as long as broad, inferointernal margin bearing only several long setae distally but more proximally bearing several small spines. Inferoexternal 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. Tsurnamal. 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 alpheids 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 at.*, 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 at.*, 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

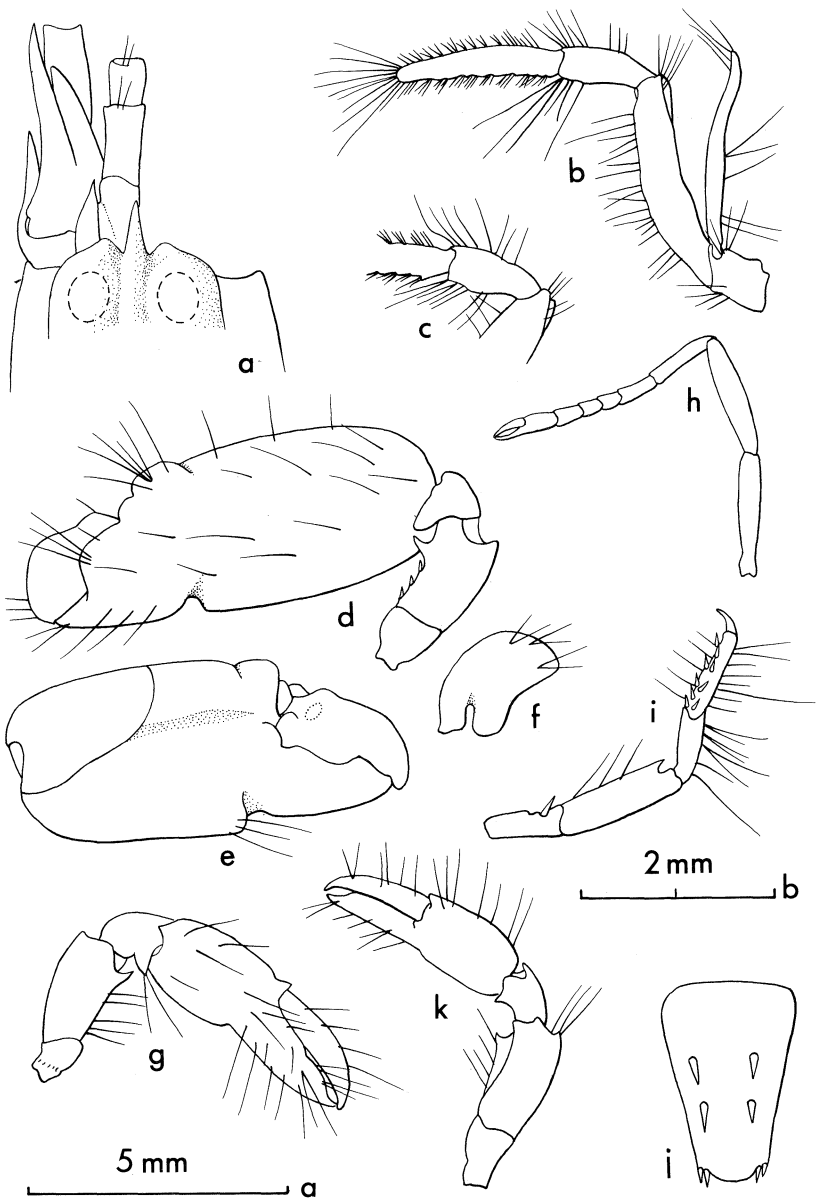


Fig. 56 *Alpheus parvirostris* Dana
12 mm male from BAU 20. **a.** Anterior region, dorsal view; **b, c.** third maxilliped, lateral face and detail of second article; **d.** large chelped, medial face; **e, f.** large chela and dactylus, lateral face; **g.** small cheliped, medial face; **h.** second 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 time as 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. Coutière 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

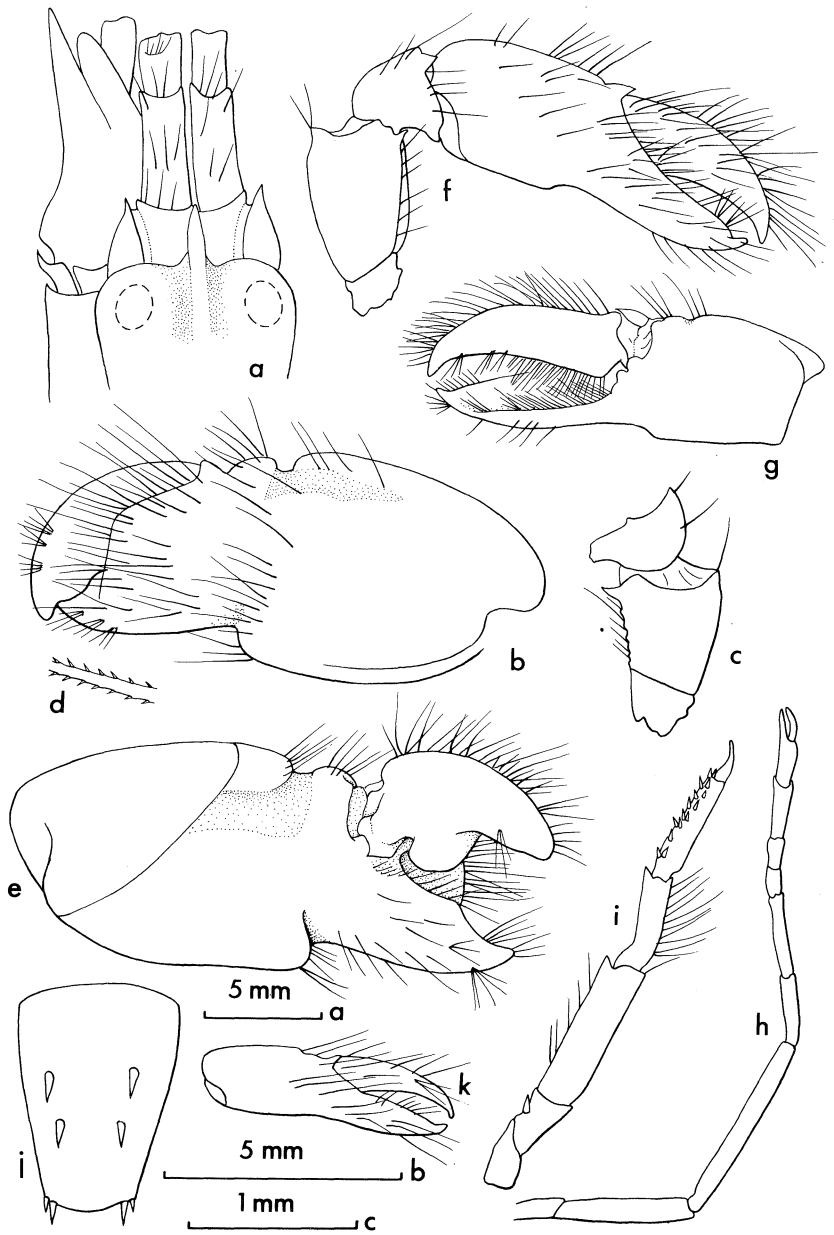


Fig. 57 *Alpheus edamensis* De Man
42 mm male from AM P. 14960. **a.** Anterior region, dorsal view; **b, c.** large chela and merus, medial face; **d.** detail of bristles of large chela; **e.** large chela, lateral face; **f.** small cheliped, medial face; **g.** small chela, lateral face; **h.** second 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 inferointernal 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 inferointernal 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. Inferointernal 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, bearng 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 propdous, 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.*

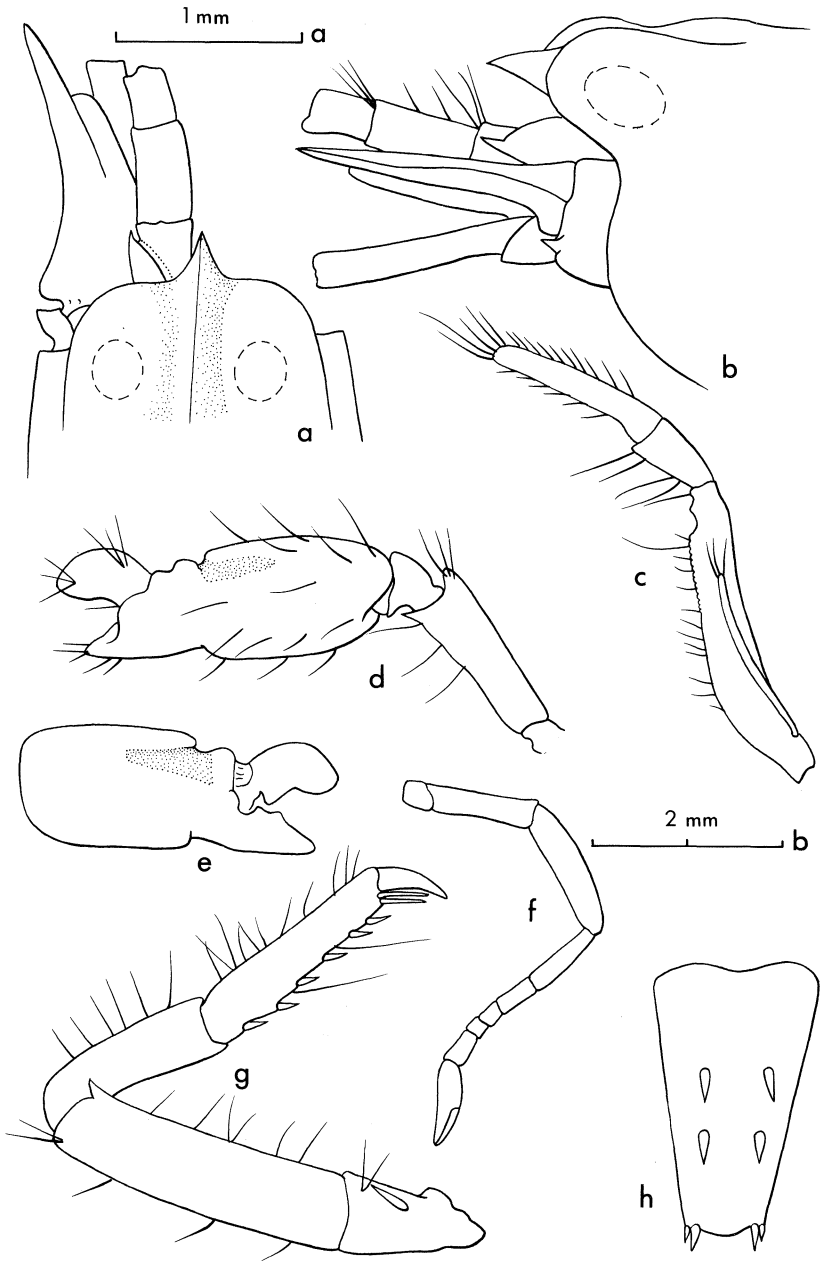


Fig. 58 *Alpheus hutchingsae* sp. nov.
Holotype (female). **a, b.** Anterior region, dorsal and lateral view; **c.** third maxilliped; **d.** large cheliped, medial face; **e.** large chela, lateral face; **f.** second leg; **g.** third leg; **h.** telson. a, b, c, f, g, h scale a; d, e scale b.

*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 identation, 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, *Prionalpheus*). 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

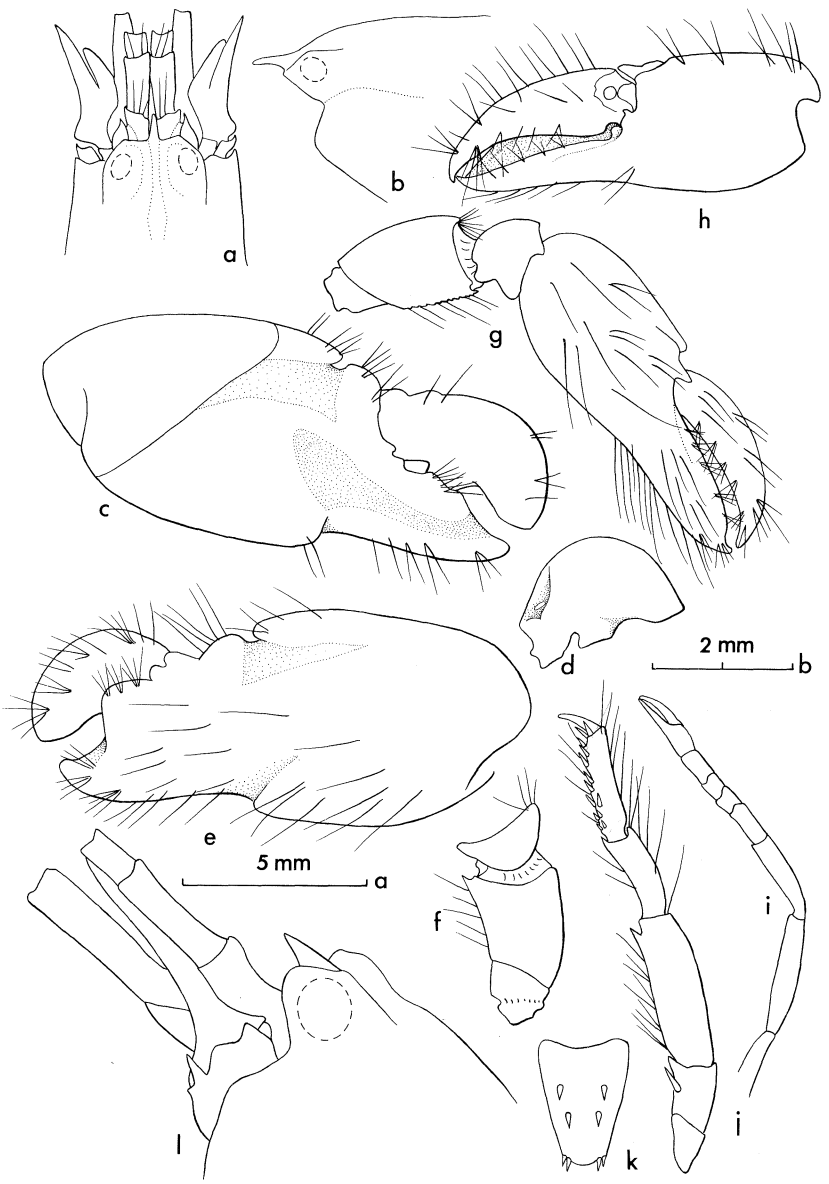


Fig. 59 *Alpheus hippothoe* De Man
28 mm male from WM 172-65. **a, b.** Anterior region, dorsal and lateral view; **c, d.** large chela and dactylus, lateral view; **e, f.** large chela and merus, medial view; **g.** small cheliped, medial view; **h.** small chela, lateral view; **i.** second leg; **j.** 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 carpocerite. 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

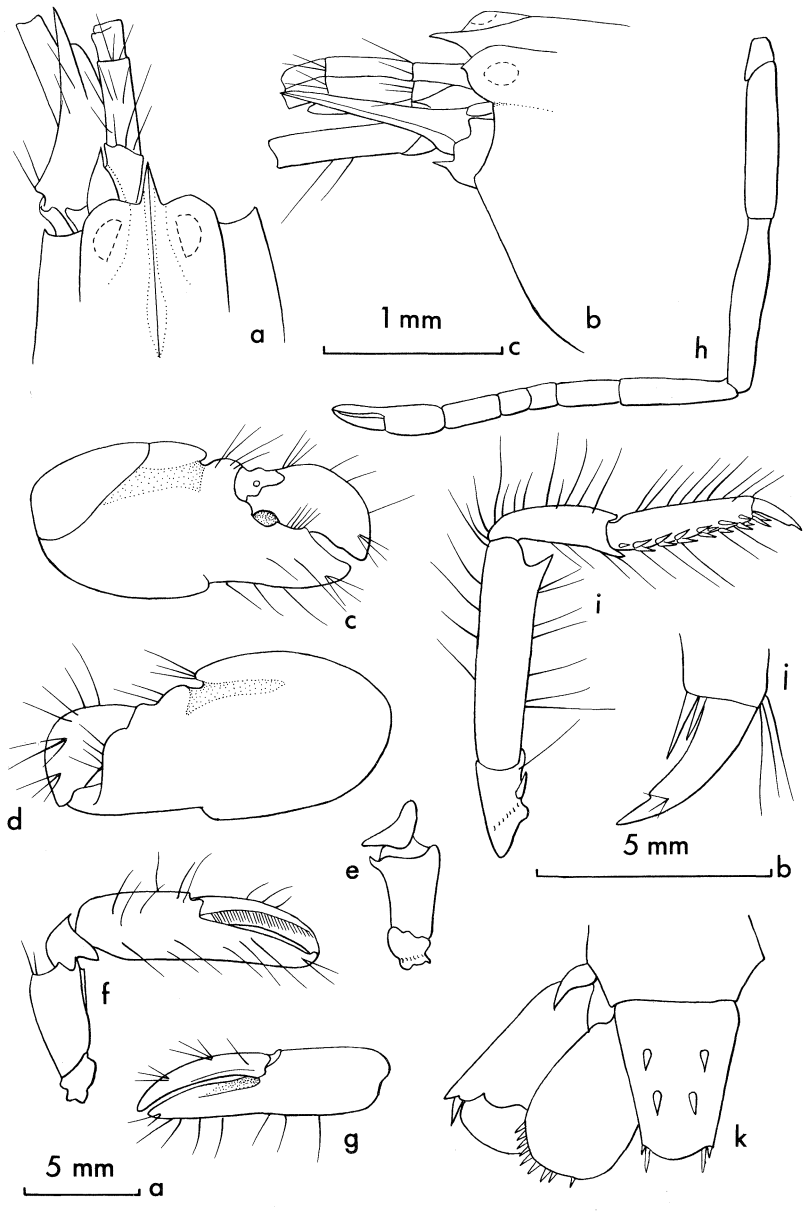


Fig. 60 *Alpheus serenei* Tiwari
30 mm male from BAU 27. **a, b.** Anterior region, dorsal and lateral view; **c.** large chela, lateral face; **d, e.** large chela and merus, medial face; **f.** small cheliped, medial face; **g.** small chela, lateral face; **h.** second leg; **i, j.** third leg and 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 carpocerite. 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 Nouhuys 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

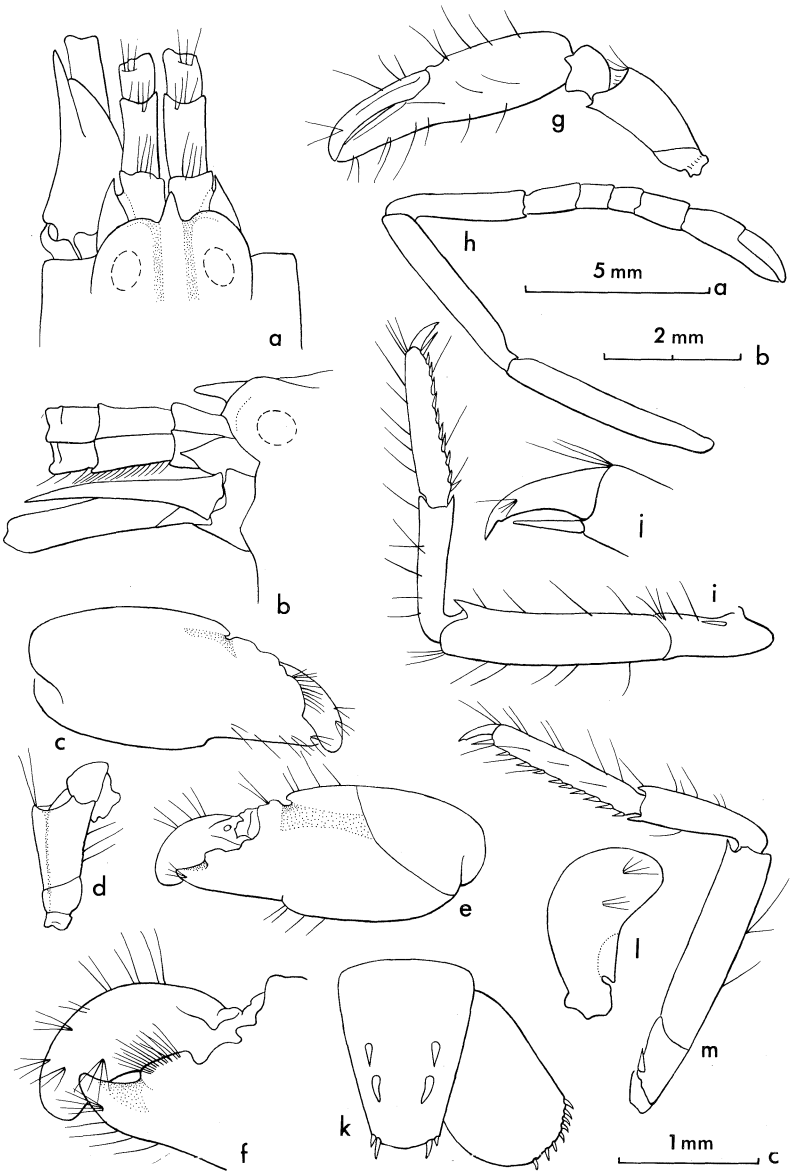


Fig. 61 *Alpheus georgei* sp. nov.
Holotype (22 mm male). **a, b.** Anterior region, dorsal and lateral view; **c, d.** large chela and merus, medial face; **e, f.** large chela and enlarged distal portion, lateral face; **g.** small cheliped, medial face; **h.** second leg; **i, j.** third leg and enlarged 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, inferointernal 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 inferointernal 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 slighlty longer than carpus, bearing on its

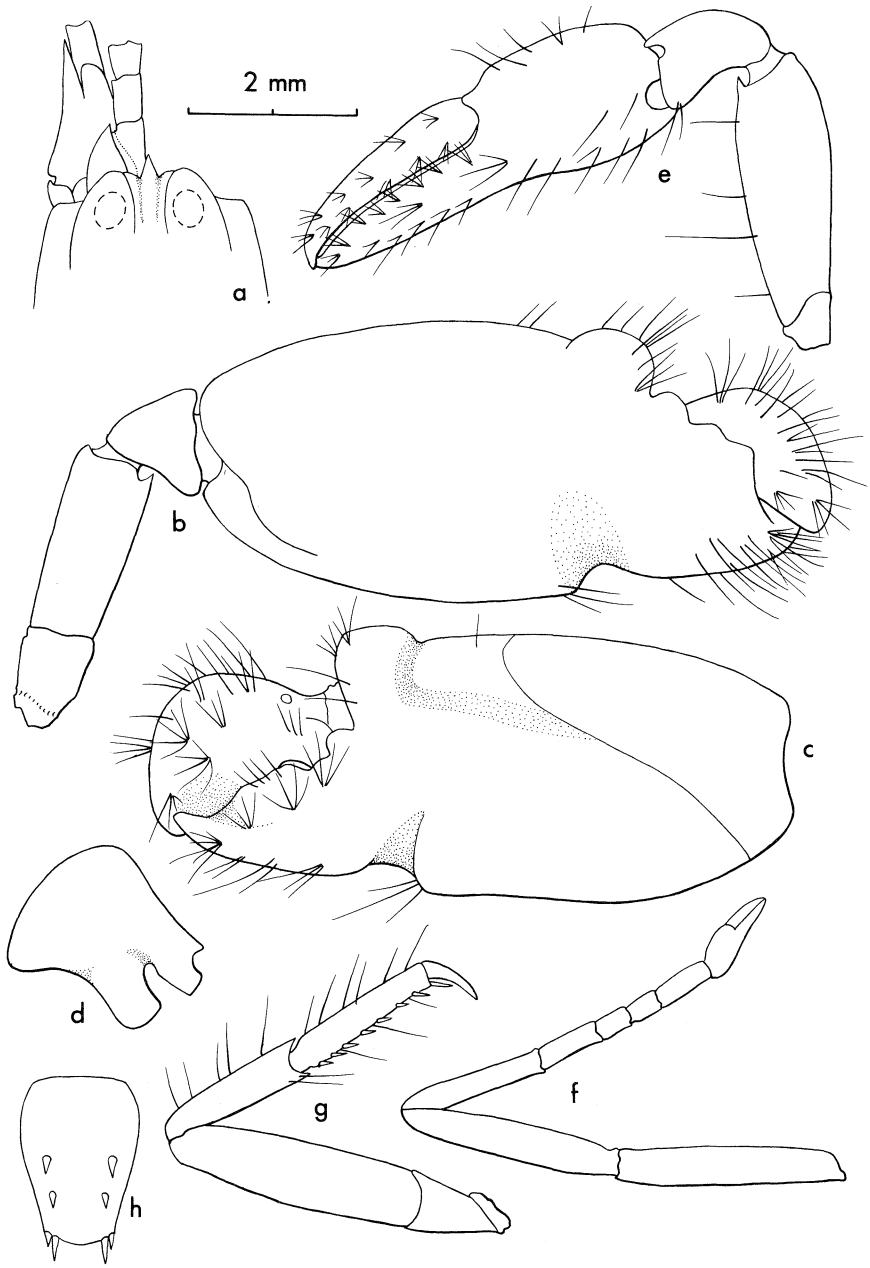


Fig. 62 *Alpheus maindroni* Coutière
20 mm female from BAU 10. **a.** Anterior region, dorsal view; **b.** large cheliped, medial face; **c, d.** large chela and dactylus, lateral face; **e.** small cheliped; **f.** second leg; **g.** third leg; **h.** telson. All figures same scale.

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 superiéure ou interne, surtout a 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. Carpocerite 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

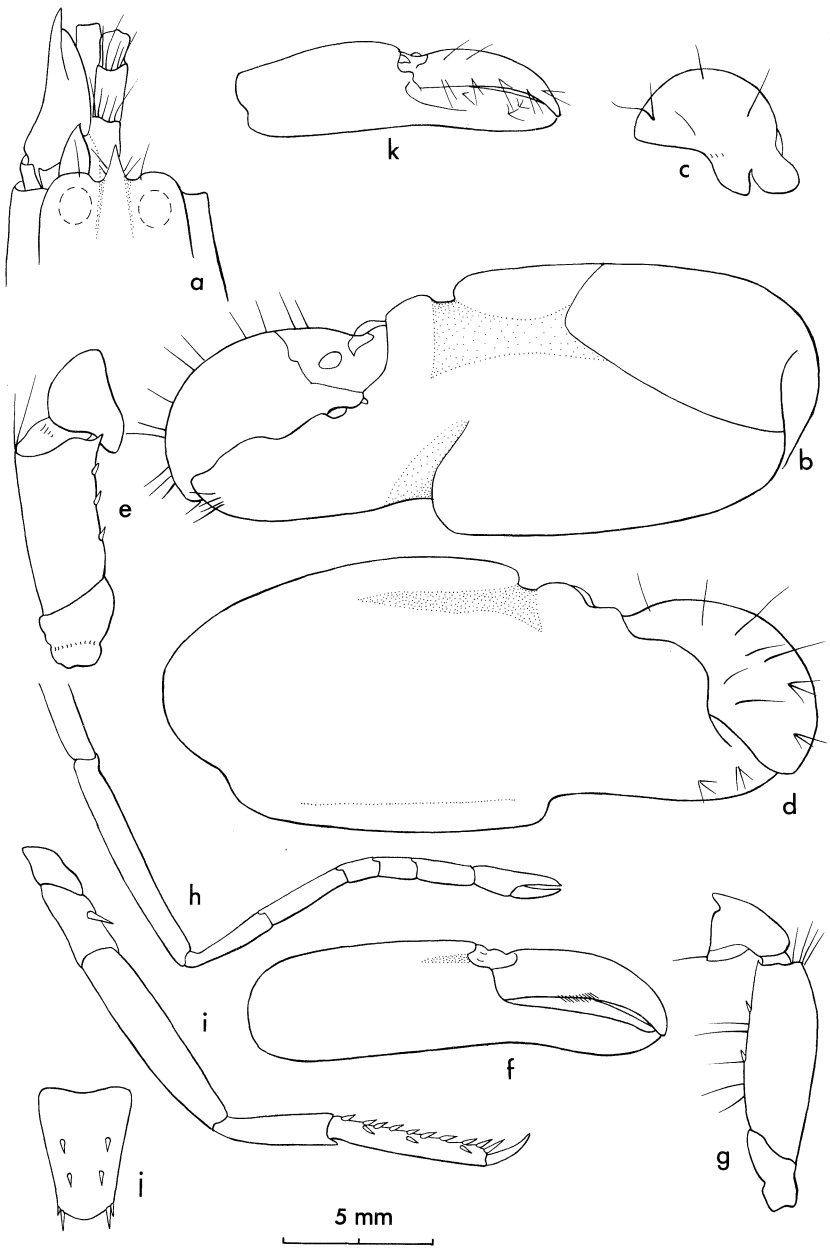


Fig. 63 *Alpheus dolerus* Banner
17 mm male from BAU 29. **a.** Anterior region, dorsal view; **b, c.** large chela and dactylus, lateral face; **d, e.** large chela and merus, medial face; **f, g.** small chela, lateral face, and merus, medial face; **h.** second leg; **i.** third leg; **j.** telson. 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 oppositive 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

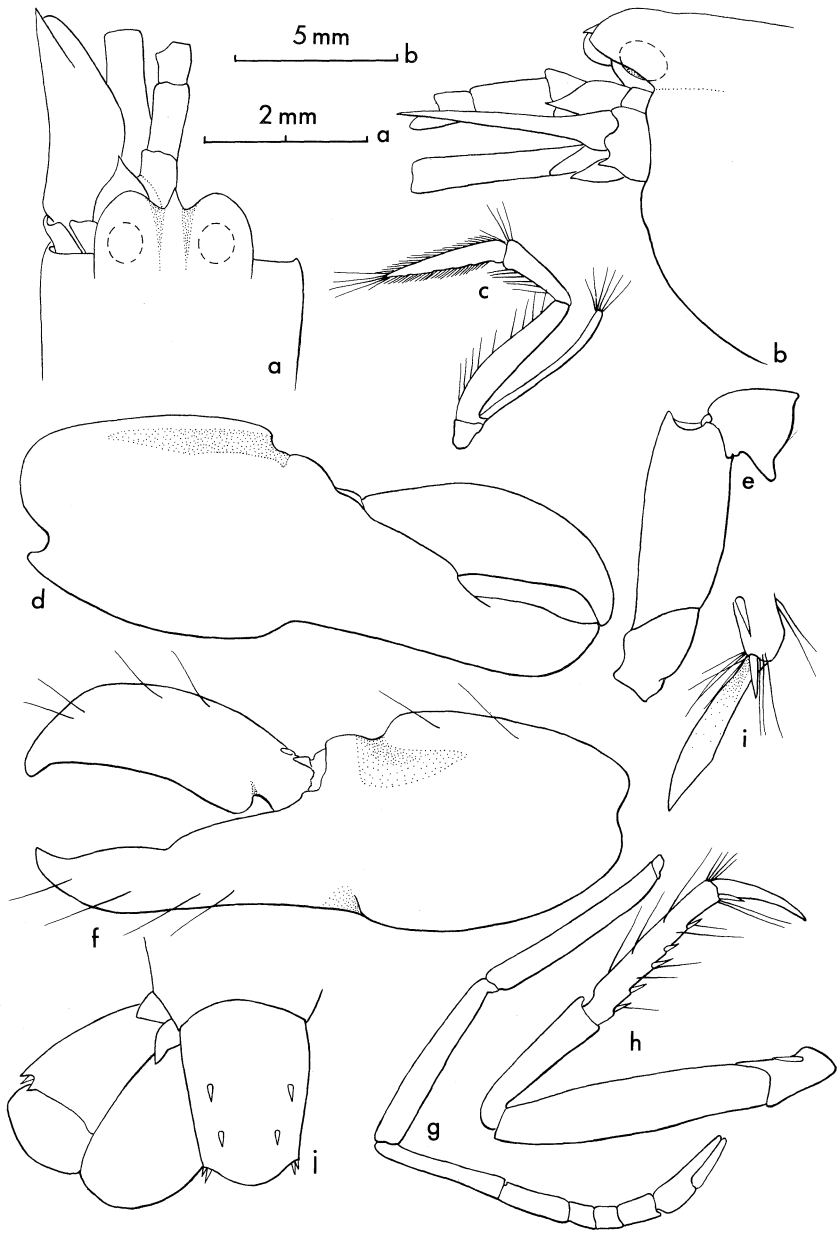


Fig. 64 *Alpheus malabaricus trefzae* subspec. nov.
Holotype (female). **a, b.** Anterior region, dorsal and lateral view; **c.** third maxilliped, lateral face; **d, e.** large chela and merus, medial face; **f.** large chela, lateral face; **g.** second leg; **h, i.** third leg and enlarged dactylus; **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* Ortmann 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 orbtial 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.

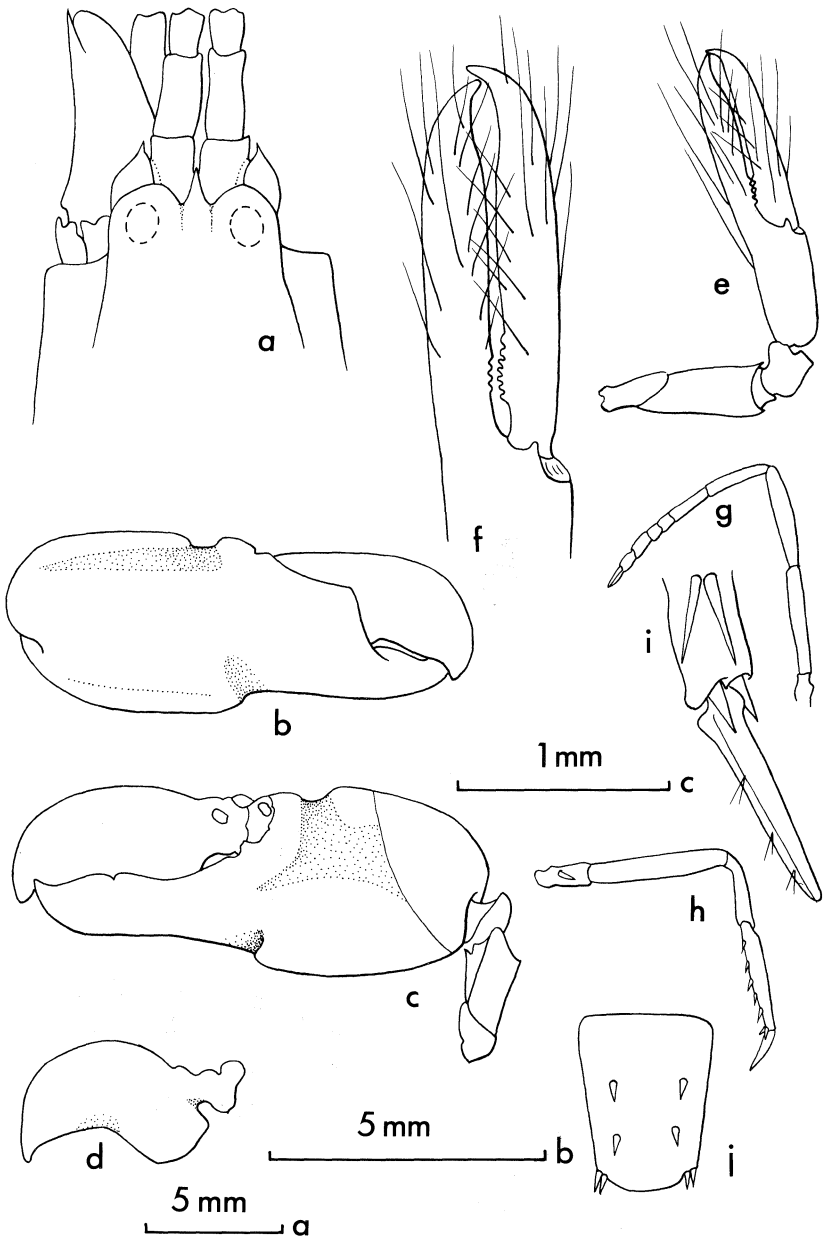


Fig. 65 *Alpheus macrodactylus* Ortmann
35 mm male from AM P. 4288. **a.** Anterior region, dorsal view; **b.** large chela, medial face; **c, d.** large cheliped and dactylus, lateral face; **e, f.** small cheliped medial view and enlarged distal region; **g.** second leg; **h, i.** third leg and enlarged 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 muddly, 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 magins 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 suface 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* subspec. 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*

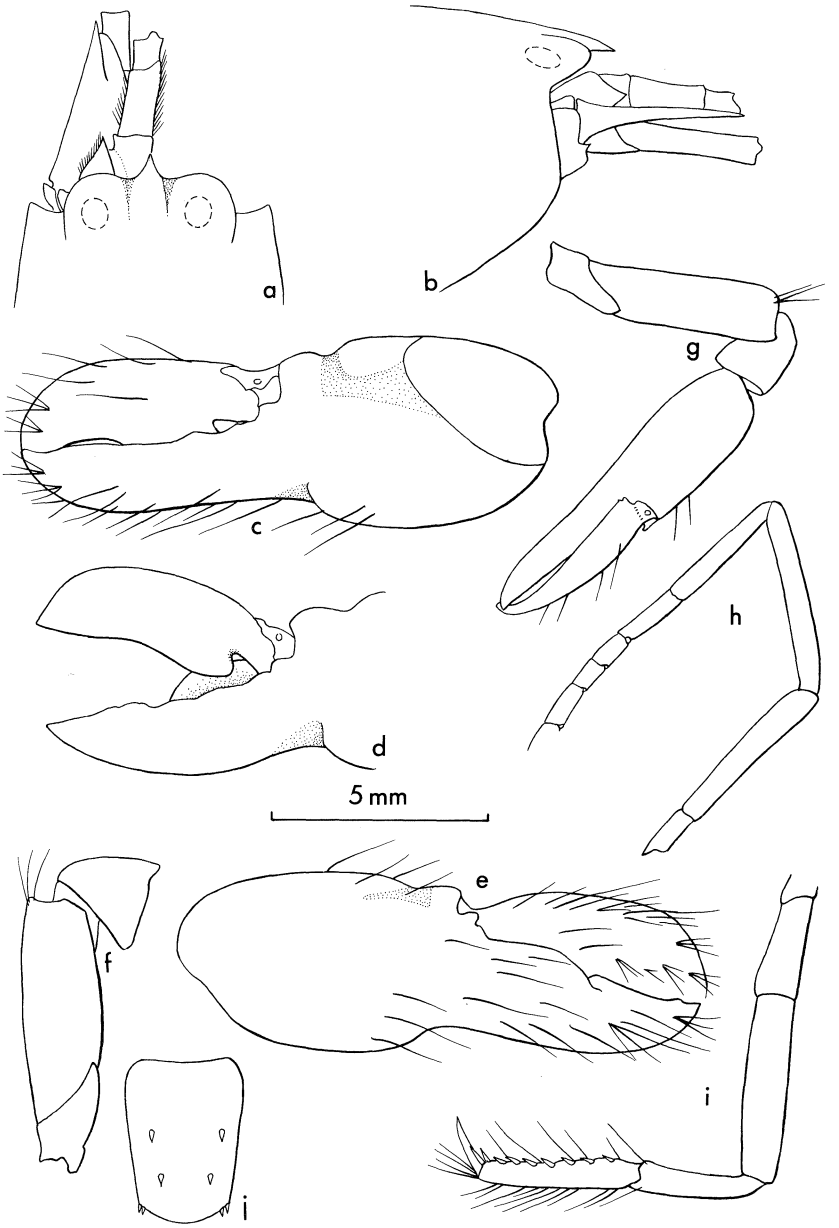


Fig. 66 *Alpheus bunburius* sp. nov.
Holotype (female). **a, b.** Anterior region, dorsal and lateral view; **c, d.** large chela and detail of dactylus, lateral face; **e, f.** large chela and merus, medial view; **g.** small cheliped, lateral view; **h.** second leg; **i.** fourth leg; **j.** telson. 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

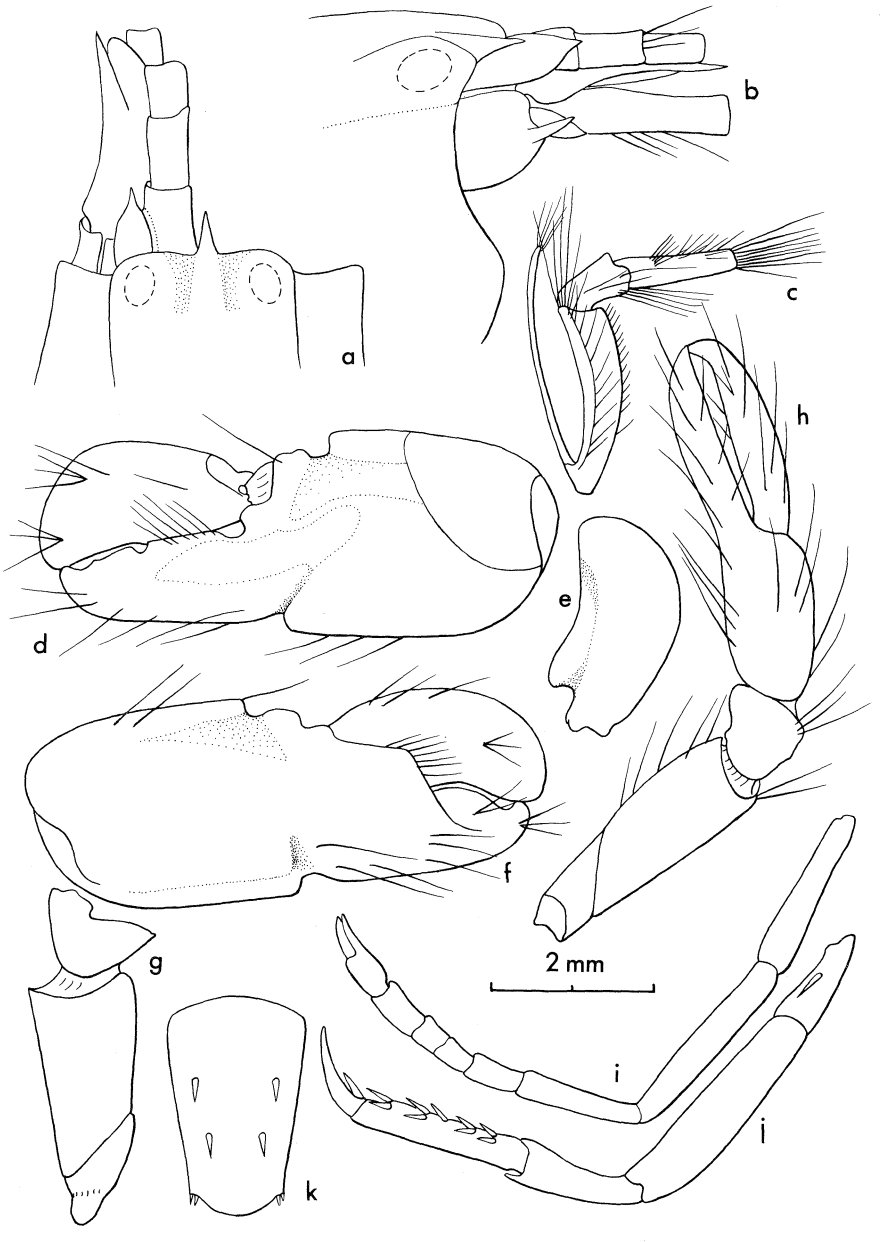


Fig. 67 *Alpheus tasmanicus* sp. nov.
Holotype (male). **a, b.** Anterior region, dorsal and lateral view; **c.** third maxilliped, lateral face; **d, e.** large chela and dactylus, lateral face; **f, g.** large chela and merus, medial face; **h.** small cheliped, medial face; **i.** second leg; **j.** 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 datcylus 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 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

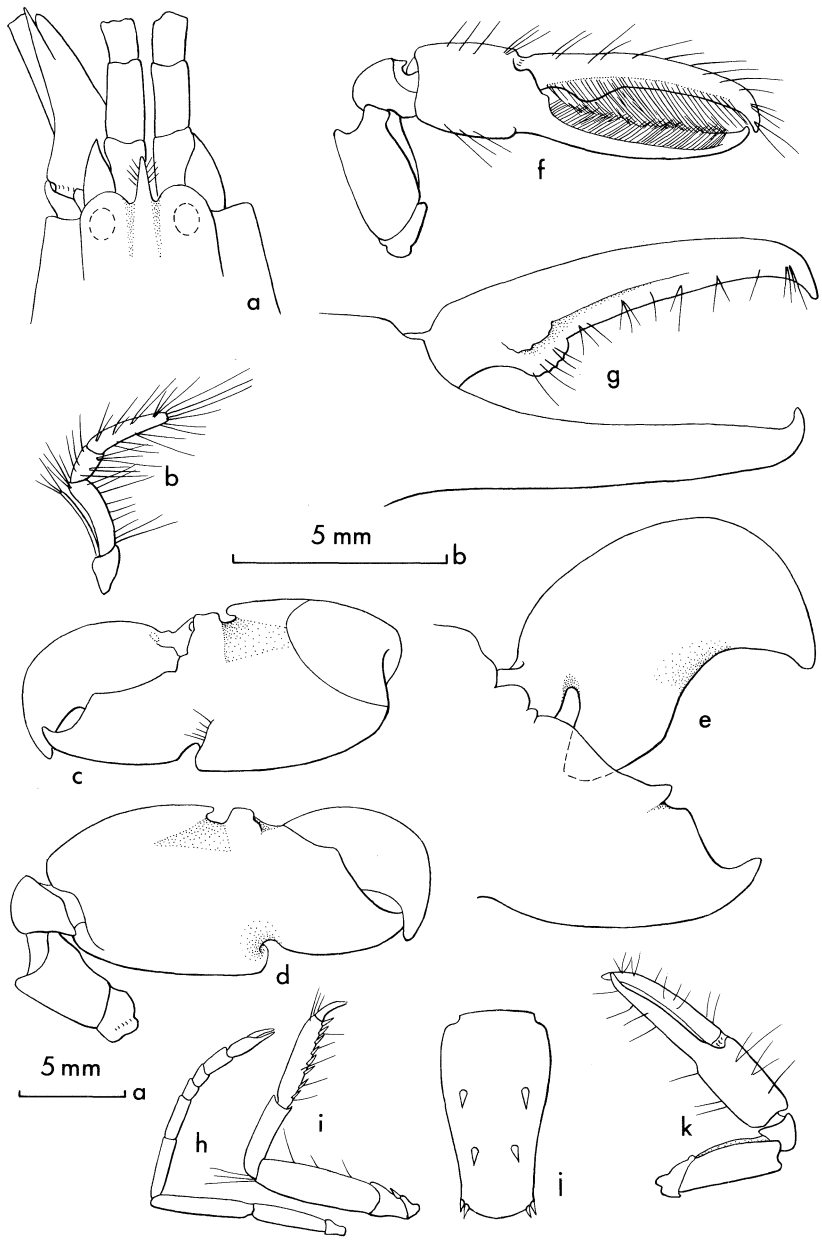


Fig. 68 *Alpheus pacificus* Dana
40 mm male from AM 211. **a.** Anterior region, dorsal view; **b.** third maxilliped; **c.** large chela, lateral face; **d, e.** large cheliped and enlargement of distal region, medial face; **f, g.** small cheliped and enlargement of distal region (with setae removed), 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.

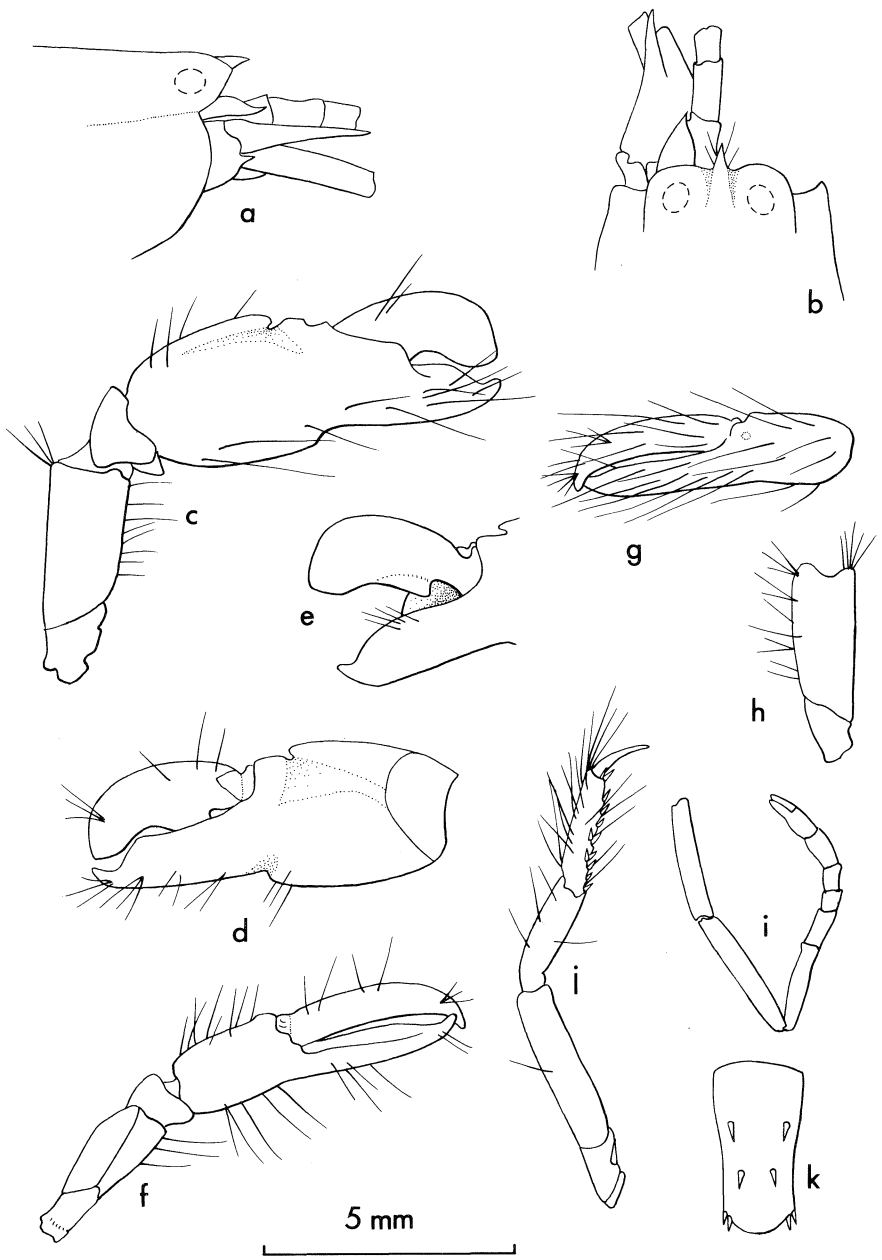


Fig. 69 *Alpheus heronicus* sp. nov.
Holotype (female). **a, b.** Anterior region, lateral and dorsal view; **c.** large cheliped, medial face; **d, e.** large chela and detail of plunger, lateral face; **f.** small cheliped, lateral face; **g, h.** small chela and merus, medial face; **i.** second leg; **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

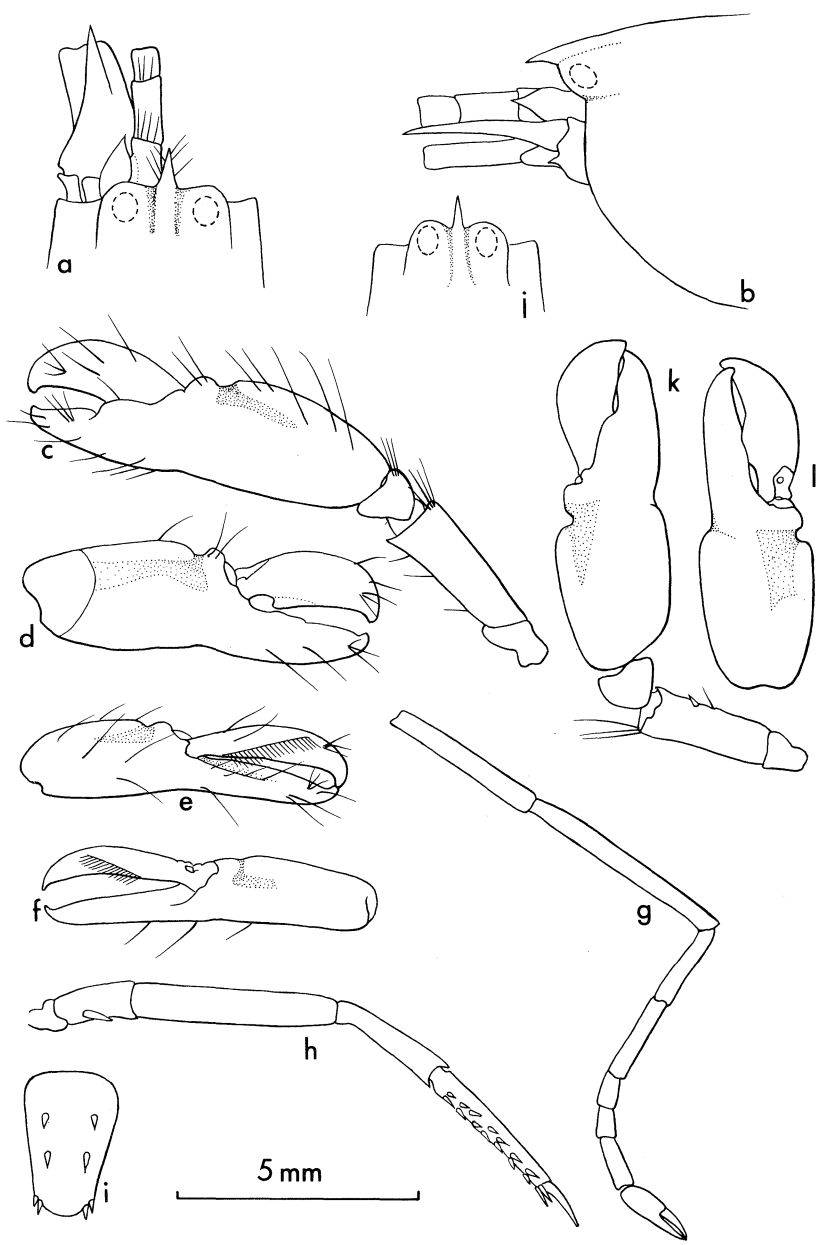


Fig. 70 *Alpheus balaenodigitus* sp. nov.
Holotype (female). **a, b.** Anterior region, dorsal and lateral view; **c.** large cheliped, medial face; **d.** large chela, lateral face; **e, f.** small chela, lateral and medial face; **g.** second leg; **h.** third leg; **i.** telson. 22 mm female from 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*).

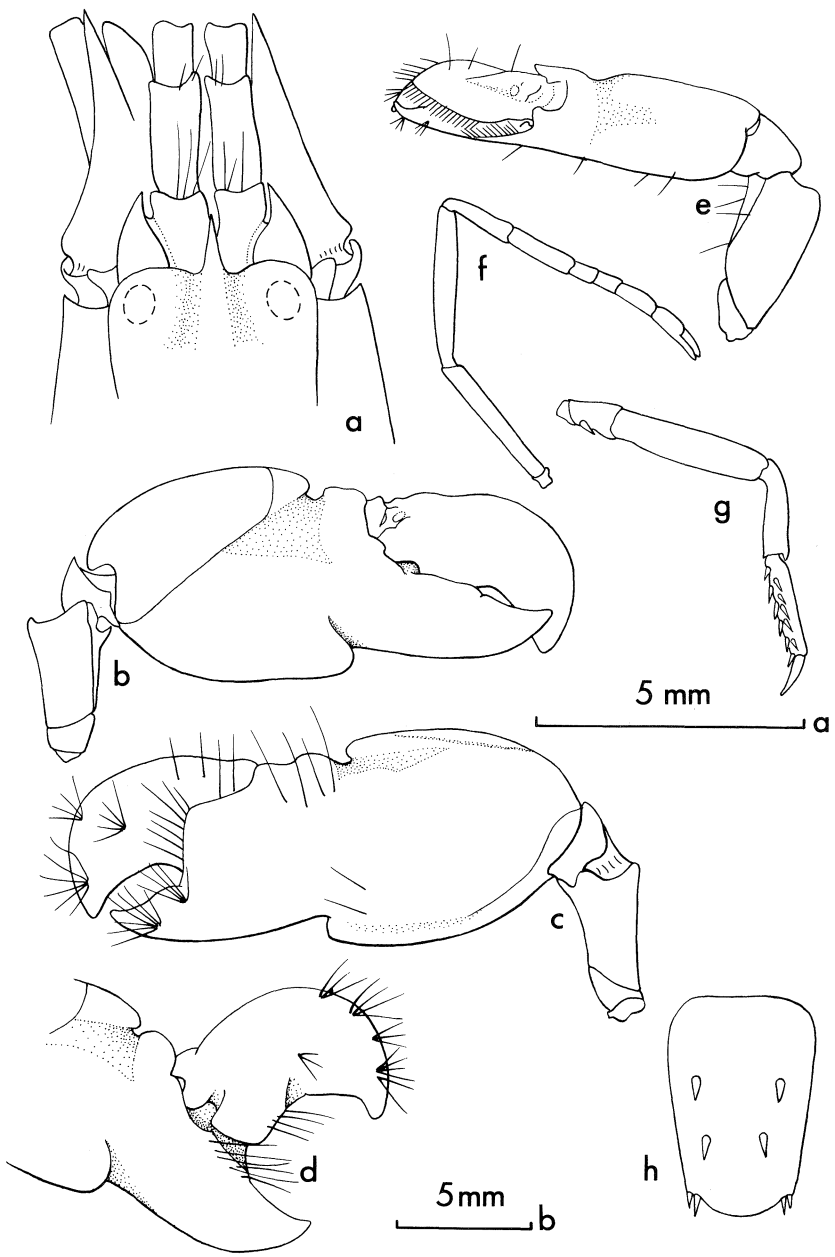


Fig. 71 *Alpheus strenuus strenuus* Dana
40 mm male from BAU 23. **a.** Anterior region, dorsal view; **b, c.** cheliped, lateral and medial face; **d.** fingers of large chela, lateral face; **e.** small cheliped, lateral face; **f.** second leg; **g.** third leg; **h.** telson. b, c, d, e, f, g scale 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 demarked 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 porportions 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* (Lamark, 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". Gravely (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 Coutière (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* subspec. 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** subspec. 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; anteriorly 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

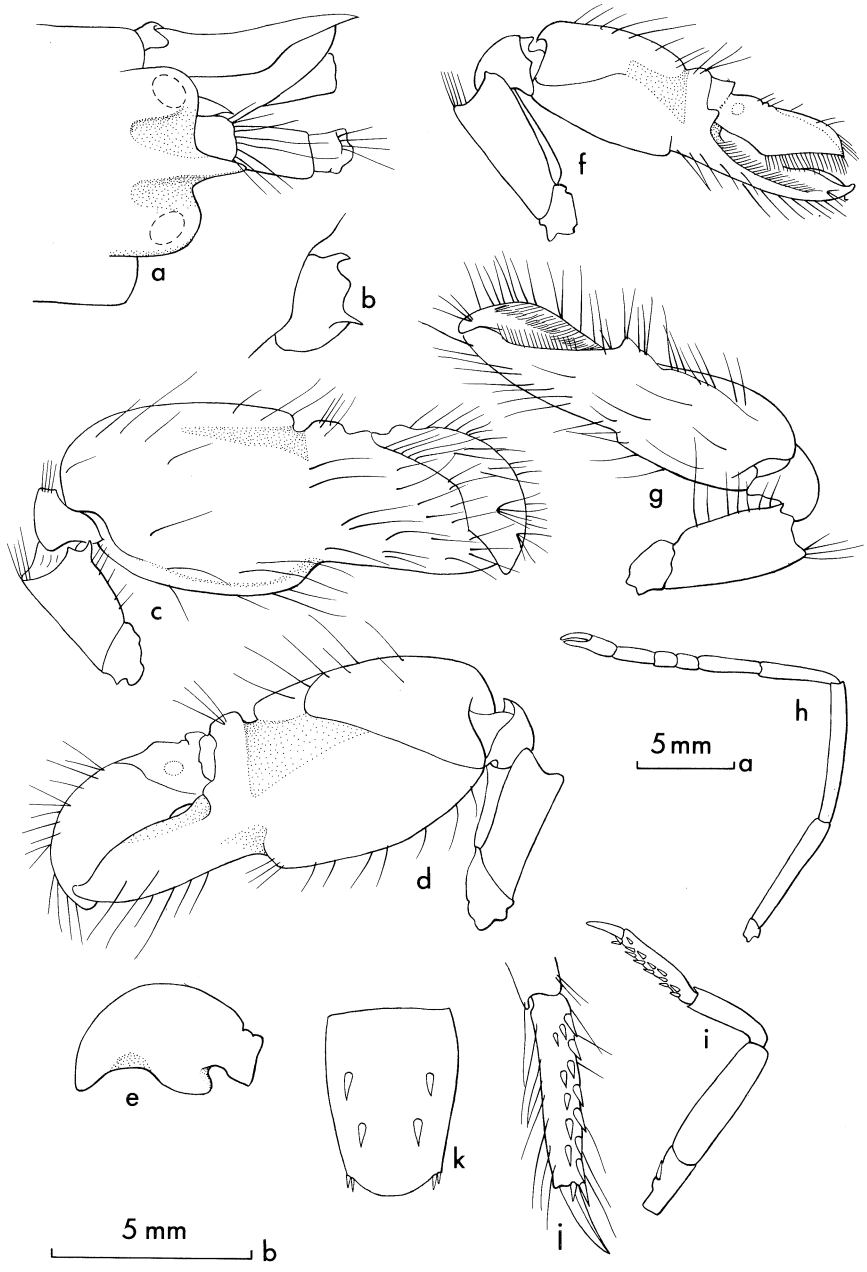


Fig. 72 *Alpheus strenuus cremnus* subspec. nov.
Holotype (male). **a.** Anterior region, dorsal view; **b.** basicerite, lateral view; **c, d, e.** large cheliped, medial and lateral face and dactylus; **f, g.** small cheliped, lateral and medial face; **h.** second leg; **i, j.** third leg and enlarged 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 triangluar 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

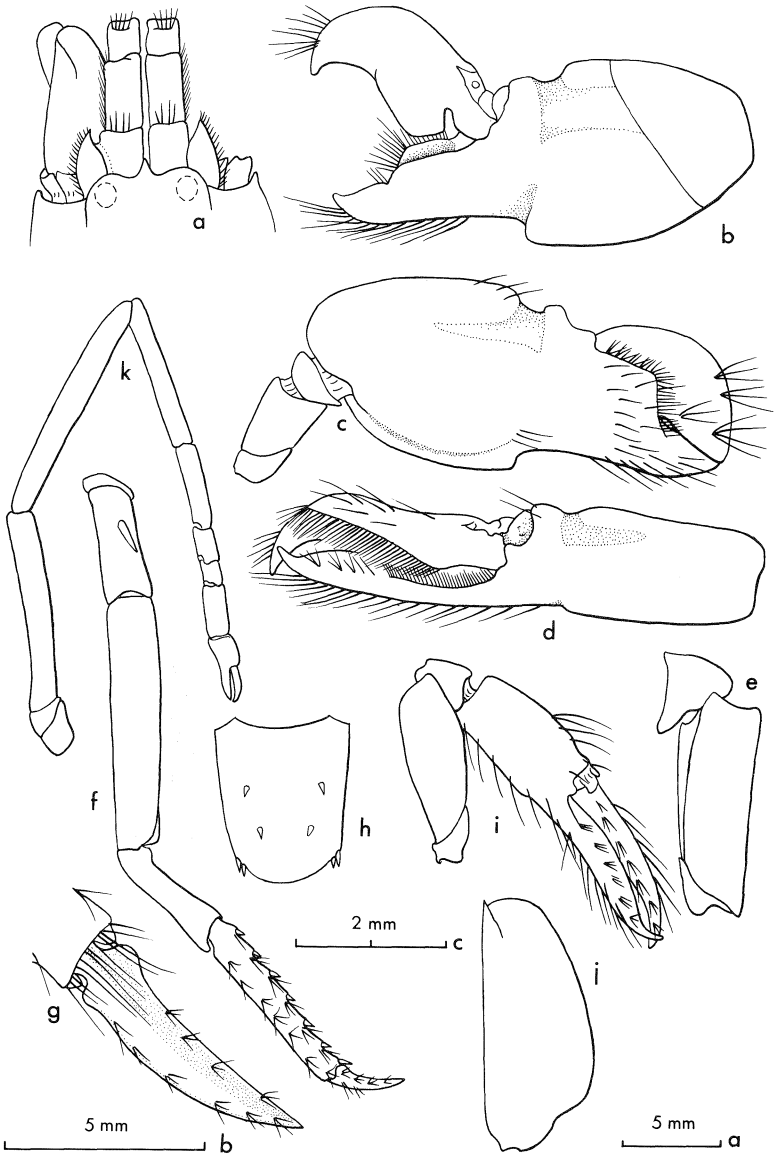


Fig. 73 *Alpheus euphrosyne euphrosyne* De Man
78 mm male from AM 162. **a.** Anterior region, dorsal view; **b.** large chela, lateral face; **c.** large cheliped, medial face; **d, e.** small chela and merus, lateral face; **f, g.** third leg and enlarged dactylus, superomedial face (spatulate side 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, AMG. 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.

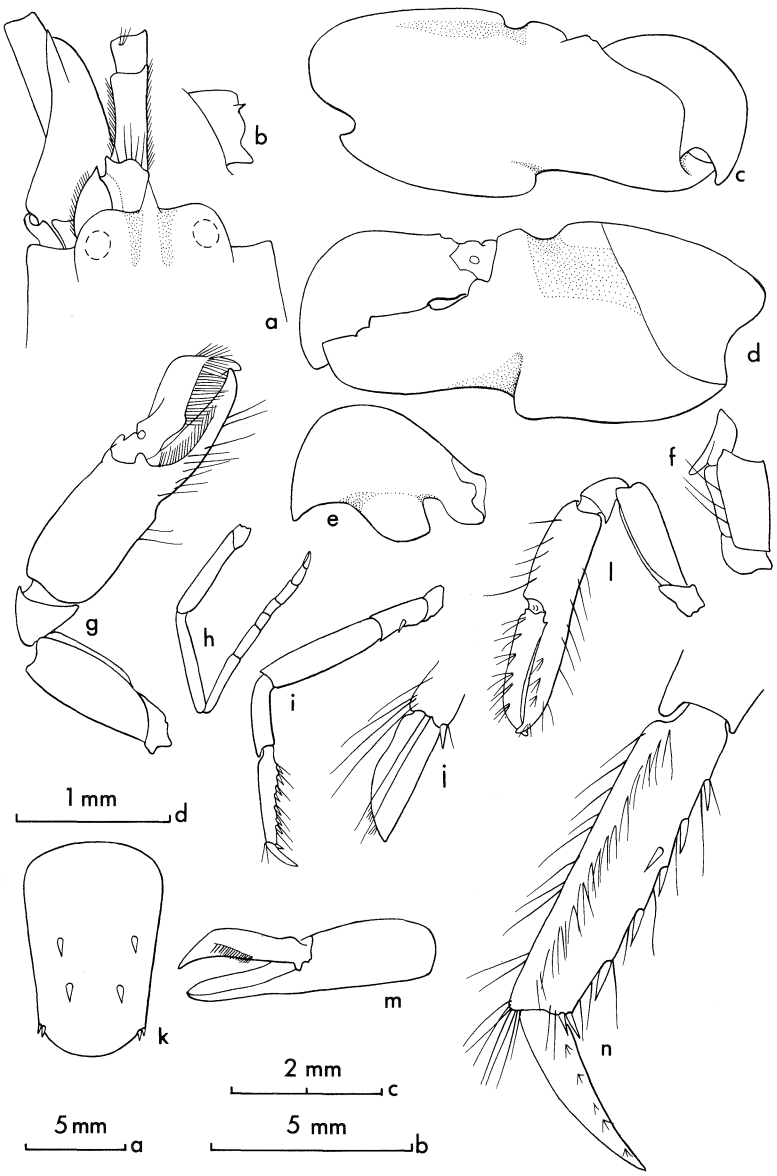


Fig. 74 *Alpheus euphrosyne richardsoni* Yaldwyn
45 mm male from AM P. 4497. **a.** Anterior region, dorsal view; **b.** basicerite, lateral view; **c.** large chela, medial face; **d, e.** large chela and dactylus, lateral face; **f.** merus large chela, lateral face; **g.** small cheliped, lateral 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 euphrosyne***

| | *A. e. euphrosyne* | *A. e. richardsoni* | *A. e. langi* |
|---|---|---|---|
| 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 slighlty 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 balaeniceps 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 oppositive 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 month 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 adpated 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°/00 to about 35°/00. 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 feeing 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. Carpocerite 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 promixal 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 alpheids 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 inermous 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 Reeef 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

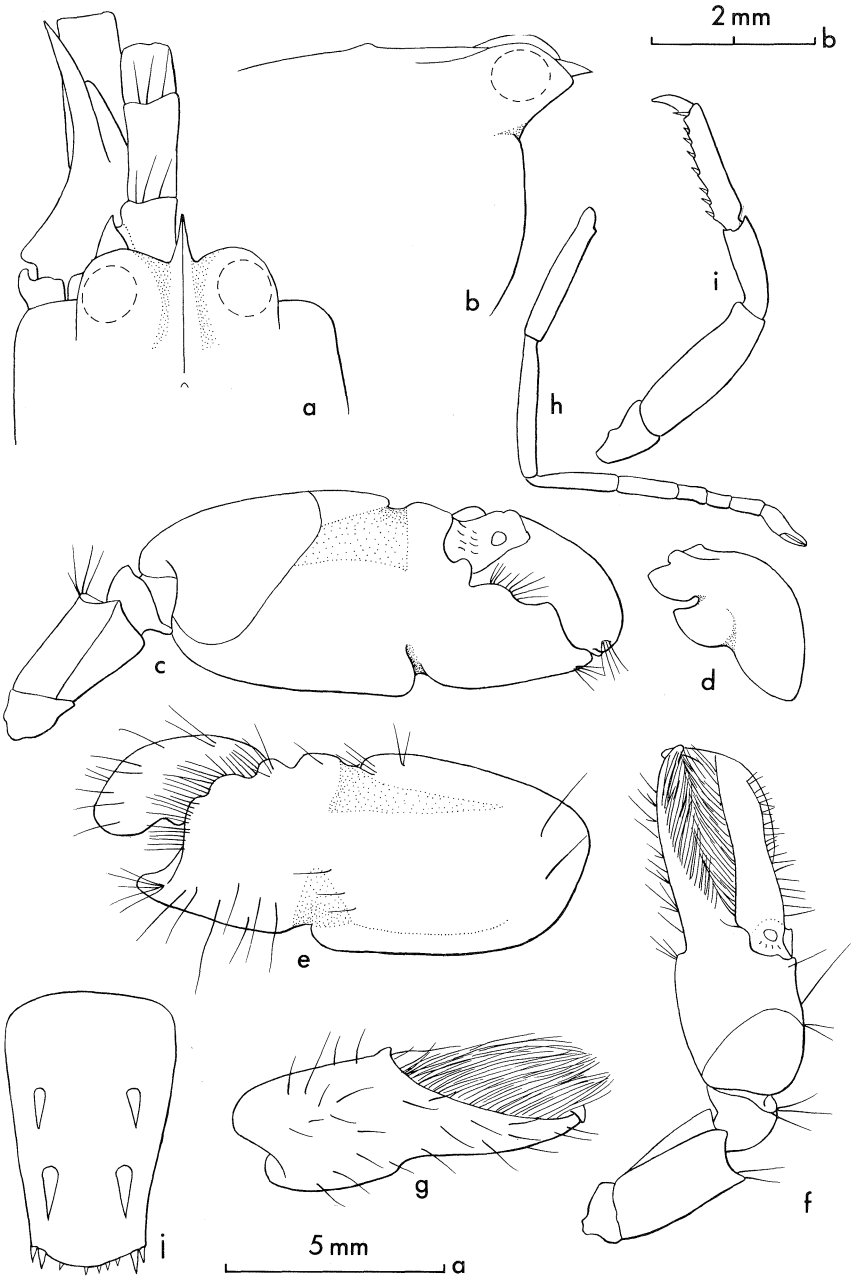


Fig. 76 *Alpheus sudara* B & B
25 mm male from AM 112. **a, b.** Anterior region, dorsal and lateral view; **c, d.** large cheliped and dactylus, lateral face; **e.** large chela, medial face; **f, g.** small cheliped, lateral and small chela, medial face; **h.** second leg; **i.** third leg; **j.** 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. l. lobidens* De Haan). For remarks on the relationship of these specimens to *A. sudara* see discussion under *A. l. 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, inferointernal 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 Altantic *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:

| | *A. leviusculus* | *A. bouvieri* |
|---|---|---|
| Large cheliped, merus | small tooth | rounded |
| palm, length/breadth | 1.90 | 1.48-1.80; average 1.66 |
| Small cheliped, male | rarely balaeniceps | always balaeniceps |
| Tooth of dactylar articulation | sharp | subrectagular 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 familar 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

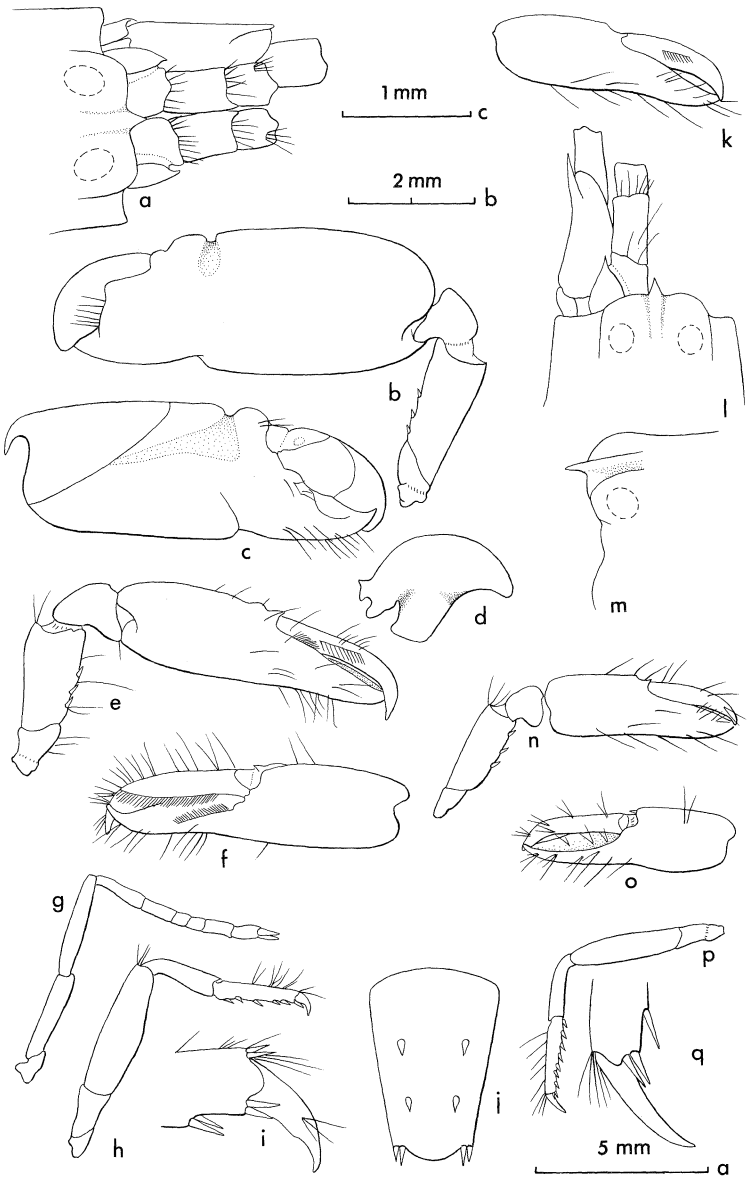


Fig. 77 *Alpheus leviusculus leviusculus* Dana
25 mm male from AM 226. **a.** Anterior region, dorsal view; **b.** large cheliped, medial face; **c, d.** large chela and dactylus, lateral face; **e, f.** small cheliped, medial and lateral face; **g.** second leg; **h, i.** third leg and dactylus enlarged; **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.

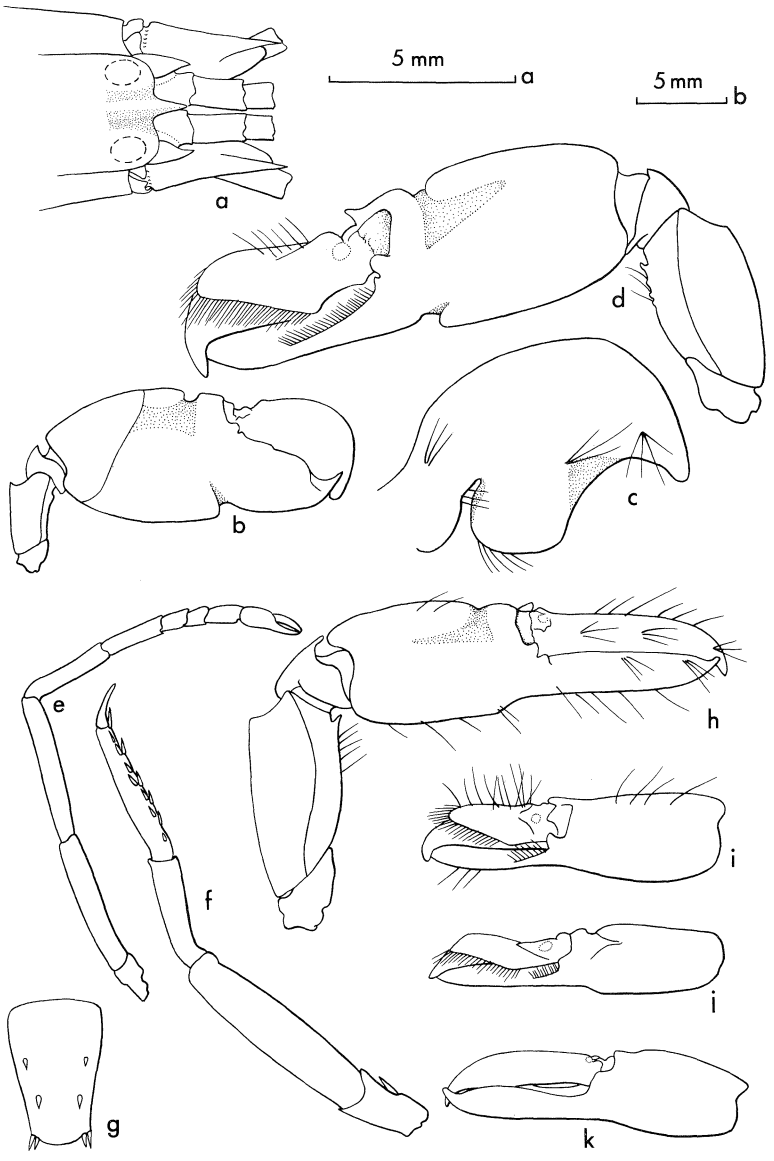


Fig. 78 *Alpheus lobidens lobidens* De Haan
40 mm male from AM 213. **a.** Anterior region, dorsal view; **b, c.** large cheliped, enlarged dactylus, lateral face; **d.** small cheliped of male, lateral face; **e.** second leg; **f.** third leg; **g.** telson. 38 mm female from AM 213. **h.** Small cheliped 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, AM P. 3127; 2, AM P. 5215; 4, AM P. 8009; 3 AM P. 13561; 2, AM P. 13569; 1, AM P. 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 carpocerite 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 approximatley 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 associaton with gobiid fish (see also discussion on p. 182).

Almost all our 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 inferointernal 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***

| | *A. l. lobidens* | *A. l. polynesica* | *A. australiensis* |
|---|---|---|---|
| 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 |

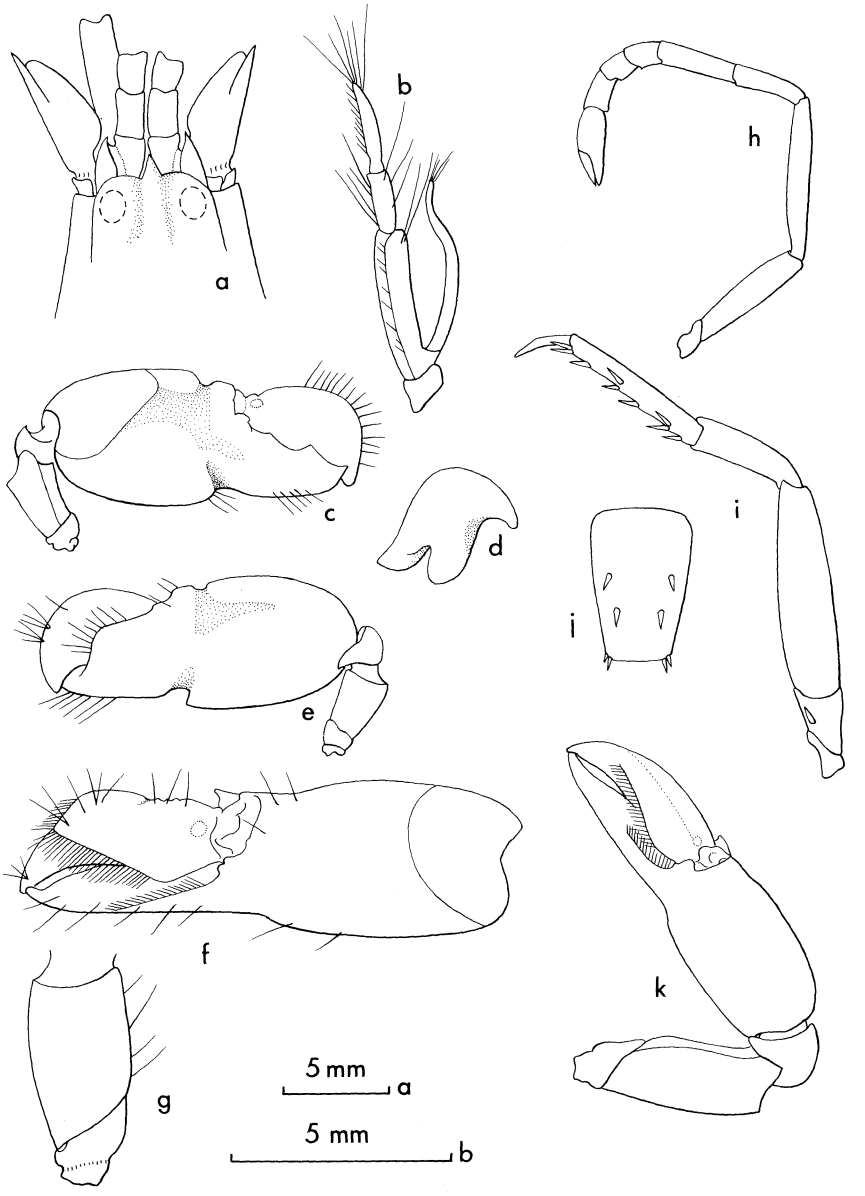


Fig. 79 *Alpheus australiensis* sp. nov.
Holotype (male) **a.** Anterior region, dorsal view; **b.** third maxilliped, lateral face; **c, d, e.** large cheliped medial and lateral face and dactylus; **f, g.** small chela and merus, lateral face; **h.** second leg; **i.** third leg; **j.** telson; Allotype (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 alpheids 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 117 (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. Carpocerite 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 oppositive 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 oppositive 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

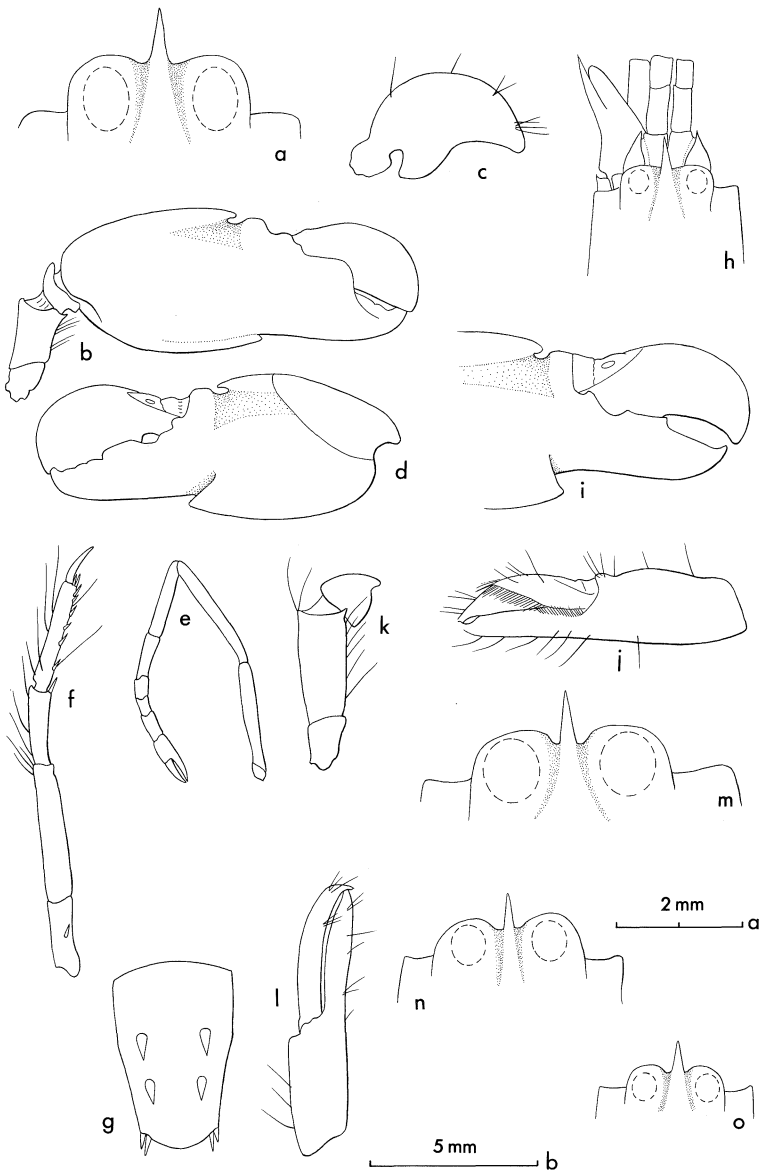


Fig. 81 *Alpheus bisincisus* De Haan
28 mm male from WM 144-65. **a.** Anterior region, dorsal view; **b, c.** large cheliped and dactylus medial face; **d.** large chela, lateral face; **e.** second leg; **f.** third leg; **g.** telson. 30 mm male from AM P. 7711. **h.** Anterior region, dorsal view; **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)

| | *A. bisincisus* | *A. b. malensis* | *A. b. stylirostris* | *A. b. variabilis* | *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 our 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.

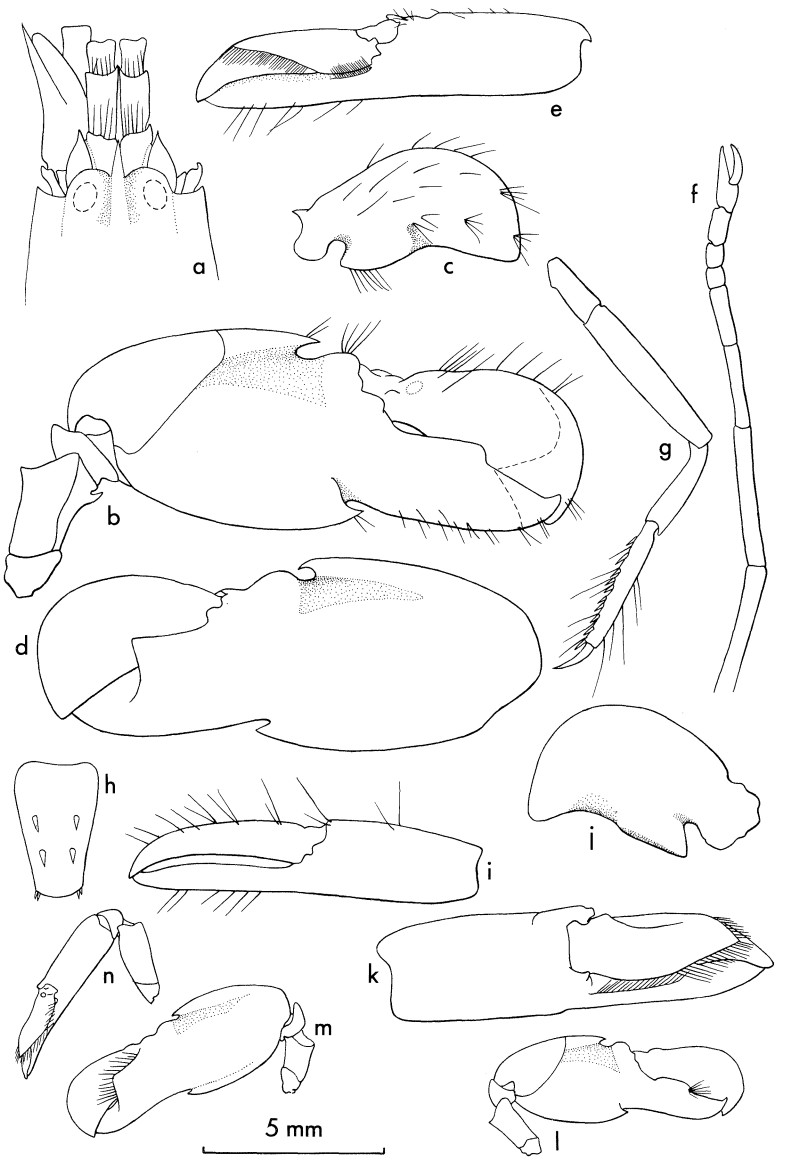


Fig. 82 *Alpheus chiragricus* Milne-Edwards
30 mm male from AM 42. **a.** Anterior region, dorsal view; **b, c.** large cheliped and dactylus, lateral face; **d.** large chela, medial face; **e.** small cheliped, medial face; **f.** second leg; **g.** third leg; **h.** telson. 28 mm female from AM 42. **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'Historie 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 atempting 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. Edwardsi"* and his *"A. Edwardsi 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.

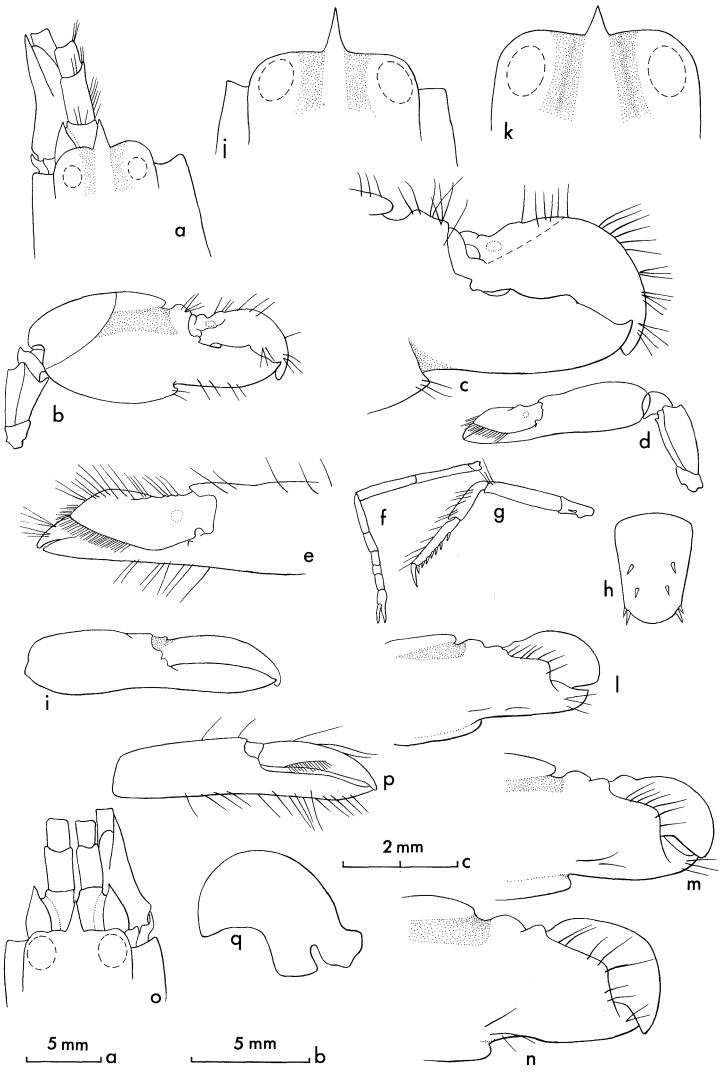


Fig. 83 *Alpheus edwardsii* (Audouin)
32 mm male from AM 217. **a.** Anterior region, dorsal view; **b, c.** large cheliped and enlargement of distal region, lateral face; **d, e.** small cheliped and enlargement of distal region, lateral face; **f.** second leg; **g.** third leg; **h.** telson. 30 mm 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 neoparatypic 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 gooves 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.

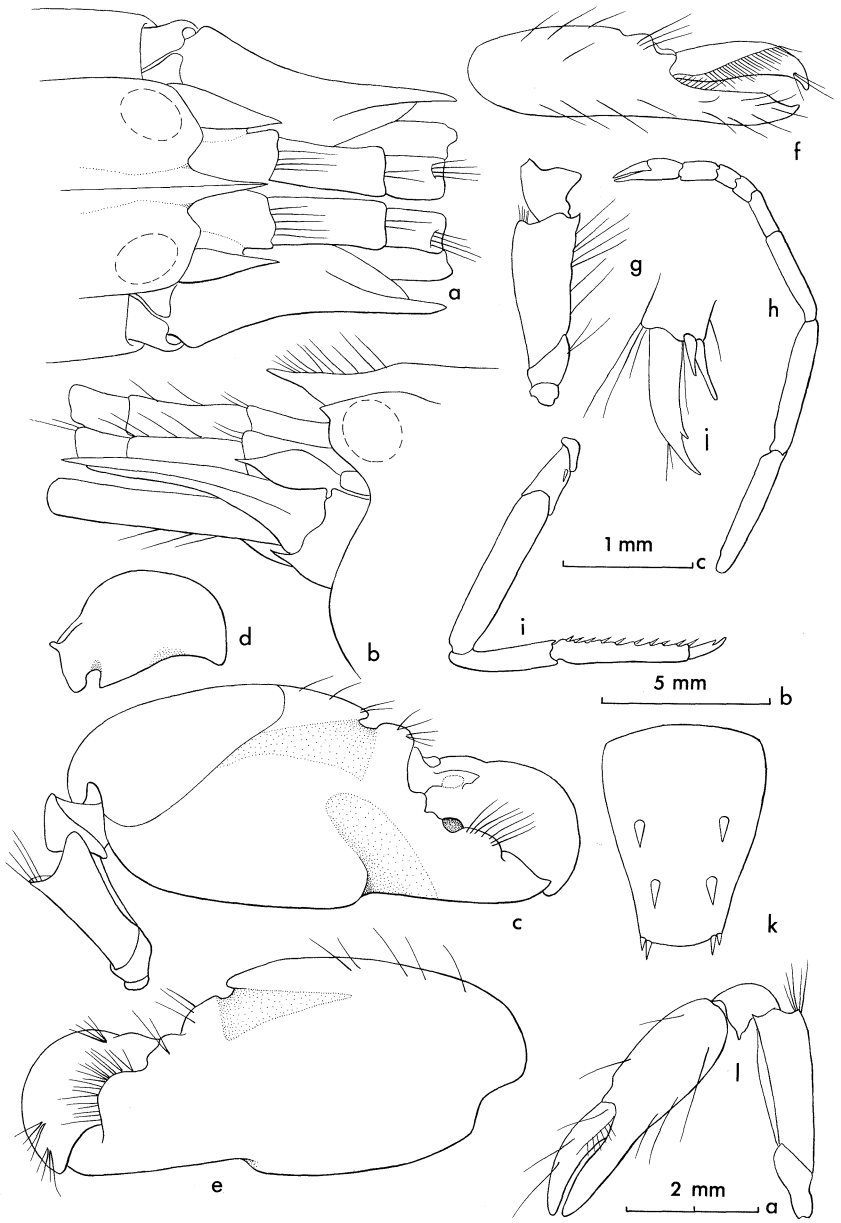


Fig. 84 *Alpheus polyxo* De Man
32 mm male from AM 280. **a, b.** Anterior region, dorsal and lateral view; **c, d.** large cheliped and dactylus, lateral face; **e.** large chela, medial face; **f, g.** small chela, merus and carpus, medial face; **h.** second leg; **i, j.** third leg and enlarged dactylus; **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.

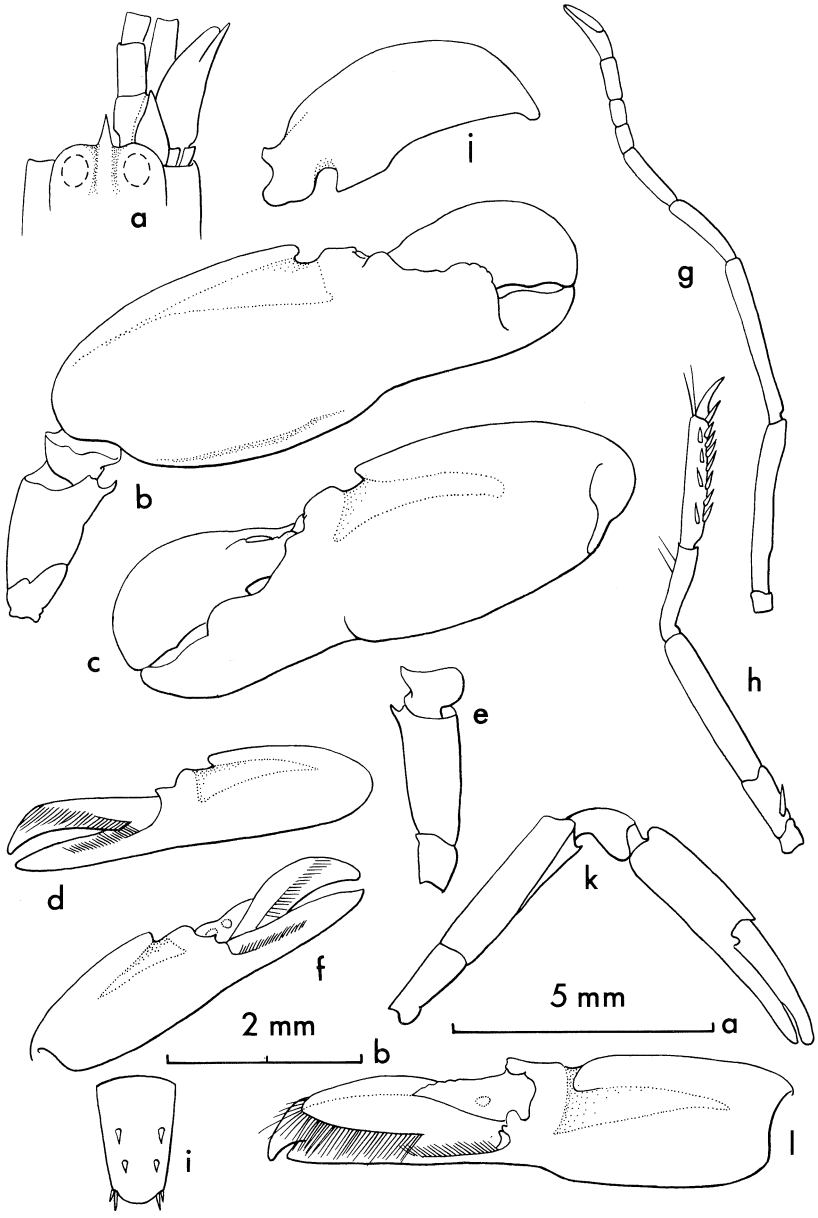


Fig. 85 *Alpheus pareuchirus pareuchirus* Coutière
24 mm male from AM E. 3190. **a.** Anterior region, dorsal view; **b, c.** large cheliped, medial face and chela, lateral face; **d, e.** small chela and merus, medial face; **f.** small chela, lateral face; **g.** second leg; **h.** third leg; **i.** 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 Diemans 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 carpocerite 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 pereiopods have ben lost. We found his illustrations to be accurate. On the basis of the protrudant 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 pereiopods 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 Lisiansky 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.

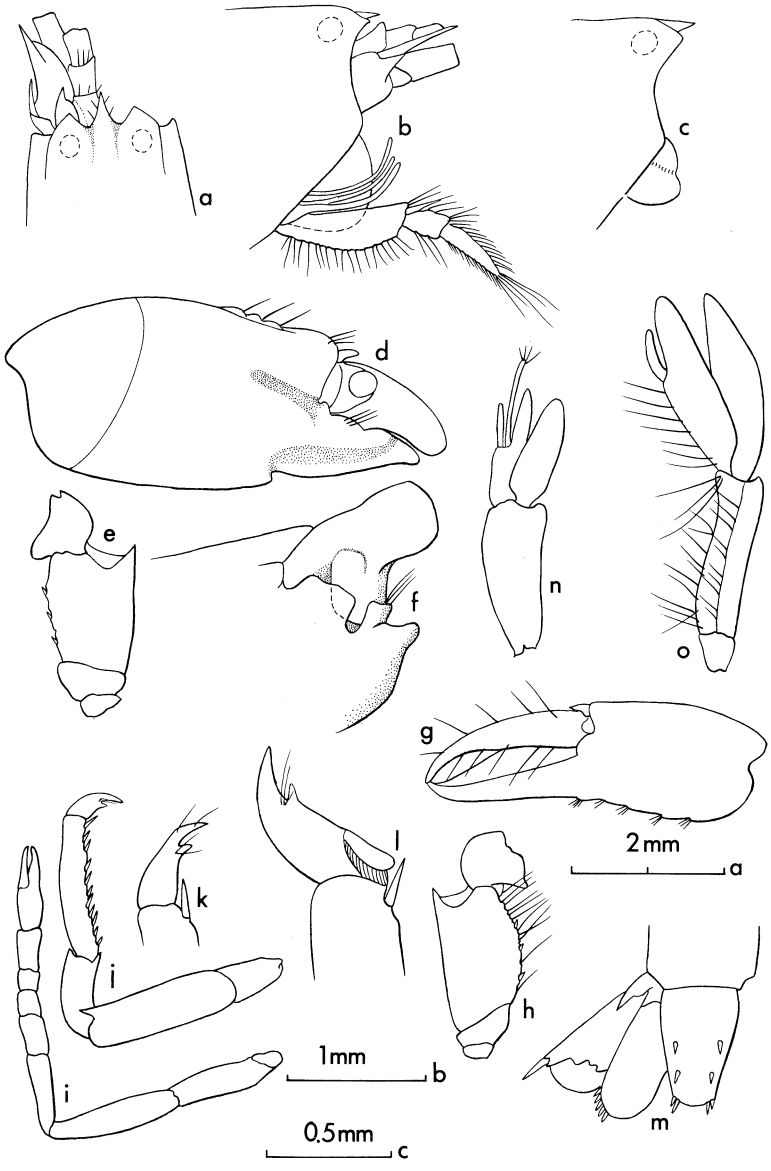


Fig. 86 *Metalpheus paragracilis* (Coutière)
14 mm male from BAU 58. **a, b.** Anterior region, dorsal and lateral view; **c.** anterior region of carapace showing labrum; **d, e.** large chela, lateral face and merus, medial face; **f.** large chela, distolateral face and detail of dactylus; **g, h.** 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 protrudant 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; inferointernal 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 inferointernal 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 basicerite 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

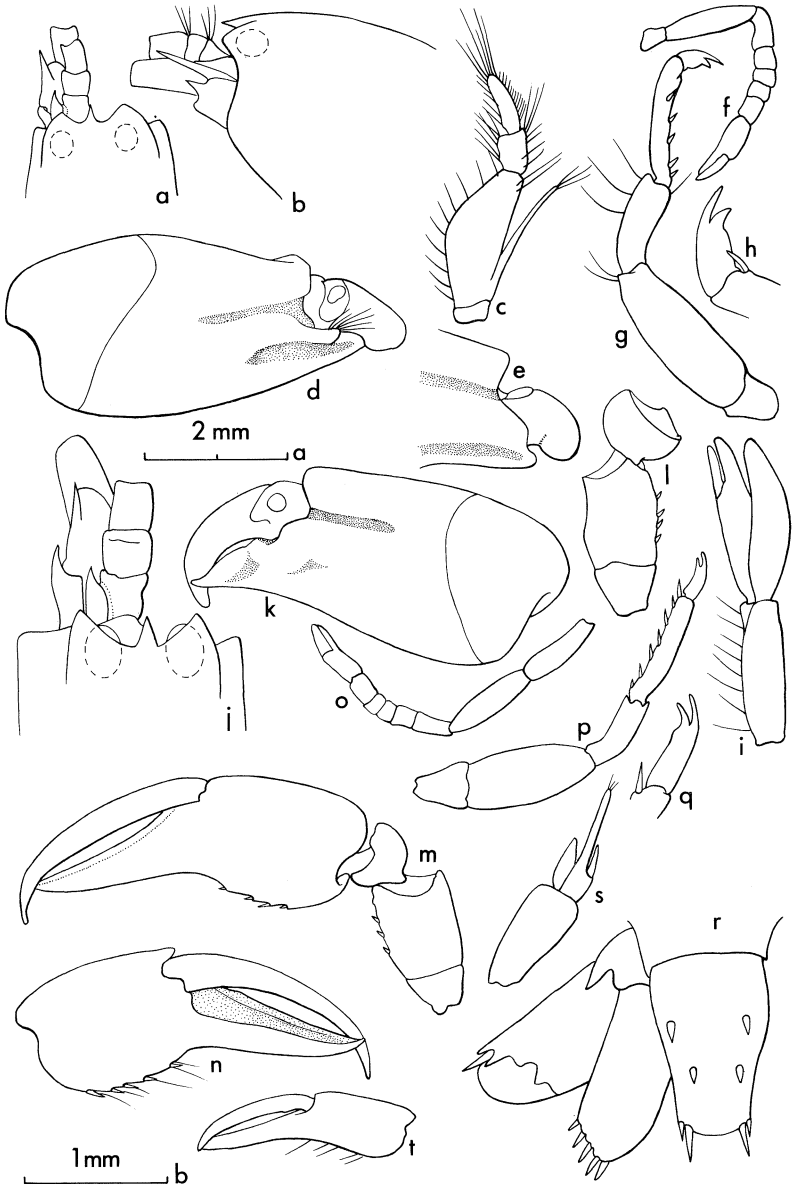


Fig. 87 *Metalpheus rostratipes* (Pocock)
15 mm female from BAU 47. **a, b.** Anterior region, dorsal and lateral view; **c.** third maxilliped; **d, e** large chela, lateral face and detail of dactylus; **f.** second leg; **g, h.** third leg and enlarged dactylus; **i** second pleopod. 12 mm male from BAU 47. **j.** Anterior region, dorsal view; **k, l.** large chela, latera face and merus, medial face; **m.** small cheliped, medial face; **n.** small chela, lateral face; **o.** seconc 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 heretofor. 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 Holthius (1955a:93) maintained Hay and Shore's family, but combined it with Alpheidae, Hippolytidae and Processidae into the superfamily Alpheoida. 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 Alpheoida.

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-directly 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

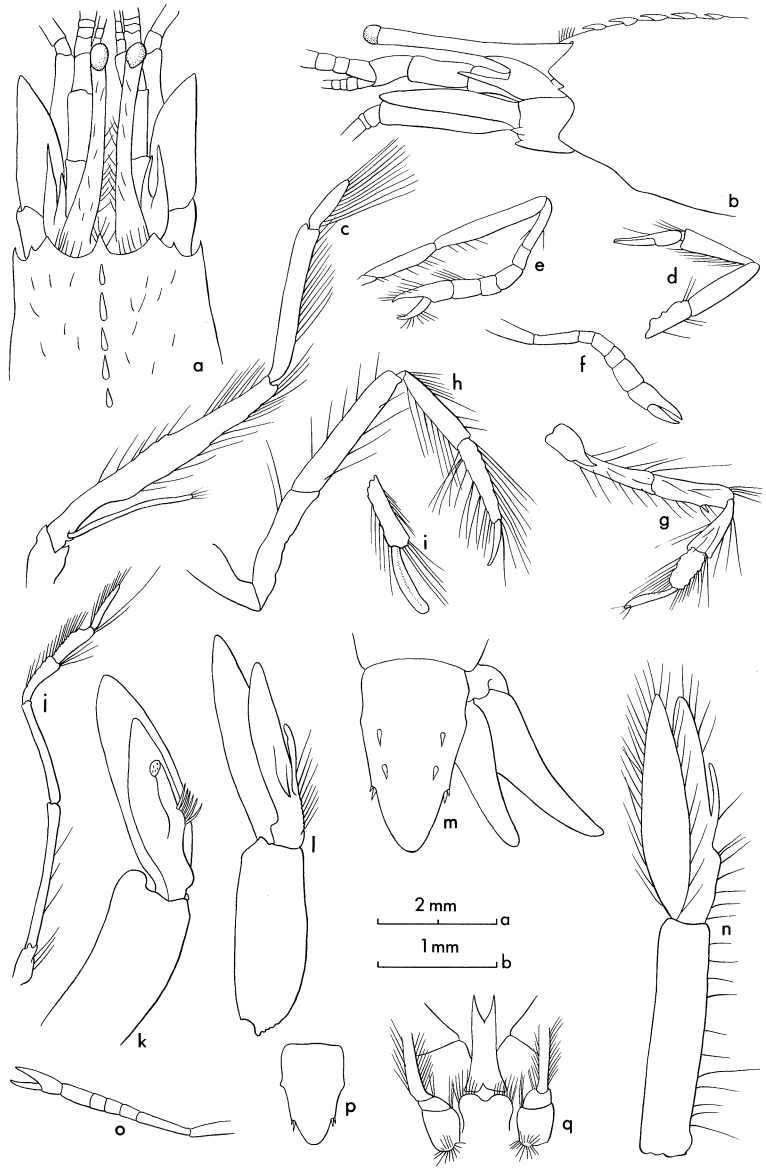


Fig. 88 *Ogyrides delli* Yaldwyn

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.

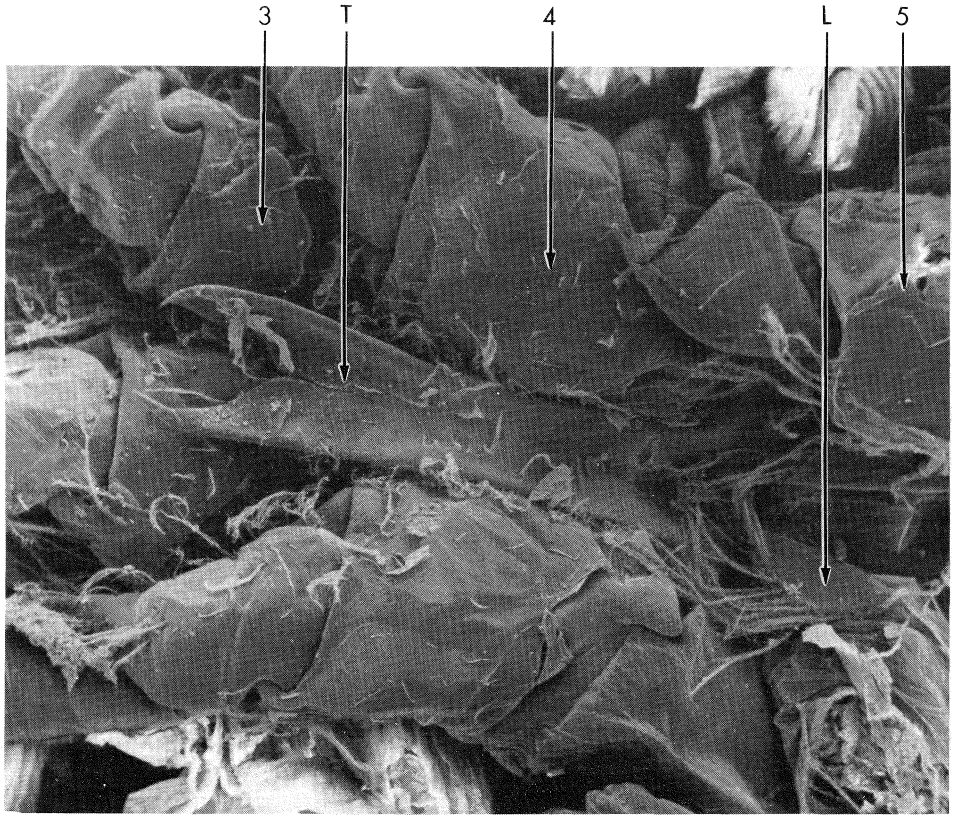


Fig. 89. *Ogyrides delli* Yaldwyn
20 mm male specimen from AM P. 21599. Scanning electron microscope photograph of ventral side, posterior thoracic segments. 3, 4, 5 bases of thoracic legs, as numbered; **T,** notched plate of thelycum-like structure, **L,** setiferous lobe. SEM photography made by Dr 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 mjöbergi* 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 antennal 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).

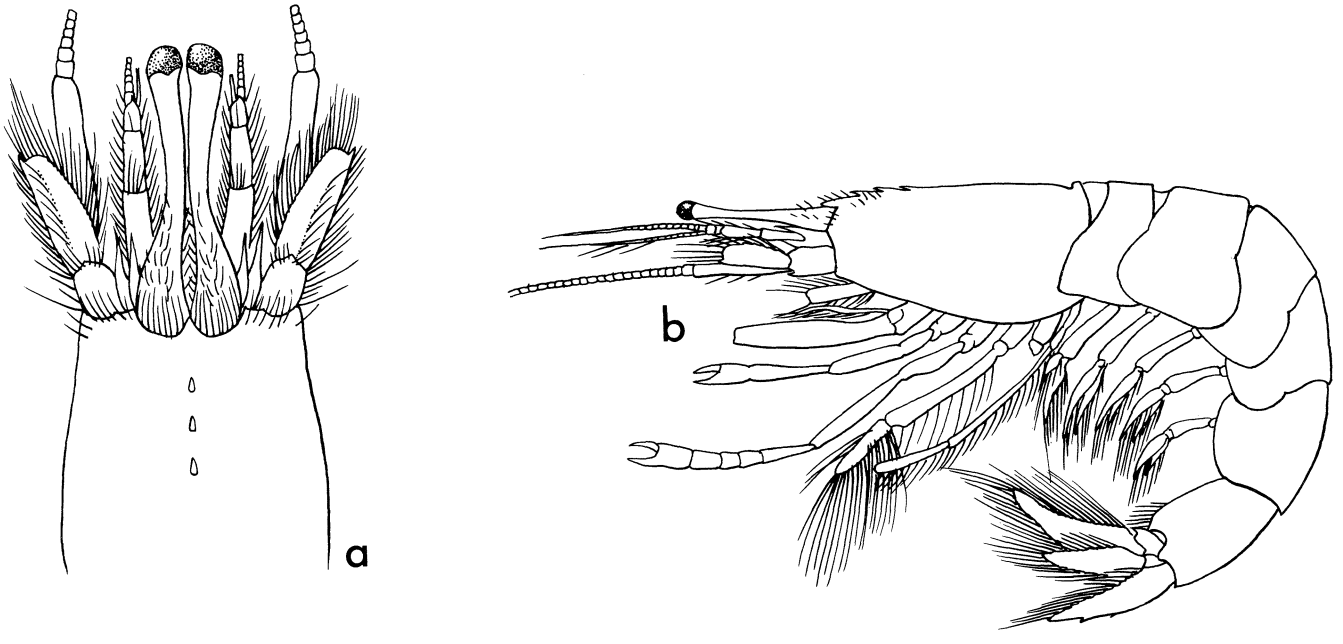


Fig. 90 *Ogyrides mjobergi* (Balss)
**a.** Anterior region dorsal view; **b.** whole animal, lateral view. (Figs. after Balss).

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,

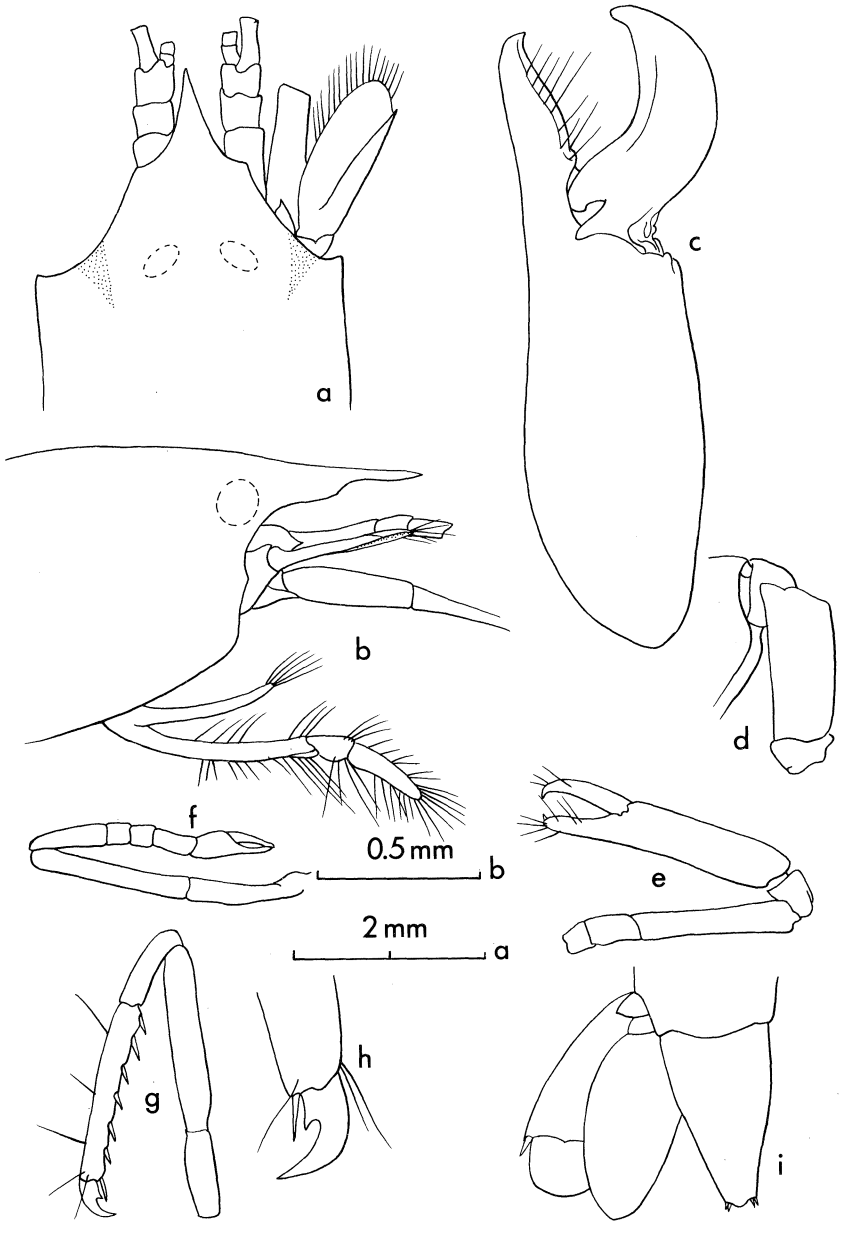


Fig. 91 *Synalpheus tijou* sp. nov.
Holotype (female). **a, b.** Anterior region, dorsal and lateral view; **c, d.** large chela and merus, lateral face; **e.** small cheliped, medial face; **f.** second leg; **g, h.** third leg and dactylus, enlarged; **i.** telson and uropods. a, b, c, d, e, f, g, 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 dessication, 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 oribitorostral 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 addtiion 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 paralaticeps** 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 circlet 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

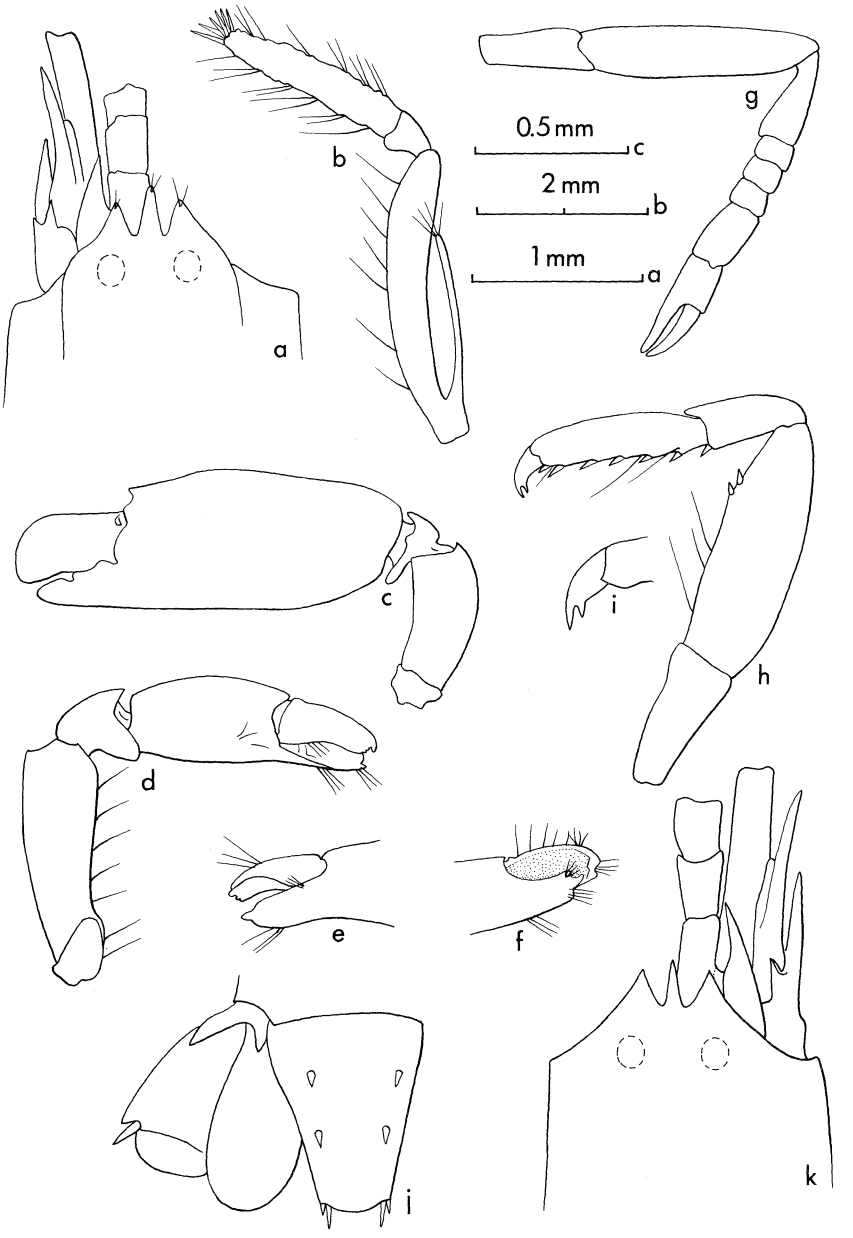


Fig. 92 *Synalpheus paralaticeps* sp. nov.
Holotype (female). **a.** Anterior region, dorsal view; **b.** third maxilliped; **c.** large cheliped, medial face; **d.** small cheliped, lateral face; **e, f.** distal region of small chela, medial and inferior face; **g.** second leg; **h, i.** third leg and enlarged dactylus; **j.** telson and uropods. Alloytype (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 shoulders .....10A

— 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 irregluar 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.

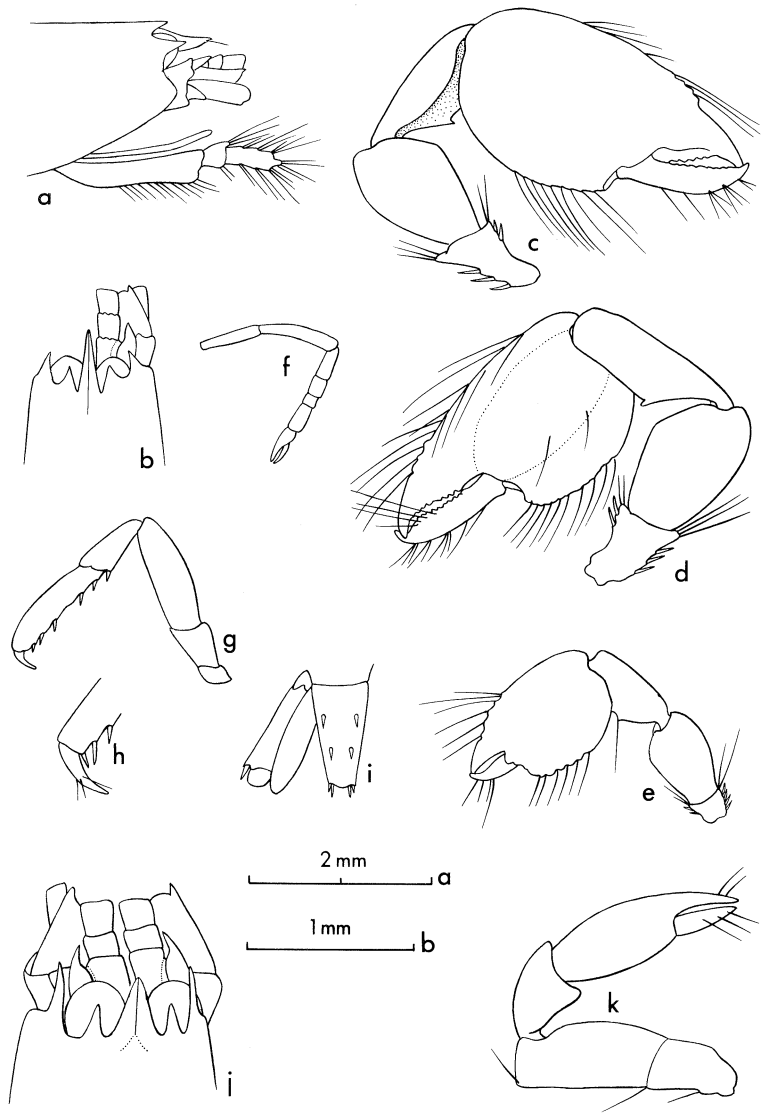


Fig. 93 *Athanas polynesia* B&B
8 mm male from AM P. 25161. **a, b.** Anterior region, lateral and dorsal view; **c, d.** large cheliped, lateral and medial face; **e.** small cheliped, lateral face; **f.** second leg; **g, h.** third leg and enlarged dactylus; **i.** telson and uropod. 8 mm female from 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. ghardaqensis* (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 protrudant (the mouthparts for *A. ghardaqensis* 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 separted 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 biunguiculate ..... 11"

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

*Jousseaumea 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 prosteriorly 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 alpheids of the Red Sea and Gulf of Aden.

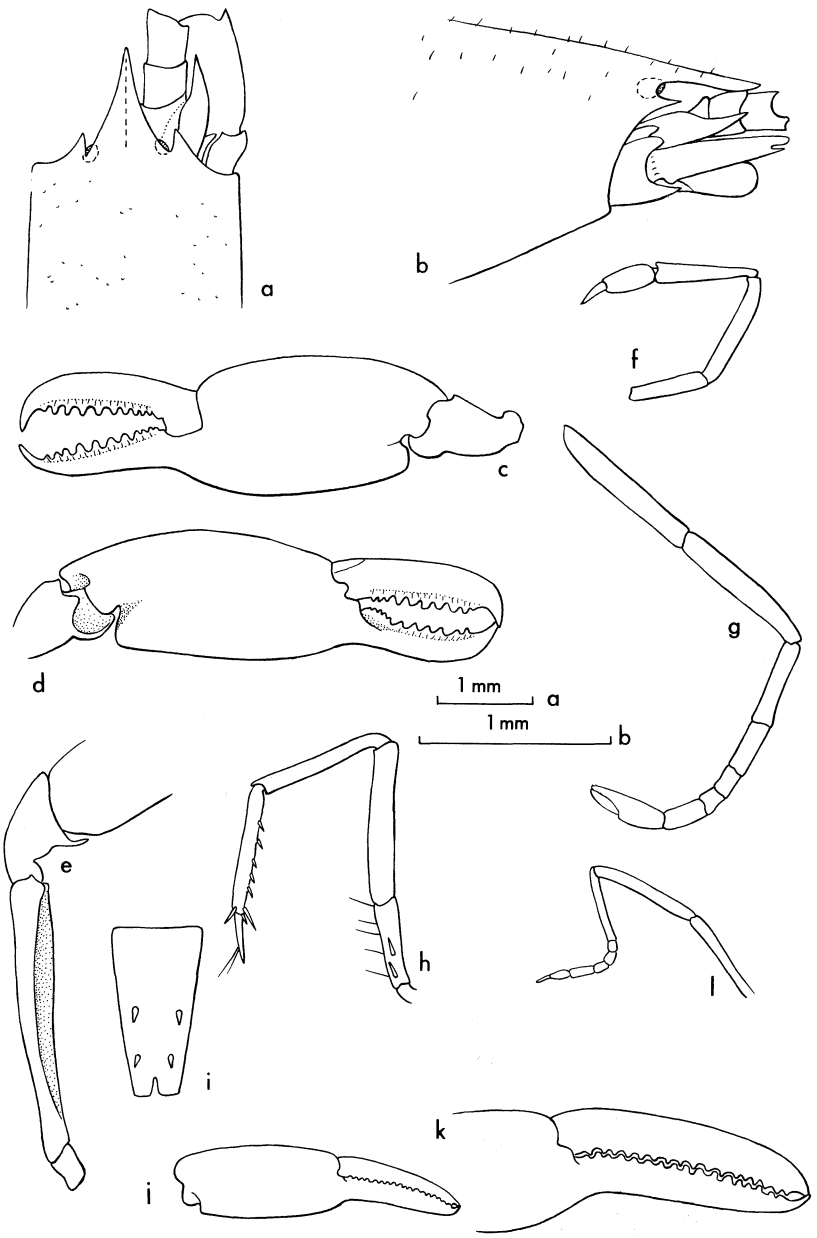


Fig. 94 *Salmoneus sibogae* De Man

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 I: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 dimorhphus* 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 centry — *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 alpheids).

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 alphameric 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. | Sorento, 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 |
|---|---|---|---|
| *Alpheus alope* White | White, 1847:75; Miers, 1874:5 | *Nomen nudem* | B&B, 1977:281 |
| *A. avarus* Fabricius* | Heller, 1865:108; ? Bate, 1888:544 | *? Alpheus strenuus* Dana | See footnote |
| *A. comatularum* Haswell | Haswell, 1882a:762 | *Synalpheus comatularum* (Haswell) | II:289 |
| *A. crassimanus* Heller | Bate, 1888:554 | *Alpheus lobidens* de Haan | III:252 |
| *A. crinitus* Dana | Coutière, 1900:413 | *Alpheus bucephalus* Coutière | III:120 |
| *A. doris* White | White, 1847:75; Miers, 1874:5 | *A. strenuus strenuus* Dana | B&B, 1977:281 |
| *A. doto* White | White, 1847:75; Miers, 1874:5 | *A. socialis* Heller | B&B, 1977:282 |
| *A. galathea* White | White, 1847:75; Miers, 1874:5 | *Nomen nudem* | B&B, 1977:282 |
| *A. gracilidigitus* Miers | Nobili, 1899:233 | *A. pacificus* Dana | III:217 |
| *A. insignis* Heller | ? Nobili, 1899:233 | *A. diadema* Dana | III:140 |
| *A. laevis* Randall | Heller, 1865:107; Haswell, 1882b:191 | *A. lottini* Guérin | III:65 |
| *A. neptunus* White | White, 1847:74; Miers, 1874:4 | *? A. edwardsii* (Audouin) | B&B, 1977:280 |
| *A. paraculeipes* Coutière | Green, 1972:67 | *A. spongiarum* Coutière | III:116 |
| *A. rapax miersi* | Coutière, 1898d:166 | *A. miersi* Coutière | III:168 |
| *A. richardsoni* Yaldwyn | Yaldwyn, 1971:88 | *A. euphrosyne richardsoni* Yaldwyn | III:235 |
| *A. thetis* White | White, 1847:75; Miers, 1874:5 | *A. lottini* Guérin | B&B 1977:282 |
| *A. ventrosus* Milne-Edwards | Coutière, 1900:413; Patton, 1966:282; McNeill, 1968:15 | *A. lottini* Guérin | III:65 |
| *Betaeus trispinosus* Stimpson | Stimpson, 1861:32; Haswell, 1882b:192; Whitelegge, 1889:224 | *Alpheopsis trispinosus* (Stimpson) | I:337 |
| *Betaeus microstylus* Bate | Bate, 1888:566 | *Alpheus microstylus* (Bate) | III:319 |
| *Cheirothrix parvimanus* Bate | Bate, 1888:533 | *Batella parvimanus* (Bate) | III:16 |
| *Crangon bucephalus var.* (Coutière) | Rathbun, 1914:654 | *Alpheus bucephalus* Coutière | III:120 |
| *C. edwardsii* (Audouin) | Rathbun, 1914:654; Hale, 1927b:308 Pope, 1949:327 | *A. edwardsii* (Audouin) | III:270 |
| *C. novae-zealandiae* (Miers) | Hale, 1927a:47; 1927b:308 | *A. novaezealandiae* Miers | III:145 |
| *C. praedator* (De Man) | Hale, 1927a:47; 1927b:308 | *A. bidens* (Olivier) | III:136 |
| *C. strenuus* (Dana) | Pope, 1949:326 | *A. strenuus strenuus* Dana | III:225 |
| *C. villosus* (Olivier) | Hale, 1927a:46; 1927b:407; 1941:265 | *A. villosus* (Olivier) | III:49 |
| *Ogyris mjöbergi* Balss | Balss, 1921:7 | *Ogyrides mjobergi* (Balss) | III:294 |
| *Palaemon bidens* Olivier | Olivier, 1811:663 | *Alpheus bidens* (Olivier) | III:136 |
| *P. brevirostris* Olivier | Olivier, 1811:664 | *A. brevirostris* (Olivier) | III:170 |
| *P. diversimanus* Olivier | Olivier, 1811:663 | *A. villosus* (Olivier) | III:49 |
| *P. villosus* | Olivier, 1811:664 | *A. villosus* (Olivier) | III:49 |

**APPENDIX III, continued**

| | | | |
|---|---|---|---|
| *Paralpheus diversimanus* (Olivier) | Bate, 1888:568 | *A. villosus* (Olivier) | III:51 |
| *Synalpheus bakeri stormi* De Man | Hale, 1941:265 | *Synalpheus fossor* (Paulson) | II:335 |
| *S. biunguiculatus* (Stimpson) | Ortmann, 1894:14; Coutière, 1900:411 | *S. coutierei* Banner | II:343 |
| *S. brucei* Potts | Potts, 1915:76; Clark, 1921:624 | *S. stimpsonii* (De Man) | II:292 |
| *S. falcatus* Bate | Bate, 1888:574 | *S. comatularum* (Haswell) | II:289 |
| *S. laevimanus haddoni* Coutière | Coutière, 1900:411 | *S. haddoni* Coutière | II:341 |
| *S. latastei* Coutière | Coutière, 1909:26 (listed with question) | (Evidently in error) | II:278 |
| *S. maccullochi* Coutière | ? Coutière, 1908a:13; Hale, 1927a:48; 1927b:308 | *S. tumidomanus* (Paulson) | II:377 |
| *S. neomeris pococki* Coutière | Coutière, 1898d:167 | *S. pococki* 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.

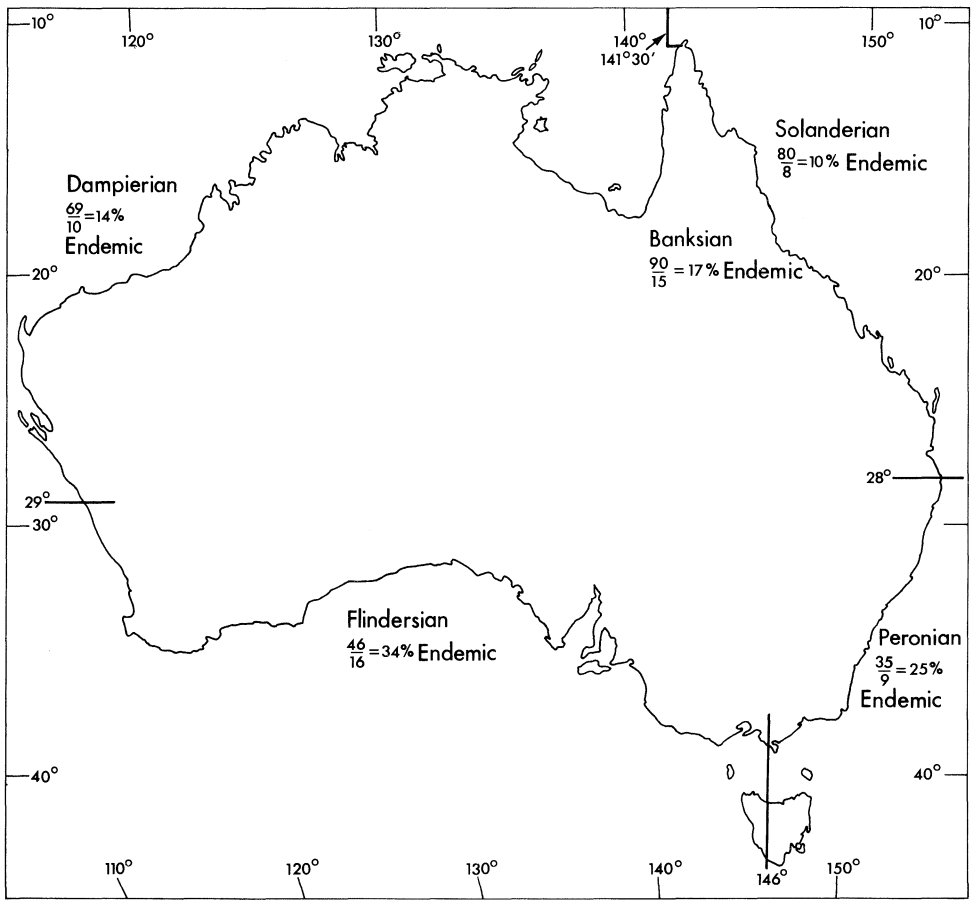


Fig. 95
Australia (sinusoidal projection), showing faunal provinces and percentages of endemism of alpheid and ogyridid shrimp. The location of the boundaries is discussed in the text, as well as the distinction between the Solanderian and Banksian provinces; in the figures, the numerator is the total 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 Ogyridids.

| General Distribution \ Australian Distribution | Total Number of Species | 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 | All Zones |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 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 inadvertant 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 | *S. stimpsonii* | *S. amboinae* | *S. brucei* | *S. striatus* | 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 *S stimpsonii* | Same as *S. amboinae* | 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 *S. amboinae* | Same as *S. amboinae* | Varying from condition in *S. stimpsonii* to condition *S. amboinae* |
| 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 *S. amboinae* | Same as *S. amboinae* | 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.

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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.

## 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".