prodomus descriptionis animalium evertibratorum, quae in expeditione ad Oceanum Pacificum septentrionalum... Pars VIII. Crustacea eacrura. *Proc. Acad. nat. Sci. Philad.* 12:22-47. (Alpheidae: pp. 29-32; Ogyrididae: p. 36).
- Suzuki, H., 1970. Taxonomic review of four alpheid shrimps belonging to the genus *Athanas* with reference to their sexual phenomena. *Sci. Rep. Yokohama natn. Univ.* Sec. II, (17):1-37, 21 text figs. 4 pls.
- 1971. On some commensal shrimps found in the western region of Sagami Bay. *Res. Crust., Carcinol. Soc. Jap.* nos. 4, 5, pp. 1-28, 12 text figs., 3 pls. (Alpheidae: pp. 19-24, text figs. 10-12)
- Takagi, K., 1966. Distributions and ecology of the gobioid fishes in Japanese waters. *J. Tokyo Univ. Fish.* 52(2):83-127 (In Japanese, not seen).
- Tattersall, W., 1921. Report on the Stomatopoda and macrurous Decapoda collected by Mr Cyril Crossland in the Sudanese Red Sea. *J. Linn. Soc.* 34(229):345-398, pl. 27, 28. (Alpheidae: pp. 368-381, pl. 27, 28. Station information pp. 345-351).
- Thomassin, B. A., 1971. Les facies d'épifauna et d'épiflora des biotopes sédimentaires des formations corallines dans la région de Tuléar (sud-ouest de Madagascar). In D. R. Stoddard and M. Yonge (eds.), Regional variation in Indian Ocean coral reefs. *Symp. zool. Soc. Lond.* 28:371-396.
- Thomson, G. M., 1903. On the New Zealand Phyllobranchiate Crustacea-Macrura. *Trans. Linn. Soc. Lond.* II, 8:433-453, pls. 27-29. (Alpheidae: pp. 436-439, pls. 27, 28).
- Tirmizi, N. M. and M. A. Kazmi, 1969. The occurrence of *Alpheus inopinatus* Holthuis & Gottlieb, 1958, in the Arabian Sea. (Decapoda, Alpheidae). *Crustaceana* 16(1):99-100, fig. 1.
- Tiwari, K., 1963. Alpheid shrimps (Crustacea: Decapoda: Alpheidae) of Vietnam. *Ann. Fac. Sci. Saigon* 1963:269-362, 1 table, 32 figs.
- 1964. Diagnosis of two new species of alpheid shrimps from Vietnam (Indo-China). *Crustaceana* 7(4):313-315.
- U, Khin Khin, 1977. On the biology of *Alpheus richardsoni*, Yaldwyn, 1971. Submitted Ph. D thesis, University of Tasmania, Hobart Tasmania.
- Vaughan, R. A., 1973. Aspects of ecology of *Alpheus deuteropus* (Crustacea, Decapoda), a boring shrimp. Manuscript, Plan B Masters Directed Research. University of Hawaii, Honolulu, Hawaii.
- Verrill, A. E., 1922. Decapod Crustacea of Bermuda. Part II, Macrura. *Trans. Conn. Acad. Arts Sci.*

- 26:1-179, 48 pls., 10 text figs. (Alpheidae: pp. 60-123, pl. 19-34, 36-41, 47, 48, text figs. 5-8).
- Weber, F., 1795. *Nomenclator entomologicus secundum entomologiam systematicam ill. Fabricii* . . . viii + 177 pp. Chilonii et Hamburgi. (Not seen)
- White, A., 1847. See Anonymous (White, A.)
- Whitelegge, T., 1889. List of the marine and fresh-water invertebrate fauna of Port Jackson and neighborhood. *J. Proc. R. Soc. N.S.W.* 23(2): 163-323. (Alpheidae: p. 224).
- Williams, A., 1965. A new genus and species of snapping shrimp (Decapoda, Alpheidae) from the southeastern United States. *Crustaceana* 9(2):192-198, 2 figs.
- Yaldwyn J., 1956. A redescription of the type material of *Alpheus novae-zealandiae* Miers, 1876. (Crustacea, Decapoda, Natantia). *Ann. Mag. Nat. Hist.* XII, 9:805-811, 7 figs.
- 1971. Preliminary descriptions of a new genus and twelve new species of natant decapod Crustacea from New Zealand. *Rec. Dom. Mus., Wellington* 7(10):85-94. (Alpheidae: p. 87-89; Ogyrididae: p. 89).
- Yokoya, Y., 1927. Notes on two alpheoid shrimps from Japan. *J. Coll. Agric. imp. Univ., Tokyo.* 9(3):171-175, pl. 7.
- 1936. Some rare and new species of decapod crustaceans found in the vicinity of the Misaki Marine Biological Station. *Jap. J. Zool.* 7:129-146, figs. 1-10. (Alpheidae: pp. 129-135, figs. 1-3).
- 1939. Macrura and Anomura of decapod Crustacea found in the neighbourhood of Onogawa, Miyagi-ken. *Sci. Rep. Tohoku Imp. Univ.* IV, 4:261-289, 13 figs. (Alpheidae: pp. 264-267, figs. 2, 3).
- Yu, S. C., 1931. Description of deux nouvelles crevettes de Chine. *Bull. Mus. Hist. nat., Paris* II, 3(6):513-516, 2 figs. (Alpheidae: pp. 513-514, fig. 1).
- Zehntner, L. 1894. Crustacés de l'Archipel Malais. Voyage de MM. M. Bedot et C. Pictet dans l'Archipel Malais. *Rev. Suisse Zool.* 2:135-214, pls. 7-9. (Alpheidae: pp. 200-206, pl. 8).

The following article has appeared while this paper was in press. It is cited as it contains the records of alpheids from the Philippine which are given as unpublished in the three parts of the Australian study: Banner, D. M. and A. H. Banner, 1979 (1978). Annotated checklist of alpheid and ogyridid shrimp from the Philippine Archipelago and the South China Sea. *Micronesica*, 14(2): 215-257.

INDEX TO NAMES OF ALPHEIDS AND OGYRIDIDS in Parts I, II, III

The index gives current and previous names cited in the text and tables, but only for the families Alpheidae and Ogyrididae; the page indicated in bold face gives the description or definition or its citation in a key; the subspecific and varietal names are listed only under the name of the nominate species. The Roman numerals refer to the part number and *fn.* to footnotes.

- acanthitelsonis, *Synalpheus*, II:353, Table 4(354), 388
- acanthomerus, *Alpheus*, III:188
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INDEX TO PLANTS AND ANIMALS

REPORTED TO BE ASSOCIATED WITH ALPHEID SHRIMP

In many cases the shrimp is reported to be associated with "a sponge" or "a crinoid", etc. so in addition to listing the associate under its scientific name, when available, we have also listed the references collectively, by phyla if plants, and by classes if animals. We have also indicated these broader groups after the scientific names for those unfamiliar with the taxon. In a few cases we have used English common names as well, as for "eel grass" and "living coral".

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