D. M. Banner & A. H. Banner 1981

ZOOLOGISCHE VERHANDELINGEN

UITGEGEVEN DOOR HET RIJKSMUSEUM VAN NATUURLIJKE HISTORIE TE LEIDEN

(MINISTERIE VAN CULTUUR, RECREATIE EN MAATSCHAPPELIJK WERK)

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by

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With 12 text-figures

Abstract

The 72 species and subspecies of alpheid shrimp previously reported from the Red Sea and Gulf of Aden are listed, and the following 20 species and subspecies previously known from the Indo-Pacific or the Indian Ocean, are added: *Alpheus bisincisus* De Haan; *A. clypeatus* Coutière; *A. distinguendus* De Man; *A. edamensis* De Man; *A. euphrosyne euphrosyne* De Man; *A. lanceostylus* Banner; *A. leptochirus* Coutière; *A. miersi* Coutière; *A. pareuchirus pareuchirus* Coutière; *A. tenuicarpus* De Man; *Athanas marshallenis* Chace; *Betaeopsis indicus* (De Man); *Salmoneus brevirostris* (Edmondson); *Synalpheus ancistrorhynchus* De Man; *S. gracilirostris* De Man; *S. hastilicrassus* Coutière; *S. nilandensis* Coutière; *S. sladeni* Coutière; *S. trianthus* De Man; *S. tricuspidatus* (Heller).

In addition, three species are described as new, the first two from the southern Red Sea and the third from the Gulf of Aden: *Athanopsis brevirostris*; *Synalpheus paradoxus*; *Synalpheus spongicola.*

Other changes in nomenclature or records and in other characterizations are as follows: A lectotype is selected and described for *Alpheus bucephaloides* from Nobili's type series from the Persian Gulf. *A. fasciatus* Lockington, recorded by Coutière (1899: 486) from the area, is considered probably to be *A. alpheopsides* Coutière, and Lockington's nominal taxon itself to be a nomen dubium until types are redescribed or topotypes are established. *A. djiboutensis* De Man is considered to be a synonym of *A. djeddensis* Coutière. The species recorded by Coutière as *A. euchirus* Dana from the area was probably *A. serenei* Tiwari. *A. inopinatus* Holthuis & Gottlieb and *A. lobidens polynesica* Banner & Banner are placed into synonymy under *A. lobidens* De Haan. The genus *Salmoneus* Holthuis is redefined, and a provisional key is given to its species. Characteristics of the remaining "types" of Coutière's two species, *S. cristatus* and *S. serratidigitus*, are discussed; and *S. latirostris* (Coutière) and *S. sibogae* (De Man) are considered to be synonyms of the latter species. Finally *Synalpheus savigny* (Guérin) is considered to be a nomen dubium and Tattersall's record of it from the Red Sea to be equally dubious.

As an appendix to the study, the listing of 15 species from a small Danish collection and two private collectors from the Persian Gulf is given: all are known from the Red Sea, but nine of the species have not been previously recorded from the Persian Gulf.

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1) Contribution No. 620 Hawaii Institute of Marine Biology.

Introduction

This checklist brings together notes on 95 species and subspecies of alpheid shrimp from the Gulf of Aden and the Red Sea, including its northernmost extensions, the Gulfs of Suez and Aqaba. The most extensive collections reported in the checklist were made by Tel-Aviv University in their Israel South Red Sea Expeditions and by the Hebrew University-Smithsonian Institution Joint Program (with the Mediterranean collection of the latter not studied — see Por et al., 1972, and Lewinsohn & Fishelson, 1967). Smaller collections from the area, mostly by individuals, are also reported on. We are including the Gulf of Aden in this checklist because it undoubtedly represents a continuum of the Red Sea fauna; however, specimens from that area are not well represented in our study collections. None of the specimens were collected by ourselves.

In addition to the species from the above mentioned collections, this checklist includes all species reported in the literature from the Red Sea and Gulf of Aden. The first publication for the area was the issuance of plates representing two unnamed alpheids by Savigny (1809), subsequently named by Audouin (1827). Since then a number of authors such as Paulson, Heller and Nobili have described other alpheids from the area. Probably the greatest single contribution to the knowledge of the alpheids of the region was that of Coutière who visited Djibouti on the Gulf of Aden during an expedition of the Museum National d'Histoire Naturelle (Paris) during the first quarter of the year of 1897 (Chace & Forest, 1970). In his thesis, Coutière (1899: 486) reported collecting a total of 40 species in 9 genera (note that other references to the morphology and biology of these species are scattered throughout Coutière's thesis and can best be found by the use of the index prepared by Chace & Forest, 1970).

While reviewing the works of the earlier authors, we discovered two errors in Tattersall (1921). He listed *Parabetaeus cullierети* Coutière and *Pterocaris typica* Heller as coming from the Red Sea; both are known only from the type specimens, the former from Tahiti, Society Islands, and the latter from Ambon, Indonesia. The same author listed *Synalpheus savignyi* (Guérin) as coming from the Red Sea. As we point out in our text below, the species of Guérin is at present a nomen dubium and Tattersall's record is doubtful. Other species of dubious record for the Red Sea are: *A. fasciatus* Lockington recorded by Coutière (1899: 486), *A. euchirus* Dana recorded by Coutière (1899: 486) and Calman (1939: 209).

Distributional pattern. — The distributional pattern of the alpheids in the Red Sea is markedly different from the pattern in other margins of the Indo-Pacific faunal realm that we have studied. In Hawaii the fauna is

markedly reduced and has some endemism (Banner & Banner, 1953, 1974); in the Gulf of Thailand the number of species is greatly reduced as one proceeds towards the head of the Gulf (Banner & Banner, 1966b); along both eastern and western coasts of Australia the number of tropical species is rapidly reduced as the more temperate waters are penetrated, and the number of endemic species rapidly rises in the southernmost water (Banner & Banner, in press A).

In the Red Sea-Gulf of Aden, of the 95 species and subspecies we recognize, 80 are definitely of the Indo-Pacific fauna with records from the Pacific. Two species, *Alpheus hululensis* Coutière and *Synalpheus sladeni* Coutière, were known only from the central Indian Ocean but are now being reported from the Red Sea. The two species, *Alpheus bucephaloides* Nobili and *Synalpheus paulsoni* Nobili, and one subspecies, *S. paulsoni liminaris* Coutière, are known from the Red Sea-Gulf of Aden and Persian Gulf.

Ten species have been recorded to date only from the Red Sea-Gulf of Aden: *Amphibetaeus jousseaumea* (Coutière); *Athanas crosslandi* Tattersall; *Athanas ghardaqensis* (Ramadan); *Athanopsis brevirostris* new species; *Athanopsis platyrhynchus* Coutière; *Synalpheus mushaensis* Coutière; *Synalpheus paradoxus* new species; *Synalpheus physocheles* Coutière; *Synalpheus quinquedens* Tattersall; *Synalpheus spongicola* new species. These may be endemic to the area, but inasmuch as only one of the species has been reported subsequent to the original type-series (*A. ghardaqensis* — see text), one suspects that they are each living in a unique habitat that is seldom sampled and that if collections were made from the same habitat elsewhere in the Red Sea or elsewhere in the Indo-Pacific realm the same species might be found; this is certainly true of the sponge-dwelling species of the genus *Synalpheus* that we are describing.

The data on the collection of the various species does not lend itself to zoogeographic division of the alpheid fauna within the area studied. The numbers of different species and subspecies reported in the various zones are as follows (for the geographic limits of the zones, see "Notes on format"): Gulf of Aqaba: 46; Gulf of Suez: 33; Northern Red Sea: 32; Middle Red Sea: 27; Southern Red Sea: 57; Gulf of Aden: 48.

From these figures we can only conclude that while the number of species in the Gulf of Aden and the southern Red Sea may represent a richer fauna, the high figures for the Gulf of Aqaba certainly must represent a more extensive effort at collecting. Indeed, the whole range of figures may merely reflect the amount of effort expended in field collecting.

Acknowledgements. — As indicated above, the large collections were made by Tel-Aviv and Hebrew Universities, the latter in conjunction with the U. S.

Smithsonian Institution. The loans of specimens from the two universities and from the Rijksmuseum van Natuurlijke Historie, Leiden, were facilitated by Drs. Lev Fishelson, Lipke B. Holthuis and Ch. Lewinsohn. We were also loaned older specimens, especially of the type-series for some Red Sea species, from the University Museum of Zoology, Cambridge, England; Museum National d'Histoire Naturelle, Paris; and the Museo ed Istituto di Zoologia Sistematica, Università di Torino. Private collections loaned by the institutions and by some individuals are acknowledged in the collection lists.

Our work was supported in part by a series of grants from the U. S. National Science Foundation (GB 25020, GB 42498, DEB 77-23378).

We are especially indebted to Dr. Holthuis of the Rijksmuseum van Natuurlijke Historie, Leiden for the use of extensive colour notes that he made while conducting field studies in the Red Sea in 1965. In every case we have acknowledged his contribution, but at times for brevity we have paraphrased his notes.

The collections will be returned to the Rijksmuseum van Natuurlijke Historie (RMNH), Leiden. Dr. Lewinsohn has written, "Type material and duplicates will be deposited in Leiden, while the rest will be returned from Leiden to the respective Universities."

Notes on format. — In the following listing we present the genera and species in simple alphabetic sequence; subspecies are listed under the nominal species. A large number of species has been reported from the Red Sea and adjacent waters under names other than those in current use; these are listed in Appendix II with cross references to the presently accepted name.

To conserve space, we do not give the complete bibliography for each species but instead confine ourselves to the original description, subsequent changes in names as used in the Red Sea literature, and previous records to the collections of the species from the Red Sea. As an aid to future workers, where the original description was brief and the original author subsequently gave a more detailed description, we have placed the reference to the subsequent description in brackets at the end; as our recently issued Australian studies may be more available than the original (or subsequent) descriptions, we also place in the same brackets the reference to our redescriptions in those publications under B & B, 1973b, 1975a and in press A.

Under "Specimens Examined" we list specimens by area by the alphanumeric code of the collecting institution; specimens by individuals which are not in a numbered series are listed under Miscellaneous collections (Misc). All notes that were available to us for each collection are given in the appendix. The comprehensive headings such as "E62/" or "Misc" are not repeated,

and the individual station or collection numbers of that series are separated by semicolons; the comprehensive headings are separated one from the other by periods (full stops). To facilitate rapid scanning for distributional patterns, we separate the records into zones, which are delimited as follows: Gulf of Aqaba, north of 28°N; Gulf of Suez, north of 27°45'N; Northern Red Sea, between 23° and 28° or 27°45'N; Middle Red Sea, between 17° and 23°N; Southern Red Sea, between 12°30' and 17°N; Gulf of Aden, from Cape Guardifui to Perim Island (most of these specimens are from near Djibouti). We could not locate some previous records more exactly than "the Red Sea". For our present records we use the present standard transliteration and orthography as supplied by Dr. Lev Fishelson and Dr. Ch. Lewinshon of Tel-Aviv University; for the records of collections from the literature we use the place names as they were spelled by the various authors.

Family *Alpheidae*

Alpheopsis equalis Coutière

Alpheopsis equalis Coutière, 1896c: 382, Red Sea; 1898a: 190, Djibouti (colour note); 1899: 486, Djibouti. [See also Coutière, 1905: 868, fig. 138. B & B[1]), 1975a, 343, fig. 16.]
Alpheopsis equalis truncatus Coutière, 1903: 89. Holthuis, 1958: 14, Eylath.

Specimens examined. — S. Red Sea: 2, E62/1416; 1, 1458.

Alpheus alcyone De Man

Alpheus alcyone De Man, 1902: 870, pl. 27 fig. 61. Holthuis, 1958: 23, Eylath, Abu Zabad, Sinai Peninsula. Tattersall, 1921: 379, Engineer Is. [See also B & B, in press A.]
Alpheus aculeipes Coutière, 1905: 894, pl. 89 fig. 31, Djibouti.

Specimens examined. — S. Red Sea: 1, E62/1375.

Alpheus alpheopsides Coutière

Alpheus fasciatus Coutière, 1899: 486-497, Djibouti. Not *A. fasciatus* Lockington, 1878.
Alpheus alpheopsides Coutière, 1905: 901, pl. 83 fig. 40

Specimens examined. — S. Red Sea: 1, ISRSE 1569.

Remarks. — Coutière (1899: 486, 497) listed *A. fasciatus* as occurring in the Djibouti region and stated that he had also seen specimens collected off Baja California (Mexico) by Diguet (Lockington's type locality was in the Gulf of California). In Coutière's (1905) description of *A. alpheopsides* from the Maldives, he listed his earlier reference as a questionable synonym of his new species. He suggested that the Red Sea specimens and his new

1) B & B = Banner & Banner.

species should be verified by comparing them with Lockington's type specimens. This has never been done. Indeed, the only records we have of *A. fasciatus* being cited in the literature are Lockington's description and Coutière's slight references. As Lockington's description is so broad, we feel that *A. fasciatus* must be regarded as a nomen dubium until either the types are found and redescribed or topotypes are established. Until that is done, we believe that Coutière's reference to the *A. fasciatus* in the Red Sea should be regarded (as he indicated in 1905) as dubious and that his reference to his specimens from the Red Sea as *A. alpheopsides* should be allowed to stand.

Dr. Holthuis described the colour of this specimen: "Transparent colourless with pink bands along posterior margin of abdominal somites. Large chela light pink with a darker pink spot at the base of the fixed finger. Tailfan pink. Some small pale red chromatophores on antennular peduncle and small first cheliped."

Alpheus barbatus Coutière

(fig. 1a)

Alpheus barbatus Coutière, 1897a: 235, Djibouti; 1899: 486, Djibouti. [See also De Man, 1911: 387, fig. 88. B & B, in press A.]

Specimens examined. — Gulf of Aqaba: 1, NS 5807; 1, SLR, 616. N. Red Sea: 1, NS 1961.

Remarks. — The 17 mm male specimen from SLR 616 is different from the other 2 specimens in this collection, from those described by Coutière (1897a) and De Man (1911: 387), and from our specimens from Australia (B & B, in press A). The rostrum is distinct, twice as long as broad at the base instead of being of minimal development and broader than long at the base. The articles of the antennules and the antennae are of the same relative measurements one to the other, but they are much more slender than those figured by De Man and those we reported from Australia in which the second antennular article was only slightly longer than broad while in the Red Sea specimens the second antennular article is over 2 times as long as broad. Finally the merus of the large cheliped bears 4 spines on its infero-internal margin. Similar spines are lacking in the other specimens in the collection and in our specimens from Australia. However, De Man did state that some of the specimens in Coutière type series had spines on this margin. This specimen lacked the definitive small chela and had only one leg each of the third and fifth pairs. With such a fragmentary specimen we hesitate to call it new and are assigning it to this species, but with serious doubts.

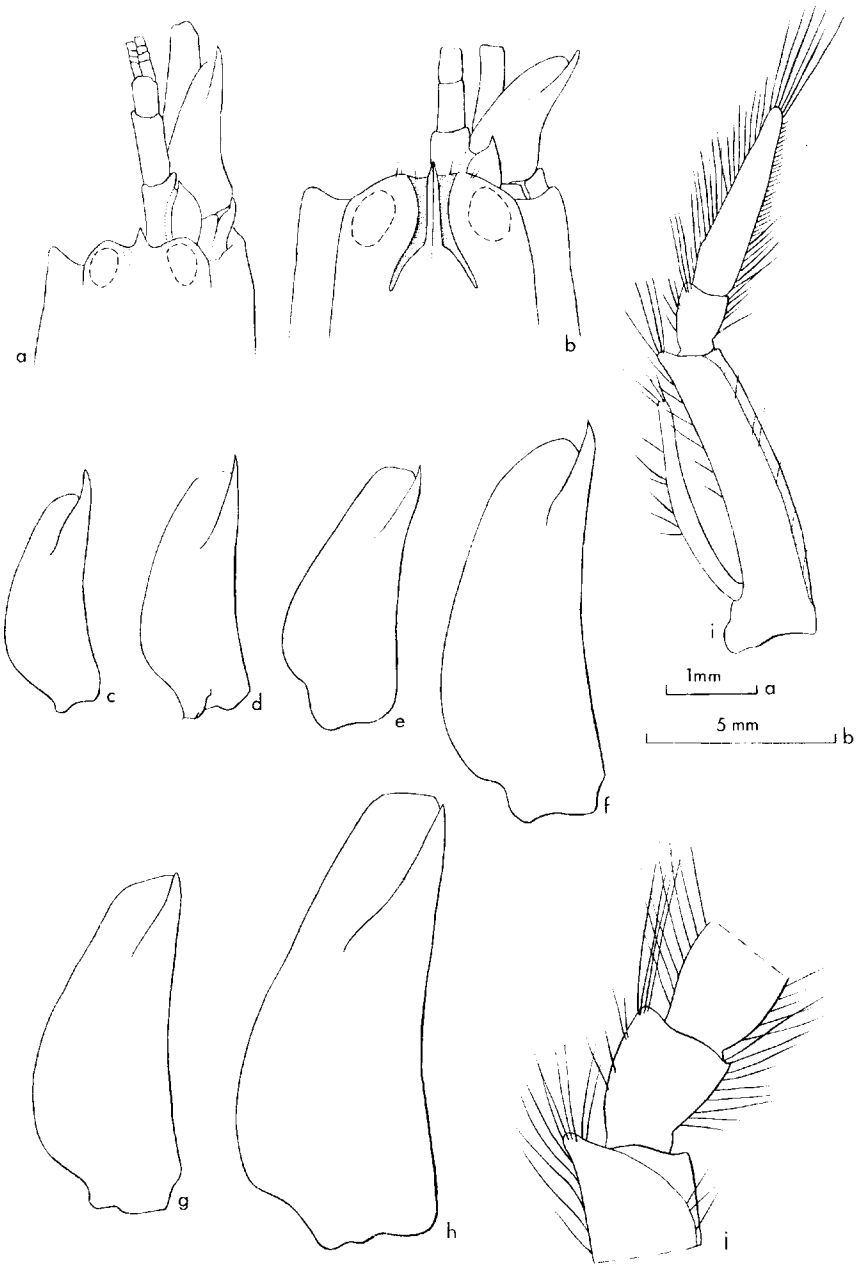

Fig. 1. *Alpheus* species. a, *Alpheus barbatus* Coutière (17 mm ♂ from SLR 616: anterior region, dorsal vied. b, *Alpheus diadema* Dana (14 mm ♂ from NS 7326): anterior region dorsal view. c-j, *Alpheus djeddensis* Coutière: c-h, series of scaphocerites showing variation from specimens from ISRSE 2050; i, j, third maxilliped and second article enlarged, from 54 mm ♂ from ISRSE 2050. All drawings except i scale a; i scale b.

Alpheus bisincisus De Haan

Alpheus bisincisus De Haan, 1850: 179, pl. 45 fig. 3. [See also B & B, in press A.]

Specimens examined. — Gulf of Suez: 1, NS 12147; 2, 2264, 1, SLR 2825.

Remarks. — The specimen from NS 12147 was reported as coming from a sponge at 20 fathoms.

Alpheus bucephaloides Nobili

(fig. 2)

Alpheus bucephaloides Nobili, 1905: 238. Tattersall, 1921: 379, Khor Dongonab, Tella Tella Kebira. Holthuis, 1958: 23, Eylath. [See also Nobili, 1906b: 20.]

Lectotype: 20 mm male from Golfo Persique Sta. 53. Banc au N. E. d'île Arzana et pêche côtiere dans les polypiers. Côte d'Arabie from Mission J. Bonnier et Ch. Perez, 1901. Museo ed Istituto di Zoologia Sistematica, Università Torino, specimen Cr. 382, ex. 2158.

Allolectotype: 25 mm female from same station as lectotype. Museum National d'Histoire Naturelle, Paris, Na. 2252.

Paralectotypes: 1, 17 mm male, 1, 18 mm female indicated by Nobili as "types" and other specimens in the Museum National d'Histoire Naturelle, Paris.

Specimens examined. — Gulf of Aqaba: 1, NS 6919. S. Red Sea: 1, E62/0189; 2, 1323; 6, 1366; 1, 1413; 1, 4420.

Description. — Rostrum short, acute, reaching to middle of visible part of first antennular article. Rostral carina sharp, extends to gastric region. Orbital hoods inflated. Area between orbital hoods and dorsal carina depressed, broad, forming moderately deep grooves. Anterior margin of carapace extending anteromedially to orbital hoods, nearly straight, only slightly concave at base of rostrum, bearing 1-2 upturned setae.

Visible part of first and third antennular articles nearly equal, second article 2.2 times as long as broad. Distal margins of antennular articles bearing a few setae. Small acute projection of stylocerite reaching to last quarter of visible part of first antennular article. Outer margin of scaphocerite concave, lateral tooth strong, reaching past end of antennular peduncle, squamous portion narrow, reaching to end of third antennular article. Carpocerite 5 times as long as broad (viewed from below), and reaching past lateral tooth of scaphocerite. Inferior and superior margins of basicerite inermous.

Ratio of articles of third maxilliped: 10:2.6:6.3, distal article 2.7 times as long as broad, bearing a brush of long fine setae.

Large chela cylindrical, 2.3 times as long as broad with fingers occupying distal 0.3. Tip of dactylus rounded, overhanging propodal finger when closed. Plunger of strong development. Merus stout, 1.5 times as long as broad,

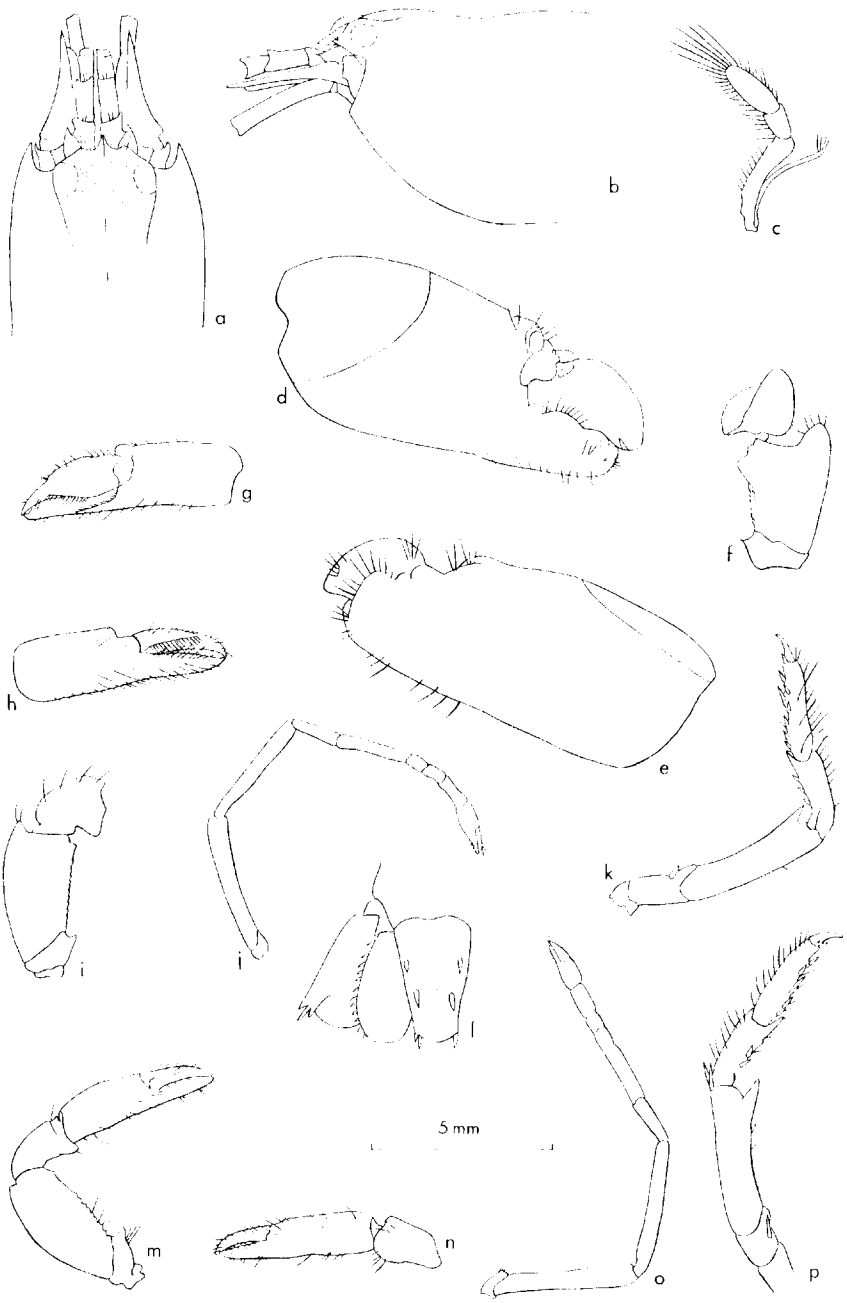

Fig. 2. *Alpheus bucephaloides* Nobili. Lectotype (20 mm ♂): a, b, anterior region, dorsal and lateral view; c, third maxilliped; d, e, large chela, lateral and medial face, f, merus, medial face; g, h, small chela, superolateral and medial face; i, merus, medial face; j, second leg; k, third leg; l, telson and uropods. Allolectotype (25 mm ♀): m, n, small cheliped, lateral and medial face; o, second leg; p, third leg. All figures same scale.

superior margin terminating in a rounded projection bearing a few long setae; inferomedial margin bearing rounded tooth subterminally; inferolateral margin distally slightly projecting but rounded.

Small chela sexually dimorphic. Dactylus of male 3.3 times as long as broad with fingers almost half the total length. Dactylus expanded, subbalaeniceps (rows of hairs not meeting distally), crest of medial margin more dense than that of lateral. Merus 1.7 times as long as broad, inferomedial margin with small rounded tooth, superodistal margin bearing a few setae. Carpus 0.4 as long as chela, without distal teeth, bearing a few long hairs on superior surface. Small chela in female 3.5 times as long as broad, fingers occupying distal third; without crests of hairs on dactylus, merus similar to that of male.

Ratio of carpal articles of second leg: 10:12:3:4:6.

Ischium of third leg with strong spine. Merus 4.0 times as long as broad, bearing a few hairs on inferior margin and a heavy acute tooth distally. Carpus 0.5 as long as merus, bearing on inferior margin 4 strong spines and terminating distally in a strong acute tooth; superior margin bearing a few to many hairs and terminating in a rounded projection. Propodus 0.7 as long as merus, bearing on inferior margin 7 spines and a pair distally, superior margin bearing scattered setae with a distal tuft. Dactylus simple, strongly curved, 0.3 as long as propodus. Carpus of fourth leg also bearing 4 small spines on inferior margin. (In the allolectotype the merus of one of the third legs carries a small spine on the inferior margin [fig. 2p] that is not found on the opposite leg nor on any leg of the lectotype).

Telson 2.4 times as long as posterior margin is broad. Posterolateral angles not projecting, inner posterolateral spine on left twice as long as outer (right side bearing a single spine in lectotype). Anterior pair of dorsal spines placed anterior to midline. Shallow longitudinal depression lying between dorsal spines. Inner uropod with a series of spines on outer margin.

Discussion. — In a preliminary description in 1905 and in a detailed description in 1906b (both without figures), Nobili established the name *A. bucephaloides* for something over 20 specimens collected in the Persian Gulf by J. Bonnier and Ch. Perez at their station LIII. Nobili's 1906 description was based on two females and two males of the series; the two females and one male were placed in the "Museum Paris" with the label "Type", and the second male was deposited in the museum of the University of Turin and designated as "Co-type". The remaining specimens of the series from the same station, about "une vingtaine" in number and bearing the label of Nobili, were of the syntypic series but were not so designated (according to Dr. Forest of the Museum National d'Histoire Naturelle, Paris). In 1921

Tattersall applied Nobili's name to 2 specimens from the Sudanese Red Sea, and in 1958 Holthuis did the same with 2 specimens from Elat; both men had reservations about these decisions. The species is otherwise unrecorded.

According to Nobili's 1906 description the outstanding characteristic of *A. bucephaloides*, unique to the genus, was found on the third leg: "Le carpe se prolonge à l'extrémité de son bord *supérieur* en une épine qui mesure presque un tiers de la longueur de ce bord et offre en plus en avant de l'épine, 3-4 spinules bien distinctes... Le bord *inférieur* a aussi deux ou trois autres spinules mobiles." [Emphasis ours; in the next sentence Nobili describes the propodus.] This description was offered without emphasis or further discussion by Nobili. The presence of the superior tooth and spinules on the carpus was used by De Man in his key (1911: 315), and the absence of his armature was remarked upon by Tattersall and Holthuis in the specimens they reported.

When we examined the specimens from the Red Sea, listed above, we were going to describe them as a new species because they lacked this armature. However, as they were so close in other characteristics to Nobili's description we had doubts about the accuracy of his description. At our request, Dr. Forest examined Nobili's type series at the museum and found they all had the armature on the inferior margin of the carpus but not on the superior; Dr. Forest remarked (personal communication): "Si on remplace le mot 'supérieur' par 'inférieur', la description devient adéquate." This, however, would not account for Nobili's separate description of the spines on the inferior border. Dr. Forest also explained about the designations in the syntypic series. Accordingly, we decided to correct Nobili's error, and as Nobili had not selected a holotype and allotype, we felt we should do so in order to offer a new description with figures for the species. For this we borrowed the "co-types" from Paris and Turin and part of the other Nobili specimens from Paris. As the male in the museum in Turin was the most complete, we have designated it as the lectotype and the largest female from Nobili's four co-types as the allolectotype. By modern convention the other specimens from Station LIII, all examined by Nobili, must be regarded as paralectotypes.

Variations in three characteristics should be remarked upon: First, the presence of a spine on the merus of the third leg of the allolectotype is unique in all of the specimens of the series we have examined. Second, the measurements for the first two carpal articles of the second legs as reported by Nobili were of the ratio of 10:16; the ratio for the designated lectotype is 10:12 and for the allolectotype 10:16 (the ratios for the 9 specimens in

the present collection with intact second legs vary from 10:10 to 10:16 — average 10:13.8). Third, in the lectotype and in the 17 mm male paralectotype, the small chela closely approaches the full balaeniceps form; but in none of the Red Sea specimens, either in the present collections or as remarked upon by Tattersall and Holthuis, is the male chela of other than normal (or female) form. This may be a mark of sexual maturity, but the size differences between the largest of the present collection and the male reported by Holthuis (both 16 mm in length) and Nobili's co-type (17 mm) is not great. This also may be a variable difference, as in the related *A. bucephalus* (see Banner, 1957: 201). Finally, the development of the chela may reflect genetic differences between the populations in the Persian Gulf and Red Sea, but if so, we would be loath to name it as a geographic subspecies (see the confusion resulting from reliance upon the small chela under *A. lobidens*, below).

In view of these variations, we believe that the doubts expressed by Tattersall and Holthuis about the identity of their specimens with Nobili's species can be disregarded.

A. bucephaloides plainly belongs to the Crinitus group and was contrasted by Nobili to *A. crinitus* Dana, *A. crinitus* Bate (= *A. alcyone* De Man), and *A. bucephalus* Coutière. With the much larger number of species now included in the subgeneric group, this species can be separated from most by the strong tooth of the merus and the spines on the carpus of the third legs. Five species bear this armature. Three of the species bearing the meral tooth and carpal spines have the second carpal article of the second legs about 3 times the length of the first, instead of 1.0-1.6 times the length as in this species; these are *A. alcyone* De Man, *A. paralcyone* Coutière, and *A. spongiarum* Coutière.

The two species have been described with a ratio of the first two carpal articles of 10:20, a ratio that might, with the inherent variation, overlap the ratio found in this species. One of these, *A. providencei* Coutière, has a biunguiculate rather than a simple dactylus on the third leg, so it also can be easily separated from *A. bucephaloides*. The separation of this species from the remaining species, *A. longecarinatus* Hilgendorf, is more subtle and definitely less certain. The species has been reported only three times: Hilgendorf's specimen, a 25 mm female, came from Zanzibar (1879: 833); Coutière (1921: 426) reported specimens from Amirante Bank and Providence Island without comment or figures; Barnard (1950: 745) described and figured 2 specimens from Delagoa Bay (southern Mozambique) without chelae. The two species may differ in the following characteristics:

1. The dorsal carina of the carapace reaches only the end of the gastric

region in *A. bucephaloides,* but in *A. longecarinatus* it reaches "hinter die mitte des cephalothorax" (Barnard indicates that in his specimens it extends "2/3 length of carapace").

2. The second article of the carpus of the second leg is at most 1.6 times the length of the first in *A. bucephaloides,* but in *A. longecarinatus* it is twice (Hilgendorf) or three times (Barnard) the length of the first.

3. The merus of the third leg is unarmed in *A. bucephaloides* except for the strong terminal tooth and the one aberrant spine on the allotype mentioned above; Hilgendorf does not mention other than the terminal tooth (he also does not mention movable spines on the carpus or propodus) but shows in his figure three spines on the inferior margin of the merus that are similar (under magnification) to those depicted for the carpus and propodus; Barnard specifies the carpal and propodal spines but makes no mention of movable spines on the merus. We now have in our collections about 20 specimens of what appears to be *A. longecarinatus* from Madagascar, across the Mozambique channel from the type locality and also from the coasts of Kenya and Tanzania. As none of these specimens have spines on the inferior margin of the merus of the third leg, we believe it is an error in delineation.

In addition, Barnard remarks on and shows long setae on the anterior carapace, setae not found in *A. bucephaloides.* It should be noted that Hilgendorf remarks upon an "Eindruck" on the dorsal surface of the telson, evidently similar to the longitudinal depression on the specimens that we have examined.

These differences, the strongest being the carpus of the second leg, are great enough to maintain both species as separate for the present. We recommend, however, that if Hilgendorf's holotype is found or if topotypes from Zanzibar can be studied, the validity of the separation of the two species be reconsidered. Hilgendorf's name would take priority over that of Nobili.

The specimens Nobili reported upon came from "polypiers", probably corals, near the island of Arzana in the Persian Gulf; Tattersall's came from "among coral on the reef" and from "half-loose fragments and nullipore" at the edge of the reef in the middle Red Sea; Holthuis' specimen came from Elat in the Gulf of Aqaba; ours were collected intertidally or subtidally from Entedebir Island in the southern Red Sea except for one specimen from Elat. The specimens from E62/1323 and 1366 were noted as coming from the coral *Stylophora.*

Alpheus bucephalus Coutière

Alpheus bucephalus Coutière, 1905: 890, pl. 78 fig. 29, Djibouti. Nobili, 1906a: 32, Massaouah. Balss, 1915: 23, 6 localities, Red Sea. [See also B & B, in press A.]
Alpheus consobrinus De Man, 1908: 101. Tattersall, 1921: 380, Khor Dongonab, Mersa-Ar-Rakiya, Tella Tella Kebira.

Specimens examined. — Gulf of Aqaba: 5, Misc. 2; 1, 45. S. Red Sea: 2, E62/0301D; 2, 1323; 10, 1382; 1, 1390; 1, 1393; 1, 1412; 1, 1413; 2, 1479. 2, ISRSE 0260; 2, 0268; 2, 0820; 1, 1077; 2, 1080; 1, 2018.

Remarks. — The field notes indicated that the specimens from E62/1323 came from corals of the genus *Stylophora* and those from E62/1382 from the genus *Galaxea*. Normally, *Stylophora* is the host to *A. lottini* Guérin and *Synalpheus charon* (Heller) and *Galaxea* is the host of *Racilius compressus* Paulson (see Bruce, 1976: 87). We, however, have found *A. bucephalus* from "sponges and algae" (B & B, 1968: 284). Dr. Holthuis has given us colour notes on the specimens from ISRSE 0260: "Transparent. Abdomen with transverse bands of a pale green colour. Large cheliped pale green. The colour in a reticulate pattern. The eggs are bright green, as are also the inner parts (intestines)." This colour description is similar to that reported by Dr. Yaldwyn from Australia (B & B, in press A).

Alpheus clypeatus Coutière

Alpheus clypeatus Coutière, 1905: 897, pl. 81, 82 fig. 36.

Specimens examined. — S. Red Sea: 1, ISRSE 0806.

Alpheus collumianus Stimpson

Alpheus collumianus Stimpson, 1861: 30. Coutière, 1899: 486, Djibouti. Balss, 1915: 22, 4 localities, Red Sea. Holthuis, 1958: 21, Eylath, Ras Nasrani, Sinai Peninsula. [See also B & B, in press A.]

Specimens examined. — Gulf of Aqaba: 1, DR 146. 2, E60/2. 2 Misc. 46. 1, SLR 254; 3, 1389. Gulf of Suez: 3, NS 12135.

Alpheus crinitus Dana

Alpheus crinitus Dana, 1852a: 21. Coutière, 1897c: 369, Djibouti; 1899: 486, Djibouti. Balss, 1915: 22, 6 localities, Red Sea. [See also Dana, 1852b: 548, pl. 34 fig. 8.]

Alpheus deuteropus Hilgendorf

Alpheus deuteropus Hilgendorf, 1879: 834, pl. 4 figs. 8-10. Coutière, 1899: 487, Djibouti. [See also B & B, in press A.]

Alpheus diadema Dana

(fig. 1b)

Alpheus diadema Dana, 1852a: 23. Holthuis, 1958: 24, Eylath, Ras Muhammed, Sinai Peninsula. Fishelson, 1971: 121, 122, Red Sea. [See also B & B, in press A.]
Alpheus insignis Heller, 1862a: 269, Taf. 2 figs. 17-18, Red Sea. Coutière, 1899: 486, Djibouti. Nobili, 1901: 2, Eritrea; 1906a: 32, Eritrea. Balss, 1915: 23, 11 localities, Red Sea. Tattersall, 1921: 380, Red Sea.
Alpheoides insignis Paulson, 1875: 106, Red Sea.

Specimens examined. — Gulf of Aqaba: 2, DR 19; 1, 136; 1, 141; 1, 145; 1, 159. 2, E50/25.5. 1, E54/7. 10, Misc. 2; 1, 3; 1, 4; 1, 24. 2, NS 1056; 1, 1598; 1, 7326. 2, SLR 1592; 18, 1626; 4, 2315. N. Red Sea: 1, DR 99. S. Red Sea: E57/449; 1, E62/1413; 2, 1436. 1, Misc. 12.

Remarks. — Four specimens in the collections, ranging in size from 10-14 mm, had unusually narrow rostral bases between the eyes; one is shown in fig. 1b. We have remarked before on variation in the rostral configuration, especially with size of the specimens (B, 1953: 119; B & B, in press A). As the specimens agree otherwise with the characteristics of *A. diadema*, we are considering the extreme narrowness of the rostrums merely as a further extension of the range of variation.

Alpheus distinguendus De Man

Alpheus distinguendus De Man, 1909b: 155, pl. 7 figs. 9-14. [See also B & B, in press A.]

Specimens examined. — N. Red Sea: 2, Misc. 32.

Alpheus djeddensis Coutière

(figs. 1c-j)

Alpheus brevirostris Ortmann, 1890: 477, Massaua. Not Olivier, probably = *A. djeddensis*.
Alpheus djeddensis Coutière, 1897d: 202, Djeddah.
Alpheus djiboutensis De Man, 1909b: 160, pl. 8 figs. 17-24, Djibouti. Balss, 1915: 23, 3 localities, Red Sea. Holthuis, 1958: 25, Port Sudan. Luther, 1958a: 175, Daedalus Reef; 1958b: 144, Red Sea. Abel, 1960: 459, Ghardaqa. Klausewitz, 1960: 152, Red Sea. Magnus, 1967: 510, Red Sea. Fishelson, 1971: 121, Red Sea. Karplus et al., 1972a: 96; 1972b: 259; 1974: 275, Elat. [See also B & B, in press A.]

Specimens examined. — Gulf of Aqaba: 1, Misc. 38; 1, 39; 1, 40; 1, 43. Gulf of Suez: 4, SLR 2085. Middle Red Sea: 1, Misc. 34; 2, 35. S. Red Sea: 2, E62/1356. 1, ISRSE 1435; 1, 1507; 1, 1565; 1, 1586; 6, 2050; 1, 2446. 1, Misc. 48.

Discussion. — In our Australian study (B & B, in press A) we reported upon the rather great variation in form and colour in a large series of speci-

mens that had been collected in many parts of the Pacific Ocean by individuals studying alpheid-goby symbiosis; we identified these as *A. djiboutensis*. In this paper we wish to review the separation of *A. djiboutensis* from *A. djeddensis*, both described from the Red Sea. We examined the type specimen of *A. djeddensis* through the courtesy of the Rijksmuseum van Natuurlijke Historie in Leiden and found it in agreement with Coutière's description; De Man also examined and figured, in part, Coutière's type (1909: figs. 25, 26). We also searched for De Man's type and paratype for *A. djiboutensis* in the museums of Paris, Leiden and Amsterdam but could not find them.

Coutière based his description of *A. djeddensis* upon 3 males and 2 females (sizes not given). In his thesis (1899: 54) he stated that "*A. djeddensis*... sans doute simple variété de *A. rapax*," but in 1905 (p. 904) he was still recognizing it as a species in his description of *A. miersi* Coutière. De Man (1909b) reviewed the species of the Brevirostris group which were then known and described *A. djiboutensis* (p. 160) on the basis of one complete 35 mm male and another specimen "beaucoup plus jeune" that was lacking both chelae. This he compared to two of Coutière's type series in the Museum of Leiden, one a complete male of 55 mm and a younger specimen lacking its large chela. In the footnote De Man stated that the two specimens of Ortmann (1890: 479) reported from Massawa as *A. brevirostris* (Olivier) were certainly different from *A. brevirostris* and were probably identical to *A. djeddensis*. The name *A. djeddensis* has not been applied in the literature to any additional specimens since Coutière's original 5; the name *A. djiboutensis* has been used by at least 9 authors (including us).

The major distinctions between the two species cited by De Man are in the scaphocerite and the chelipeds, although he also cited slight differences in the anterior carapace and other parts. The latter distinctions are too slight to be considered of specific value in this variable species (B & B, in press A), and we will address only the characteristics emphasized by De Man:

1. The scaphocerite: De Man stated that in *A. djiboutensis* the scaphocerite was 3 times as long as broad, that its lateral margin was concave, and that its terminal spine exceeded the tip of the squamous portion by one-fourth of its length. In *A. djeddensis*, he stated that the scaphocerite was broad, that its lateral margin was less concave, and that the terminal spine scarcely passed the squamous portion. We figure the development of the squame in a group of specimens from ISRSE 2050 (fig. 1c-h). In the remaining 17 specimens, not figured from the same station, 10 have the lateral tooth approaching the condition described for *A. djeddensis*, and the other 7 more closely approach the condition described for *A. djiboutensis*.

2. The large cheliped: Holthuis has already pointed out that the merus of the large cheliped may be variable (1958: 27). Here the differences reported and our findings are easily expressed in tabular form (Table 1). The differences between the two nominal species are from De Man (1909b), except for the armature of the merus of *A. djeddensis* which is taken from the type. Our ranges of the present specimens are from 19 chelipeds, some of which were loose in the vials.

TABLE 1

Variation in the large chelipeds, *A. djeddensis* and *A. djiboutensis*

	A. djeddensis	*A. djiboutensis*	Range in present collection
Large chela			
length/breadth	3.0	2.5	2.75-3.4
palm/fingers	1.3	1.7	1.6-2.0
Merus			
length/breadth	3.0	2.5	2.3-3.2
spines on inferointernal margin	1	5-6	2-6
distal tooth on inferointernal margin	rounded	large, acute	12 round 4 with acute angle 3 with strong acute tooth

3. The small cheliped: In our Australian paper (B & B, in press A) we found in most males the dactylus is of sub-balaeniceps development, but in some the lateral rows of hairs extend to meet over the superodistal surface as in a true balaeniceps condition. In these, however, the dactylus is not significantly broadened. In small females the lateral rows of hairs may be almost lacking; in most they are sub-balaeniceps, but in a few large and presumably older females they are of the some full development as in the males.

In view of the great variation in the species, and as the two principal criteria used by De Man for the separation of the two nominal species are largely encompassed by the variation we found in the Red Sea specimens, we believe that *A. djiboutensis* must be regarded as a junior synonym of *A. djeddensis*.

We are appending a figure of the third maxilliped (figs. 1 i, j) to contrast to other species of the Brevirostris group because this is often a useful diagnostic characteristic (cf. *A. platyunguiculatus* Banner and *A. rapax* Fabricius in B, 1959: fig. 10).

Biological notes: All except four of the specimens in these collections were noted as being in association with gobiid fishes. The species were

identified as *Lotilia graciliosa* Klausewitz, *Cryptocentrus caeruleopunctatus* (Ruppell), and *C. sungami* Klausewitz. These and other gobiid species have been previously reported in the literature as living in association with this species of alpheid (Luther, 1958a, b; Magnus, 1967; Karplus et al., 1972a, b; 1974; Polunin & Lubbock, 1977). Field notes in one collection stated (ISRSE 2050) "Suffocated by thick cover of algae washed by heavy wind in the area of shallow water and covering burrows at low tide. Animals crawled on top of algae. *Alpheus* from gobies." Dr. Holthuis has supplied detailed colour notes on two specimens and shorter notes on a third. The colours of these three were not consistent: one was white with greyish-green marbling in transverse bands on the anterior carapace and chelipeds but with grey longitudinal bands on the abdomen; the second was a "pale grey" background colour with greyish-green transverse bands on chelae, carapace and abdomen; the third had blue transverse bands. Tsurnamal supplied a fourth colour pattern for the specimen he collected (Misc. 38). "Pale, large lateral dark spot on each side of carapace; antennae brown."

We had discussions with Dr. Yasuhiko Miya of Kyushu University, Japan, on the reliability of colour patterns for differentiation of species of alpheids of the *Brevirostris* group that live in association with gobies during his visit to Honolulu in May, 1980. From colour transparencies of Dr. John E. Randall of the Bishop Museum, Honolulu, taken in various parts of the Indo-Pacific, Dr. Miya pointed out four colour patterns associated with what he considered to be particular species of alpheids: 1. A marbled pattern of greens and browns on the carapace and abdomen with a broad brown band on the chelae; this, he said, was the pattern for his species, *A. bellulus* (1969: fig. 1). 2. A more mottled pattern on the body and chelipeds, but with a white transverse "saddle" on the abdomen immediately behind the carapace; this was the pattern he assigned to *A. djiboutensis*. 3. A less conspicuously mottled pattern but with a large dark "eye spot" on the posterior third of the branchiostegites; this was the pattern of *A. djeddensis*. 4. A pattern characterized by fine longitudinal yellow stripes or lines on the carapace and abdomen; Dr. Miya stated he plans to publish on this form in the future, assigning it to a new species. Dr. Miya contended that while the hue of the pattern may change, as from olive to brown or yellow to red, the pattern itself remains constant within the species. He, also, had colour photographs of these and other patterns.

In addition to this numerous photographs of the goby-shrimp relationship, Dr. Randall also had collected specimens of some of the shrimp in the pictures. Of the total of nine preserved specimens for which we had photographs, Dr. Miya was able to assign seven to his four colour patterns. Of

the two remaining specimens, one was somewhat intermediate between the "*bellulus*-pattern" and the "*djiboutensis*-pattern," the other had indications of longitudinal stripes, but they were pale and not well-defined as is usual with this last pattern. In Dr. Randall's other photographs, all taken under water, Dr. Miya could assign the shrimp to one of the patterns if the photograph were clear enough.

However, upon examination of the preserved (and colourless) specimens for which the transparencies were available we found variation in morphological characteristics. The 2 specimens available with the "*djiboutensis*-pattern" showed the following difference: the 59 mm ♂ from Sri Lanka had a strong acute tooth on the merus of the large cheliped and the infero-distal margin of the middle article of the third maxillipeds carried a tuft of setae that reached to the end of the third article, while the other specimen, a 32 mm ♀ from Tanzania, lacked the tooth and the setae reached only to the first third of the final article of the maxilliped. Comparable differences were noted in 3 specimens of the "*bellulus*-pattern."

Convincing observations have been made on the use of colour in species differentiation in other decapods — the use of colour in the spiny lobsters of the genus *Panulirus* (George & Holthuis, 1965) is an excellent example. Among the species of alpheids there are some that almost always retain the same colour pattern. *Alpheus lottini* Guérin, whose morphology can leave no doubts as to its identification, almost always has the same colour pattern and similar hues, but may at times show marked differences (see below). However, others show strong differences [see Miya & Miyake on *Athanas japonicus* Kubo (1968: fig. 6) or the shrimp of the Comatularum group of *Synalpheus* that change their colours depending upon the colour of their host crioid (see B & B, 1975a: 283-296, passim)]. A student of ours, studying a population of *A. pacificus* Dana in a narrow site on the Waikiki (Hawaii) reef flat was convinced she had 3 species, a light banded species, a dark banded species and a mottled species, but she discovered that they all assumed the same pattern over time when raised in a laboratory aquarium.

The colour patterns of this group are found wide-spread across the Indo-Pacific, the shrimps bearing them are often co-mingled in the same narrow habitat, and are associating with a number of different species of gobies (Polunin & Lubbock, 1977). Their morphological characteristics are variable, as with the related *A. floridanus* Kingsley (see Chace, 1972: 65). At present it seems to us that a separation of the species based upon colour patterns alone, without support from distribution, ecology, associations with gobies or morphology, is not warranted on the basis of knowledge available. We strongly recommend that workers in the future attempt to draw firm corre-

lations between distinct colour patterns, distinct ecological patterns and distinct morphological differences; if these be found, the separation of the species can be supported. Otherwise, the forms in the complex must be considered to be but a single variable species.

Alpheus edamensis De Man

Alpheus edamensis De Man, 1888a: 518. [See also De Man, 1911: 437, fig. 107. B & B, in press A.]

Specimens examined. — Middle Red Sea: 1, Misc. 11.

Alpheus edwardsii (Audouin)

Athanas edwardsii Audouin, 1827: 274, Suez.
Alpheus edwardsii Guérin, 1829-44, 2: pl. 21 fig. 5; 3: 15. Heller, 1862a: 267, Red Sea. Coutière, 1896c: 190, Red Sea; 1897c: 369; 1898a: 197; 1899: 486, all to Djibouti. Nobili, 1901: 2, Eritrea. Fishelson, 1971: 119, 121, Red Sea. B & B, 1973a: 1142, fig. 1, Suez (neotype astablished). [See also B & B, in press A.]
Alpheus audouini Coutière, 1905: 911. Nobili, 1906a: 33, Red Sea. Balss, 1915: 24, 14 localities, Red Sea. Tattersall, 1921: 381, Khor Dongonab, Red Sea. Gurney, 1927: 263, Suez Canal. Balss, 1927: 24, Suez Canal. Ramadan, 1936: 21, Ghardaqa. Holthuis, 1956: 323, Great Bitter Lake, Egypt. Steinitz, 1967: 167, Suez Canal.

Specimens examined. — Gulf of Suez: 1, NS 2264; 1, 2279; 2, 12134; 2, 12137; 2, 12138; 1, 12142; 1, 12147. 1, SLR 2001; 1, 2110; 2, 2117; 3, 2205; 1, 2232; 1, 2706; 2, 2737, 1, 2996; 1, 3094; 11, 3098; 2, 3169. S. Red Sea: 2, E57/520; 1, E62/1363; 1, 1375; 1, 1383; 13, 1458; 1, 3921. 1, ISRSE 0268; 2, 1001; 5, 1057; 5, 1068; 1, 1078; 1, 1207; 1, 1589; 1, 1939. 1, Misc 9; 1, 20.

Biological notes. — Dr. Holthuis has supplied us with colour notes for a specimen from ISRSE 1057: "Carapace uniformly greyish green, no colour above the eyes; the sides of the carapace lighter than the dorsum. Abdomen also greyish green with seven longitudinal rows of white spots; the median spots small like the next, those of the third row largest, those of the fourth row (at the base of the pleura) are very large in the posterior somites (even larger than the third), in the first somites they are smaller than the third. The tips of the pleura with a white spot. A pale transverse band over the base of the tailfan. The distal part of the tailfan is darker (bluish) with brown hairs. Antennulae and antennae are bluish grey. The chelipeds are bluish grey; fingers paler, with brown tips. The following legs are pink."

Alpheus ehlersii De Man

Alpheus ehlersii De Man, 1909c: 663, pl. 70. Holthuis, 1958: 25, Eylath. [See also B & B, in press A.]

Alpheus euchirus Dana

Alpheus euchirus Dana, 1852a: 21. Mergner & Schuhmacher, 1974: 266, Gulf of Aqaba.

Remarks. — We have been unable to examine the specimen(s) reported by Mergner & Schuhmacher, so we cannot confirm their identification (see discussion under *A. serenei* Tiwari).

Alpheus euphrosyne euphrosyne De Man

Alpheus euphrosyne De Man, 1897: 745. [See also De Man, 1898: fig. 64 a-d. B & B, in press A.]

Specimens examined. — S. Red Sea: 6, E62/1360; 1, 2420; 1, 2421; 1, 2714; 1, 2997.

(?) **Alpheus fasciatus** Lockington

(?) *Alpheus fasciatus* Lockington, 1878: 478. Coutière, 1899: 486, 497, Djibouti.

Remarks. — This is a doubtful record, see remarks under *A. alpheopsides.*

Alpheus frontalis Milne-Edwards

Alpheus frontalis Milne-Edwards, 1837: 356. Holthuis, 1958: 24, Eylath. Fishelson, 1966: 98, Elat; 1971: 122, Red Sea. B & B, 1980: 26, Straits of Jubal. [See also B & B, in press A.]

Specimens examined. — Gulf of Aqaba: 3, NS 1060. 2, SLR 1; 2, 1353; 1, 1626; 2, 2315. S. Red Sea: 3, E62/1334; 2, 2186; 5, 2711.

Biological notes. — The specimens from SLR 1353 and E62/1334 were accompanied with the typical felted tubes of the alga *Lyngbya* (see B & B, in press A). Dr. Holthuis has supplied the following colour notes for a specimen from E62/1334. "The general impression of the shrimp is that it is rather uniform bluish-grey like the algae. The body is dark purplish blue-grey with many small and very small round white spots. Antennular, antennal peduncles, scaphocerite and chelipeds purplish blue-very like the body. The other legs are transparent with a few chromatophores."

Alpheus gracilis Heller

Alpheus gracilis Heller, 1861: 27. Coutière, 1898a: 197, Djibouti; 1899: 486, Djibouti. Balss, 1915: 22, 5 localities, Red Sea. Tattersall, 1921: 378, Suakin Harbor. Ramadan, 1936: 31, Ghardaqa. Holthuis, 1958: 21, Eylath. [See also Heller, 1862a: 271, pl. 3 fig. 19, 20. B & B, in press A.]

Specimens examined. — Gulf of Aqaba: 1, DR 143; 1, Misc 1; 1, SLR 1389. Gulf of Suez: 2, NS 12136; 1, 12139. N. Red Sea: 1, NS 4575. S. Red

Sea: 3, E62/1363; 2, 1382; 2, 1393; 1, 1420; 11, 1458; 1, 2195. 1, ISRSE 0268; 1, 1059; 1, 2018. 1, Misc 12.

Biological notes. — Dr. Holthuis has supplied us with the following colour notes on the specimen from E62/1420. "Three black transverse bands over the carapace: (1) a rather narrow one over the eyes, (2) a rather narrow one over the middle of the carapace, and (3) a broad band over the posterior part; a median black spot is present behind the anterior band. A broad black band is visible over each of the abdominal somites (except somite 1); these bands are placed slightly more posteriorly than anteriorly (especially in the posterior somites), but do include the transverse middle line of the segments. A black band is also present over the middle of the tailfan. Both chelipeds with weak dark bands; one over the middle of the fingers and one over the base of the fingers, one over the middle of the palm, one over the base of the palm, one over the carpus and one over the merus. These dark bands are dark olive, between them the colour is whitish. The rest of the legs are colourless."

Alpheus gracilipes Stimpson

Alpheus gracilipes Stimpson, 1861: 31. Coutière, 1897d: 195, Djeddah; 1898a: 197, Djibouti; 1899: 486, Djibouti. [See also B & B, in press A.]

Specimens examined. — Gulf of Aqaba: 1, NS 3614; 3, 4034; 1, 7309. 2, SLR 288; 1, 292. N. Red Sea: 4, NS 1431; 2, 1973; 1, 4561. S. Red Sea: 1, E62/1458. 1, ISRSE 1055.

Biological notes. — Dr. Holthuis has supplied colour notes for the specimen from ISRSE 1055. "Greenish gray with larger and smaller white spots. The larger spots tend to form longitudinal rows on the abdomen. The tailfan has the hairs brown. Chelipeds greyish-green marbled with white, fingers brown, distal part of palm brownish. Legs greyish, but distal part of second periopods brownish." This colour pattern is not consistent with those previously reported. Coutière (1898a: 197) stated that the species was reddish with patches of ferruginous grey, had the chelipeds and following legs of "beau bleu" and carried black ocilliforme patches on the sides of the abdomen. We reported a specimen from Hawaii (1953: 116) to be dark mottled with some clear areas and with dark "eye spots" on the abdomen; later notes from Hawaii (B & B, in press A) reported a lighter but "overall rusty appearance" again with emphasis on the abdominal eyespots which were "black, tinged with orange". Miya (1974: 152) also reported on the abdominal spots on specimens from Japan.

Alpheus hippothoe De Man

Alpheus hippothoe De Man, 1888b: 268, pl. 17 figs. 1-5. Coutière, 1898a: 197, Djibouti; 1899: 486, Djibouti. [See also B & B, in press A.]

Specimens examined. — Gulf of Aqaba: 2, NS 7309. S. Red Sea: 1, E58/152; 1, 244; 1, E62/1363; 12, 1393; 4, 1458; 1, 4600. 2, ISRSE 0257; 2, 1059.

Biological notes. — Dr. Holthuis has supplied colour notes on the specimens from ISRSE 0257. "With reddish brown transverse bands over the abdomen. The proximal half of the tailfan is brown, the distal half blue, both with irregular white spots. The median part of the carapace is dark olive green, the lateral parts pale orange-brown transparent. The large chela is dark olive green, the tips of the fingers are pink. The legs are bright red, the distal part of the second pair more orange." Coutière (1898a: 197) reported that on his specimens from Djibouti the bands were olive green with touches of light brown and that the outer uropod carried a blue eyespot on its distal third.

Alpheus hululensis Coutière

Alpheus bouvieri hululensis Coutière, 1905: 908, pl. 85 fig. 46. Tattersall, 1921: 381, Khor Dongonab. [See also B & B, in press A.]

Alpheus lanceloti Coutière

Alpheus lanceloti Coutière, 1905: 900, pl. 83 fig. 30. Holthuis 1958: 25, Eylath.

Specimens examined. — Gulf of Aqaba: 1, NS 4007; 1, 4016; 3, 4411.

Alpheus lanceostylus Banner

(fig. 3)

A. lanceostylus Banner, 1959: 136, fig. 3 a-h.

Specimens examined. — Gulf of Aqaba: 1, NS 3619; 1, 4034; 2, 4177; 1, 5072; 1, 7308.

Discussion. — These specimens show only minor variation one from another, as in the proportions of the antennular articles and the telson. The two specimens, both females, which have the large chelipeds intact differ slightly in the distal armature of the merus: the specimen from NS 3619 bears an acute superior tooth and three small teeth on the inferointernal angle, while in the specimen from NS 7308 the superior angle is only somewhat produced and rounded, and the inferointernal angle bears two teeth (figs. 3f, l).

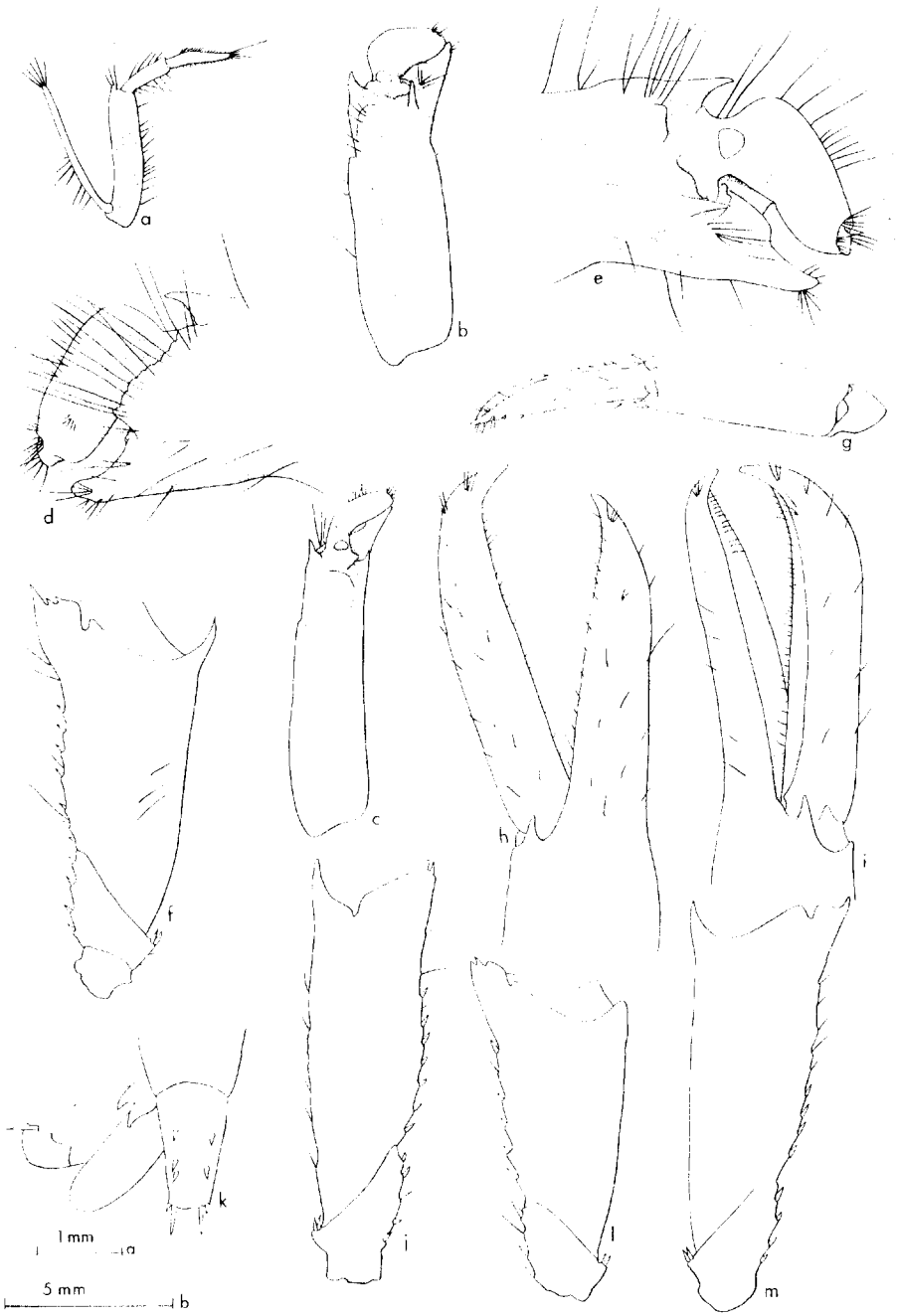

Fig. 3. *Alpheus lanceostylus* Banner (29 mm ♀ from NS 3619): a, third maxilliped; b, c, large chela, superolateral and superior face; d, e, distal end of large chela, medial and superolateral face; f, merus, large cheliped, medial face; g, small chela, superior face; h, i, distal end of small chela, medial and lateral face; j, merus, small cheliped; k, telson and uropods. 30 mm ♀ from NS 7308: l, merus, large chela, medial face; m, merus, small chela, medial face. a-c, g, k scale a; d-f, h-j, l, m scale b.

These specimens agree well with the original description of *A. lanceostylus* from the north central Pacific (the holotype and paratype were destroyed in a fire: B & B, 1962: 238) when the variation in proportions in this series is considered except for what appears to be a minor difference. In the holotype the ischium of the large cheliped was shown to have a strong but rounded tooth on the superiodistal margin, while on the two females cited above the same margin carries two spines; the small chelipeds in this collection carry similar spines. While this may indicate a geographical difference worthy of a subspecific differentiation, we feel such a division should not be made with so few specimens known.

Although in the original description we offered a paragraph of description and three drawings of the large chela, we would like to amplify that description and add more figures. The dactylus is high, thin and twisted, with the superior surface almost knifelike. Distally the dactylus expands into a bulbous, almost knoblike subterminal portion on the oppositive face, best seen from medial view; the extremity, while heavy, is more narrow than the bulbous portion and laterally is demarked from it by narrow grooves bearing short, stiff setae. The tip itself is rounded. Proximally from the knob the oppositive face continues as a knifelike cutting edge, without a trace of the normal plunger. The propodal finger or pollex proximally lacks any socket that would normally be developed to accommodate a plunger but instead carries a deep groove for the dactylar cutting edge; distally, the margin of the medial side of the groove falls away, allowing a rounded concavity to accommodate the knob of the dactylus, and finally terminates in an acute tooth. In at least two other species of the Macrocheles group, *A. crockeri* Armstrong and *A. hailstonei* Coutière, the plunger-socket arrangement is lacking; in these, either the pollex or the dactylus (or both) develop acute cutting teeth in the position of the plunger-socket. In other species, such as *A. brachymerus* (Banner), the plunger may also be lacking, but this was not explicitly stated in the original description.

Both of the original specimens lacked the small cheliped. In this collection the females cited above had both chelipeds and a sole male (NS 4034) had a small cheliped. We therefore offer this supplementary description:

Small cheliped without sexual dimorphism, longer but more slender than large cheliped. Chela 5.7 times as long as broad; fingers almost as long as palm; palm subcylindrical. Dactylar articulation flanked by 2 acute teeth; dactylus displaced at almost 90° to palmar axis. Dactylus with "superior" surface rounded; oppositive surface proximally developed as a broadly triangular ridge, distally becoming knifelike. Propodal finger grooved to accommodate ridge of dactylus, broad proximally and narrowing distally.

Near tip, ridge of dactylus crosses surface of projecting ridge of propodal finger, giving a shearing effect; tips of both fingers hooked, acute and crossing. Oppositive faces bear a few short, weak setae proximally, being transformed distally into a regularly spaced row of short, stiffer setae on oppositive edges of dactylus and propodus; fingers also bearing scattered longer setae. Carpus cyathiform, 0.2 length of palm, distally somewhat emarginate. Merus 2.5 times as long as broad (breadth measured at mid-article); distosuperior margin projecting as acute curved tooth; inferior margin bearing 7 spines in the proximal two-thirds and distally projecting similarly to large chela except that it bears only one secondary distal tooth; inferoexternal margin terminating in angular projection. Medial face of merus bearing rounded longitudinal depression from near ischium to carpal articulation. Ischium bearing 5 spines on inferior margin and 2 on distosuperior margin.

We are somewhat disconcerted by the strangely discontinuous collection records of this species and have sought collection data that might explain why it has been overlooked in the extensive collections made elsewhere. The original description was based on the holotype from Pearl and Hermes Reef, Hawaiian leeward chain, and the paratype (without chelipeds) was from Saipan, Marianas; presumably both specimens came from the reef flats. One additional specimen, also without chelipeds and therefore without confirmation of identification, we reported from American Samoa from a narrow reef-flat swept with rather turbulent water (1966a: 159). Of the Gulf of Aqaba specimens, 3 were collected at fish-poisoning stations, presumably in shallow water, and two were listed merely by geographic locations. The two from NS 4177 carried the intriguing collection data: "From cave at 7 m." We hope that in the future better data on the ecological niche of the species will be obtained so that it can be sought in the expanse between its records from Polynesia and the Marianas and the specimens from the Red Sea.

Alpheus leptochirus Coutière

Alpheus leptochirus Coutière, 1905: 914, fig. 54.

Specimens examined. — Gulf of Suez: 1, NS 2279. S. Red Sea: 1, E58/280.6; 2, E62/1451. 3, ISRSE 2018.

Alpheus leviusculus leviusculus Dana

Alpheus edwardsii leviusculus Dana, 1852b: 543, pl. 34 figs. 3 a-f. Coutière, 1898e: 249, Djibouti.

Alpheus bouvieri bastardi Coutière 1898b: 133 ,Djibouti; 1899: 486, Djibouti. Balss, 1915: 23, Suez.

Alpheus leviusculus Coutière, 1899: 486, Djibouti. Holthuis, 1958: 28, Eylath and Ras Nasrani, Sinai Peninsula. [See also De Man, 1911: 411. B & B, in press A.]

Specimens examined. — S. Red Sea: 5, E62/4524.

Alpheus lobidens De Haan

(fig. 4)

Alpheus lobidens De Haan, 1850: 179. [See also B & B, in press A.]
Alpheus crassimanus Heller, 1865: 107, pl. 10 fig. 2. Coutière, 1899: 486, Djibouti. Monod, 1937: 1, Suez Canal. Holthuis, 1956: 324, Great Bitter Lake, Egypt; 1958: 28, Ras Nasrani, Sinai Peninsula. Steinitz, 1967: 167, Red Sea. Fishelson, 1971: 119-121.
Alpheoides crassimanus Paulson, 1875: 106, Red Sea. Kossman, 1880: 81, Red Sea.
Alpheus inopinatus Holthuis & Gottlieb, 1958: 42, figs. 8, 9.
Alpheus lobidens polynesica Banner & Banner, 1975b: 429, figs. 3, 4.

Specimens examined. — Gulf of Aqaba: 2, Misc. 44. 5, NS 1590; 1, 2391; 3, 2421; 8, 3734; 10, 3737; 1, 3738; 7, 4007; 1, 4012; 10, 4016; 7, 4017; 6, 4411; 4, 5807. 13, SLR 564; 5, 616; 3, 1479; 134, 1480. Gulf of Suez: 3, Misc. 28. 1, NS 2269. 2, SLR 882; 4, 1784; 8, 1868; 4, 1881; 5, 2001; 14, 2062; 2, 2205; 13, 2258; 1, 2264; 7, 2929; 2, 2987; 1, 2996; 2, 3093; 2, 3094; 7, 3154; 80, 3169. N. Red Sea: 1, NS 1522; 3, 1967; 7, 1968; 7, 1971. 2, SLR 688. S. Red Sea: 2, E57/521; 4, E62/1314; 4, 1356; 13, 1363; 8, 1393; 32, 1413; 1, 1476; 11, 1517; 4, 4600. 2, ISRSE 0209; 1, 0227; 6, 0232; 3, 0279; 1, 0287; 5, 1077; 3, 1088; 2, 1208; 1, 1213; 10, 1230; 43, 1231; 7, 1232; 3, 1248; 3, 1257; 1, 1266; 20, 1274; 2, 1508; 25, 1527; 4, 1528; 56, 1529; 17, 1537; 83, 1561; 1, 1570; 1, 1591; 3, 2018; 13, 2057; 6, 2058; 4, 2446. 2, Misc. 12; 2, 48. Gulf of Aden: 1, Misc. 22.

Remarks. — In this paper we wish to review the taxonomic status of two species, *A. lobidens* De Haan and *A. inopinatus* Holthuis & Gottlieb, and one subspecies, *A. l. polynesica* Banner & Banner. All three taxa have been largely collected intertidally on muddy-sandy substrates and usually under somewhat imbedded rocks or boulders. They evidently can tolerate brackish water but do not require it. The nominate form of *A. lobidens* has been known from the far western tropical Pacific and Indian Oceans and the Mediterranean (usually listed under its synonym, *A. crassimanus* Heller — see B & B, 1975b: 429); *A. l. polynesica* has been reported only from the more central Pacific (B & B, 1975b: 423). *A. inopinatus* was originally reported from the Mediterranean coast of Israel but has been reported subsequently by Tirmizi & Kazmi (1969: 379) from Pakistan and by us from Australia (B & B, in press A).

The morphological distinction between *A. l. lobidens* and *A. l. polynesica* lay only in the degree of sculpturing on the small chela of the mature male,


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heavy in the nominate form, light to lacking in the subspecies. *A. inopinatus* was separated from *A. crassimanus* (= *A. lobidens*) by the original authors by the lack of acute teeth on the distal end of the inferointernal margin of the meri of both chelipeds. We reported this to be variable in the small cheliped in *A. l. polynesica* (B & B, 1975b: 433) and in both chelipeds in some specimens from Australia. In our Australian paper we accepted the separation of the three nominate forms; and although we questioned the separation between *A. lobidens* and *A. inopinatus*, we offered 5 tentative criteria which we hoped could be used to distinguish them from each other. These were differences in 1) the strength and curvature of the lateral tooth of the scaphocerite, 2) the development of the inferior shoulder of the large chela, 3) the superior transverse groove or "saddle" on the small chela of the male, 4) the degree of hirsuteness of the inner face of both chelae, 5) the development of the inferodistal tooth on the meri of both chelipeds. Apparently supporting this separation was the fact that we found in more than 500 specimens of the two species collected in overlapping ranges in Australia, what we thought to be both species in only three separate collections with a total of 17 specimens. This we took to be evidence of ecological separation.

Our discussion below is based upon additional observations on three lots of material: 1) a male and female from southern Japan that may be regarded as topotypes of De Haan's species, loaned to us by Dr. L. B. Holthuis (see discussion, B & B, 1975b: 431); 2) the large collection from Pakistan at the Invertebrate Reference Collection, University of Karachi, through the courtesy of Dr. N. M. Tirmizi (number of specimens not tallied but in the hundreds); and 3) the present collections, numbering over 500 specimens with some individual collections containing over 50 or even 100 specimens. We have found the variation in the large collections especially useful.

Fig. 4. *Alpheus lobidens* De Haan. Topotype (34 ♂, see also v): a, large chela, lateral face; b, small chela, lateral face; c, scaphocerite. Topotype (32 mm ♀, see also w, x): d, large chela, lateral face; e, small chela, lateral face; f, scaphocerite. Variations in scaphocerites: g, 34 mm ♀ (E 62/1356); h, 38 mm ♂ (E 62/1363); i, 36 mm ♀ (ISRSE 1529); j, 40 mm ♂ (ISRSE 2446); k, 35 mm ♀ (ISRSE 1529); l, 22 mm ♂ (ISRSE 1529); m, 30 mm ♀ (ISRSE 1529); n, 38 mm ♀ (ISRSE 1529). Variation in inferior shoulder, large chela: o, 34 mm ♀ (E 62/1231); p, 32 mm ♀ (ISRSE 1561); q, 32 mm ♀ (ISRSE 1232); r, 36 mm ♂ (ISRSE 1561). Variation in armature of meri, large chelipeds: s, 30 mm ♂ (ISRSE 1561); t, 27 mm ♂ (ISRSE 0232); u, 37 mm ♂ (SLR 2929); v, ♂ topotype; w, small cheliped, ♀ topotype; x, ♀ topotype. Variations in sculpturing, small chelae, ♂ ♂: a′, 32 mm (ISRSE 1232); b′ 32 mm (ISRSE 0227); c′, 38 mm (E 62/1363). Variation in sculpturing, small chelae, ♀ ♀: d′, 32 mm (Misc. 28); e′ 28 mm (ISRSE 1528); f′, 22 mm (ISRSE 1537). All drawings except large chelae, scale a; large chelae (a, d, o-r), scale b.

As we examined the Red Sea specimens, we especially noted variation in the following characteristics:

1. Development of the scaphocerite: Here the blade at times was broad and at times narrow, with the lateral tooth varying from markedly longer to slightly longer than the blade; while the outer margin always showed a degree of concavity, this was never great and varied from specimen to specimen.

2. Sculpturing on the large chela: The superior saddle was always shallow and rounded but varied in proportional breadth and depth; the inferior shoulder on the external face was always well developed but varied from rounded and at right angles to the margin, to more angular and thrusting forward.

3. Sculpturing on the small chela of males and females: Usually the palm of the small chela of the male showed strong sculpturing, but it was variable. In some specimens, however, sculpturing was entirely lacking, as we described for *A. l. polynesica*; while such specimens tended to be smaller, there was in the same collection a wide overlap in size ranges between the sculptured and nonsculptured. One individual, 35 mm long, had no trace of sculpturing. Females usually had a small concavity opposite the dactylar articulation on the inferior margin and a slight depression proximal to the articulation on the superior margin, but even in females of the same size from the same locality these depressions varied from nonexistent to a definite transverse groove on the superior margin and the development of a slight rounded shoulder on the inferior margin.

4. Hirsuteness of the inner face on the small chela: This characteristic, subjective at best, varied in the number and length of the setae, both on the distal portion of the palm and on the fingers in both sexes; the male, of course, always had the heavy balaeniceps fringe on the dactylus and the female always lacked this development.

5. Armature of the meri, large and small chelipeds: As mentioned above, the tooth on the distal end of the inferointernal margin of the meri of both chelipeds may be well developed and acute, smaller and either acute or rounded, or lacking entirely; it was absent more frequently on the small chelipeds than on the large, but its development did not seem to be correlated with size or sex of the specimens.

6. Spines on the posterior margin of the telson: In addition to the large posterolateral spines, the posterior margin was described as bearing a row of small spines above the bases of the usual hairs in *A. inopinatus* that were lacking in *A. lobidens*. These spines, at best never large or conspicuous, varied in size and number among specimens from the same locality and were at times absent.

The variation in other characteristics, such as the proportions of the antennular peduncle and relative lengths of the first two carpal articles of the second legs were described in Banner (1953: 136). In our joint studies we also reported upon populations of *A. lobidens* in the Society Islands in the central Pacific and in Aldabra in the Indian Ocean that may develop an acute tooth on the inferodistal margin of the meri of the third legs (B & B, 1967: 283; 1980: 26). The Aldabra males also lacked the sculpturing on the palm of the small chela.

Thus we find that the variation in the collections from the Red Sea not only destroys the distinctions between *A. lobidens* and *A. inopinatus*, but also the geographic separation between our subspecific form of *A. lobidens*. The single species, *A. lobidens*, we now believe extends from the Society Islands and Hawaii through the Red Sea into the Mediterranean as far as Tunisia, and from Kyushu, Japan to as far south as Sydney, Australia. The evidence seems to indicate that in various parts of the wide range of this species, different gene pools exist that are expressed by somewhat distinctive sets of morphological characteristics. However, these variations are not delimited geographically and may be found in populations in other parts of the range. Therefore, these populations should not be considered as subspecies, but at most as races or varieties.

With this type of variation in one species, the separation of the score or more of other burrowing shoreline species of the Edwardsii group that are often separated by subtle characteristics should be questioned. There may be differences in ecological requirements, such as those known for *A. euphrosyne euphrosyne* De Man (found in muddy estuaries and mangrove swamps), or for *A. lobidens*, *A. heeia* B & B and *A. pacificus* Dana (outlined in B & B, 1975b: 435). However, for many species the extent of variation is not known and their ecological requirements have never been studied.

The ecological information that appeared on the field notes for many of these specimens indicates that *A. lobidens* is intertidal, being collected in either sandy or muddy conditions. The specimens from ISRSE 2057 and 2058 bore the note stating the shrimp had been suffocated by a thick layer of algae (quoted for ISRSE 2050 under *A. djeddensis*, above).

Dr. Holthuis has supplied us with colour notes and sketches on 13 lots of specimens from the southern Red Sea. The specimens varied greatly in colour. One specimen, for example, was described as having "the entire body a pale yellowish grey" through which one could see the darker gut. In contrast, another was described as very dark with light coloured transverse bands on the posterior carapace, on the three posterior abdominal

somites and on the anterior tailfan; this specimen also had white spots on the carapace and on the dark chelae. Most other specimens were noted to have the abdomen carrying transverse bands of greyish brown to greyish green with chelae of "marbled greyish green". The eggs were reported to be green in two specimens, while in two others they were "brownish purple" and "dark greyish purple". Colour notes made by others (included in the vials) indicated the abdomen was transversely banded with black, brown or green. Most specimens found in Hawaii also carry dark bands on the abdomen.

Alpheus lottini Guérin *

Alpheus lottini Guérin, 1830-31, pl. 3 fig. 3; 1838: 38. Holthuis, 1958: 22, Eylath, Abu Zabad, Sinai Peninsula. B & B, 1980b: 26, Straits of Jubal [See also B & B, in press A.]

Alpheus ventrosus Milne-Edwards, 1837: 352. Nobili, 1906b: 32, Massaouah. Balss, 1915: 22, 22 localities, Red Sea. Tattersall, 1921: 378, Khor Dongonab, Suakin Harbor. Pesta, 1928: 72, Port Sudan. Ramadan, 1936: 21, Ghardaqa.

Alpheus laevis Randall, 1839: 141. Heller, 1862a: 269, Red Sea. Miers, 1878: 411, Gulf of Aqaba. Hilgendorf, 1879: 834, Red Sea. Ortmann, 1890: 487, Red Sea; Coutière, 1899: 486, Djibouti. Nobili, 1901: 2, Eritrera.

Alpheoides laevis Paulson, 1875: 106, Red Sea. Kossman, 1880: 81, Red Sea.

Specimens examined: — Gulf of Aqaba: 1, E50-25.1; 1, 25.4, 2, 25.6. 1, E54/7. 2, Misc. 3; 1, 5; 2, 23. 1, NS 1058; 2, 1059; 5, 1737; 5, 1738; 8, 3616; 7, 3619; 1, 3732; 2, 3763; 2, 4006; 2, 5345; 1, 5459; 3, 5461. 4, SLR 526; 1, 583; 9, 1592; 64, 1626; 32, 2315. Gulf of Suez: 1, SLR 2110; 1, 2117. N. Red Sea: 1, NS 1428; 1, 4493; 2, SLR 3239. S. Red Sea: 2, E57/449, 2, 676.19; 2, 676.20; 1, 676.21; 5, E62/1320; 4, 1323; 3, 1364; 5, 1366; 5, 1375; 15, 1383; 1, 1402; 1, 1408; 6, 1431; 4, 1435; 2, 1446; 3, 1452; 37, 1454; 19, 1455; 9, 1458; 2, 2036; 6, 2184; 2, 2712; 1, 4203 D; 12, 4600. 2, ISRSE 0211; 1, 1002; 15, 1037; 9, 1039; 2, 1069; 13, 1073; 1, 1218; 5, 1287; 5, 1587; 1, 2013. 1, Misc. 19; 2, 21; 1, 48.

Biological notes. — Dr. Holthuis supplied the following colour notes of

*) We note that Holthuis (1979: 7) has proposed the substitution of *Alpheus sublucanus* (Forskål, 1775) for the currently-used *A. lottini*; we have not followed the change in this and our other current publications for we are formally protesting the substitution to the International Commission on Zoological Nomenclature on the basis that *A. sublucanus* is a nomen oblitum and its use should be suppressed under Article 23, sections (a, b) of the current International Code (B & B, in press C). The name of *A. sublucanus* has been used twice recently in the Red Sea literature: Fishelson, 1971: 121, 128, Red Sea; Mergner & Schuhmacher, 1974: Tables 6, 13, Gulf of Aqaba (the community records of Fishelson are questionable as this species is an obligate commensal on corals of the family Pocilloporidae and he lists none of these corals in the specific communities from which he reports the shrimp).

a specimen from E62/1323. "General impression: orange-brown with a dark dorsal stripe. Over the middle of the dorsum a broad very dark brown longitudinal band extends over the full length; sometimes this dark band shows a narrow pale median line. The sides of the body are a much paler brown with an orange tinge. The articulations of the abdominal somites each show a red spot. The tailfan is dark brown, being slightly paler and more reddish basally. The antennular and antennal peduncles are brown, the flagellae are blue. The fingers of the large chela are reddish brown, the palm is lighter reddish brown beneath; the upper half, both inside and out, shows dark (blackish) spots. The carpus shows the same colour and colour pattern, the merus is uniformly orange-brown. The following legs are orange-brown." This species usually is of bright orange-red ground colour with deeper red mottling, and may or may not bear a darker red longitudinal stripe middorsally; a rare and markedly different colour pattern has been described from Hawaii (B, 1959: 141).

Alpheus macrodactylus Ortmann

Alpheus macrodactylus Ortmann, 1890: 473, pl. 36 fig. 10. Coutière, 1897d: 196, Suez. [See also B & B, in press A.]

Alpheus macroskeles Alcock & Anderson

Alpheus macroskeles Alcock & Anderson, 1894: 153. Balss, 1915: 23, Red Sea. Calman, 1939: 208, Gulf of Aden. [See also Alcock & Anderson, 1899: pl. 9 fig. 5. B & B, 1979: 224, fig. 1.]

Alpheus maindroni Coutière

Alpheus maindroni Coutière, 1898b: 133, figs. 2, 2'; 1899: 486, Djibouti. [See also B & B, in press A.]

Specimens examined. — Gulf of Aqaba: 1, E54/7. 1. Misc. 2. 2, NS 4007. S. Red Sea: 1, E62/1452. 1, ISRSE 0270; 2, 1077; 2, 2012; 2, 2018.

Alpheus malleodigitus (Bate)

Betaeus malleodigitus Bate, 1888: 565, pl. 101 fig. 5.
Alpheus malleodigitus Coutière, 1898a: 197, Djibouti; 1899: 486, Djibouti. [See also B & B, in press A.]

Specimens examined. — S. Red Sea: 2, E62/1452. 2, ISRSE 0268; 3, 0270; 3, 2021.

Biological notes. — ISRSE 0268 contained one specimen each of *A. microstylus* and *A. obesomanus* as well as the two of *A. malleodigitus*. Dr. Holthuis supplied the following colour notes on one specimen from

ISRSE 2021. "Pink transverse bands over abdominal somites along the posterior margin and over the base of the pleura. Small first cheliped yellow with distal part of palm and fingers orange. Large cheliped yellow with distal part of propodus pale orange, dactylus white. Second pereiopods yellow. Following legs uncoloured. Eggs transparent and slightly greenish." This pink colour was noted in the female of an Australian pair, but the male was tan (B & B, in press A).

Alpheus microstylus (Bate)

Betaeus microstylus Bate, 1888: 566, pl. 101 fig. 6.
Alpheus microstylus Coutière, 1899: 42. Balss, 1915: 22, 4 localities, Red Sea. Tattersall, 1921: 379, Khor Dongonab. Ramadan, 1936: 21, Ghardaqa. Holthuis, 1958: 23, Eylath. Fishelon, 1971: 122, Red Sea. [See also B & B, in press A.]

Specimens examined. — Gulf of Aqaba: 4, Misc. 2; 3, SLR 1389. S. Red Sea: 1, E62/0122; 1, 1333; 2, 1356; 4, 1375; 1, 1452; 1, 1458; 1, 4600. 1, ISRSE 0268; 3, 0270; 8, 0886; 1, 1006; 2, 1044; 1, 1079; 2, 1592; 14, 2011.

Biological notes. — Field notes indicate that many of these specimens were found "among corals"; we have found it in galleries usually under sheets of *Porolithon* (B & B, 1966b: 101). In six collections for which Dr. Holthuis gave colour notes and in three other collections carrying colour notes the body was described as "bright yellow" or "lemon yellow". Dr. Holthuis also noted that in one specimen the fingers of the large chela were white and that the small chela was "greenish"; in three ovigerous females he described the eggs as green.

Alpheus miersi Coutière

Alpheus rapax miersi Coutière, 1898c: 166, fig. 1.
Alpheus miersi [See also Coutière, 1905: 903, pl. 83, 84 fig. 42. B & B, in press A.]

Specimens examined. — Gulf of Aqaba: 1, DR 136; 3, E59/70; E60/62.23. 1, NS 1061; 1, 1590; 1, 7236; 1, 7258.

Alpheus obesomanus Dana

Alpheus obesomanus Dana, 1852a: 21. Coutière, 1898a: 197, Djibouti; 1899: 486, Djibouti. [See also Dana, 1852b: 547, pl. 34 fig. 7. B & B, in press A.]

Specimen examined. — S. Red Sea: 1, ISRSE 0268.

Alpheus pachychirus Stimpson

Alpheus pachychirus Stimpson, 1861: 30. Coutière, 1899: 486, Djibouti. Tattersall, 1921: 380, Tella Tella Kebira. [See also B & B, in press A.]

Alpheus pacificus Dana

Alpheus pacificus Dana, 1852a: 21. Nobili, 1906a: 32, Red Sea. Balss, 1915: 24, Shadwan Is. Holthuis, 1958: 28, Eylath. Mergner & Schuhmacher, 1974: 266, 294, Gulf of Aqaba. [See also B & B, in press A.]

Specimens examined. — Gulf of Aqaba: 1, E60/62.21; 5, 62.23. 3, NS 1744; 1, 3517; 4, 3731; 25, 4007; 1, 4012; 27, 4016; 17, 4017; 1, 4176; 4, 4411; 3, 5444; 15, 5807. 1, SLR 616; 13, 1626. Gulf of Suez: 1, SLR 882; 9, 2001. N. Red Sea: 2, Misc. 49. 1, NS 1428. 14, SLR 1892a. S. Red Sea: 1, E62/1328; 10, 1363; 1, 1413; 3, 1489; 1, 1514; 16, 4524.

Alpheus paracrinitus Miers

Alpheus paracrinitus Miers, 1881: 365, pl. 16 fig. 6. Coutière, 1899: 486, Djibouti. Balss, 1915: 23, Ras Abu Somer. [See also B & B, in press A.]
Alpheus bengalensis Holthuis, 1958: 25, Eylath and Ras Nasrani, Sinai Peninsula.

Specimens examined. — S. Red Sea: 1, E62/1357; 1, 1416; 2, 2166.

Alpheus pareuchirus pareuchirus Coutière

Alpheus pareuchirus pareuchirus Coutière, 1905: 906, pl. 84 fig. 42. [See also B & B, in press A.]

Specimen examined. — Gulf of Suez: 1, Misc. 30.

Alpheus parvirostris Dana

Alpheus parvirostris Dana, 1852a: 22. Heller, 1862a: 271, Red Sea. Coutière, 1898a: 197, Djibouti; 1899: 486, Djibouti. Balss, 1915: 24, 4 localities, Red Sea. Tattersall, 1921: 381, 6 localities, Red Sea. Ramadan, 1936: 21, Ghardaqa. Holthuis, 1958: 29, Eylath. [See also Dana, 1852b: 551, pl. 35 fig. 3. B & B, in press A.]

Specimens examined. — Gulf of Aqaba: 2, DR 145. 1, Misc. 2. 3, SLR 1389. Gulf of Suez: 1, NS 12140; 2, 12143. 2, SLR 2117. S. Red Sea: 4, E62/0117; 2, 0132; 6, 0189; 5, 1338; 1, 1363; 1, 1375; 15, 1382; 1, 1390; 1, 1416; 2, 1421; 1, 1446; 1, 1452; 2, 1479; 2, 1482; 2, 1499; 2, 1981; 2, 2047; 2, 2166; 1, 4203 D; 1, 4419; 1, 4600. 2, ISRSE 0259; 1, 02070; 26, 0299; 1, 0825; 2, 0862; 5, 1045; 1, 1059; 11, 1077; 9, 1287; 1, 1589; 6, 1591; 51, 2012; 16, 2018. 1, Misc. 9; 1, 14, 2, 20.

Biological notes. — Dr. Holthuis described the specimens from ISRSE 0259 as follows: "The abdomen shows strong transverse dark (black or dark brown) bands. The tailfan has a dark distal tooth on the exopod of the uropod. Large chelipeds are olive green with the distal half of the fingers white, and some white spots on the palm. The perciopods 2-5 are transparent. The carapace is pale brownish grey." He noted four other specimens had dark bands on the abdomen; one specimen carried green eggs.

Alpheus rapacida De Man

Alpheus rapacida De Man, 1908: 105. Steinitz, 1967: 167, Red Sea. [See also De Man, 1911: 394, fig. 91. B & B, in press A.]

Specimens examined. — N. Red Sea: 1, Misc. 31; 1, 49.

Biological notes: Dr. Magnus reported the specimen from Misc. 31 as living symbiotically "with the gobiid *Vanderhorstia delagoae* or *Cryptocentrus caeruleopunctatus.*"

Alpheus rapax Fabricius

Alpheus rapax Fabricnus, 1798: 405. Coutière, 1898a: 197, Djibouti; 1899: 486, Djibouti. Nobili, 1906a: 33, Massaouah. Fishelson, 1971: 128, Red Sea. B & B, 1980: 28, Straits of Jubal, Red Sea. [See also De Man, 1909b: 147, pl. 7 figs. 1-8. B & B, in press A.]

Specimens examined. — Gulf of Aqaba: 1, Misc. 42. 42 SLR 616. N. Red Sea: 2, Misc 33. 1, NS 1973. 6, SLR 1892a; 1, 3239. Middle Red Sea: 1, Misc 36.

Biological notes. — Dr. Tsurnamal reported the specimen from Misc. 42 was associated with "the gobiid fish *Cryptocentrus cryptocentrus.*" His notes also indicated that it was red in colour and had "dense reddish brown longitudinal stripes on abdomen".

Alpheus serenei Tiwari

Alpheus serenei Tiwari, 1963: 310, figs. 27, 28 [See also B & B, in press A.]
Alpheus euchirus Dana, 1852a: 21. Coutière, 1899: 486, Djibouti. Calman, 1939: 209, Red Sea.

Remarks. — In our Australian paper we considered the identity of *A. euchirus* Dana and concluded that it had not been accurately reported since Dana's original description. In this paper we also considered the specimens recorded from the Red Sea. Coutière's sole specimen, which he reported as *A. euchirus*, could not be found, but as it carried a strong tooth on the merus of the third leg (1899: 260), it could not be *A. cuchirus*. Because Coutière's specimen was examined by De Man and considered by him to be identical to those specimens he was reporting as *A. euchirus* (1911: 434), but which in our reexamination were found to be *A. serenei*, we are presuming that Coutière's specimen probably was *A. serenei* also. We examined the specimens that Calman reported as *A. euchirus* and found them also to be *A. serenei*, although they showed slight differences from specimens from the Pacific. We suggested, therefore, that if differences noted by us in Australian stocks are found to be constant in future collections, the Red Sea form might be considered as a possible geographically isolated subspecies of *A. serenei.*

Alpheus splendidus Coutière

Alpheus splendidus Coutière, 1897a: 235, Djibouti; 1898a: 197, Dpibouti; 1899: 486, Djibouti. Crosnier & Forest, 1965: 361, fig. 4 [See also B & B, in press A.]

Specimens examined. — Gulf of Aqaba: 1, E50/25.5. S. Red Sea: 2, ISRSE 1036.

Biological notes. — Dr. Holthuis has supplied the following colour notes for one of the specimens from ISRSE 1036. "Two longitudinal dark bands extend from the eyes to the base of the tailfan. The distal part of the tailfan is dark. A dark line extends on the carapace from near the base of the antenna upward and backward to the nearest longitudinal dark band. The antennular and antennal peduncles are dark; the scaphocerite shows a dark band along the outer margin. The flagella are purple or pink. The pereiopods are pink. The exopod of the uropod has a black spine. The distal part of the telson and of the uropods is dark blue. The outer margin of the uropodal exopod is yellow, the distal margin of the endopod is also yellow. Yellow chromatophores are also seen on the rostral carina. The chelae of the first pair are brownish orange, the fingers being darkest."

Alpheus spongiarum Coutière

Alpheus spongiarum Coutière, 1897a: 236, Djibouti; 1897c: 369, Djibouti. Calman, 1939: 208, Gulf of Aden. [See also B & B, in press A.]
Alpheus crinitus spongiarum Coutière, 1899: 486, Djibouti.

Specimens examined. — Gulf of Aqaba: 1, NS 7315. 1, SLR 1034. Gulf of Suez: 2, NS 12145. S. Red Sea: 1, E62/1355. 1, ISRSE 0821, 2, 0822; 2, 0833.

Remarks. — Although Coutière described this species as *A. spongiarium*, he used both that name and the trinomial *A. crinitus* Dana var. *spongiarum* rather indiscriminately in his thesis, without any explanation. As he never again used the varietal name and we have found it in only one other place in the literature (Arndt, 1933: 248), we believe it should be ignored.

Alpheus strenuus strenuus Dana

Alpheus strenuus Dana, 1852a: 21. Coutière, 1898a: 196, Djibouti; 1899: 486, Djibouti. Nobili, 1906a: 33, Red Sea. Tattersall, 1921: 381, Suez, Khor Dongonab, Suakin Harbor. B & B, 1980: 28, Straits of Jubal. [See also Dana, 1852b: 543, pl. 34 fig. 4. B & B, in press A.]

Specimens examined. — Gulf of Aqaba: 3, NS 3730; 3, 3731. Gulf of Suez: 2, NS 2264. N. Red Sea: 1, Misc. 49. 2, NS 1972; 1, 1973. S. Red Sea: 5, E62/1363; 1, 1367; 2, 1383, 3, 1413; 3, 1455; 2, 1458; 2, 4600. 2, ISRSE

0222; 51, 1047; 10, 1056; 2, 1069; 2, 1077; 1, 1088; 13, 1230; 2, 1249; 2, 1266; 28, 1508; 19, 1526; 1, 1528; 4, 1529; 5, 1537; 27, 1589; 1, 1591; 2, 1594; 3, 2018; 2, 2446; 2, 2454.

Biological notes. — Dr. Holthuis has supplied colour notes on eight lots of specimens. They were all described as greyish-green. Some carried lighter or even white spots and patches on the abdomen, tailfan and chelae; some chelae had pink or blue tips. Thoracic legs were variously green, green with red, yellow, etc. Eggs were orange to brown.

Alpheus tenuicarpus De Man

Alpheus tenuicarpus De Man, 1908: 104. [See also De Man, 1911: 381, fig. 84.]

Specimens examined. — Gulf of Aqaba: 1, NS 7206; 2, 7268.

Remarks. — The 3 specimens are fragmentary and lacking their third legs, but a 15 mm male has a large and small cheliped and another specimen has a second leg. The parts present agree well with *A. tenuicarpus*. The chelae are not as granulate as those figured by De Man, and the small chela is slightly more slender, i.e. 6.0 instead of 5.0 times as long as broad as stated by De Man (however, his figure measures 5.7 times). The first carpal articles of the second legs have the ratio of 10:15; De Man gave lengths for two specimens with ratios of 10:13 and 10:14. The lateral margin of the second article of the third maxilliped ends in a spiniform tooth, similar to that described by De Man. The specimens from the Gulf of Aqaba came from 150-180 fathoms while De Man's came from 36 to 75 m.

Amphibetaeus jousseaumei (Coutière)

Betaeus jousseaumei Coutière, 1896a: 313, figs. 1-12, Perim, Tadjourah.
Amphibetaeus jousseaumei Coutière, 1896c: 384 (same specimens as 1896a); 1897a: 234, Djibouti (remarks on colour); 1899: 486, Djibouti.

Remarks. — Coutière stated that at Djibouti (1899: 494) this species was found on relatively hard bottom among some stone rubble in association with "Thalassiniens et de Géphyriens, Phascolosomes et Echiures" especially with *Callianassa micronata* Strahl. Coutière's reports are the only records for this species.

Aretopsis amabilis De Man

Aretopsis amabilis De Man, 1910: 311. [See also De Man, 1911: 171, fig. 14 B & B, 1973b: 330.]
Aretopsis aegyptiaca Ramadan, 1936: 16, Ghardaqa. Holthuis, 1958: 14, Eylat. Fishelon, 1971: 122, Red Sea.

Specimens examined. — Gulf of Aqaba: 1, E59/120.1. S. Red Sea: 2, E62/1391. 1, ISRSE 0112, 1, 1508.

Remarks. — In some specimens the eyes are almost completely covered, in others nearly exposed. The length of the rostrum is also variable. The two specimens from E62/1391 were noted as coming from a gastropod shell inhabited by the hermit crab, *Dardanus lagopodes*. Their relationship to hermit crabs has been reported upon before (see B & B, 1973b: 333). There were no comments on the ecology of other specimens. Dr. Holthuis has supplied the following notes for the specimens from E62/1391: "Body dark red. A broad bright white band extends over the median line of the body from the tip of the rostrum to the base of the telson. The white band is flanked at each side with a narrow yellow line. Furthermore, the carapace shows a rather broad white band along the lateral margin; such a band is not shown on the abdomen. The telson is red. The uropods are red in the basal half, white in the distal part. The large chela is dark red with a white band on the lower half of the palm; this band continues on to the carpus. A narrow yellow line borders the white band dorsally and near the base of the fingers curves upward along the base of the dactylus. The fixed finger is entirely white, the dactylus is red. The ischium of this cheliped is whitish, the merus red. The smaller cheliped is entirely yellow, only the upper part of the palm and carpus are reddish. The peduncles of the antennula and antenna and the distal two segments of the third maxilliped are yellow; the rest of the third maxilliped is red."

Athanas areteformis Coutière

Athanas areteformis Coutière, 1903: 79, figs. 17, 19. Balss, 1915: 21, Ras Abu Somer. [See also B & B, 1973b: 304.]
Athanas erythraeus Ramadan, 1936: 13, Ghardaqa.

Athanas crosslandi Tattersall

Athanas crosslandi Tattersall, 1921: 372, pl. 27 figs. 13-17, Khor Dongonab. Ramadan, 1936: 12, Ghardaqa.

Athanas dimorphus Ortmann

Athanas dimorphus Ortmann, 1894: 12, pl. 1 fig. 1. Coutière, 1899: 486, Djibouti. Balss, 1915: 21, Red Sea; 1927: 222, Suez Canal. Tattersall, 1921: 371, Gulf of Suez. Gurney, 1927: 261, Red Sea [See also B & B, 1973b: 313.]
Athanas solenomerus Coutière, 1896c: 381, Red Sea.
Athanas leptocheles Coutière, 1896c: 381, Red Sea.
Athanas dispar Coutière, 1897a: 233, Djibouti and Suez.

Specimens examined. — S. Red Sea: 1, E57/701.3, 701.5. 5 Misc. 20.

Discussion. — Coutière described the male and female forms of this

species in 1896c as 2 species; in 1897a he recognized them as a single species to which he gave the new name *A. dispar*. In his thesis (1899: 49) he placed *A. dispar* into synonymy under *A. dimorphus*.

Athanas djiboutensis Coutière

Athanas djiboutensis Coutière, 1897a: 233, Djibouti; 1899: 486, Djibouti. Nobili, 1906a: 31, Red Sea. Tattersall, 1921: 368, 6 localities, Red Sea. Ramadan, 1936: 12, Ghardaqa. Holthuis, 1958: 14, Eylath and Abu Zabad, Sinai Peninsula. Fishelson, 1971: 119-122, Red Sea. [See also Coutière, 1905: 856, fig. 129. B & B, 1973b: 306.]

Specimens examined. — Gulf of Aqaba: 1, DR 16; 4, 22; 1, 28; 9, 65; 3, 38; 1, 101; 3, 125; 1, 136; 4, 141; 1, 143; 9, 144; 3, 145; 2, 157; 1, 158; 4, 159; 1, 166. 1, E59/57.4. 8, Misc. 2. 1, NS 5807 1, 7379. Gulf of Suez: 1, SLR 1777.

Athanas dorsalis (Stimpson)

Arete dorsalis Stimpson, 1861: 32. Coutière, 1897a: 234, Djibouti; 1899: 486, Djibouti.
Athanas dorsalis [See B & B, 1960: 151; 1973b: 324.]

Specimens examined. — Gulf of Aqaba: 1, Misc. 2; S. Red Sea: 2, E62/0252.

Athanas ghardaqensis (Ramadan)

Arete ghardaqensis Ramadan, 1936: 15, pl. 1 figs. 2-8, Ghardaqa.
Athanas ghardaquensis [See B & B, 1960: 138.]

Specimens examined. — Gulf of Aqaba: 1, Misc. 2.

Athanas indicus (Coutière)

Arete dorsalis indicus Coutière, 1903: 84, figs. 25-30, Djibouti.
Arete indicus Coutière, 1905: 863. Balss, 1915: 21, 3 localities, Red Sea.
Arete iphianassa De Man, 1910: 317. Holthuis, 1958: 17, Eylath. Fishelson, 1971: 121, 122, Red Sea.
Athanas indicus [See B & B, 1960: 149, 1973b: 327.]

Specimens examined. — Gulf of Aqaba: 1, Misc. 47. 5, NS 1050; 1, 1055. Gulf of Suez: 1, SLR 1797; 1, 2039. S. Red Sea: 1, E62/1393; 4, 1456; 4, 1516; 1, 10170. 1, ISRSE 0822; 1, 2493.

Biological notes. — Dr. Holthuis has supplied us with colour notes from a specimen from E62/1516 which was living symbiotically with the urchin *Echinometra mathaei* Blainville: "Dark purplish red-brown with a pale brown longitudinal median stripe over the full length of the body, and a white line over each side. The lateral pale line is broad on the carapace and the first abdominal somites, but posteriorly it becomes narrower, being a

line on the sixth somite; this pale line runs over the bases of the abdominal pleura. A narrow longitudinal pale line is visible in the dark area of the carapace between the dorsal and lateral pale bands, and one between the pale lateral band and the lateral margin of the carapace. A brownish spot is present in the white of the broad lateral band. On the fourth abdominal somite an irregular whitish spot is present along the anterior margin in the dark area between the dorsal and lateral pale lines; behind this anterior irregular white spot there is a smaller of the same colour."

Athanas marshallensis Chace

Athanas marchallensis Chace, 1955: 17, fig. 8.

Specimens examined. — S. Red Sea: 10, E62/1363.

Athanas minikoensis Coutière

Athanas minikoensis Coutière, 1903: 76, figs. 9-11. Ramadan, 1936: 13, Ghardaqa.

Athanas monoceros (Heller)

Alpheus monoceros Heller, 1862a: 274, Red Sea.
Arete monoceros Heller, 1862b: 404. Paulson, 1875: 105, Red Sea.
Athanas leptocheles var. *monoceres* Coutière, 1896c: 381, Red Sea.
Athanas dimorphus var. *monoceres* Coutière, 1899: 61, 62 (presumably Red Sea).
Athanas monoceros [See B & B, 1960: 137.]

Remarks. — Both Coutière (1899: 20) and Johnson (1962: 49) have suggested that *A. dimorphus* Ortmann is the same as this species (with Coutière using Ortmann's name). However, Heller in his original description stated that the tip of the rostrum reached beyond the antennular base and that the carapace carried a strong extracorneal tooth and a smaller infracorneal tooth as well, while Ortmann stated that in *A. dimorphus* the rostrum reached the end of the second antennular article and made no mention of, nor showed, the infracorneal tooth. These may be variable characteristics, but until the range of variation is shown to encompass the two forms, we prefer to keep both nominal species. The variety of Coutière, *A. leptocheles* var. *monoceros* evidently had the longer type of rostrum.

Athanas sibogae De Man

Athanas sibogae De Man, 1910: 315. [See also De Man, 1911: 151, fig. 6. B & B, 1973b: 321.]
Athanas parvus De Man, 1910: 315. Tattersall, 1921: 372, Khor Dongonab.

Specimens examined. — Gulf of Suez: 1, SLR 2831. S. Red Sea: 1, E62/1455.

Athanopsis Coutière

Remarks. — *Athanopsis* Coutière and *Arctopsis* De Man are the only genera in the family that have the tip of the rostrum developed into a laterally compressed dorsoventral keel that continues posteriorly under the triangular portion of the rostrum. The two genera are best distinguished by the chelipeds of the first pair, which in *Athanopsis* may or may not have strong asymmetry (possibly with sexual dimorphism). If large, the chelae are carried flexed in a groove provided by the extension of the margins of the meri; the palm is rounded in section. In *Arctopsis* the chelipeds have strong asymmetry and no sexual dimorphism; they are carried extended, with the dactylus in a somewhat inferior position to the palm, and the palm is compressed. If the chelipeds are lacking, as in the new species described below, the genera can be distinguished by three other characteristics: First the dactyli of the third to fifth pereiopods are simple and slender in the four known species of *Athanopsis* and strongly biunguiculate in the one known species of *Arctopsis*. Second, the anterior margin of the carapace is produced into a dorsolateral tooth (extracorneal tooth) over the corneas in *Athanopsis*, while in *Arctopsis* that section of the corneas is free, with only slight but evidently variable projection ventrolateral to the corneas (infracorneal tooth). (Note: In both genera the eyes appear to be variable in anteriorposterior positioning, producing variable coverage of the cornea by the carapace). Third, the first carpal article of the second legs is equal to or longer than the sum of the four following articles in *Athanopsis* but shorter than the sum in *Arctopsis*; this appears to be a somewhat variable characteristic.

Coutière's original description of *Athanopsis platyrhynchus* was based on two specimens from Djibouti; he did not indicate if he had additional specimens for those mentioned in the biological notes in his thesis (he states [1899: 544] that this species is "moins pauvrement représéntés" than others like *Pterocaris typica* Heller, which is known from only a single specimen). The species has not been reported since his description and thesis. Two other species have recently been reported: *A. australis* Banner & Banner (in press A) *, based on a single specimen from 8 m in the Port Phillip Bay, Victoria, Australia, and *A. dentipes* Miya (1980: 118), based on two specimens, one taken at Amakusa and one at Nagasaki, Kyushu, Japan.

While it is possible that the colour, a characteristic emphasized by Miya in his description, and the form of the cheliped may be valuable in the separation of the four species, those characteristics cannot be used at present

*Specific name to appear in "in press A" and is conditional upon its publication there.

as both are unknown for this species and for *A. australis*. The following key differentiates between the species on other morphological characteristics:

Key to the known species of *Athanopsis*

1. Meri of third to fifth legs unarmed with either spines or teeth . 2
   Meri of third to fifth legs with spines and, in one species, an acute tooth 3
2. Rostrum longer than broad and reaching to second antennular article; second antennular article slightly longer than broad *A. platyrhynchus*
   Rostrum markedly broader than long, reaching only to middle of first antennular article; second antennular article almost twice as broad as long . . . . . *A. brevirostris*
3. Distoinferior margin of merus of third legs without a tooth; dorsal surface of telson without spines . . . . . *A. australis*
   Distoinferior margin of merus of third legs with small but acute tooth; dorsal surface of telson with normal two pairs of spines *A. dentipes*

If the members of this genus are similar to some members of the related genus *Athanas*, future workers with the group should be warned that the form and the asymmetry of the chelae may change with sex and degree of maturity (see B & B, 1960: 135).

Athanopsis brevirostris new species

(fig. 5)

Holotype (RMNH No. D 32942). — 9 mm nonovigerous female from Cundabilu Is., Dahlak Arch., Southern Red Sea, among corals, 0.3 m. Collected 25 March 1962. (E62/1393).

Description. — Distal portion of corneas exposed in dorsal and lateral views. Rostrum in dorsal view almost an equilateral triangle with acute tip reaching past middle of first antennular article; rostrum flattened, except for low dorsal carina arising near base; in lateral view dorsal carina joins strong ventral carina forming a dorsoventral lamellar plate; tip rounded in lateral view. Supraorbital teeth half as long as rostrum, broad at base, with acute tips somewhat directed towards rostrum; margin between base of teeth and rostrum broadly rounded; no other anterior teeth except acute and protruding pterygostomial tooth.

Antennular articles short and broad, second article about twice as long as broad and about half as long as visible part of first and third article. Second article carrying strong inferointernal projection. Stylocerite narrow-

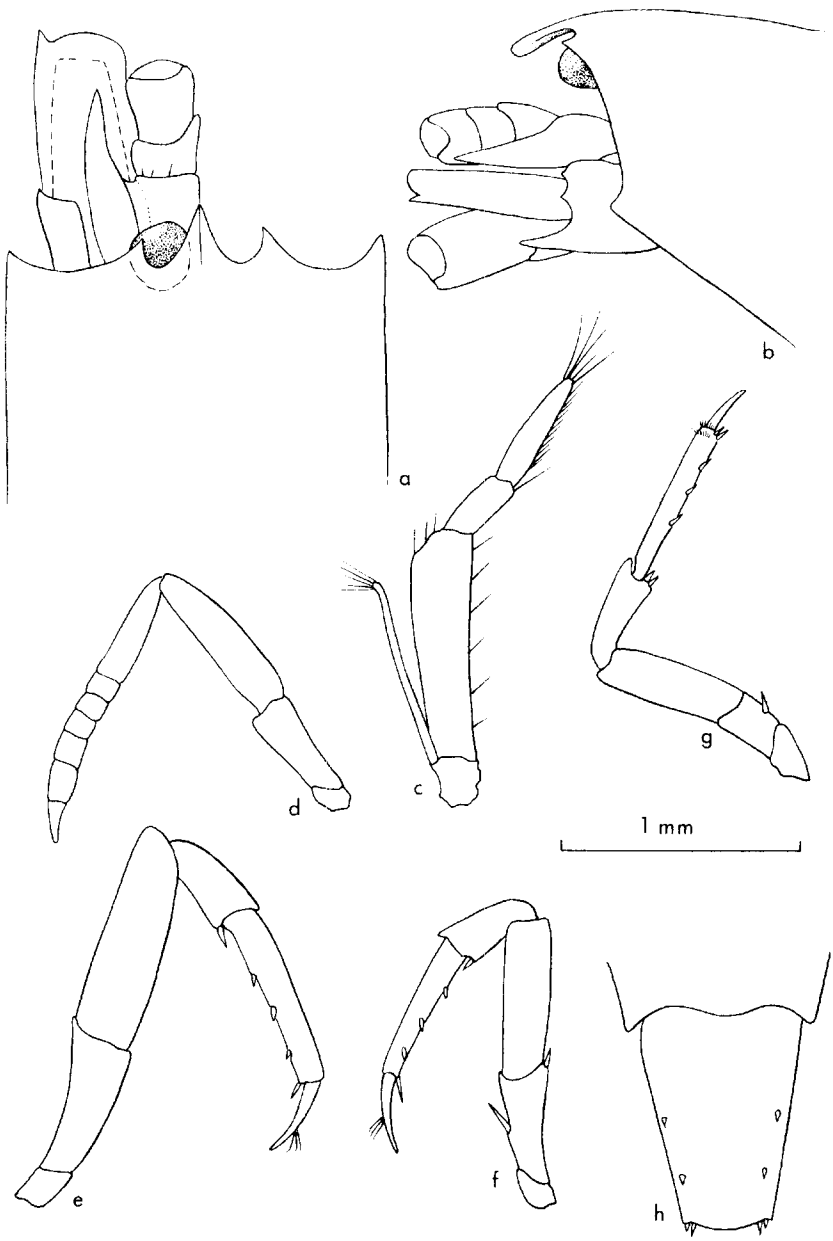

Fig. 5. *Athanopsis brevirostris* new species, holotype (9 mm ♀): a, b, anterior region, dorsal and lateral view; c, third maxilliped; d, second eg; e, f, g, third, fourth and fifth leg; h, telson. All drawings same scale.

ing distally and obtuse tip reaching almost to end of third article. Squame broad, reaching slightly beyond antennular peduncle; lateral tooth small and reaching beyond tip of squame. Carpocerite as long as antennular peduncle, 2.5 times as long as broad when viewed from ventral side. Basicerite with strong inferolateral tooth reaching to end of first antennular article; superior section of basicerite bearing 2 slight rounded teeth.

Ratio of articles of third maxilliped: 10:3:5. Ultimate article bearing usual rows of short setae on inner face; tip bearing tuft of moderately long setae.

Both chelipeds missing.

Ratio of carpal articles of second leg: 10:2:2:2:3, with sum of distal four articles subequal to proximal; chela 0.7 length of proximal carpal article.

Articles of third legs with ratio of lengths, starting with ischium: 10:14:6:13:5; merus 3.1 times as long as broad. Ischium and merus unarmed; carpus with small heavy spine on distoinferior margin; propodus bears 3 inferior spines and a pair distally; dactylus slender, curved, acute, with 3 short curled setae on superior margin. Fourth legs markedly shorter than third, with merus only 0.6 as long as merus on third; articles with ratio of lengths: 10:14:5:12:7. Armature similar to third legs except ischium carrying strong spine on middle of inferior margin and smaller spine on superodistal angle. Fifth legs similar in length to fourth but somewhat more slender; ischium bearing only inferior spine; carpus bearing a pair of spines; propodus with 3 spines and a brush of setae.

Sixth abdominal segment articulated.

Telson 2.4 times as long as posterior margin is broad. Dorsal and posterolateral spines normal but small; dorsal spines placed near lateral margin. Posterior margin broadly arcuate.

Discussion. — The sole specimen is small and in poor condition; it has a soft integument and may not be mature. It may be differentiated from the other members of the genus by the characteristics given in the key to the species on p. 45. It is suspected that the chelipeds, when found, may offer other characteristics suitable for differentiation between the species.

Biological notes. — The specimen was found "among corals" in a shallow water fish-poisoning station; its colour in life was not noted.

Athanopsis platyrhynchus Coutière

Athanopsis platyrhynchus Coutière, 1897b: 301; Djibouti; 1899: 486, Djibouti.

Biological notes. — Coutière reported that this species carries transverse orange bands and that it lives under rocky debris (1899: 496, 541).

Automate dolichognatha De Man

Automate dolichognatha De Man, 1888a: 529, pl. 22 fig. 5. Coutière, 1897a: 234, Djibouti; 1899: 486, Djibouti. [See also B & B, 1973b: 299.]
Automate gardineri Coutière, 1902: 337, Djibouti; 1903: 73, Djibouti. Holthuis, 1958: 17, fig. 6. Eylath.

Specimens examined. — S. Red Sea: 1, ISRSE 1535; 1, 1563; 1, 1564.

Biological notes. — Dr. Holthuis reported that 3 specimens were colourless. and transparent except for the gonads, eggs and intestines, which were bright orange-red. Miyake and Miya (1966: 139) reported that Japanese specimens were pale orange in life with touches of light yellow-orange and dark orange and with dark orange eggs.

Betaeopsis indicus (De Man)

Betaeus indicus De Man, 1910: 309. [See also De Man, 1911: 173, fig. 15.]
Betaeopsis indicus [See Yaldwyn, 1971: 88.]

Specimens examined. — S. Red Sea: 5, E62/1363.

Racilius compressus Paulson

Racilius compressus Paulson, 1875: 107, pl. 14 fig. 2, Red Sea. Balss, 1927: 226, Suez Canal. Ramadan, 1936: 22, Ghardaqa. B & B, 1980b: 28. Straits of Jubal. [See also B & B, 1973b: 350.]

Specimens examined. — S. Red Sea: 2, E62/0186; 19, 1382; 20, 2168. 2, ISRSE 1278.

Biological notes. — Only the specimens from ISRSE 1278 were noted as coming from the coral *Galaxea* sp., but all others probably were also found in the association (see Jacquotte, 1964: 175). One specimen from E62/2168 was 20 mm long, unusually large for this species. Dr. Holthuis has supplied the following colour notes for a specimen from E62/1382. "Entirely transparent. The internal organs and the contents of the guts shine through yellowish. Very small red chromatophores are scattered regularly over the entire body. The base of the fingers of the chelae and the distodorsal part of the palm are greyish. The eggs are olive-green."

Salmoneus Holthuis

Salmoneus Holthuis, 1955. Zool. verh., Leiden 26: 88.
Jousseaumea Coutière, 1896c: 381 (name preoccupied). [See also: Holthuis, 1961. Bull. zool. Nom., 18(5): 227 and International Commission on Zoological Nomenclature, Opinion 673, 1963, op. cit. 20(5): 325.]

Definition (modified and expanded from Coutière, 1899: 325). — Carapace with or without crests, projecting into large triangular rostrum;

orbital teeth (extracorneal teeth) present; without orbital hoods. Anterior field of vision unobstructed; corneas at times partially visible in dorsal and lateral view. Without orbitorostral process.

Antennular peduncle usually heavy, with stylocerite well developed and acute. Undivided portion of lateral flagellum short. Scaphocerite broad, lateral tooth variable; carpocerite usually short and heavy.

Mouthparts as usual for the family.

Cheliped very asymmetrical, larger, very massive *; and carried folded back at short, expanded carpus; merus curved and somewhat flattened on inferior face to accommodate heavy, swollen palm *; fingers bearing matching teeth, either proximally or along entire length *, tips curved and crossing *, no adhesive plaque *. Small cheliped short and feeble, length about equal to length of large chela or less *; chela itself subequal to or shorter than preceding slender carpus and finger subequal to length of palm *.

Second pereiopods as usual for the family, carpus of 5 articles, first secondary article usually longer than sum of following four. Third to fifth pereiopods with or without spines on ischium; merus and carpus unarmed; propodus usually with spines; dactylus simple.

Pleura of sixth abdominal segment not articulated. Telson without anal tubercles. Elongate, tapering with truncate tip bearing two pairs of heavy spines and with or without a median indentation which may bear one or more pairs of plumose setae; superior surface with usual two pairs of spines. Uropods normal.

Branchial formula. — 5 pleurobranchs, 1 arthrobranch, and 8 epipods (5 setobranchs, 7 mastigobranchs).

Type species (by subsequent designation — see Holthuis, 1955: 88). — *J. serratidigitus* Coutière.

Discussion. — In this paper we wish to give a preliminary review of the genus *Salmoneus* especially to clarify the taxonomic status of some of the species for which the Red Sea-Gulf of Aden are the type localities.

This genus was erected by Coutière under the name *Jousseaumea* (name preoccupied by *Jousseaumia* or *Jousseaumea* Sacco, a genus of molluscs — see Holthuis, 1955, 1961) with a very terse definition for two species from the Red Sea. In the generic description he stated that the "distal angle" of the sixth abdominal segment was articulated; however, in his 1899 thesis,

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* Note: The starred parts of the above description do not fit *S. jarli* (Holthuis) in which the "large" cheliped is shorter than the more slender small cheliped; the merus is apparently not flattened; the fingers are without teeth; the chela of the small cheliped is longer than the carpus and the fingers are 1.5 times the length of the palm.

using the term pleuron, he stated they were not "mobiles". In almost all of the specimens we have examined, no indication of the articulation could be seen; however, in a few a slight groove could be seen at the base of the lappet, that might or might not be a vestige of an articulation.

Coutière (1896c) stated that the tip of the telson carried 4 spines but made no metion of the median indentation. In 1899 (p. 313-314, and fig. 395 for "type" of *S. serratidigitus*) he stated that in the genus the tip was emarginate and carried 4 *pairs* of spines (the 4 pairs of spines were also incorporated into his definition on p. 325). Inasmuch as several species have since been placed in the genus that lacked the emargination of the tip, that characteristic should not be part of the generic description. We cannot account, however, for his drawing and his statement about the four pairs of spines. Of the 3 species he described, we have been able to find only the questionable "type" of *S. serratidigitus* (see under that species), and that had the normal two pairs of spines. Moreover, none of the species subsequently described had four pairs of spines on the tip, and none of the specimens of any species that we have examined from anywhere have carried this unusual armature.

We have listed all species named within the genus and all subsequent citations with localities and number of specimens (Table 2). It will be seen that 10 of the species were based upon a sole type specimen (and that was often fragmentary) and that six of the species have not been reported after the original description. Some of the descriptions are most inadequate, especially those of Coutière although he did remark upon and illustrate certain characteristics in his 1899 thesis. All of the species are small and apparently more fragile than members of other alpheid genera; moreover, the chitin in many specimens appears to be soft and easily distorted by collection and preservation (see the remarks below on the chelae of *S. serratidigitus*). There has been only one study (B & B, 1966a: 155) on the possible variation in the characteristics that have been, or that could be, used for separation of the species.

We are placing two species in synonymy below and suspect that others may be so relegated in the future when more specimens are found and studied. With these many difficulties in the definitions of the species, we present the following key to all known species with great reservations. We are sure that when more is known about the species some of our dichotomies will be found to be based on specious criteria. We consider the key, therefore, to be merely a point of departure for future workers.

If little is known about the characteristics of the species, even less is known of their biology. Where collecting information has been given, most

TABLE 2

Species of the genus *Salmoneus* * with all known references

1.	*latirostris*	Coutière, 1896c: 382	(1 specimen, Red Sea).	Coutière, 1897a: 234, (numerous specimens, Djibouti).
2.	*serratidigitus*	Coutière, 1896c: 382	(4 specimens, Red Sea).	Coutière, 1897a: 234, (no numbers given, Djibouti).
3.	*cristatus*	Coutière, 1897a: 234	(1 specimen, Djibouti).	Holthuis, 1958: 18 (1 specimen Red Sea). B & B 1966b: 40 (1 specimen, Thailand).
4.	*ortmanni*	Rankin, 1898: 251	(1 specimen, Bahamas).	Coutière, 1900: 356 (1 specimen). Verrill, 1900: 579 (1 specimen Bermuda); 1922: 122 (same specimen as 1900). Schmitt, 1936: 367, Bermuda (Verrill's specimen). Chace, 1972: 78 (13 specimens, West Indies).
5.	*sibogae*	De Man, 1910: 303; 1911: 158 (amplification of 1910)	(1 specimen, Indonesia).	Holthuis, 1958: 20 (1 specimen, Eylath). B & B, 1964: 86 (1 specimen, Canton); 1966a: 155 (11 specimens, Fiji); 1967: 261 (3 specimens, Societies); 1968: 270 (5 specimens, Marshall Is.).
6.	*hilarulus*	De Man, 1910: 304; 1911: 160 (amplification of 1910)	(2 specimens, Indonesia).	Johnson, 1962: 49 (several specimens, Singapore).
7.	*mauiensis*	Edmondson, 1930: 5	(2 specimens, Hawaii).	Banner, 1953: 12 (sceveral specimens, Hawaii).
8.	*brevirostris*	Edmondson, 1930: 8	(1 specimen, Hawaii).	Banner, 1953: 12 (repeat of original). B & B, 1966b: 39 (1 specimen, Thailand). Kazmi, 1974: 310 (3 specimens, Pakistan).
9.	*arubae*	Schmitt, 1936: 366	(1 specimen, Aruba).	
10.	*jarli*	Holthuis, 1951: 94	(1 specimen, Tropical W. Africa).	Holthuis & Gottlieb, 1958: 39 (1 specimen, Medit. Coast. Israel).
11.	*tricistatus*	Banner, 1959: 131	(1 specimen, Caroline Is.).	B & B, 1966a: 153 (2 specimens, Samoa); 1967: 262 (2 specimens, Society Is.); 1973b: 334 (1 specimen, Australia). Miya, 1972: 43 (1 specimen, Japan).

* All species previous to Holthuis, 1955: 88 were described under the generic name *Jousseaumea*. *Salmoneus trigonus* (Rathbun) has been moved to the genus *Alpheopsis* by Chace, 1972: 56.

12.	*rostratus*	Barnard, 1962 : 240	(2 specimens, E. Africa).	
13.	*bruni*	B & B, 1966b : 42	(1 specimen, Thailand).	
14.	*babai*	Miyake & Miya, 1966 : 133	(2 specimens, Japan).	Miya, 1972 : 42 (2 specimens, Japan — repeat of original).
15.	*tafaongae*	B & B, 1966a : 155	(1 specimen, Samoa).	
16.	*gracilipes*	Miya, 1972 : 38	(5 specimens, Japan).	

specimens have been reported from under rocks in the intertidal zone or from coral heads collected in immediate subtidal depths, except for *S. hilarulus, S. jarli* and *S. bruni,* which were collected by dredging from relatively shallow water (32, 19, 28 m respectively). Chace (1972: 79) stated that most of the specimens of *S. ortmanni* he reported upon came from "turtle grass flats to a depth of 6 feet". Edmondson found *S. mauiensis* in association with the polychaete *Eurythoe* (1930: 7), and we found *S. sibogae* (= *S. serratidigitus*) and *S. tricristatus* occurring under the same boulders on a sandy substrate as *Alpheus strenuus strenuus* Dana and *Athanas marshallensis* Chace; the polychaete (*Eurythoe*) was also found there. Because of the disruption of the tunnels of the various animals by removal of the rock, no association could be proven (B & B, 1968: 271).

For the species for which the colour in life was noted, all were yellow to yellow-orange, at times varying from "muddy white" to transparent, except for *S. gracilipes,* which was reported as transparent, and *S. cristatus* and *S. latirostris,* which Coutière reported to be transversely banded with brilliant red and white.

Key to the species of *Salmoneus*

1. Posterior margin of telson straight or with only slight concavity 2
   Posterior margin of telson definitely emarginate between bases of heavy posterolateral spines, either broadly "U"-shaped or an abrupt cleft 5
2(1). Carapace with strong dorsal carina extending from rostrum to anterior third of carapace; fingers of large chela without teeth . . . . . *S. jarli*
   Rostrum with or without slight carina which does not extend to anterior third of carapace; fingers of large chela (where known) armed with teeth 3

3(2). Rostrum short, not reaching to end of first antennular article; fingers of large chela armed with 3 heavy teeth basally *S. bruni*
Rostrum reaching to near end of second antennular article . 4

4(3). Rostrum with lateral margins straight, with tip almost forming a right angle; rostral carina a "very slight trace" (Schmitt, 1936: 366); dactylus of third leg about 0.4 length of propodus (large chela unknown) . . . . . *S. arubae*
Rostrum with lateral margins concave, reaching to an acute tip; rostral carina present but rounded and difficult to see; dactylus of third leg about 0.5 length of propodus; fingers of large chela with about 15 teeth . . . . . *S. ortmanni* *

5(1). Rostrum with small ventral tooth near tip 6
Rostrum without any ventral teeth 7

6(5). Orbital teeth upturned, half length of first antennular article; rostrum 3 times as long as broad at base; dactylus of third legs 7 times as long as broad at base (large cheliped unknown) . . . . . *S. tafaongae*
Orbital teeth not upturned, much less than half length of first antennular article; rostrum 4 times as long as broad; dactylus of third legs over 10 times as long as broad. (All characteristics taken from Barnard's figures, 1962) ** . . . . . *S. rostratus*

7(5). Rostrum and anterior portion of carapace bearing strong keel or keels 8
Rostrum if bearing keel, keel slight and not reaching posterior to level of eyes 10

8(7). Rostrum barely reaching to end of first antennular article; orbital area with slight crest running diagonally towards midline . . . . . *S. brevirostris*
Rostrum reaching to or beyond end of second antennular article; ridges or crests arising in orbital area and running parallel to median crest 9

9(8). Lateral crests arising from orbital teeth and reaching beyond middle of carapace . . . . . *S. tricristatus*
Lateral crests arising from lateral edges of rostrum, medial to orbital teeth, and extending but a short distance behind eyes *S. cristatus*

10(7). Scaphocerite reaching at most slightly beyond end of second antennular article (large chela unknown) . . . . *S. hilarulus*

* See discussion and figures under *S. cristatus*, p. 54.

** It should be noted that Barnard drew the antennular peduncle without the penultimate articulation but he did mention it in his text.

Scaphocerite reaching to or beyond end of third antennular aricle 11

11(10). Dactylus of third legs heavy and short, about twice as long as broad or less, and about one-quarter length of propodus; tip of dactylus of large chela strongly hooked and extending well beyond propodal tip when closed . . . . . *S. babai*

Dactylus of third legs at least 3 times as long as broad, longer than one-quarter length of propodus; hooked tip of dactylus of large chela not extending much beyond propodal tip 12

12(11). Dactylus of third legs very slender and elongate, 6-10 times as long as broad at base, about one half length of propodus *S. gracilipes*

Dactylus of third legs about 3 to 5 times as long as broad at base, and about one-third length of propodus 13

13(12). Teeth on fingers of large chela 5-7 in number . *S. mauiensis*

Teeth on fingers of large chela 10-16 in number *S. serratidigitus*

Salmoneus brevirostris (Edmondson)

Jousseaumea brevirostris Edmondson, 1930: 7, fig. 3.
Salmoneus brevirostris [See B & B, 1966b: 39.]

Specimens examined. — 2 specimens from Museum National d'Histoire Naturelle, Paris, Acc. No. Na 2788, Red Sea.

Remarks. — See discussion under *S. serratidigitus*.

Salmoneus cristatus (Coutière)

(fig. 6)

Jousseaumea cristata Coutière, 1897a: 234, Djibouti.
Salmoneus cristatus Holthuis, 1958: 18, fig. 7, Eylath. [See also B & B, 1966b: 40, fig. 10.]

Specimens examined. — Gulf of Suez: 1, ISRSE 0266; 1, 1597; 1, 2014. Djibouti: 1, Museum National d'Histoire Naturelle, Paris, Na 2781 (see discussion under *S. serratidigitus*).

Discussion. — The 8 mm female (Na 2781), in surprisingly good shape, was collected at Djibouti by Ch. Gravier and labelled by someone as the "holotype" of "*J. latirostris*" (see discussion under *S. serratidigitus*). It is plainly *S. cristatus*. Because it is a topotype, we are offering drawings of it. The outstanding characteristic of the species is the presence of a "shoulder" at the point where the lateral margins of the rostrum meet the anterior carapace; this shoulder is not a true ridge or carina, for it is the abrupt transition between the broadly rounded dorsal surface (interrupted by the middorsal carina) and an area where the carapace runs almost "vertically"

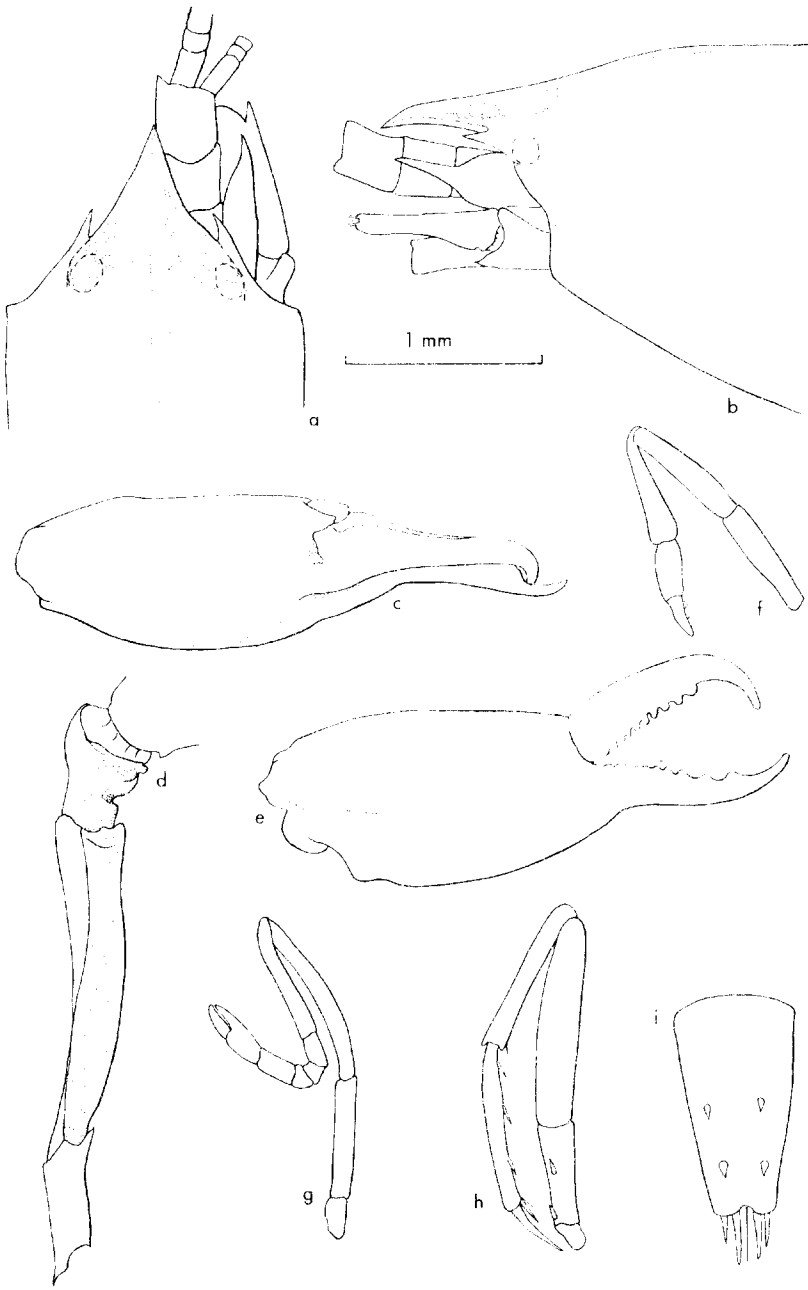

Fig. 6. *Salmoneus cristatus* (Coutière). Topotype (8 mm ♀): a, b, anterior region dorsal and lateral view; c, large chela, "superior" aspect*; d, merus, large chela, "medial" aspect*; e, large chela, "medial" aspect*; f, small cheliped; g, second leg; h, third leg; i, telson. (*See text, p. 56). All drawings same scale.

(or dorsoventrally) like a cliff. The shoulder lies mesad to the orbital teeth, which also are distinct in their curvature from its vertical portion; the shoulder runs posteriorly but a short distance. We call attention to the broad "U"-shaped indentation in the tip of the telson in this species and contrast it to the narrow "V" in the specimen we identified as this species from Thailand (1966b: 40, fig. 9) and the broad and extremely shallow indentation depicted by Holthuis (1958: 19, fig. 7b). The other four specimens in this collection have the broad "U"-shaped indentation similar to the topotype. This variation exceeds that noted for *S. serratidigitus*, but with so few specimens available we do not wish to use it for a criterion for the establishment of a new species.

In this paper it is not our purpose to review species of alpheids from other than the Indo-Pacific realm, but Schmitt's drawing of *S. ortmanni* (1936: fig. 2h) hints, by two short longitudinal lines medial to the orbital teeth, of a condition similar to that found in *S. cristatus*. For that reason we obtained specimens from the Smithsonian Institution that had been identified by Chace as *S. ortmanni* from the Caribbean (1972: 79). The two lots we examined were both collected in the Bahia de la Ascension, Quintana Roo, Mexico (sta. 85-60, 91-60) (see fig. 7 h-k, below). In dorsal view the outline of the rostrum in these specimens shows the concave margins illustrated by Schmitt, although in some of the smaller specimens the rostral base was more narrow in respect to its length; the dorsal carina was low, rounded and difficult to see. However, there was no trace of a shoulder, ridge or carina medial to the orbital teeth at the point indicated by the lines in Schmitt's drawings. Instead, the surface of the carapace had a uniform curvature.

We were interested in the extreme sculpturing of the large chelae in the two large ovigerous females in these two American collections. As the development of the chelae have not been discussed before, we are appending figures (7 h-k) and will give a description. While both large chelae are extended, they are obviously modified to fold flat against the underside of the thorax, as shown for *S. serratidigitus* by Coutière (1899: fig. 212). (The flexure and rotation of the cheliped destroys the normal directional terms, for a superior surface would lie inferiorly when folded, and in most rotations of the chela the dactylus lies inferolaterally to the propodal finger. For our description, the anatomical orientation is used, with the dactylus being considered to lie on the "superior" surface, the propodal finger lying "inferior" to the dactylus).

The palm is imperfectly oval in section, tapering towards the fingers, with the long axis of the oval lying in the "superior-inferior" plane. However, from the base almost to the articulation of the fingers the oval is

as if excised in the whole "medioinferior" quarter, leaving a deep excavation to accommodate the merus and ischium when the appendage is flexed. The superior margin of the excavation is strong and abrupt, setting off a marked concavity; the inferior margin is more rounded. The carpus, narrow proximally, is relatively elongate and expanded distally where it meets the palm; it folds at right angles to the palm and to the merus. The merus has its inferior side (towards the folded palm) flattened and curved, but towards the distal end the medial margin is extended to form a broad, thin lamella that reaches even beyond the articulation. When the chela is folded back the lamelliform portion lies tightly against the shoulder on the palm and the extension covers the inferior portion of the merocarpal articulation and much of the carpus itself. Similarly, the ischium is narrow proximally, expanded distally, and flattened like the merus. When the appendage is folded the proximal articulation of the ischium lies at the level of the dactylar articulation of the chela. The chitin of the whole cheliped is relatively soft and flexible; this is especially surprising in the palm, for through the transparent exoskeleton of the palm can be seen many massive muscles — one would believe that their contraction would cause the exoskeleton to be distorted rather than having their strength transmitted to the "pincher". The fingers are somewhat curved, have strongly hooked and acute tips, and bear about 10 sets of teeth that are small proximally but increasing in size distally.

We should add that in the third legs of *S. ortmanni*, the ischium is elongate but unarmed; the propodus bears 3 feeble spines on its inferior margin and, distally, a spine half the length of the dactylus; and the dactylus is slender and almost half the length of the propodus. In this species the tip of the telson is without a vestige of a notch but carries 2 pairs of slender spines and a series of long plumose setae.

Coutière (1897a: 234) wrote that the body of *S. cristatus* had the same colour as *S. latirostris* (Coutière) which he had described "regulièrement annelé de rouge vif". Dr. Holthuis has given more detailed notes on the specimen from ISRSE 0266 (in part paraphrased): "Body perfectly transparent, whitish. Abdominal somites 2 to 6, each with distinct red line running from the bases of the pleura along the posterior margin of the tergum. Endopod of uropod with red spot in basal portion. Carapace with short median red line extending from tip of rostrum backward to slightly behind base of rostrum; posterior portion of carapace carrying a transverse red line, with lateral ends curving slightly forward; third paired red lines extending ventrally from near eye. Antennular peduncle with some red spots. Eggs orange-red."

Salmoneus serratidigitus (Coutière)

(figs. 7 a-g, 8)

Jousseaumea latirostris Coutière, 1896c: 382.
Jousseaumea serratidigitus Coutière, 1896c: 382, Djibouti; 1897a: 234, Djibouti (color note).
Jousseaumea sibogae De Man, 1910: 303.

Specimens examined. — Gulf of Suez: 4, SLR 1480. S. Red Sea: 1, E62/1452. 3, ISRSE 0286; 2, 1229; 4, 1255; 1, 1535; 1, 1541; 1, 2051.

From Muséum National d'Histoire Naturelle, Paris, accession numbers: 2, Na 2778, Red Sea; 1, Na 2779 [no additional information]. 2, Na 2780 [no additional information]. 8, Na 2782, Gulf of California [from Diguet Collection, 1897]. 1, Na 2781, Djibouti (labelled as *Jousseaumea serratidigitus* "holotype" = *S. cristatus* — see discussion below).

From Museum of Comparative Zoology, Harvard University: 1, labelled "type", MCZ Reg. no. 5556, Djibouti.

Description of "type" (= "neotype" — see discussion below) MCZ Reg. no. 5556. Specimen a 14 mm ovigerous female, Djibouti.

Rostrum acute, with slightly concave margins, 1.1 times as long as broad (both length and breadth measured from the posteriormost portion of the broad "U"-shaped concavity in the margin between rostrum and orbital teeth); tip reaching to middle of third antennular article. Orbital teeth acute, directed forward, 0.2 as long as rostrum. Orbitorostral margin broadly concave; dorsal surface of carapace and rostrum without carinae. Corneas concealed in dorsal view, slightly exposed laterally.

Antennular peduncle stout. Visible part of first article 0.6 as long as second; second article 1.7 times broader than long; third article approaching twice as long as second. Stylocerite acute, reaching near middle of third antennular article. Scaphocerite with broad squame, reaching to end of third antennular article; lateral tooth small, not reaching to end of squame. Carpocerite stout, reaching only to end of second antennular article. Lateral tooth of basicerite broad with tip truncate at an angle.

Articles of third maxilliped with ratio 10:3:8; ultimate article tapered towards acute tip.

Large chela nearly cylindrical in section with slight depression on superior surface (possibly an artifact — see discussion), 3.1 times as long as broad; fingers 0.8 length of palm. Fingers compressed with tips markedly curved and crossing; oppositive surface bearing 10 conical teeth on dactylus and 11 on propodus that extend from near articulation to hiatus just proximal to tips; teeth progressively increasing in size toward tip. Chela deeply

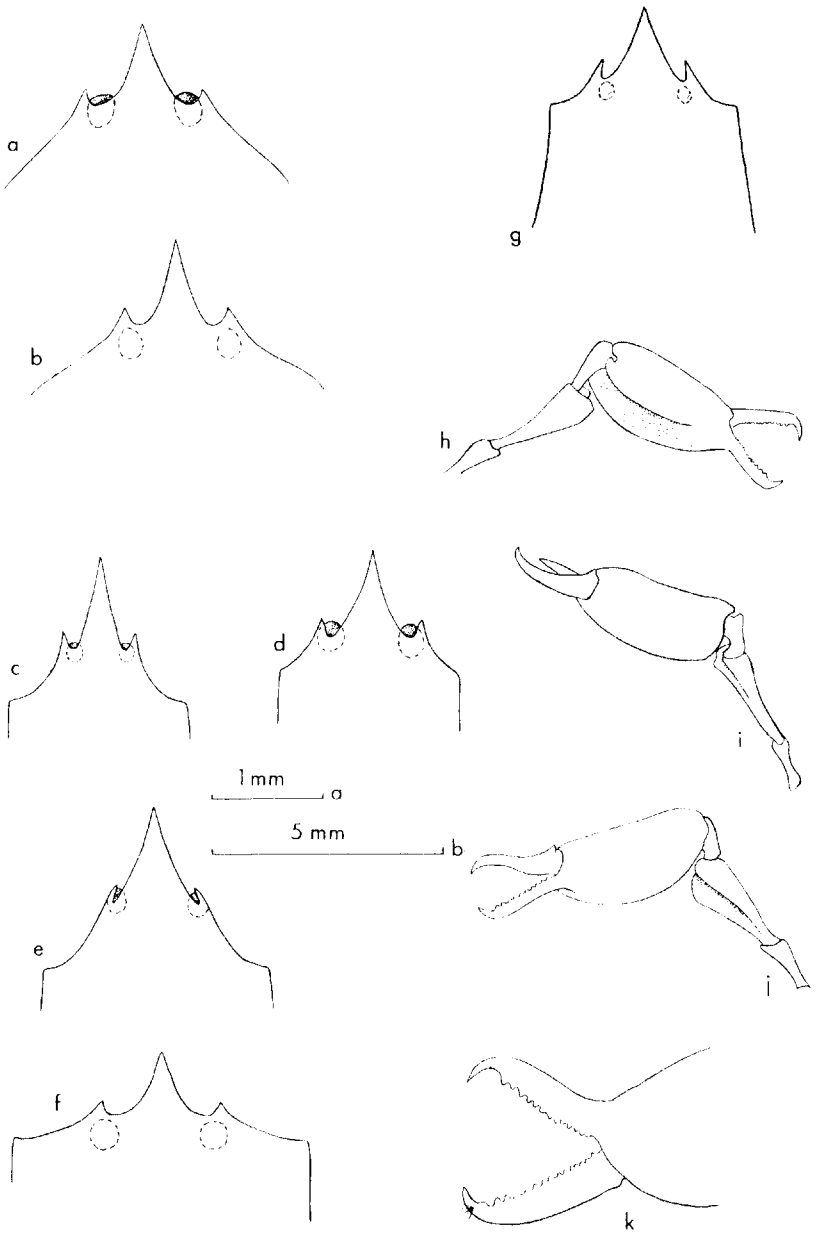

Fig. 7. *Salmoneus serratidigitus* (Coutière): Anterior region dorsal view, showing variation: a, 15 mm (ISRSE 0286); b, 14 mm (ISRSE 1229); c, 10 mm (E 62/1514); d, 15 mm (ISRSE 2051); e, f, 15 and 16 mm (Tulear, Madagascar); g, 16 mm (Gulf of California, Diguet collection. Mus. Nat. Hist. Nat., Paris na. 2780). *Salmoneus ortmanni* (Rankin), 13 mm ovigerous ♀ (Quintana Roo, Mexico, Sta. 01-60. USNM acc. no. 131106): h, large chela, "inferomedial" aspect*; i, large chela, "superior" aspect*; j, large chela, "inferolateral" aspect, enlarged*; k, fingers of large chela, "medial" aspect, enlarged*. (*See text, p. 56). a-g, k, scale a; h-j, scale b.

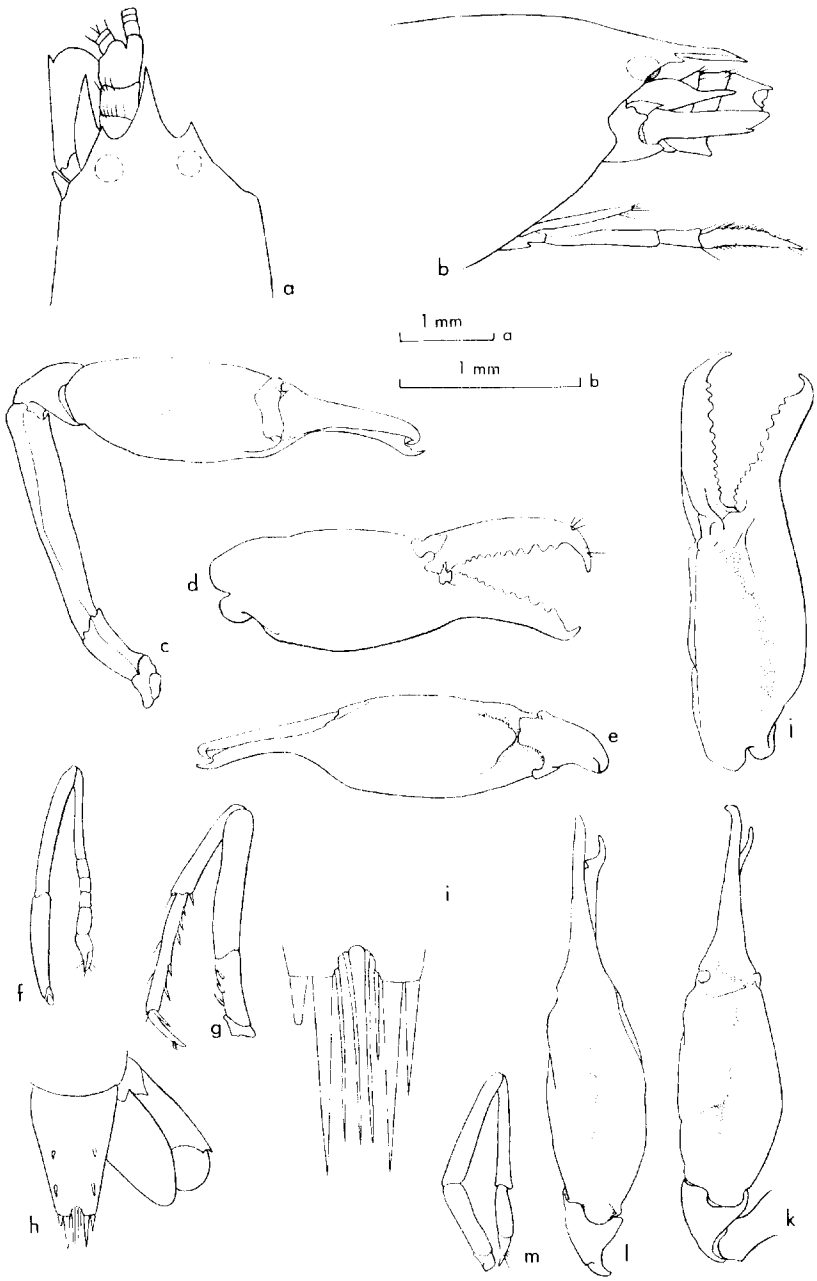

Fig. 8. *Salmoneus serratidigitus* (Coutière). 14 mm ♀ ("Type", Museum of Comparative Zoology, Harvard University — see discussion) : a, b ,anterior region, dorsal and lateral view; c, large cheliped, "superior" (= lateral) aspect*; d, e, large chela, "medial" and "inferior" aspects*; f, second leg; g, third leg; h, telson and uropod; i, posterior end of telson enlarged. 14 mm ♂ (Mus. Nat. Hist. Nat., Paris, na. 2778) : j, k, l, medial, superior and inferior aspect of deformed chela*. 15 mm ♀ (Mus. Nat. Hist. Nat., Paris na. 2778) ; m, small cheliped. (*See text, p. 56). All drawings scale a except i which is scale b.

notched on inferodistal margin and bearing large rounded boss near articulation with carpus. Carpus cupshaped and encompassing the proximal end of chela; distal margin irregular. Merus slender, 7.0 times as long as broad, slightly arched and flattened to accommodate chela when cheliped is flexed, without distal projections. Ischium 0.2 as long as merus, also somewhat distorted to accommodate flexure.

Small cheliped of "type" missing. Small cheliped from 15 mm female from Djibouti (MNHNP, Na 2778): Appendage small; if extended, slightly longer than large chela proper. Ischium and chela equal in length, 0.6 as long as merus. Merus and carpus equal, slender and tapered toward distal end. No armature on any article. Small chela rounded in section, slight, smaller in diameter than base of merus; fingers about half length of palm.

Carpal articles of second leg with ratio: 10:2:2:2:3; chela 0.4 length of first carpal article.

Ischium of third legs 0.5 length of merus, bearing 3 spines. Merus 6.0 times as long as broad. Carpus 0.7 as long as merus, bearing a few hairs on superodistal margin and a fine spine on inferodistal margin. Propodus slender, 0.85 as long as merus, bearing on its inferior margin 5 slender spines and a pair distally. Dactylus slightly curved, simple, 0.4 as long as propodus.

Telson 4.7 times as long as posterior margin is broad. Posterior margin with narrow "U"-shaped notch in middle and bearing 2 pairs of heavy spines. Outer left spine broken; inner pair as long as tip is broad. Notch bearing only 2 pairs of setae with the left one of the outer pair as long as the inner pair, the right half as long. (The middle pair appeared to be plumose, the outer not, but this observation could not be confirmed without destruction of the specimen.)

Discussion. — We have sought in European museums for the holotype, or at least members of the type series, for *S. serratidigitus, S. latirostris* and *S. sibogae*. We found none of the specimens of *S. serratidigitus* in Europe that Coutière himself had identified but did find a specimen at the Museum of Comparative Zoology, Harvard University, with his name. This specimen was loaned to us for study (MCZ registration number 5556). It carried the following label. "*Jousseaumea serratidigitus* (H. Coutière — TYPE) Museum Paris, Djibouti H. Coutière 109-97." The writing on the label is similar to the writing on other specimens identified by Coutière, and we presume it may have been written by him. However, it is unlikely that this is one of the four original "types" described by Coutière, for in his 1896 description he specified the four were collected by Dr. Jousseaume in the "Red Sea", which would mean they were obviously collected in 1896 or before. The label quoted above shows the specimen to be from Djibouti in the Gulf of Aden,

not the Red Sea. We interpret the "H. Coutière 109-97" to mean that he personally collected it, and that it probably was the 109th lot he collected during his 3 months at Djibouti in 1897. However, as this specimen agrees well with his one-sentence original description and with his subsequent figures and descriptions in 1899, we believe that this "type" should be regarded as at least a neotype designated by the original author. This specimen is the basis of the above description.

The "type" of *S. latirostris* from the Muséum National d'Histoire Naturelle of Paris is worse. It carried one label in pencil and one in ink (of different handwriting): "*Jousseaumea latirostris* [alone on one label, on the other followed by "H. Coutière"] Gravier, Djibouti." There was also a typewritten label "HOLOTYPE" and the museum accession number Na 2781 (the original number tag was lost and replaced by us). No date of collection was given. The pencilled label may have been that of Coutière; the inked label and the typed label probably were not his (we have seen no typed labels of Coutière, and he did not use the term "holotype"). In his 1896 description Coutière specified that the species was represented by "1 exemplaire mer Rouge (M. le docteur Jousseaume)." Therefore, this could not be the "type" or "holotype". Even worse, the specimen (an 8 mm female) showed the ridges at the lateral margins of the rostrum medial to the eyes, a characteristic that Coutière specified in his original description for *S. cristatus* and shown plainly in his 1899 figures (figs. 22, 23). Further he stated that "L'une des pattes antérieures manque", while this specimen had both chelipeds. Plainly, the specimen was misidentified by someone, possibly even Coutière himself, and someone else added the "HOLOTYPE" label. The specimen is described under *S. cristatus* above.

The type specimens of *S. sibogae*, which would be desirable for comparison, could not be found.

The series of 17 specimens in this collection, together with several from Tulear, Madagascar, and from Baja California, Mexico (discussed below), show a wide range of variation in characteristics that have been used previously for separation of the species:

1. Anterior carapace: The variation in the rostrum, the orbitorostral margin and the orbital teeth is best shown in the series of outline drawings in fig. 7 a-g. The length of the rostrum varies between reaching to end of first antennular article and reaching to first quarter of third. Six Red Sea specimens have slight rostral carinae, the others none.

2. Second antennular article: usually about 1.1-1.3 times as broad as long.

3. Stylocerite: reaching from middle of second to slightly beyond proximal end of third antennular article.

4. Scaphocerite: reaching from distal third to end of third antennular article; the lateral tooth at times being shorter than squamous portion.

5. Carpocerite: reaching from middle to end of second antennular article.

6. Lateral spine of basicerite: from acute to truncate.

7. Large chela: varying in proportions from 3.0-3.6 times as long as broad. However, more important, in many specimens the exoskeleton of the palm is apparently soft, and the muscles, when contracting from preservation, changed its shape from cylindrical in section to bearing quite deep but not well-demarked depressions. We have drawn (figs. 8 j-l) one that is distorted, even more than that shown by Coutière in his figures 215, 216 (1899). As noted above, the palm of the "type" is almost cylindrical. The number of serrations on the fingers vary from 10-16. In all cases the merus is flattened towards the palm and curved to accommodate it.

8. Third legs: Ischium bearing 2-3 spines; merus varying from 4-5 times as long as broad; propodus carrying 3-6 spines along its inferior margin.

9. Telson: Varying from 2.6-4.7 times as long as broad. Notch varying from a narrow, abrupt "U" to a broad one, and carrying 2-4 pairs of setae. (We noted in the central Pacific specimens the form of the notch was more constant [B & B, 1966a: 155].)

The separation between *S. latirostris* and *S. serratidigitus* was initially made by Coutière on the breadth of the rostrum and the size of the orbital teeth (contrast figs. 19 and 21, 1899); in 1897a he added that the large chela of *S. latirostris* was very similar to that of *S. serratidigitus*, but was "plus régulièrement ovale et manque du sillon profound de la surface superieure de la paume". The variations in these two characteristics are encompassed by the variation remarked upon above.

One other characteristic was given by Coutière: *S. serratidigitus* was described as a uniform orange-yellow and *S. latirostris* as being transversely banded with brilliant red and white. It is our experience that species in other genera that carry that type of red-white banding (for example *Alpheus paracrinitus* Miers, *A. gracilis* Heller, *Alpheopsis equalis* Coutière, etc.) are quite, if not entirely, consistent in their colouration. Further reinforcing Coutière's colour notes were the observations of Dr. Holthuis on the colour of 5 lots of specimens he collected. Three sets (ISRSE 0286, 1255, 1541) of specimens were described as being red-banded on the abdomen, with a red band at the middle or the end of the caudal fans and three transverse rows of red chromatophores or red lines on carapace. In addition, the peduncles of the antennules and antennae were red or had red spots (he describes one specimen as having a distinct red spot on the scaphocerite). Both specimens from ISRSE 1229 are described as yellow or bright yellow,

one with orange-red viscera showing through the carapace. The last specimen from ISRSE 2051 was described as being "Uncoloured, [with] eggs and gonads orange". None of the preserved specimens we have examined had any trace of colour left, and therefore the colour pattern could not be correlated with any of the variation we noted in morphology.

Thus, without firm anatomical differences we are still tentatively placing *S. latirostris* in synonymy to *S. serratidigitus*. We strongly suggest that if future workers find live populations with this contrasting colouration near a laboratory or field station where they might be collecting, as did Coutière in the Djibouti region, they study the two populations to determine if the differences in colour are correlated with differences in anatomical structure, in habitats or in behavior. Especially interesting to note would be the possibility that colouration might change with changing environmental factors and whether the red-banded form might mate with the yellow form.

We have chosen the name *serratidigitus* over *latirostris* in spite of page priority because the former has been officially designated as the type species for the genus. (Bull. zool. Nom. 1963: 325, name no. 1929).

To judge from De Man's description and figures, *S. sibogae* differs from *S. serratidigitus* in four characteristics: it has one spine rather than 2 or 3 on the ischium of the third legs and 2 spines rather than 3-6 on the inferior margin of the propodus. The notch in the tip of the telson in *S. sibogae* was trapeziform and carried one pair of setae instead of being "U"-shaped and carrying 2 to 4 pairs. The first two differences can be dismissed as trivial. The form of the notch is variable, but the notch in the "type" closely approaches the notch illustrated by De Man for *S. sibogae*. In the "type" the outer pair of setae were extremely difficult to see and could be visually separated from heavy adjacent spines only by the highest power on a binocular dissecting microscope (100 dia.) and careful adjustment of the light. It may be possible that De Man did not discern the second pair; but even if only two setae were on his type, we could not consider it to be a characteristic of sufficient importance for a separation into two species. The colour of *S. sibogae* and *S. serratidigitus* has been noted as similar — uniform orange-yellow.

Edmondson's species *S. mauiensis* (1930: 5, fig. 2) is extremely close to *S. serratidigitus* as redefined. We have reexamined the 9 specimens of this species in the Bernice P. Bishop Museum (including the holotype) and found none that had more than 6 teeth on the fingers of the large chela; in *S. serratidigitus* the fingers had a minimum of 10 teeth. While variation may bridge this difference, we suggest that inasmuch as *S. mauiensis* has been found only in the Hawaiian Islands, the difference may indicate an entirely

separate gene pool. Perhaps in the future the Hawaiian form should be reduced to a subspecies, but at present we prefer to retain it as an endemic species.

Through the courtesy of the Muséum National d'Histoire Naturelle of Paris we were able to examine the specimens of *S. latirostris* that Coutière had remarked upon (1899:544) as being collected from Baja California, Mexico, by M. Diguet. (The label stated they came from "G. de California".) The 6 specimens all lack the large chelae and most of their legs but otherwise are like *S. serratidigitus* except for the broad rostrum (fig. 7g). If the identification is correct, this species is one of the few Indo-Pacific alpheids that has crossed the Eastern Pacific Barrier. In the same collection (but bottled separately) were two much larger specimens of *Salmoneus* that may be of a new species, for their rostrum-orbital teeth arrangement is unlike any other species of the genus.

Synalpheus ancistrorhynchus De Man

(fig. 9)

Synalpheus ancistrorhynchus De Man, 124. [See also De Man, 1911: 267, fig. 47. B & B, 1975a: 347.]

Specimens examined. — S. Red Sea: 1, E62/1320; 1, 1382; 1, 1476; 1, 2166. 1, ISRSE 0863; 3, 1000; 2, 1060; 2, 1080; 1, 1220. 3, Misc. 21.

Discussion. — We have 16 specimens that appear to be *S. ancistrorhynchus*, either the nominal species or a new subspecies. The tips of the rostrum and orbital teeth tilt upwards; the superodistal margin of the second article of the third maxilliped usually bears (but not always) two long acute spines. Upon reexamination of our specimens of *S. ancistrorhynchus* from Australia, we find they bear similar spines. The superodistal margin of the palm of the large chela bears a much larger upturned tooth than any specimen we have seen before. The superior margin of the dactylus of the small chela bears a row of hairs similar to that described for the Australian specimens (1975a: 347) of *A. ancistrorhynchus*, but the Red Sea specimens carry more follicles and more hairs in each follicle (fig. 9b). The major difference between this form and those previously described lies in the merus of the third leg, which in these is entirely unarmed; De Man's type carried "three small and feeble movable spines", and the Australian specimens had either the spines or tufts of setae. Another difference may lie in the articulation of the outer uropod, which in these specimens is normal, but which in the Australian specimens was only partially developed and apparently nonfunctional (the characteristic was not mentioned by De Man).

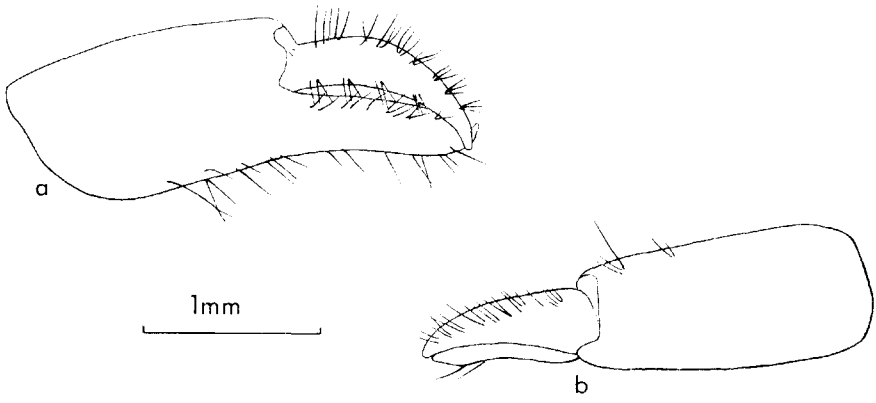

Fig. 9. *Synalpheus ancistorhynchus* De Man (14 mm ♂ from ISRSE 1000): a, b, small chela, lateral and superior face.

As the species is known only from Indonesia and Australia, we feel it would be presumptuous to apply a new subspecific name to a form that differs so little from the nominal species.

Dr. Holthuis states that the specimens from ISRSE 1060 were whitish with brownish-yellow fingers.

Synalpheus charon (Heller)

Alpheus charon Heller, 1861: 27, Red Sea. Paulson, 1875: 104, Red Sea.
Synalpheus charon Coutière, 1899: 486, Djibouti. Balss, 1915: 21, 3 localities, Red Sea. Ramadan, 1936: 19, Ghardaqa. Holthuis, 1958: 29, Eylath. [See also B & B, 1975a: 369.]

Specimens examined. — Gulf of Aqaba: 1, Misc. 45; 1, 46. 1, NS 3767. 1, SLR 254; 2, 1626. N. Red Sea: 1, NS 4560.

Synalpheus coutierei Banner

Synalpheus coutierei Banner, 1953: 36. [See also B & B, 1975a: 343.]
Synalpheus biunguiculatus Coutière, 1898d: 232, Djibouti; 1899: 486, Djibouti. Nobili, 1901: 2, Red Sea; 1906a: 32, Red Sea. Tattersall, 1921: 375, Khor Dongonab, Engineer Is., Trinkitat Harbour. Balss, 1927: 222, Suez Canal. Ramadan, 1936: 19, Ghardaqa. Not *S. biunguiculatus* (Stimpson, 1861).

Specimens examined. — Gulf of Suez: 2, NS 12146. S. Red Sea: 1, E58/280.6; 1, E62/10037. 1, ISRSE 0822; 1, 2490.

Synalpheus demani Borradaile

Synalpheus demani Borradaile, 1900: 416. [See also B & B, 1975a: 324.]
Synalpheus brockii Nobili, 1901: 2, Eritrea.

Synalpheus fossor (Paulson)

Alpheus fossor Paulson, 1875: 103, pl. 13 fig. 3, Red Sea.
Synalpheus fossor [Coutière, 1905: 872]. Tattersall, 1921: 374, Shubuk, Agig. Calman, 1939: 208, Red Sea. Holthuis, 1958: 29, Ras Nasrani, Tor, Sinai Peninsula [See also B & B, 1975a: 335.]

Specimens examined. — S. Red Sea: 1, E62/2166. 1, ISRSE 1000; 9, 1644.

Synalpheus gracilirostris De Man

Synalpheus gracilirostris De Man, 1910: 291. [See also De Man, 1911: 269, fig. 49. B & B, 1975a: 372.]

Specimens examined. — Gulf of Aqaba: 1, SLR 424. Gulf of Suez: 5, NS 9819. S. Red Sea: 1, E62/1338.

Synalpheus hastilicrassus Coutière

Synalpheus hastilicrassus Coutière, 1905: 875, pl. 72 fig. 12. [See also B & B, 1975a: 353.]

Specimens examined. — S. Red Sea: 1, ISRSE 0816.

Synalpheus heroni Coutière

Synalpheus heroni Coutière, 1909: 42, fig. 24, Djibouti. Tattersall, 1921: 374, Tella Tella Kebira, Red Sea. Ramadan, 1936: 19, Ghardaqa. [See also B & B, 1975a: 332.]

Specimens examined. — Gulf of Suez: 1, NS 12431. S. Red Sea: 1, E62/1363; 4, 1413; 2, 1458. 1, ISRSE 0261; 1, 0268.

Biological notes. — Dr. Holthuis states that the specimen from ISRSE 0261 was "very dark and somber, uniformly dark greenish-grey".

Synalpheus mushaensis Coutière

Synalpheus mushaensis Coutière, 1908: 202, Gulf of Aden, 1909: 92, (same specimen as 1908).

Synalpheus neomeris (De Man)

Alpheus neomeris De Man, 1897: 734, figs. 61 a, d, e.
Synalpheus neomeris Coutière, 1899: 486, Djibouti. [See also B & B, 1975a: 357.]
Synalpheus gravieri Coutière, 1905: 870, fig. 2. Balss, 1914: 37, Djibouti; 1927: 222, Suez Canal. Tattersall, 1921: 373, Mersa Abu Hamâma. Gurney, 1927: 261, Suez Canal. Calman, 1939: 208, Gulf of Aden.

Specimens examined. — S. Red Sea: 1, E62/1399. 13, ISRSE 0191; 1, 1406.

Biological notes. — The specimen from E62/1399 was found living commensally on an alcyonarian.

Synalpheus nilandensis Coutière

Synalpheus nilandensis Coutière, 1905: 871, pl. 70 fig. 4. [See also B & B, 1975a: 327].

Specimens examined. — S. Red Sea: 1, E62/1323; 1, 1416; 2, 1452. 2, ISRSE 0268.

Remarks. — These specimens are all of the "forma beta" (see B & B, 1975a: 327).

Synalpheus pachymeris Coutière

Synalpheus biunguiculatus Coutière, 1899: 486, Djibouti. Not *S. biunguiculatus* (Stimpson, 1861).

Synalpheus biunguiculatus var. *pachymeris* Coutière, 1905: 873, pl. 71 fig. 9, Djibouti (evidently the same specimens referred to in 1899).

Synalpheus pachymeris De Man, 1911: 275. Balss, 1915: 21, 2 localities, Red Sea.

Specimens examined. — Gulf of Suez: 3, NS 9819; 1, 9829. S. Red Sea: 2, E58/223.

Remarks. — These 6 specimens, 3 of which are complete, confirm our observations on the differences between *S. pachymeris* Coutière and *S. bituberculatus* De Man (B & B, 1975a: 308). The scaphocerite is definitely shorter than the antennular peduncle rather than longer; on the large cheliped the distosuperior angle of the merus is rounded rather than projecting as a distinct and acute tooth and the superior margin of the palm projects above the dactylar articulation as a single forward-projecting tooth rather than two; finally, on the small cheliped the inferointernal margin of the merus bears only scattered hairs rather than a distinct row of hairs and the tip of the dactylus bears no trace of an accessory tooth. The specimen from NS 9829 was found in a "pocket" of a sponge.

Synalpheus paradoxus new species.

(fig. 10)

Holotype (RMNH no. D 32943). — 12 mm male from sponge, Negus Salomon, Sta. 10: 15°37'N 40°43'E, 23 Oct. 1965. 15 fms. Bottom hard, rolling (ISRSE 1842).

Paratypes (RMNH no. D 32944 and 32950, and in the Zoological Museum, Tel Aviv University, Israel). — 110 males and 2 females ranging in

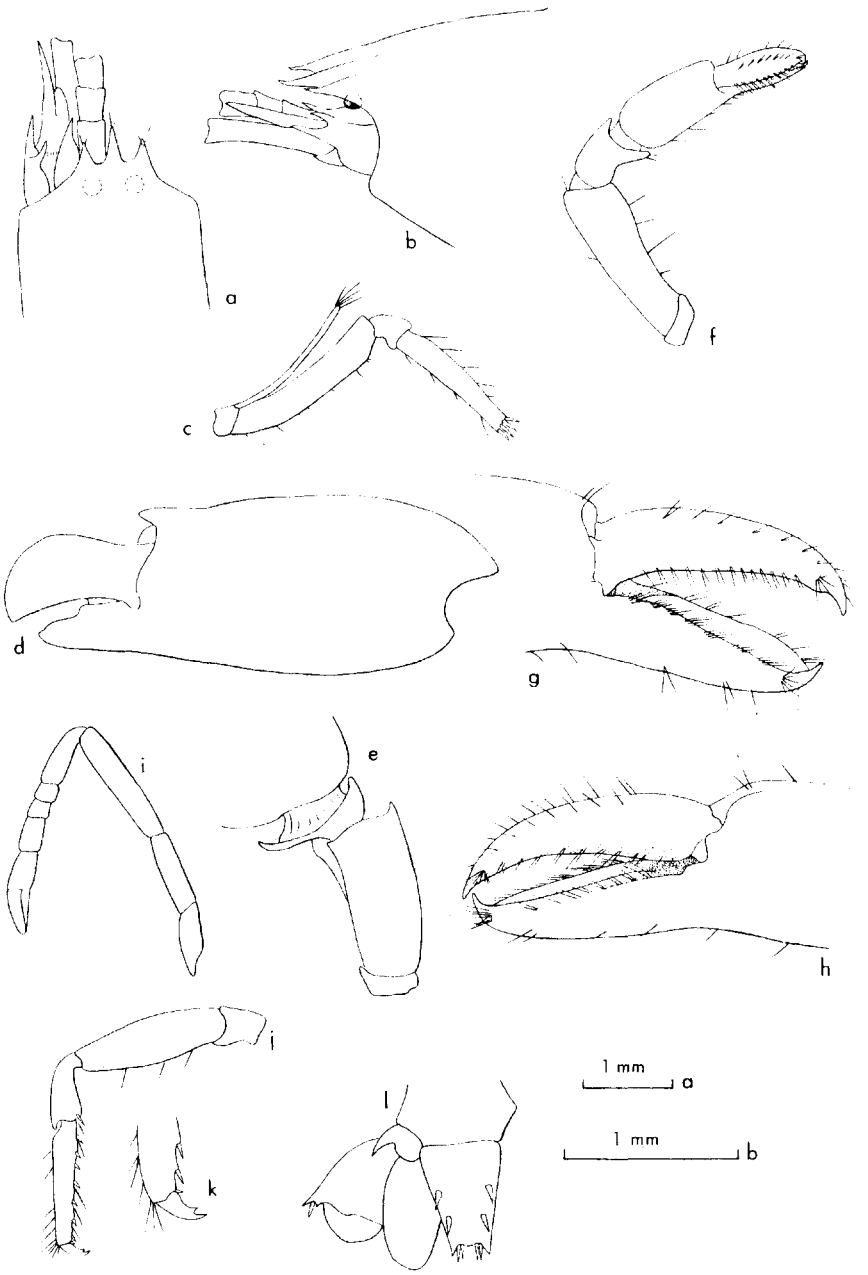

Fig. 10. *Synalpheus paradoxus* new species, holotype (12 mm ♂): a, b, anterior region, dorsal and lateral view; c, third maxilliped; d, e, large chela and merus, lateral face; f, small cheliped, lateral face; g, h, distal portion of small chela, lateral face; i, second leg; j, k, third leg with dactylus enlarged; l, telson and uropods. a-f, i, j, l scale a; g, h, k scale b.

size from 7-16 mm from ISRSE 1842 collection; 130 males and 2 females ranging in size from 7-16 mm from ISRSE 1842 collection; 130 males and 2 females ranging in size from 7-12 mm from sponge ISRSE 1841 (same location as ISRSE 1842).

Description. — Rostrum triangular, acute, 1.8 times as long as broad, reaching to near end of first antennular article and bearing 2 fine setae at tip. Orbital teeth 0.6 as long as rostrum, acute, and bearing 1 or 2 setae; rostrum and orbital teeth slightly upturned at tip. Rostral base with orbitorostral process. Visible part of first antennular article slightly longer than second article; second article 0.8 as long as broad; third article equal to second. Stylocerite reaching to end of first antennular article. Scaphocerite with outer margin concave; lateral tooth reaching slightly beyond antennular peduncle; squamous portion of minimal development, reaching only to end of second antennular article. Carpocerite half length of third antennular article past that article; equal to lateral tooth of squame. Carpocerite viewed inferiorly 4.4 times as long as broad. On basicerite lateral tooth reaching to level of tip of stylocerite; acute superior tooth about half length of lateral tooth.

Large chela cylindrical, 2.5 times as long as broad with fingers occupying distal third. Palm bearing a heavy subacute tooth above dactylar articulation. Tip of dactylus angular but not projecting as a tooth and reaching beyond end of propodal finger by almost one quarter of its length. Merus 2.2 times as long as broad; superodistal margin projecting as small acute tooth; inferoexternal margin distally angular and inferointernal margin extended but rounded. Carpus short, cyathiform; inferoexternal margin projecting.

Small chela 3.4 times as long as broad, fingers almost as long as palm. Fingers broadened, both with curved acute tips; face of propodal finger flattened with raised medial margin, that of dactylus somewhat excavate. Superior surface of dactylus bearing a thin line of setae in middle, 1 or 2 setae per follicle. Margins of lateral faces of both propodus and dactylus bear patches of short setae; margins of medial face armed with setae which cross in a regular fashion when finger is closed.

Ratio of articles of third maxilliped: 10:2:8. Tip of third article armed with 5 spines.

Second leg bearing only 4 carpal articles with ratio: 10:3:3:6; middle articles broader than long.

Ischium of third leg unarmed. Merus 3.5 times as long as broad, tapering distally. Carpus 0.4 as long as merus; superodistal margin projected into heavy but subacute tooth; inferodistal margin rounded and bearing a slender spine. Propodus 0.8 as long as merus; inferior margin bearing 6 spines and

a pair distally, interspersed with a few setae; superior margin bearing sparse setae. Dactylus 0.2 as long as propodus, biunguiculate with inferior unguis shorter than superior; margin between ungui rounded.

Telson 2.7 times as long as posterior margin is broad; anterior margin 2.1 times as broad as posterior. Posterolateral angles acute, extending well beyond arcuate middle margin. Outer spines of posterolateral pair slightly longer than posterolateral angles; inner spines half as long as outer. Dorsal spines heavy; anterior pair placed anterior to middle. Outer uropod with transverse articulation.

Discussion. — The two large groups of specimens are remarkably uniform in all characteristics that are often variable, especially in sponge-dwelling members of the genus. For example, there is almost no variation in the length of the squamous portion of the scaphocerite. However, in the 113 specimens from ISRSE 1842, one nonovigerous female of 12 mm length had both carpi of the second legs divided into 5 secondary articles, and three males had 5 articles on one side and 4 on the other. The number of carpal articles has been found to be variable in some other species of *Synalpheus*: Coutière (1909: 85) found four articles in "young specimens of *S. longicarpus* and especially of *S. brooksi*, but very exceptionally". Chace (1972: 85, 104) reported that while the holotype of his new species *S. anasimus* had but 4 articles, two other specimens tentatively assigned to the species had 5 articles; he also reported that in a collection of 442 specimens of *S. rathbunae* Coutière, 2 "apparently adult males" had 5 articles and one adult female had 3.

Presuming the 4-articled carpus to be a reliable specific characteristic for this and other species, *S. paradoxus* can be separated from all other members of the genus except for a group of 6 from American waters and 2 from the Indo-Pacific. The 6 American species, which may have 4 articles at times (*S. barahonensis* Armstrong, *S. filidigitus* Armstrong and the four mentioned in the preceding paragraph) all belong to the Gambarelloides Group and bear the characteristic dense tuft of setae on the superior surface of the dactylus of the small chela; most have a relatively longer carpus on that leg as well and a relatively narrower tip to the telson than does the new species. *S. redactocarpus* Banner, known only from Hawaii, lacks the tooth above the articulation of the dactylus of the large chela, the numerous spines on the propodus of the third leg, and the posterolateral teeth on the telson. *S. quadriarticulatus* Banner & Banner from Australia also lacks the telsal teeth but has a vestigial squame and a swollen, almost lenticular, dactylus on the large chela; it also lacks an articulation on the outer uropod. Should the genus ever be revised, this species may be considered as most closely related to that group, not at present separated, which has broadened and excavate fingers on the small chela.

We found a strange sex ratio in these collections — 241 apparent males and only 4 females. Of the 4 females, only one (16 mm long and the largest specimen in the collection) was ovigerous; it carried but 10 eggs of about 1 mm maximum diameter which showed no signs of development, whether from immaturity or sterility we do not know. A second female had a few distorted pieces of debris between the anterior pleopods that might have been the outer egg membranes of recently hatched larvae. A third carried only a large bopyrid parasite. The last "female" (14 mm long) was intermediate in sexual development with the appendix interna of the second pleopods being carried in the middle of the endopod, neither at the end of the basal third as in the males nor well beyond the middle as in the females. Moreover, its pleura were neither short and pointed as in the males nor large and rounded as in the females. The smaller males, on the other hand, showed the characteristics of maturity in the abdominal pleura and the second pleopods.

Abnormal sex ratios have been reported before. Coutière (1909: 17) wrote of a single dredge haul that produced 5,000 to 6,000 specimens of *S. longicarpus* (Herrick) and *S. pectiniger* Coutière. In the latter species he found "only two or three" of 227 females with normal pleura and eggs, but even these did not have "the very large eggs carried by normal females". He found 320 males "all inferior in size to the normal". On the other hand, while the specimens of *S. longicarpus* were smaller than usual and the males were in excess, "the eggs of the females are altogether normal". Both species that Coutière reported upon are known to occur in sponges (see Chace, 1972), but Coutière did not remark upon any symbiotic association of these specimens; we suggest, however, that such a large concentration of specimens could only have been found in large sponges. Chace's 1972 report on species of *Synalpheus* from West Indian waters shows a few cases of similar sexual disparity: *S. paraneptunus* Coutière in one station "from coral-encrusted rocks in 5 feet of water" had 139 specimens, with only one ovigerous female (Chace did not report on the male-female ratio, only the total number of specimens and the number ovigerous). An entire collection of *S. rathbunae* from 8 stations yielded 750 specimens, of which 0.7% (53) were ovigerous; he reported none from sponges but suggested that they came from "cracking coral, some probably from weeds along shore and on reef margins as well as on turtle grass flats with *Pocillopora*". He reported only two other species in which single collections had more than 100 individuals: *S. brooksi*, with Sta. 77-60 containing 170 specimens, 14% ovigerous ("Many of the specimens... were found in sponges"); *S. longicarpus*, with Sta. 35-56 yielding 194 specimens, 30% ovigerous; and Sta. 24-56 yielding

253 specimens, 38% ovigerous (he specified that these two lots came from loggerhead sponges).

In Australian waters we found what we interpreted to be two subspecies of *S. neptunus* (Dana) with unusual sex ratios when collected from sponges (B & B, 1975a: 317, 321). In *S. neptunus neptunus* almost all the specimens identified as living in sponges were small, not reaching over 8 mm in length. All were primarily male in the development of the abdominal pleura; but they showed signs of immaturity, the smaller specimens lacking the appendix interna on the second pleopods and the articulation of the outer uropod. On the other hand, a large number of specimens of the species were found not living in sponges; these were much larger, 18 to 26 mm long, and had a normal sex ratio with ovigerous females. An exception to this was found in a sample from WM 60-65, where 14 specimens from a sponge in Exmouth Gulf were of large size and sexually mature (the station and number of specimens was unfortunately omitted from "Specimens examined" on p. 317 of that paper). In *S. neptunus germanus* from near Fremantle in Western Australia, all specimens came from sponges. All of these had the appendix interna developed on the second pleopods and located on the basal third of the endopod, and all had angular corners to the abdominal pleura. However, all lacked the articulation on the outer uropod, a sign of immaturity. No sexually mature female approaching the characteristics of the subspecies was found in the Australian collections, either in sponges or free living, just as no sexually mature adult (except the one female with the few eggs) of *S. paradoxus* has been found in the Red Sea.

Many species of the genus *Synalpheus* are known to occur at least occasionally in sponges, and some, such as *S. streptodactylus* Coutière, may be obligate sponge commensals (B & B, 1975a: 364). Many of these reach sexual maturity in some or possibly all sponges they inhabit. We have just examined 130 specimens of *S. streptodactylus* from a sponge from Madagascar (to be reported upon in a later paper) and have found 68 males, 37 ovigerous females and 25 nonovigerous females, which would appear to be a normal ratio. But it is patently obvious that if a species is found largely or only in sponges and it does not reach sexual maturity in the sponge or its females are not fecund there, the species will become extinct.

Coutière, while not addressing the sponge problem, in the case of *S. pectiniger* cited above suggested that the "castration so general among these females is due to a parasite, a Microsporidian or Bacterial [sic] or simply to hunger". In our Australian study we suggested two hypotheses: first, that the larvae settling in certain sponges were inhibited in reaching maturity by a "pheremone-like chemical" given off by the sponges; or, second, that the

sponge constitutes a nursery from which the alpheids move as they attain greater size before they reach maturity. The presence of the one ovigerous female in the present collection and the few in the two species reported upon by Chace (above) may suggest a combination of the two hypotheses, with the pheremone-like substance being not completely effective in the suppression of the female maturation, but with the escape from the spongocoel being necessary for effective reproduction. As we pointed out in the Australian paper, the solution to this problem cannot lie with museum-type studies on dead specimens but could present a fascinating problem to an individual working in the field and laboratory with living specimens.

The name, *S. paradoxus* refers to the observed sex ratio.

Synalpheus paraneomeris Coutière

Synalpheus paraneomeris Coutière, 1905: 872, pl. 71 fig. 7; 1899: 486, Djibouti.* Balss, 1915: 21, Red Sea. [See also B & B, 1975a: 383.]

Specimens examined. — S. Red Sea: 23, E62/1363.

Synalpheus paulsoni Nobili

Synalpheus paulsoni Nobili, 1906b: 28, fig. 1. Coutière, 1908: 201, Djibouti. Holthuis, 1958: 31, Eylath.
Alpheus tricuspidatus Paulson, 1875: 105, Red Sea. Not *A. tricuspidatus* Heller, 1861.

Synalpheus paulsoni liminaris Coutière

Synalpheus paulsoni liminaris Coutière, 1908: 201, Djibouti; 1909: 92, same specimen as 1908.

Synalpheus physocheles Coutière

Synalpheus physocheles Coutière, 1908: 200, Djibouti; 1909: 91 (same specimen as 1908).

Synalpheus quinquedens Tattersall

Synalpheus quinquedens Tattersall, 1921: 376, pl. 28 figs. 1-5, Suez, Khor Dongonab, Mersa Ar-Rakiya, Suakin Harbour. Ramadan, 1936: 19, Ghardaqa.

Specimens examined. — Gulf of Aqaba: 1, NS 6930, 1, 7315. Gulf of Suez: 3, NS 12146. 4, SLR 2825; 2, 2883. S. Red Sea: 1, E57/520; 1, 521; 1, E62/1320; 9, 1355; 1, 1357; 3, 1449; 1, 1452. 2, ISRSE 0079; 1, 0268; 2, 0814; 1, 0820; 2, 0821; 2, 0822; 2, 0823; 4, 0826; 2, 0884; 1, 0890; 1, 1000; 2, 1003; 5, 1080; 6, 1644; 1, 1934; 1, 1939. 2, Misc. 21; 1, 48.

* Coutière used the name *S. paraneomeris* four times in his thesis (p. 456, 466, 486, 501) without description, and at that time it was a nomen nudum; the name was not acceptable to zoological nomenclature until he published his description in 1905.

Biological notes. — Dr. Holthuis states that the specimen from ISRSE 9884 was "uniformly orange-pink, tip of large chela dark orange. Eggs yellow".

Synalpheus savigny (Guérin)

[unnamed] Savigny, 1809: pl. 9 fig. 4, Suez.
Athanas nitescens Audouin, 1827: 274 (name applied to Savigny's figures). Not *A. nitescens* Leach, 1814.
Alpheus savigny Guérin, 1857: 49.
Synalpheus savigny Tattersall, 1921: 375, Suez. (Record doubtful, see below).

Remarks. — Savigny in 1809 published a series of figures of crustaceans to which he applied no names. Audouin in 1827 applied the name *Athanas nitescens* Leach to the species Savigny figured in plate 9, figure 4 (for discussion of these papers, see B & B, 1972: 1141). Guérin (1857: 49) recognized that Savigny's figures were not of *A. nitescens* and named the species figured as *Alpheus savigny*. Coutière (1899: 17) placed this species with others named by Guérin in the genus *Synalpheus*. Finally, Tattersall in 1921 reported a 15 mm female from the Gulf of Suez ("28°N") saying it was a rediscovery of the Audouin-Savigny-Guérin species and the first report of capture of the species since its original collection by Savigny.

On the basis of most characteristics, we agree with Coutière that this species is likely to be in the genus *Synalpheus*, and if it is placed there perhaps it may be a senior synonym in the *S. tricuspidatus* (Heller) — *S. tumidomanus* (Paulson) complex (see under *S. tumidomanus*, below). However, two characteristics shown in Savigny's figure make the placement of the species in the genus *Synalpheus* questionable. First, the dactyli of the third to fifth legs are shown as simple, not biunguiculate or triunguiculate, a specification in the diagnosis of this genus. Second, the first carpal article of the second leg is shown to be about one-half the length of the sum of the following four articles, whereas in all the members of the genus with which we are familiar the first article is at least subequal and often markedly longer than the sum of the lengths of four distal articles. We admit that these differences may well be due to errors in delineation of the specimen, but unless Savigny's specimen is found, the figure must be accepted as accurate. We suggest, therefore, that Guérin's name for the species be considered a nomen dubium.

The specimen that Tattersall assigned to this species (he did not remark on the carpal articles of the second leg nor the dactyli of the more posterior pereiopods) was to be "housed in the Zoological Department of the University of Liverpool". Officials of the Zoological Department stated in 1970

that the specimen could not be found nor were there any records of its disposition. Thus, like *S. savigny* itself, Tattersall's record of it must be regarded as questionable unless the specimen can be rediscovered.

Synalpheus sladeni Coutière

(fig. 11)

Synalpheus sladeni Coutière, 1908: 108. [See also Coutière, 1921: 417, pl. 62 fig. 12.]

Specimens examined. — Gulf of Aqaba: 1, NS 7225; 2, 7431.

Discussion. — This is the first time any specimens of this species have been reported since Coutière described the species on the basis of a sole specimen from Cargados Carajos Shoals (16°38'S, 50°38'E, in the Seychelles-Mauritius Ridge). Our specimens show only slight differences from the description and figures of Coutière, but we have presented some drawings so that later workers may make comparisons.

In his description Coutière remarked in both 1908 and 1921 "Les fouets des maxillipèdes externes sont très asymetriques en longeur et surtout en volume. J'ignore si cette disposition est fortuite ou constante." He offered no figures of this development. We find that the exopods of the three maxillipeds (fig. 11 l, m) are greatly elongated and very heavy, rounded in cross section except for their superior surfaces, which are flattened evidently to accommodate the underlying mouthparts. They are also curved for this accommodation (because of the curvature they became distorted when they were flattened under a coverslip for drawing). There is no great modification of the more anterior mouthparts, and the endopodal development is normal except that the brush on the ultimate article of the third maxilliped is somewhat heavier than that usually found in the genus *Synalpheus*. The exopodites show no trace of bilateral asymmetry on any of the maxillipeds.

This species, like many others of the Gambarelloides group, lacks the orbitorostral process.

The body of the specimens examined seems heavier and softer than is usual. In the two large specimens the branchiostegites appear thickened, which causes them to flare, partially exposing the gills. The thickening material appears to be fatty. We have seen such deposits in the lateral margins of the carapace (technically not branchiostegites) in planktonic euphausiids in the more northern parts of the Pacific. These developments may be reflections of the shrimp's protected habitat, for these specimens, like Coutière's, came from spongocoels of sponges.

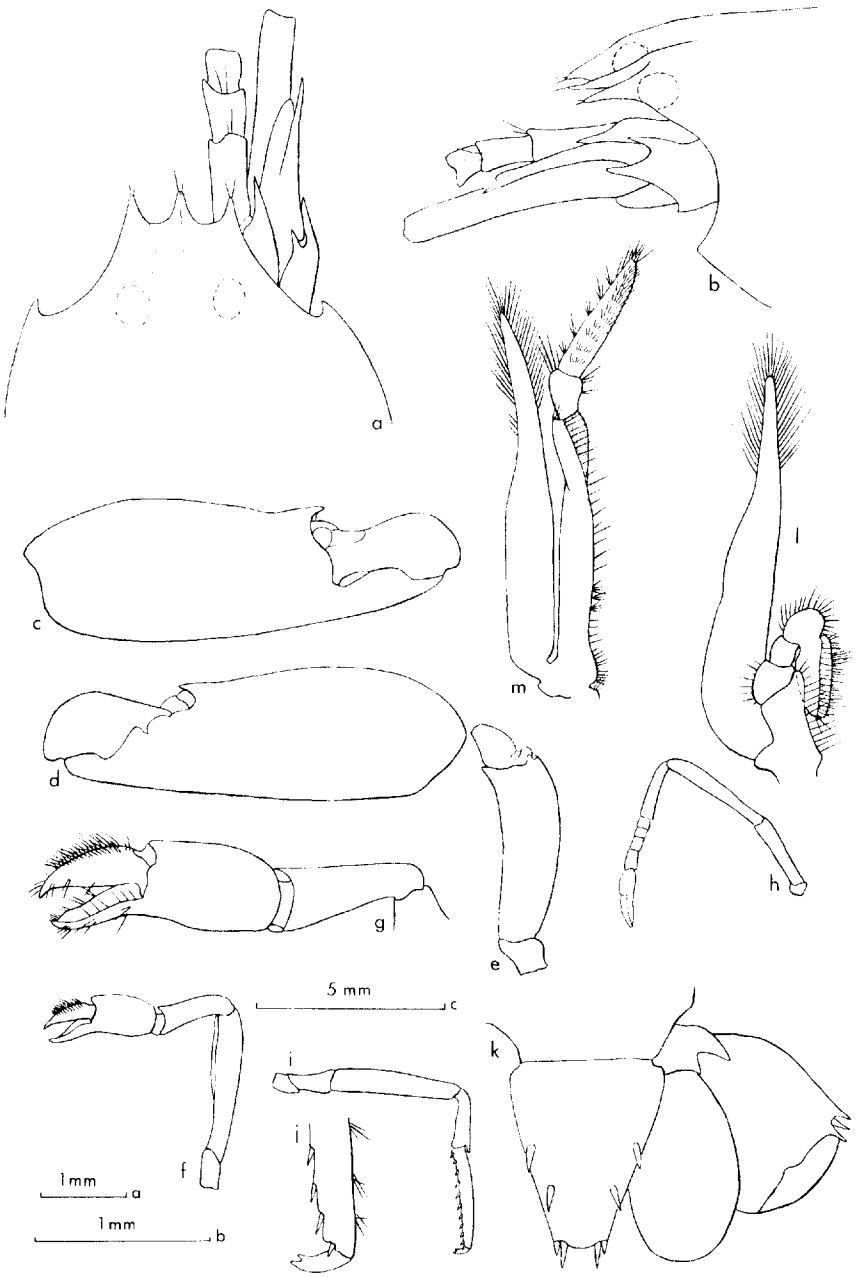

Fig. 11. *Synalpheus sladeni* Coutière 17 mm ♂ (NS 7431): a, b, anterior region, dorsal and lateral view; c, large chela, lateral face; d, e, large chela and merus, medial face; f, g, small cheliped, carpus and chela enlarged; h, second leg; i, j, third leg and dactylus enlarged; k, telson and uropods. 20 mm ♂ (NS 7225): l, m, second and third maxilliped, exopodite somewhat distorted. a, b, g, k, l, m, scale a; j, scale b; c–f, h, i, scale c.

Synalpheus spongicola new species

(fig. 12)

Holotype (RMNH no. D 329450). — 24 mm ovigerous female from Marsa Murach. Collected by Tel-Aviv University, 22 February 1968. From inside sponge. (NS 7315)

Allotype (RMNH no. D 32946). — 16 mm male from same collection as holotype.

Paratypes (Deposited in Zoological Museum, Tel Aviv University, Israel). — 8 females, 20-22 mm in length from same collection as holotype.

Description. — Rostrum and orbital teeth of equal length, reaching to middle of visible portion of first antennular article; bases of orbital teeth much broader than those of rostrum and separated from rostrum by narrow "U"-shaped indentation; tips of rostrum and orbital teeth bearing a few setae. Rostrum with orbitorostral process.

Visible part of first antennular article 1.3 times longer than second article; second article 1.7 times as long as broad; third article only a little shorter than second. Stylocerite acute, reaching to end of first antennular article. Outer margin of carpocerite slightly concave; lateral tooth reaching to near middle of third antennular article, squamous portion narrow, reaching just past end of second antennular article. Carpocerite 6 times as long as broad; with tip reaching about half length of third antennular article past that article. Basicerite with inferior tooth reaching to near middle of second antennular article; superior margin also with an acute tooth a little longer than orbital teeth.

Large chela subcylindrical, 2.6 times as long as broad, with fingers occupying distal quarter. Superior margin of palm terminating in a strong, acute and slightly curved tooth, with tip lying parallel to axis of chela. Both fingers with tips narrowly rounded, almost acute, of translucent hardened chitin; dactylus with narrow cutting edge running from proximal margin of tip to plunger, with distal portion of "socket" incised to accommodate ridge. Carpus cup shaped; inferodistal margin bearing one long rounded projection flanked by a smaller rounded projection. Merus 2.3 times as long as broad, superior margin arched; distal margins unarmed.

Small chela 2.5 times as long as broad, somewhat inflated in basal third and tapering towards finger. Fingers 0.4 length of chela; tips simple. Superior surface of dactylus bearing a distinct "brush", running from near articulation to tip, 4 or 5 follicles broad. Carpus somewhat elongate, 0.5 as long as chela; inferodistal margin with a rounded projection. Merus 3.3 times as long as broad; distal margins unarmed.

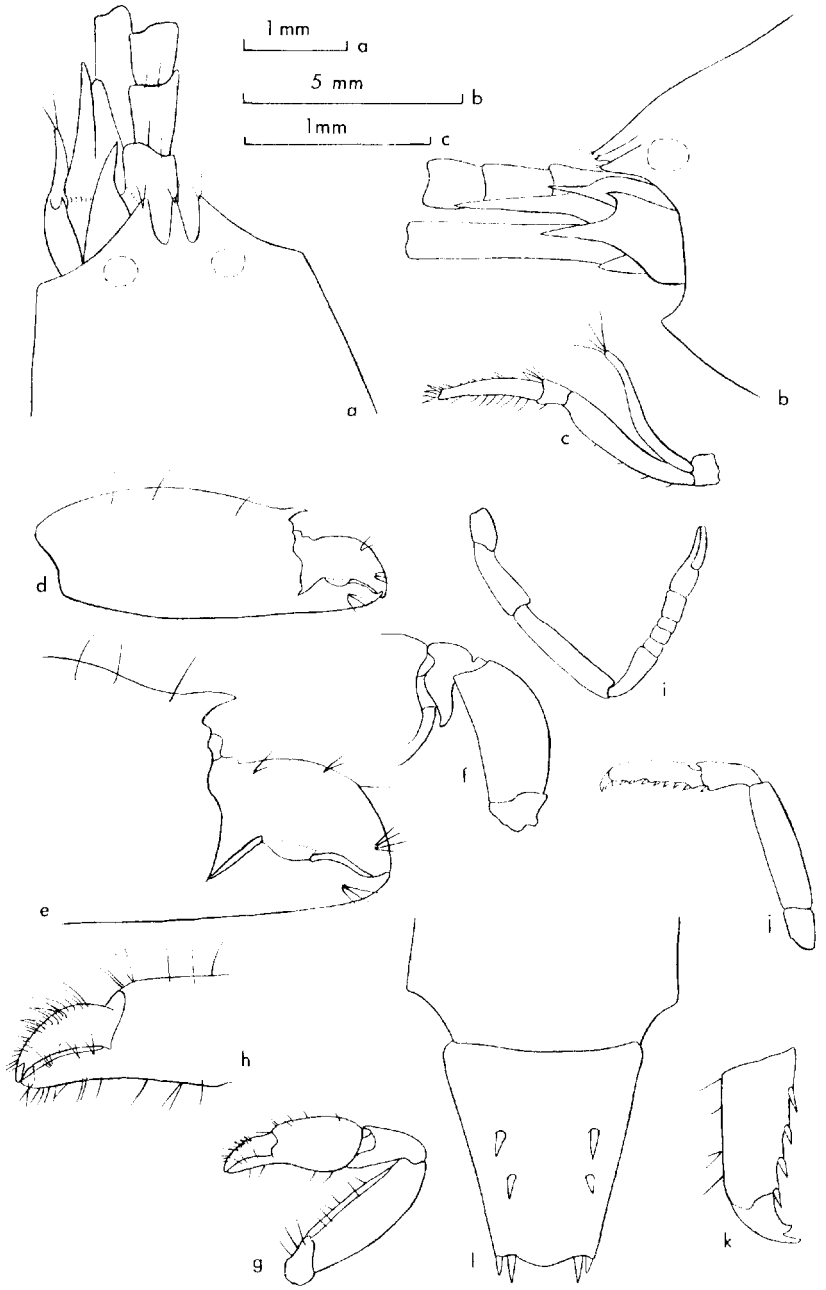

Fig. 12. *Synalpheus spongicola* new species, holotype (24 mm ♀): a, b, anterior region, dorsal and lateral view; c, third maxilliped; d, e, large chela, inferolateral face; f, merus, large cheliped, medial face; g, h, small cheliped, lateral face; i, second leg; j, k, third leg and dactylus; l, telson. a, b, e, h, l, scale a; c, d, f, g, i, j, scale b; k, scale c.

Ratio of articles of third maxilliped: 10:2:6. Tip of third article carrying a tuft of 7 stout spines.

Ratio of carpal articles of second leg: 10:2.5:2.5:2.5:5; middle articles much broader than long.

Ischium of third leg unarmed. Merus 3.7 times as long as broad, inermous. Carpus 0.5 as long as merus; superodistal margin extended into a subacute tooth; inferodistal margin rounded and bearing a small spine. Propodus 0.75 as long as merus, bearing on its inferior margin 7 spines and a pair distally. Dactylus biunguiculate, 0.18 as long as propodus; superior unguis a little longer and narrower at base than inferior unguis; notch between ungui "V"-shaped.

Telson 2.1 times as long as posterior margin is broad and 2.0 times as broad anteriorly as posteriorly. Posterodistal margins not projected; posterolateral pairs of spines similar in size to dorsal spines, inner pair a little longer than outer. Inner uropod without spines on the lateral margin; outer uropod with distal articulation.

Discussion. — The specimen we have designated as the allotype is smaller than any of the females, and only its first abdominal pleura bear the well-developed hooked margins characteristic of mature males in this genus ,with the more posterior showing only indications of male development. The basipodites of its pleopods are short, only half as long as those found in the females; the appendix interna is carried on the basal third of the endopod of the second pleopod, the "male position". We therefore believe it may be an immature male. It also differs from the holotype in that the lateral tooth of the scaphocerite reaches only to the end of the second antennular article, with the squame correspondingly shorter; the carpocerite is reduced by a similar amount.

Little variation exists in this group of 10 specimens, all taken from the same sponge. Slight differences are found in the lengths of the scaphocerite and in the scaphocerite between the lateral tooth and the squamous portion, but all lie within a narrow range. The basicerite always has the superior angle projecting and acute. In one specimen, the tooth above the dactylar articulation of the large chela is somewhat more swollen or bulbous, but not to the degree found in many American species (see, for example, *S. brevicarpus* Coutière, 1909: fig. 31K). The other appendages and the telson also are quite constant.

The brush on the dactylus of the small chela and the rather elongate carpus indicate the affinities of this species with the Gambarelloides group, a group more characteristic of Atlantic waters. Unlike most members of that group the telson of *S. spongicola* does not abruptly taper to a narrow tip and

it possesses an orbitorostral process (present only in *S. rathbunae*, but in that species it is not fully developed). However, because of the close relationship in most characteristics to Caribbean *S. mcclendoni* Coutière (see below), we are assigning *S. spongicola* to the Gambarelloides group in spite of these differences.

This species can be separated from the only other Indo-Pacific species of the group, *S. sladeni* Coutière, most easily by the normal exopods of the three maxillipeds, as well as by the different rostral front including the orbitorostral process, by the broader telson and by differences in proportions of many of the appendages (contrast fig 11g with fig. 12g). From the approximately 18 species of this group known from the waters of the Americas, including *S. mcclendoni*, and from the two species from the Eastern Atlantic and Mediterranean Sea, this species can be separated by at least two or more of the following characteristics:

1. Orbitorostral process present.
2. Stylocerite acute and reaching to end of first antennular article.
3. Squame of scaphocerite well developed and reaching about 0.9 length of lateral tooth (note: Chace, 1972: 102, states this is a variable characteristic in *S. pandionis* Coutière.
4. Basicerite with the superior external angle projecting and acute.
5. Tooth above articulation of dactylus in large chela not with bulbous base; raised at an angle to proximal profile of palm.
6. Tips of fingers of small chela simple, without accessory teeth.
7. No teeth proximal to spine on outer uropod.
8. Tip of telson broad, about 0.5 the proximal breadth and 0.5 of the total length.

There are, of course, many other characteristics unique to one or several species that could be used as well, such as the elongate and pointed fingers on the chelae of the second legs in *S. filidigitus* Armstrong.

Only rather subtle characteristics separate *S. spongicola* from *S. mcclendoni* from the Caribbean (Coutière, 1910: 487; see also Chace, 1972: fig. 33, 34). In addition to some of the characteristics listed above, in the new species the orbital teeth are heavier; the scaphocerite is shorter than the antennular peduncle; the squame is 0.9, rather than 0.7, of the length of the lateral tooth; the exopod of the third maxilliped reaches beyond the proximal article of the endopod; the palm of the small chela is slightly bulbous; the propodus of the third leg bears numerous short spines; and the tip of the telson is broader.

The name *S. spongicola* refers to the habitat of the species.

Synalpheus streptodactylus Coutière

Synalpheus streptodactylus Coutière, 1905: 870, pl. 70 fig. 1. Tattersall, 1921: 373, Khor Shinab. Ramadan, 1936: 19, Ghardaqa.

Specimens examined. — Gulf of Aqaba: 2, Dr 64. 1, NS 1056; 1, 1146; 1, 2928; 1, 6923; 1, 7226; 1, 7326. Gulf of Suez: 3, NS 2268; 6, 12144; 6, 12148. 1, SLR 2694; 1, 2737; 3, 2825; 11, 2883; 2, 2892; 1, 3134. S. Red Sea: 1, E58/208. 2, ISRSE 1831; 3, 1882. 1, Misc. 27.

Synalpheus triacanthus De Man

Synalheus triacanthus De Man, 1910: 301. [See also 1911: 282, fig. 55.]

Specimens examined. — Gulf of Aqaba: 1, NS 6194.

Remarks. — This specimen, similar to two specimens we have reported previously from the Philippines (B & B, 1979: 247) and from Sri Lanka (B & B, 1980: 34), carries inferior spines on the merus of the third legs. Here the merus of the third leg bears 3 spines and that of the fourth bears 2. The small chela is relatively more slender in this specimen also, being 4.2 times as long as broad instead of 3.1 times, as described by De Man; this, too, we have remarked upon before (B & B, in press B).

Synalpheus tricuspidatus (Heller)

Alpheus tricuspidatus Heller, 1861: 26 [see Heller, 1862a: 267, pl. 3 fig. 15], Red Sea. (Paulson, 1875: 105, Red Sea — not *A. tricuspidatus* Heller but *S. paulsoni* Nobili, 1906b.)

Synalpheus tricuspidatus Nobili, 1901: 2, Massaouah; 1906a: 32, Massaouah.

Remarks. — Nobili (1906b: 32) contended that Paulson's specimens were not the *A. tricuspidatus* of Heller and renamed them *S. paulsoni*; he recognized both species in the specimens he was studying from the Red Sea. De Man has suggested (1911: 202) that this species may be identical with *S. tumidomanus* (Paulson); if so, this will be the senior synonym. We are inclined to agree with De Man, especially in view of the variability found in the species. However, it would be wise to defer judgement until the type specimen can be examined.

Synalpheus trispinosus De Man

Synalheus trispinosus De Man, 1910: 300. Calman, 1930: 208, Gulf of Aden. [See also De Man, 1911: 288, fig. 58.]

Synalpheus triunguiculatus (Paulson)

Alpheus triunguiculatus Paulson, 1875: 103, pl. 14, figs. 1-1g, Red Sea.
Synalpheus triunguiculatus Coutière, 1899: 486, Djibouti. Nobili, 1901: 2, Massaouah; 1906a: 31, Massaouah. Balss, 1915: 21, 14 localities, Red Sea. Tatersall, 1921: 374, Suez, Suakin Harbor. Pesta, 1928: 72, Port Sudan. Ramadan, 1936: 19, Ghardaqa. Holthuis, 1958: 29, Tor, Sinai Peninsula. B & B, 1980: 34, Straits of Jubal.

Specimens examined. — Gulf of Aqaba: 1, NS 6919. Gulf of Suez: 1, NS 2203. S. Red Sea: 1, E58/224.1; 1, E62/1320; 2, 1323; 1, 1338; 1, 1356; 1, 1363; 1, 1364; 8, 1366; 12, 1375; 12, 1382; 13, 1393; 1, 1413; 6, 1446; 4, 1451; 2, 1452; 3, 1454; 5, 1455; 2, 1458; 1, 1479; 11, 2166; 1, 3953; 3, 4573; 1, 4600. 2, ISRSE 0089; 2, 0090; 2, 0226; 1, 0819; 1, 0822; 2, 0857; 1, 1004; 1, 1005; 2, 1058; 5, 1080; 1, 1220; 1, 1598; 1, 2018; 2, 2033; 1, 2044. 1, Misc. 9; 20, 12; 5, 21; 1, 27; 1, 48.

Biological notes. — The field colour notes of Dr. Holthuis illustrate how unreliable colour and colour patterns may be in some species (all stations ISRSE):

"0226: Uniformly transparently greenish grey; fingers of chela green; eyes black; dark median spot behind eyes."

"1058: Uniformly dark red; end of tailfan darker; tips of large chela somewhat greenish."

"2033: Purple all over; tips of large chela dark green."

"2044: Transparent pale green; tips of large chela [darker] green."

Specimens examined. — Gulf of Aqaba: 1, DR 145. 8, Misc. 1. 2, NS 3767. 2, SLR 1389. Gulf of Suez: 8, NS 12134; 1, 12141. 1, SLR 2232.

Synalpheus tumidomanus (Paulson)

Alpheus tumidomanus Paulson, 1875: 101, pl. 13 fig. 2, Red Sea.
Alpheus tumidomanus var. *gracilimanus* Paulson, 1875: 102, pl. 13, fig. 3, Red Sea.
Synalpheus neptunus Coutière, 1899: 486, Djibouti. Not *S. neptunus* (Dana) *.
Synalpheus hululensis Coutière, 1908: 202. Tattersall, 1921: 374, Tella Tella Kebira. Ramadan, 1936: 19, Ghardaqa. Holthuis, 1958: 31, Eylath.
Synalpheus tumidomanus Coutière, 1905: 876. Holthuis, 1958: 29, Eylath.

* Coutière in 1899 had decided that *S. tumidomanus* was a junior synonym of *S. neptunus* (Dana) and used the latter name not only for the Red Sea specimens but also for specimens from the Americas. In 1905 he indicated that after viewing "les types" for *S. neptunus*, he found the two species to be separate. Which "types" of *S. neptunus* he examined we do not know for they were very small ("Longeur du cephalothorax 2 mm"). The "types" we examined in the Museum of Comparative Zoology at Harvard had total lengths of 8 to 10 mm (B & B, 1974: 203. See also International Commission on Zoological Nomenclature, 1978: 106). Nevertheless, Coutière short description agreed quite well with our description of the neotype (B & B, 1972: 24). Further, Holthuis (1952: 36) states he believes Coutière's American "*S. neptunus*" of 1899 was *S. spinifrons* (H. Milne-Edwards).

S. Red Sea: 1, E57/521; 2, E58/242.1; 1, E62/1382; 2, 1393; 4, 1413; 3, 1451; 1, 1455; 1, 1476; 3, 1479; 1, 2034; 2, 2166; 2, 4573. 1, ISRSE 0268, 2, 0800; 2, 1209; 4, 2035. 6, Misc. 12. 1, NS 12428.

Remarks. — The variation in this species was discussed in our Australian study which was based in part on some of the Red Sea specimens. We have noted in restudying the Red Sea collections that some specimens, particularly the large ones, appear to be more hirsute than others and when these are viewed laterally a great many hairs on the dorsal surface of the rostrum and the superior surface of the chela are visible. We think this is another variation apparently correlated with growth.

Dr. Holthuis reports that a specimen from ISRSE 1209 was "greyish green, with dark fingers"; this specimen, he notes, came from a sponge.

APPENDIX I

Collection records

The collections prefixed by "DR..." were made by Dr. Lev Fishelson of the University of Tel Aviv in the Gulf of Aqaba in 1976-1977. Most were taken from algae overgrowing dead corals ("DR" refers to "Decapods, Red Sea").

DR 16 Dahab-North, 10/8/76. Substrate: *Galaxaura* sp.
19, 22 Maagna B, 6/11/76. Substrate: *Cystoseira myrica.*
28 Marsa el Mugebla, 6/11/76. Substrate: *Galaxaura* sp.
64 Elat, 26/6/76. Substrate: Turf algae.
65 Dahab-North, 8/76. Substrate: *Galaxaura* sp.
88, 99 Ras Nasrani, 9/8/76. Substrate: *Aurainville* sp.
101 Same as 28, 5/11/76.
125 Bir-Suer, 6/11/76. Substrate: *Actinotrichia fragilis.*
136, 141 Magrash, 11/9/77. Substrate: not known.
143, 144, 145, 146 Same as 136. Substrate: Lithothamnion.
157 Same as 125. Substrate: *Calopenia* sp.
158. Same as 28.
159 Same as 125. Substrate *Cystoseira myrica.*
166 Same as 125. Substrate *Sargassum* sp.

The "E50/..." to "E60/..." prefixes refer to specimens collected at Elat and the Sinai Peninsula, a joint program of the Tel Aviv and Hebrew University; the E refers to Elat and the numbers to the year of collection. (Some collections were made in 1957 in the southern Red Sea.)

E50/ 25.1, .4, .5, .6 Elat, 25/4/59. Coll. H. Steinitz.
E54/ 7 Elat, 7/54.
E57/ 449, 520, 521 Derom Is. near Massawa, Ethiopia, 27/12/57. Coll. A. Ben-Tuvia.
676.19, .20, .21 Enritrea, 1957. Coll. A. Ben-Tuvia.
701.3, .5, .6 Same as 449.
E58/ 152, 208, 223, 224.1, 242.1, 244, 280.6 South Red Sea. 8-11/2/58. Coll. O. H. Oren. Dredge and net.
E59/ 57.4, 70, 120.1 Elat, Sept., Oct. 1959. Coll. H. Steinitz.
E60/ 2, 28.1 Elat, 15/1/60, 4/5/60. Coll. H. Steinitz.
62.21, .23 Elat, 5/9/60. 3 ft. Coll. E. Clark.

The prefix "E62/..." refer to specimens collected by the first Israel south Red Sea expedition of the Tel Aviv University in 1962.

E62/ 0117, 0122, 0132, 0186, 0189, 0252, 0301D Landing Bay, Entedebir Is., 14-16/3/62.
1314 Abiad Bay, Entedebir Is., 12/3/62. Under rocks on tide line.
1302 N. of entrance to Landing Bay, Entedebir Is., 13/3/62. 2-3 m, among coral.
1323 Same as 1320. On *Stylphora* coral.
1328 Cundabilu Is., 14/3/62. 0-1 m deep, sandy shore.
1333 Landing Bay, Entedebir Is., north of entrance. 14/3/62. 2-3 m, in hole in *Isophyllia* coral.
1334 Same as 1333. 15/3/62. In tubes of *Lyngbya* algae.
1338 Cundabilu Is., 14/3/62. 2-3 m, on *Tubipora*.
1353 N. E. corner of Nocra Is., near old prison, 18/3/62. 2-3 m, on soft coral.
1355 Same as 1353. In blak sponge.
1356 Same as 1353. 0-3 m, among corals, sandy bottom.
1357 Same as 1320. 18/3/62. From *Stylophora* coral.
1360 Goliath Bay, Entedebir Is. 19/3/62. Exposed mud flat of very fine coral silt. In burrows.
1363 Cundabilu Is., rocky eastern shore. 20/3/62. 1-2 m, with sand patches and coral.
1364 Same as 0117., 20/3/62. 1-3 m, among *Stylophora* coral.
1366a & b Padina Bay, Entedebir Is. 21/3/62. 0-2 m, among *Stylophora* coral.
1367 Same as 1366. 21/3/62. 0-1 m, in burrow in sand.
1375 S. W. point of Umm Aabak Is., N. W. of Nocra Is. 22/3/62. 0-3 m, among corals.
1382 Same as 1375. 23/3/62. On *Galaxea* corals.
1383 Same as 1375. 23/4/62. Fishpoisoning in area with corals.
1390, 1391 Same as 1375. 24/3/62.
1393 Cundabilu Is. 25/3/62. 0-3 m, among corals.
1399 Umm Aabak Is. 25/3/62. On Alcyonarians.
1402 Same as 1333. 26/3/62. 0-2 m, deep.
1408 Romia Is. 29/3/62.
1412 Same as 1408. 3-4 m, from hole in *Favia* coral.
1413 Same as 1408. 0-3 m.
1416, 1420, 1421, 1431 Landing Bay, Entedebir Is. 30-31/3/62. 0-3 m, among corals *Pavona, Tubipora, Stylophora*.
1435 Melita Bay, in Zula Bay, S. of Massawa, Ethiopia. 2/4/62. 0-3 m, among corals.
1436 Same as 1360. 3/4/62. 0-0.5 m, in grey sponge.
1446 Same as 1416. 4/4/62.
1449 Umm Aabak Is 5/4/62. 0-2 m, in coarse black sponge (*Fasciospongia cavernosa* [Schmidt]) on coral reef.
1451 Same as 1449. In finer black sponge.
1452 Same as 1449. In *Acropora* coral colony.
1454, 1455 Same as 1449. 6/4/62. 0-1 m, low tide, among corals.
1456 Same as 1449. On *Echinometra mathaei*.
1458 Manta Cliff, Entedebir Is. 7/4/62. 0-5 m.
1476 Same as 1360. 30/3/62. 0.5 m, in black sponge.
1479, 1482 Same as 1476. 16/3/62. 0-1 m, on flat rocky bottom covered with thin layer of mud, in black sponge.
1489 N.E. coast of Enteraia Is., 24/3/62. 0-1 m, sandy bottom, in black sponge.
1499 No information.
1514 Rocky shore near Massawa, Ethiopia. 6-8/3/62.
1516 Same as 1366. 11/3/62. 0-1 m, on dorsal spines of *Echinometra mathaei*.

1517 Same as 1366. 11/3/62. 0-1 m, between and under rocks.
1981 Same as 1333. 19/4/62.
2034, 2036 Nocra Is. 18/3/62.
2047, 2144 Same as 1333. 21/3/62.
2166, 2168, 2184, 2186 Umm Aabak Is., 22-25/3/62.
2195 Same as 1333. 21/3/62.
2420, 2421 Same as 1435. 14/4/62.
2711, 2712 Same as 2166. 5/4/62.
2714, 2997 Same as 1435.
3836 Same as 1360. 30/3/62.
3921 Same as 1333. 4/4/62.
3953 Same as 1360.
4203D Dahlak Archipelago, 1962
4418 Entedebir Is., Dahlak Archipelago, 16/3/62.
4419 Same as 4418.
4420 Same as 1333. 21/3/62.
4524 Same as 1328.
4534 Same as 1458.
4573 Same as 1458. 14/4/62.
4600 Eritrea, 1962.
10037, 10152 Same as 4418. 16/2/62 and 3/4/62.
10170 Umm Aabak Is., Dahlak Archipelago.

The prefix "ISRSE..." refers to specimens collected by the second Israel South Red Sea Expedition by the Tel Aviv University in 1965 (Lewinsohn and Fishelson, 1967: 59).

ISRSE 0079, 0089, 0090 Braaten Bay, Museri Is. 10/10/65.
0112 Camping Bay, Museri Is. 11/10/65.
0191 "Negus Salomon" Sta. 3: 15°05'N, 40°18'E, 17/10/65. 5 fms. bottom flat, rather hard.
0209 Same as 0112. 9/10/65. Under rock, low tide.
0211 Base of Scopus Ridge, Museri Is. 9/10/65. 0-1.0 m, in scattered coral colonies on bottom.
0222 Coast near Camping Bay, Museri Is. 9/10/65. 0-1.0 m, among rocks and corals.
0226 Same as 0222. Among algae.
0227 Off Scopus Ridge, Museri Is. 9/10/65. Under stone above tide line, in sand.
0232 Same as 0222. 0-2 m.
0257, 0259, 0206, 0261, 0266, 0268, 0270 Reef before Camping Bay, Museri Is. 11/10/65. 2-3 m, among rocks.
0279, 0286 Rocky plateau just W. of Camping Bay, Museri Is. 12/10/65. 0-0.5 m, among rocks.
0287 Coast of Mangrove Bay, Museri Is 12/10/65. Intertidial zone, mud covered rock flat, under rocks.
0299 Same as 0227. 13/10/65. Among rocks, algae, sponges, etc.
0800, 0806, 0814 Same as 0079.
0816, 0819, 0820, 0821, 0822, 0823, 0825, 0826, 0833, 0857, 0862, 0863, 0884, 0886, 0890 Museri Is. 10-11/10/65.
1000, 1001, 1002, 1003, 1004, 1005, 1006 Same as 0227.
1036, 1037, 1039, 1044, 1045, 1047, 1055, 1056, 1057, 1058, 1059, 1060, 1068, 1069 Off Mangrove Bay, Museri Is. 14/10/65. 100 m offshore, 0.5-1.5 m, low tide, corals and sand, Pro-Noxfish poisoning.

1073 Same as 0227. 15/10/65. 0-1.5 m, among rocks and corals.
1077, 1078, 1079, 1080 Same as 1073.
1088 Mangrove Bay, Museri Is. 15/10/65. Rock plateau in mud exposed at low tide.
1207, 1208, 1209, 1213, 1218, 1220 Same as 0222. 16/10/65.
1229, 1230, 1231, 1232 Same as 0227. 17/10/65. 0.2 m, sandy area in rock plateau.
1248, 1249, 1255 Same as 0079. 17/10/65. 0-0.2 m, rocky plateau.
1257 Same as 0112. 17/10/65. 0-0.5 m, among rocks of rocky plateau.
1266, 1274 Same as 0211. 18/10/65. 0.1-0.5 m, shallow sandy area near rocky shore.
1278 Landing Bay, Entedebir Is. 19/10/65. 1 m, in *Galaxea*.
1282 Same as 1278.
1284 Devil's Crack, Entedebir Is. 20/10/65.
1287 Same as 1278. 20/10/65. 0.5 m, under corals.
1406 Same as 0191.
1435 "Negus Salomon" Sta. 4: 14°58'N, 40°10'E, 17/10/65. 5-6.5 fms, soft mud flat.
1507, 1508 Same as 1278.
1526, 1527, 1528, 1529, 1535, 1537, 1541 Same as 0211. 22/10/65.
1561 Same as 0287. 23/10/65.
1563 Same as 0222, 24/10/65.
1564 Mangrove Bay, Museri Is. 23/10/65. 0-1.0 m, low tide, sandy area in rock plateau.
1565, 1569, 1570 Same as 0222.
1583, 1586, 1587, 1589, 1591, 1592, 1594, 1597, 1598 Same as 1036. *Lithothamnion* bank. 25/10/65. Among *Lithothamnion* and in sand.
1644 Same as 1564. 20/10/65.
1831, 1834, 1842, 1880 "Negus Salomon" Sta. 10: 15°37'N, 40°43'E. 23/10/65. ca. 15 fms, bottom rather hard rolling.
1882 Sta. 10°37'N, 40°43'E. 23/10/65. 15 fms.
1934 "Negus Salomon" Sta. 13: 15°28'N, 40°40'E, W. of S. end of Dhu-l-Kurush, 23/10/65. 3-5 fms, dead corals, flat bottom.
1939 Same as 1831.
2011, 2012, 2013, 2014, 2018, 2021 Same as 1036. 26/10/65.
2033, 2035 Same as 2011, from black sponge.
2044 Same as 2011, from grey sponge.
2050, 2051, 2057, 2058 Same as 0112. 26/10/65. Suffocated by thick cover of algae washed by heavy wind in the area of shallow water and covering burrows at low tide. Animals crawled on top of algae.
2446 "Negus Salomon" Sta. 2: 15°17'N, 40°10'E. 16/10/65. 10-12 fms, hard flat at bottom.
2454 Same as 0112.
2457 Same as 1435.
2490, 2393, 2493 Dahlak Archipelago. 10/65.

The Miscellaneous Collections ("MISC") were loaned to us by various individuals and institutions and are not a part of the other defined series; the numbers we assigned merely represent the order in which we examined them. We reproduce fully the labels available. "HU" refers to the collection number of Hebrew University. These specimens will be deposited in the Rijksmuseum van Natuurlijke Historie, Leiden.

MISC 1 Coral Beach, S.W. of Elat, Gulf of Aqaba, 16/5/62. 0-2 m, from *Seriatopora* coral.

2 Same as Misc. 1. 17/5/62.
3 Same as Misc. 1. 16/5/62. Among *Pocillopora* coral.
4 Elat. 12/52. IIc.
5 Elat. 18/8/58.
7 Sarso Island, Farasan Group, Red Sea. 16-21/11/58. 1-3 m. Among *Seriatopora*. Coll. by S. Gerlach, Xarifa Expedition.
9 Sheik Said (Isola Verde) near Massawa, Eritrea, Ethiopia. 2/67. In living *Stylophora* corals. Coll. V. Storch.
10 Ghardaqa, Egypt. 3-4/67. From corals. Coll. V. Storch.
11 Djeddah, Red Sea. 1882. Coll. Kruyt.
12 Assab, Ethiopia. 15/1/66. Ca. 50 cm, in cracks in half dead coral, in shallow sea. Coll. B. de Wilde-Duyfjes.
14 Islet near Massawa, Eritrea, Ethiopia. 13/1/68. Among Corals. Coll. I. Gosler and D. H. O. von Hagen.
19 Eritrea, Ethiopia. 13/1/68. Among coral. Coll. D. H. O. von Hagen.
20 Assab, Eritrea, Ethiopia, S. Red Sea. 19/7/65. 0.5-1 m. Coll. B. de Wilde-Duyfjes.
21 Same as Misc. 9.
22 Red Sea coast near Aden, 4/30.
23, 24 Elat, Red Sea. 20/2/49.
27 Massawa Channel, Ethiopia. 4/61. Trawled.
28 Wadi el Dom Beach, Gulf of Suez. 22/1/67. 29°26'N, 32°30'E. Under stones in intertidal area. Coll. J. S. Pearse.
29 Port Sudan Harbor. 15/10/74. 0-5 m, mud bottom, some rock. Coll. by J. Randall.
30 Haqa, West Suez Bay. 29°57'N, 32°28'E. Under rock on intertidal dead reef platform. Coll. by A. S. Pearse.
31 Ghardaqa, Red Sea. 2/11/62. 1-4 m, muddy sand bottom. Animals in pairs in symbiosis with gobiid fish *Vanderhorstia delagoae* and *Cryptocentrus caeruleopunctatus*. Coll. D. B. E. Magnus.
32 Red Sea coast near Ghardaqa, Egypt. 6/64. In sandy mud, commensal with gobiid fish. Coll. D. B. E. Magnus.
33 Same as Misc. 32.
34 Suakin, Red Sea coast of Sudan. 18/9/68. Symbiotic with goby *Lotilia graciliosa*. Coll. D. B. E. Magnus.
35 Suakin, Sudan, Red Sea, summer, 1970. In the harbor. Symbiotic with *Cryptocentrus caeruleopunctatus*. Coll. D. B. E. Magnus.
36 Port Sudan Harbor, Red Sea, 11/9/70. In burrow in sandy bottom with gobiid fish *Cryptocentrus* sp. Coll. N. V. C. Polunin.
38 El Hamira, Gulf of Aqaba. 23/3/72. 1.5 m, associated with *Cryptocentrus sungami*. Coll. M. Tsurnamal. (HU 271).
39 Same as Misc. 38. (HU 272).
40, 41, 42, 43 Marsa Murach, Gulf of Aqaba. 5/4/72. 1-1.4 m, specimens associated with *Cryptocentrus caeruleopunctatus* and *Cryptocentrus sungami*. Coll. M. Tsurnamal. (HU 273, 274, 275, 276).
44 Shurat el Kankata, Sinai Peninsula, Gulf of Elat. 25/4/76. Mangrove region. Coll. L. Holthuis and Ch. Lewinsohn.
45 Aqaba, Jordan. 10-12/75. Lagoon reef, 1-5 m, under stones in *Sargassum* and *Cystoseira*.
46 Aqaba, Jordan. 1-5/76. 1-2 m, under stones.
47 Aqaba, Jordan, Gulf of Aqaba. Coll. H. Mergner.
48 ISRSE II, Dahlak Archipelago. 10/65 [See ISRSE collections]. Coll. L. Fishelson.

49 Ras Muhammad. 19/9/74. Reef flats. Coll. J. Randall.
50 Sanganeb Atoll, Red Sea (Sudan). 8/10/74. Lives with goby (*Lotilia*). Coll. J. Randall.

The series with the prefix of "NS..." were loaned by the Zoological Museum Tel-Aviv University (*NS* indicates "Natural Science".).

NS 1050 Elat. 10/6/64. Ch. Lewinsohn. From *Echinometra mathaei*.
1055, 1056, 1058, 1059, 1060, 1061 Elat. 4/45 to 6/65. Coll. L. Fishelson and Ch. Lewinsohn.
1146 Elat. 5/9/66. 22-27 fms. Sta. 1 "La'Merkhav". Coll. Ch. Lewinsohn.
1428, 1431, 1522 Ras Muhammad. 17-18/9/67. Coll. L. Fishelson.
1590, 1598 Shurat el Mankata. 15/9/67.
1737, 1738, 1744 Dahab. 13/9/67. Coll. L. Fishelson.
1961, 1967, 1968, 1971, 1972, 1973 Same as 1428.
2202 El Tur. 20/9/67. Coll. L. Fishelson.
2264, 2268, 2269, 2279 Abu-Zanima. 22/9/67. Coll. L. Fishelson.
2391, 2421 Marsa Murach. 22/8/67.
2928 Elat. 5/9/66. 22-27 fms. Coll. Ch. Lewinsohn.
3517 Ras el Burqa. 5/10/68. Coll. L. Fishelson.
3614, 3616, 3617, 3618, 3619 Dahab. 11/10/68. Reef, fish poison station. Coll. L. Fishelson.
3730, 3731, 3732, 3734, 3737, 3738 Wasset. 7/10/68. Fish poison station. Coll. L. Fishelson.
3763, 3767, 3769 Ras-Atantur. 15/10/68. Inside coral. Coll. L. Fishelson.
4006 Ras el Burqa. 5/10/68. Reef. Coll. L. Fishelson.
4007, 4012 Same as 3730. 8/10/68.
4016, 4017 Same as 3517.
4033, 4034, 4176, 4177 Same as 3730.
4411 Same as 3614. 9/10/68.
4493, 4560, 4561, 4575 Marsa-el-Aat. 16/10/68. Fish poison station. Coll. L. Fishelson.
5072 Elat. 20/12/68. 2 m. Coll. D. Propper.
5345 Taba, S. of Elat. 26/1/69. 10 m. Coll. D. Popper.
5444 Same as 5072. 1/69.
5457 Marsa Murach. 22/8/68. Coll. N. Gunderman.
5459 Elat. 4/12/68. On corals. Coll. J. Dafni.
5461 Elat. 4/7/63. Coll. A. Ben-Tuvia.
5807 Ras-Atantur. 2/7/69. Coll. L. Fishelson.
6194 Marsa Abu Samra. 6/10/69. 80-100 fm. "La'Merkhav" Cruise. Coll. Ch. Lewinsohn.
6919, 6923, 6930 Elat 13-17/11/70. 3-4 m. Coll. B. Gorenstain-Galil.
7206 Nuweiba el Museina. 8/10/69. 150-165 fm. "La'Merkhav" Cruise. Coll. Ch. Lewinsohn.
7225 Tiran Is., Gordon Reef. 7/10/69. 30-45 fm. Coll. Ch. Lewinsohn.
7228, 7236, 7238 Off Wadi Murach. 9/10/69. 40-45 fm. "La'Merkhav" Cruise. Coll. Ch. Lewinsohn.
7258 Marsa Abu Samra. 6/10/69. 36 fm. "Merkhav" Cruise. Coll. Ch. Lewinsohn.
7268 Same as 7206.
7308, 7309 Elat. 8/7/69. Coll. D. Popper.
7315, 7326, 7379, 7384 Marsa Murach. 22/6/68-9/11/71. Coll. L. Fishelson.
7431 Same as 7225.
9819, 9828, 9829 Ras Kanisa, Gulf of Suez. 17/10/72. From coral (*Stylophora*). Coll. L. Fishelson.
12134, 12135, 12136 Ras Kanisa, Gulf of Suez about 1 km offshore. 17/10/72. 1-2 m, from dead corals. Coll. Ch. Lewinsohn.

12137, 12138, 12139 Abu Rudeis, Gulf of Suez. 20/10/72. 1-2 m, coral reef 500 m off shore, from dead *Acropora*. Coll. Ch. Lewinsohn.
12140, 12141 Et Tur, Gulf of Suez. 18/10/72. 1-2 m, coral reef near beacon, from dead corals.
12142 Ras Garra, Gulf of Suez. 16/10/72. 1 m, from dead corals covered with algae. Coll. Ch. Lewinsohn.
12143 Three km north of Abu Durba, Gulf of Suez. 19/10/72. 1 m, from dead corals. Coll. Ch. Lewinsohn.
12144 Gulf of Suez, Red Sea 28°11'N, 32°54'E. 11/11/72. Trawled at 19 fms. Coll. Ch. Lewinsohn.
12145, 12146 Gulf of Suez, Red Sea 29°04'N, 33°02'E. 11/11/72. Trawled at 23-25 fms, from sponge. Coll. Ch. Lewinsohn.
12147, 12148 Gulf of Suez, 28°48'N, 33°08'E. 12/11/72. 29-31 fms, from sponges. Coll. Ch. Lewinsohn.
12428 South of Dahab. 24/7/72. Coll. L. Fishelson.
12431 Ras Abu Suweira. 26/9/74. Coll. L. Fishelson.

The "SLR..." prefix are those specimens collected under the 5 year research program sponsored jointly by the Hebrew University and the Smithsonian Institution (Washington); the full account of the studies is given by Por et al., 1973. (SLR was a part of an arbitrary three letter code used to differentiate collections from the Red Sea from those from the Suez Canal and Mediterranian Sea.)

SLR 1 Marsa Murach. 6/26/67.
254 Ophir Bay. 29/8/67. On the reef.
288 Same as 254. 30/8/67. Poisoning.
292 Marsa Murach. 30/8/67. Poisoning.
424 El Kura. 13/9/67. Inside stone.
526 Same as 424. 14/9/67. Poisoning.
564 Marsa Abu-Zabad. 15/9/67. In small pool near shore.
583 Same as 564. Beyond the reef.
616 Same as 564. 16/9/67. Poisoning in a pool near the sea.
688 Ras Muhammed. 17/9/67. Poisoning in lagoon.
882 Abu Zanima. 22/9/67. Intertidal, sandy shore.
1034 El-Hamira. 14/12/67.
1353, 1389 Wadi Treibe. 19/2/68. On dead reef.
1479, 1480, 1592, 1615, 1626 (N. of Nabq) El Gharqana. 0-1/5/68. Poisoning in pools near the sea.
1777 El Bilaiyim. 11/6/68.
1784 Abu Durba. 11/6/68. Poisoning near pier.
1797 Same as 1784. Taken off echinoid, near pier.
1861 Abu Zanima. 12/6/68. Poisoning near pier.
1868 Ras Abu Rudeis. 13/6/68. Poisoning, near oil camp pier.
1881 Same as 1868. Intertidal, near oil camp pier.
1892a Marsa Barrika. 7/8/68. Poisoning in tide pool.
1921 Ras Muhammed. 8/8/68. Reef, opposite channel.
2001, 2039, 2062, 2085, 2110, 2117 Et-Tur. 10-11/9/68. North and South shore poisoning.
2205 Ras Matarma. 31/1/69. Lagoon.
2232 Ras el Misalla. 1/2/69. From coral.
2258 Same as 2232. Intertidal.
2264 Ras es Sudr. 2/2/69. Intertidal.
2315 El Gharqana. 2/6/69. Poisoning.
2339 Same as 2315. From coral.

2416 Marsa et Aat. 4/6/69. On stones.
2694, 2706, 2737, 2825, 2831 El Bilaiyim 13-14/1-5/70. Lagoon.
2883, 2892 Ras es Sudr. 10/8/70. 1 m depth, near pier.
2929 Ras el Misalla. 11/8/70. Intertidal.
2987 Ras Matarma. 12/8/70. Lagoon, under stones.
2996 Same as 2987. Intertidal, near pier.
3093, 3094 Ras es Sudr. 23/9/70. Beach at low tide, unde rstones.
3098 Ras es Sudr. 23/9/70. Poisoning at 15 m depth.
3134 Ras es Sudr. 24/9/70. Reef, to 2 m depth.
3154 Ras es Sudr. 26/1/71. Poisoning in tide pools at low tide.
3169 Ras es Sudr. 27/1/71. Poisoning in 200 m offshore.
3239 Sinafir Is., 9/7/71. Shore opposite Tiran Is.

Appendix II

Species recorded from area under other than current names

Appendix III

New Records of Alpheids from the Persian Gulf

As we completed this study on the Red Sea and the Gulf of Aden we received a small collection of alpheids made by the Danish Persian Gulf Expedition in 1937-38, loaned by the Universitets Zoologiske Museum of Copenhagen. This was supplemented by two species loaned by two individual collectors. Of the 15 species in the collections, 9 are new records for the Gulf (species marked by an asterisk in the listing). The species are listed below for zoogeographic considerations, but inasmuch as all are fully cited in the main text, further references are not given. The main collection will be returned to Copenhagen and the two additional species (indicated by the collector's names) will be deposited in the Smithsonian Institution. Specific locations and collection details may be obtained from the labels in the two institutions.

**Alpheus bisincisus* De Haan. *A. edwardsii* (Audouin). **A. euphrosyne euphrosyne* De Man. **A. lobidens* De Haan. **A. lottini* Guérin. **A. rapax* Fabricius. **A. parvirostris* Dana. *Athanas indicus* (Coutière) (Collected by E. C. Dawson). **Synalpheus coutierei* Banner (Collected by J. R. Randall). *S. neomeris* (De Man). *S. paraneomeris* Coutière. *S. paulsoni* (Nobili). **S. quinquedens* Tattersall. **S. streptodactylus* Coutière. *S. triunguiculatus* (Paulson).

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