

Some Small Collections of Alpheid Shrimp from the Indian Ocean, Including Two New Species of the Genus *Synalpheus*¹

ALBERT H. BANNER and DORA M. BANNER²

ABSTRACT: Some small collections of alpheid shrimp resulting from the participation of the United States research vessels in the International Indian Ocean Expeditions are reported: 53 species in six genera were collected, with many of the collection records extending the known range of the various species within the Indian Ocean. Two new species are described from the deeper sublittoral zone: *Synalpheus cretocolatus* from off the southern tip of Burma and *Synalpheus somalia* from the oceanic coast of Somalia near the Gulf of Aden.

INCIDENTAL TO THE American participation in the International Indian Ocean Expeditions in 1962–1964, small collections were made of alpheid shrimp, some by dredging but mostly by shore collecting. These collections, containing about 450 individual specimens intact enough for identification, and representing 53 species in six genera, were made available to us by the Smithsonian Oceanographic Sorting Center. Many of these specimens represent new records for zoogeography, and two new deeper-water species of the genus *Synalpheus* were included in the specimens.

METHODS

Because the data on numbered stations have not been published elsewhere, where we could we have grouped the collection in the following areas: coastal Burma and Thailand, Andaman Archipelago, Cocos Keeling Atoll, southern India and Ceylon, Maldives, Seychelles, Madagascar and Comores, continental tropical Africa (Kenya

and Tanzania), Pakistan, oceanic coast of Somalia, and Red Sea. Aldabra Atoll does not fit into any of these groupings and because it is of increasing importance due to its new marine laboratory, we have listed it separately. Unless the depth is specified, all collections were made in shallow water, usually on coral reefs. If the record of the species is new for the area, it is marked with an asterisk. The genera and species are arranged in alphabetical order.

The collections are the result of four of the cruises of the RV *Anton Bruun*, one cruise of the RV *Te Vega* (both of the U.S. National Science Foundation), and one cruise of the U.S. Coast Guard S.S. *Pioneer*. Individual collectors were sometimes noted on the field notes, with the largest number of collections having been made by John Garth of the Allan Hancock Foundation, University of Southern California, traveling with the RV *Te Vega*.

The collections, including the type series of the new species, will be deposited at the Smithsonian Institution, and with them we will also file the collection data, species by species, as fully as we have received it.

¹This work was supported in part by National Science Foundation grants GB 25020, BMS 74-11844, and DEB 77-23378. This is contribution No. 572 from the Hawaii Institute of Marine Biology. Manuscript accepted 11 August 1978.

²Hawaii Institute of Marine Biology, University of Hawaii, Honolulu, Hawaii 96822.

Genus *Alpheus* Fabricius

- A. alcyone* de Man, 1902. 3 specimens from Somalia (11°11' N, 51°15' E), 47–49 m.*
A. barbatus Coutière, 1897. 1 specimen from off Mombasa, Kenya.*

- A. bisincisus* de Haan, 1850. 1 specimen from Somalia (11°11' N, 51°14' E), 47–49 m;* 1 from off Mombasa, Kenya.*
- A. bucephalus* Coutière, 1905. 5 specimens from Cocos Keeling;* 11 from Maldives.
- A. clypeatus* Coutière, 1905. 1 specimen from Maldives.
- A. coetivensis* Coutière, 1908. 1 specimen from Comores.*
- A. collumianus* Stimpson, 1861. 1 specimen from Cocos Keeling;* 1 from Maldives.
- A. deuteropus* Hilgendorf, 1878. 1 specimen from Sri Lanka.*
- A. diadema* Dana, 1852. 2 specimens from Cocos Keeling;* 1 from Sri Lanka; 6 from Maldives.
- A. djiboutensis* de Man, 1909. 2 specimens from Aldabra.
- A. edwardsii* (Audouin), 1827. 41 specimens from Gulf of Mannar; 1 from Sri Lanka; 3 from Pakistan (Astola Island).*
- A. eulimene* de Man, 1909. 1 specimen from Maldives.*
- A. frontalis* Milne Edwards, 1837. 3 specimens from Sri Lanka; 1 from Red Sea (Strait of Jubal).
- A. gracilipes* Stimpson, 1861. 4 specimens from Sri Lanka; 4 from Maldives.
- A. gracilis* Heller, 1861. 2 specimens from Maldives.
- A. leviusculus* Dana, 1852. 1 specimen from Maldives.
- A. lobidens* de Haan, 1850. 40 specimens from Gulf of Mannar;* 5 from Pakistan (Astola Island);* 22 from Aldabra Atoll.

Figure 1a, b

REMARKS: In a future paper on the alpheidids of the Red Sea we plan to place in synonymy to *A. lobidens*, *A. inopinatus* Hothuis and Gottlieb 1958 and *A. l. polynesica* Banner and Banner 1974. Here the records of these three nominate forms are combined. The collection from Aldabra was one of the factors that has caused us to reconsider the separation of the three forms. In the single collection there were four males complete with both chelae, but none, including one 40 mm long, had any sculpturing of the small chela. In this they were like the adult form previously known only from the central

Pacific. In six females with the small chela attached and in five loose female small chelae, none had a superior groove nor an inferior shoulder, carrying at most shallow depressions or concavities at these locations. On all large chelipeds of both sexes, the meri carried distal teeth on the inferointernal margin, and on the meri of the small chelipeds of the females, all save two had similar teeth, but none of the four males had these teeth. Finally, all specimens had an inferodistal tooth on the meri of the third and fourth legs, a condition not previously noted except in collections from the Society Islands, but there the presence of this tooth was variable (Banner and Banner 1967:283).

- A. lottini* Guérin, 1829. 6 specimens from Sri Lanka; 12 from Maldives; 2 from Comores;* 1 from off Mombasa, Kenya; 8 from Red Sea (Straits of Jubal).
- A. maindroni* Coutière, 1898. 1 specimen from Cocos Keeling.*
- A. malabaricus malabaricus* (Fabricius), 1775. 1 specimen from off Cochin, India.

Figure 1c

REMARKS: The small chela of this male bears on the base of the dactylus a strong triangular tooth that fits into a depression on the propodal finger, the latter being flanked with 5 rounded teeth. Henderson (1893:432) mentions, but does not figure, the dactylar tooth, and de Man, figures it for *A. m. dolichodactylus* (1911: fig. 105f) but does not mention it. We did not observe the tooth on specimens from Thailand (Banner and Banner 1966:145). We suggest that the development of the tooth may be variable.

- A. malleodigitus* (Bate), 1888. 1 specimen from Cocos Keeling;* 2 from Maldives.*
- A. microstylus* (Bate), 1888. 10 specimens from Cocos Keeling;* 7 from Aldabra.*
- A. miersi* Coutière, 1898. 1 specimen from Maldives; 1 from off Mombasa, Kenya.*

REMARKS: The specimen from Kenya lacked the acute tooth on the merus of the third leg but was in all other ways similar to the holotype and to the specimens we had from Australia (Banner and Banner in press).

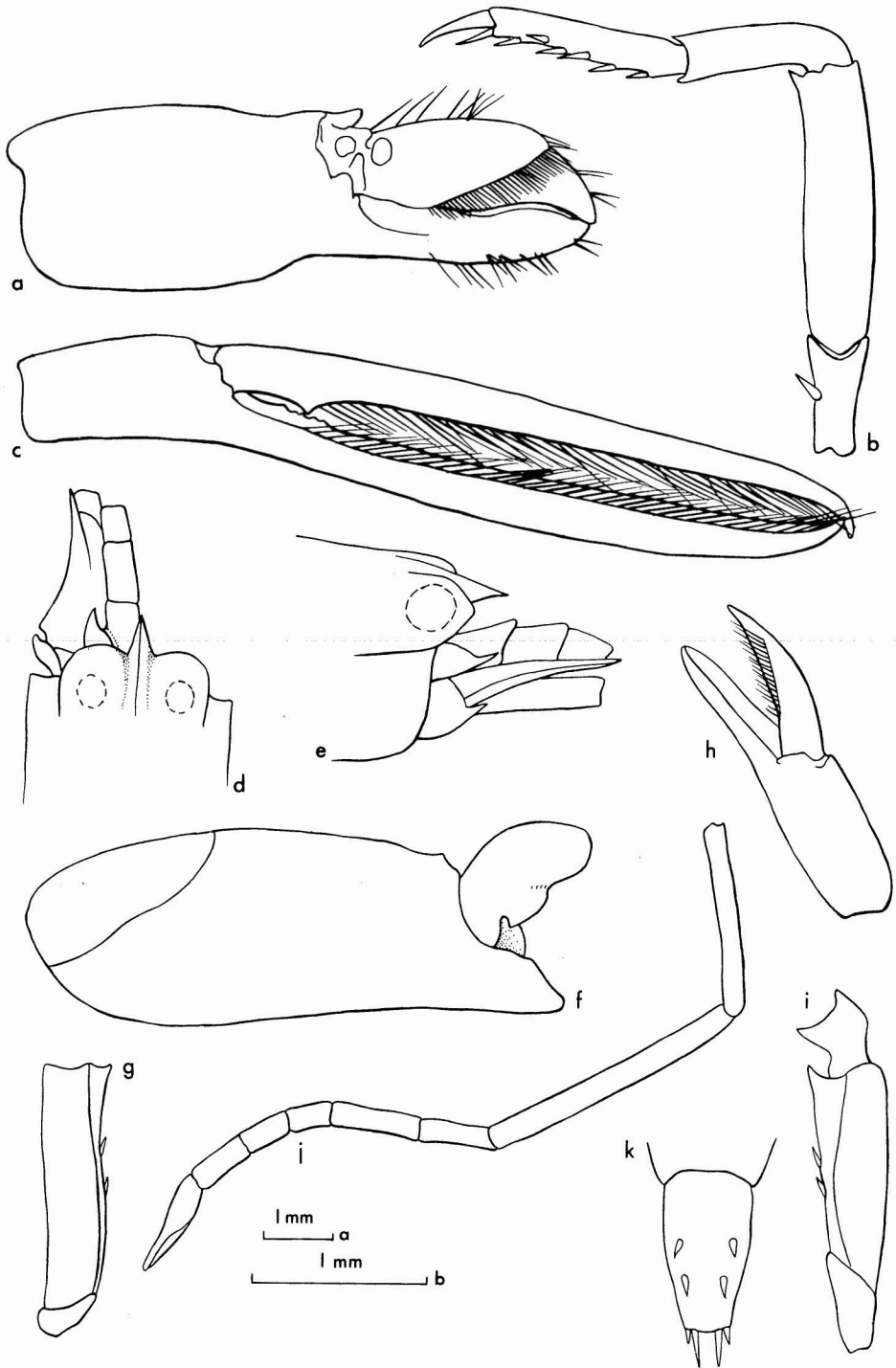


FIGURE 1. *Alpheus lobidens* de Haan, 22-mm female from Aldabra: a, large chela; b, third leg. *Alpheus malabaricus malabaricus* (Fabricius), 25-mm male from off Cochin, India: c, small chela. *Alpheus paralpheopsides* Coutière, 9-mm male from the Maldives: d, e, anterior region, dorsal and lateral view; f, g, large chela and merus, lateral face; h, i, small chela and merus, lateral face; j, second leg; k, telson. Parts a-c, scale a; parts d-k, scale b.

- A. pachychirus* Stimpson, 1861. 2 specimens from Maldives.
A. pacificus Dana, 1852. 1 specimen from Maldives; 9 from Pakistan (Astola Island);* 1 from Comores.*
A. paracrinitus Miers, 1881. 1 specimen from Maldives.
A. paralcystone Coutière, 1905. 3 specimens from Maldives.
A. paralpheopsides Coutière, 1905. 1 specimen from Maldives.

Figure 1d-k

REMARKS: We are uncertain whether this specimen, a 9-mm male lacking the third, fourth, and fifth thoracic legs, is the same species that Coutière (1905:902, fig. 41) described from the Maldives on the basis of two females (sizes not given) and from the Chagos Bank area (Coutière 1921:427) on the basis of one specimen (size and sex not given). We have been unable to find these three specimens either at the museum in Paris or at Cambridge, and the species has not been reported elsewhere in the literature. While the specimen in general agrees with his description there are a few differences: the orbital hoods are more uniformly rounded instead of carrying slight projections on their anteromedial margin; the large chela is somewhat thicker, 3.0 instead of 3.5 times as long as broad, and Coutière makes no mention of the two spines on the middle of the meri of both large and small chelipeds; the telson is of different shape and the medial pair of spines is almost as long as the tip is broad instead of half as long, as shown by Coutière. The small chela is also sub-balaeniceps, but this condition is often found in the males of the *Diadema* group. There is also a question in our minds about the separation of this species from the closely related and variable species *A. paracrinitus* Miers (Banner and Banner 1967: 279), but that cannot be considered with a single mutilated specimen.

- A. parvirostris* Dana, 1852. 11 specimens from Maldives;* 3 from Madagascar (Tulear); 11 from Red Sea (Strait of Jubal).

- A. rapacida* de Man, 1911. 1 specimen from Burma (14°52' N, 96°39' E), 48-64 m.*
A. rapax Fabricius, 1798. 1 specimen from Sri Lanka.
A. strenuus Dana, 1852. 5 specimens from Gulf of Mannar; 4 from Maldives; 4 from Aldabra;* 2 from off Mombasa, Kenya; 2 from Red Sea (Straits of Jubal).
A. sulcatus Kingsley, 1878. 1 specimen from Cocos Keeling;* 1 from Sri Lanka;* 3 from Maldives; 1 from Amirante Island; 1 from Comores;* 5 from Mombasa, Kenya;* 16 from Latham Island (near Zanzibar).

Genus *Aretopsis* de Man

- A. amabilis* de Man, 1910. 1 specimen from Maldives;* 1 from Madagascar (Nossi-Bé).

REMARKS: The specimen from Madagascar was found living in a shell inhabited by the hermit crab *Dardanus lagapodes* Forsskål.

Genus *Athanas* Leach

- A. dimorphus* Ortmann, 1894. 2 specimens from Gulf of Mannar; 8 from Sri Lanka.*
A. djiboutensis Coutière, 1897. 2 specimens from Cocos Keeling;* 3 from Maldives; 1 from Aldabra Atoll.*
A. dorsalis (Stimpson), 1861. 1 specimen from Maldives.
A. indicus (Coutière), 1903. 1 specimen from Maldives; 1 from Madagascar (Tulear).

Genus *Metalpheus* Coutière

- M. paragracilis* (Coutière), 1897. 1 specimen from Maldives.

Genus *Racilius* Paulson

- R. compressus* Paulson, 1875. 8 specimens from Red Sea (Straits of Jubal).

Genus *Synalpheus* Bate

- S. coutierei* Banner, 1953. 7 specimens from Thailand (7°34' N, 98°00' E), 77 m; 1 from Gulf of Mannar.

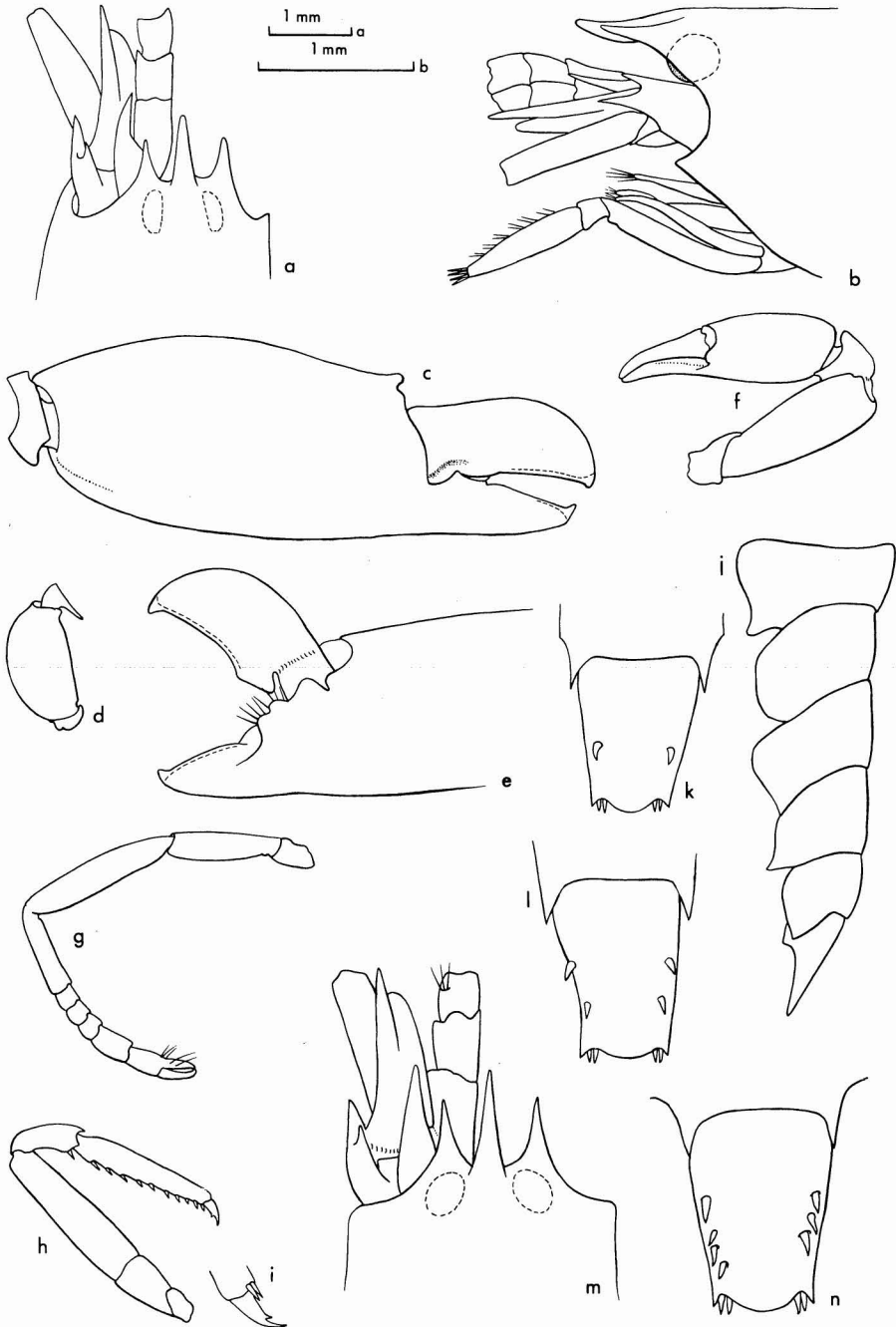


FIGURE 2. *Synalpheus cretocolatus* sp. nov. Holotype, 15-mm male: a, b, anterior region, dorsal and lateral view; c, d, large chela and merus, lateral face; e, large chela, anterior region, medial face; f, small cheliped, lateral face; g, second leg; h, i, third leg and dactylus enlarged; j, abdominal segments; k, telson. 16-mm paratype: l, telson. 18-mm paratype: m, anterior region, dorsal view; n, telson.

Parts a-h, j-n, scale a; part i, scale b.

Synalpheus cretocolatus sp. nov.

Figure 2

Holotype

15-mm male from 10°37' N, 97°34' E (Andaman Sea off southern tip of Burma). 75–80 m (*Anton Bruun* cruise 1, stat. 21, 24 March 1963).

Paratypes

2 males, 15, 17 mm; 3 females, 15–17 mm from same collection as holotype.

Diagnosis

Rostrum acute, slender, reaching just short of first antennular article, orbital teeth 0.7 as long as rostrum. Orbital teeth and rostrum curved slightly upward at tips. Rostrum with orbitorostral process. Eyes well developed but without pigmentation in preservation. Visible part of first antennular article about 1.7 times longer than second article; second antennular article a little longer than broad; third article a little shorter than second. Stylocerite reaching to near first quarter of second antennular article. Outer tooth of scaphocerite a little longer than antennular peduncle, squamous portion reaching to middle of third antennular article. Carpo-cerite 3.5 times as long as broad, equal in length to lateral tooth of scaphocerite. Basicerite with inferior tooth reaching past middle of first antennular article, and with strong superior tooth a little shorter than orbital teeth.

Third maxillipeds as normal for the genus.

Large chela subcylindrical, 2.8 times as long as broad with fingers occupying one-third of total length. Distal end of palm bearing rounded, somewhat upturned tubercle. Dactylus with superior carina and well-developed but short plunger. Oppositive faces of both fingers bearing cutting ridges on lateral face; tips curved as blunt teeth, crossing when fingers are closed. Carpus cup-shaped, inferior section flattened, platelike and developed as two rounded lobes. Merus stout, 1.8 times as long as broad, superior

margin in lateral view broadly arcuate and not projected distally; inferior margins projecting as rounded to angular lobe externally, as acute angle internally.

Small chela stout, 3.3 times as long as broad, fingers 0.7 as long as palm. Fingers carrying rounded ridge along entire length, tips curved, subacute and crossing. Carpus cup-shaped, 0.2 as long as chela. Merus 2.7 times as long as broad, distal angles rounded, not projecting.

Ratio of carpal articles of the second leg: 10 : 1.6 : 1.6 : 1.6 : 4; middle articles slightly broader than long.

Ischium of third leg without spine. Merus almost 4 times as long as broad, carpus 0.4 as long as merus, superior margin projecting into subacute tooth; inferior margin bearing two short spines distally. Propodus 0.9 length of merus, bearing on inferior margin 9 small spines and one pair distally. Dactylus biunguiculate, with superior unguis slender and gradually curved; inferior unguis much smaller than superior, slightly distal to mid-point of dactylar length.

In both sexes, sixth abdominal somite bearing posteriorly two long acute teeth flanking articulation of telson. Telson 2.0 times as long as posterior margin is broad. Posterolateral margins projecting as short acute teeth with tips reaching almost to level of medial convexity. Posterolateral pairs of spines subequal in length, slightly longer than teeth. Only one pair of spines on dorsal surface of telson in holotype.

Ova containing developing larvae with pigmented eyes 0.5×0.8 mm diameter.

Discussion

Two aspects of these specimens are worthy of note. First, while the holotype has only one pair of dorsal spines on the telson, four of the paratypes have the usual two pairs, and one specimen—a female—has three normal-sized articulated spines on the right side and four on the left. Second, the eyes lack pigment. The eyes are large and hemispheric, with surface lenses and, upon crude dissection, with underlying ommatidia (detailed observations with sectioning not

done); however, in alcoholic preservation they are entirely white with no pigment visible. When the ommatidial layer is removed, there is found at its base a thin layer of dark pigment, and in the ova with developing larvae the black eyes are visible. As the melanistic pigment in crustacean eyes does not normally bleach in either formalin or alcoholic solutions and as there is no evident loss of pigment in the eyes of the developing larvae, this would suggest that the adult eyes have almost no melanin. It is known that in dark adaptation in crustacean eyes the normal screen of black pigment separating the ommatidia migrates toward their bases, converting the apposition image to superposition image (for a discussion of vision in crustaceans, see Waterman 1961). We once tried to collect around the islets offshore from Ranong, Thailand, about 60 to 100 km from the type locality, and found the waters there so turbid both from rich plankton and from sediments stirred by strong tidal currents that underwater visibility was only a few feet. We would estimate that a very small percentage of incident sunlight would penetrate to 75–80 m. The condition of the eyes, then, may be a genetic adaptation to extremely low levels of illumination, but still permitting some vision in the dark-adapted eyes. Other eye pigments found in life, especially photosensitive pigments, could have dissolved in alcoholic preservative.

To our knowledge, no other species of the genus *Synalpheus* is so devoid in pigment in its eyes. Otherwise, this species seems to be most closely related to other species that carry teeth on the sixth abdominal segment projecting over the articulation of the telson (all in the Coutierei group). These are *S. triacanthus* de Man, *S. trispinosus* de Man, and *S. bispinosus* de Man. The first two species carry, in addition to the paired lateral teeth, a large medial tooth on the sixth segment. *Synalpheus cretocolatus* differs from *S. bispinosus* in the following characteristics: (1) the rostrum is markedly longer than the orbital teeth instead of being subequal; (2) the carapocrite reaches only to the end of the antennular peduncle instead of reaching the length of the third antennular article past the

peduncular tip; (3) the inferior unguis of the dactylus of the third leg is markedly smaller than the distal instead of having the two ungui almost equal; (4) the posterolateral angles of the telson are acute and projecting instead of being merely angular.

The name is derived from *creta*, chalk, and *oculatus*, to bear eyes, and refers to the condition of the eyes under preservation.

S. hastilicrassus Coutière, 1905. 12 specimens from Gulf of Mannar;* 6 from Somalia (11°11' N, 51°14' E), 47–49 m.*

S. neomeris (de Man), 1888. 1 specimen from Burma (19°50' N, 92°55' E), 33–30 m; 1 from Thailand (9°54' N, 97°42' E), 70 m; 1 from Somalia (9°25' N, 50°54' E), 85–95 m.*

S. nilandensis Coutière, 1905. 4 specimens from Andaman Islands (10°37' N, 97°34' E), 75–80 m;* 3 from Thailand (7°34' N, 98°00' E), 77 m.*

REMARKS: The specimens from the Andamans are of the *alpha* form and those from Thailand are of the *bandaensis* form (Banner and Banner 1975:327).

S. paraneomeris Coutière, 1905. 1 specimen from Gulf of Mannar;* 2 from Maldives.

Synalpheus somalia sp. nov.

Figure 3

Holotype

14-mm male from off Somalia (11°11' N, 51°14' E), 47–49 m (*Anton Bruun* cruise 9, Station 9–453)

Paratypes

2 females, both 18 mm long, from same locality as holotype.

Diagnosis

Rostrum narrow with straight sides, tip rounded and reaching almost to middle of visible part of first antennular article. Orbital teeth broad at base, forming an equilateral

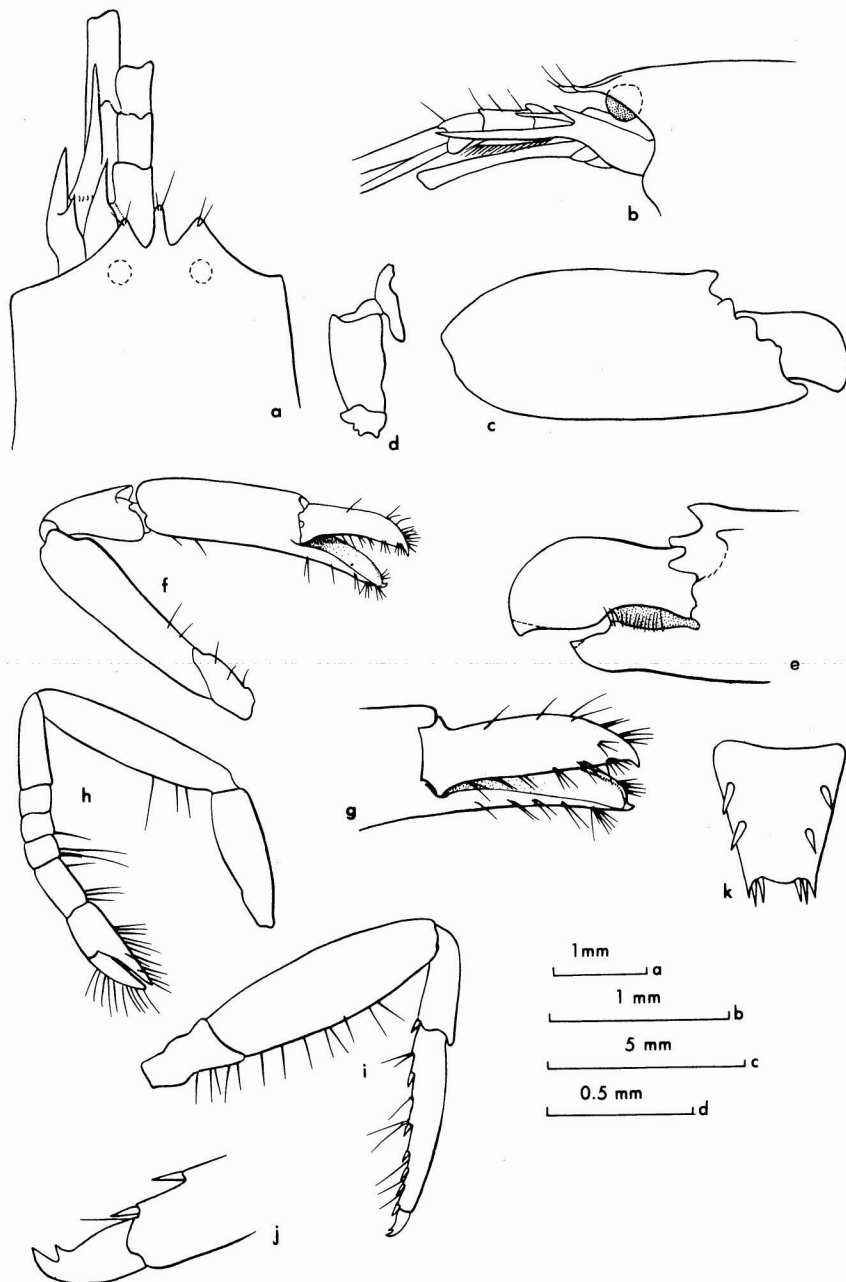


FIGURE 3. *Synalpheus somalia* sp. nov. Holotype, 14-mm male: *a, b*, anterior region, dorsal and lateral view; *c, d*, large chela and merus, medial face; *e*, large chela, distal end enlarged, lateral face; *f, g*, small cheliped, lateral view, fingers enlarged; *h*, second leg; *i, j*, third leg, enlarged dactylus; *k*, telson.

Parts *a, b, e, f, k*, scale a; parts *g, h, i*, scale b; parts *c, d*, scale c; part *j*, scale d.

triangle, almost as long as rostrum. Tip of rostrum and orbital teeth bearing several fine setae and slightly upturned; with orbitorostral process. Stylocerite acute, reaching to end of first antennular article. Visible part of first antennular article 1.6 times longer than second article, second article 1.5 times as long as broad; third article subequal to second. Lateral spine of scaphocerite reaching to end of third antennular article. Squamous portion narrow, reaching to near middle of third antennular article. Carpocerite 7.2 times as long as broad, reaching more than the length of third article past that article. Inferior spine of basicerite a little longer than stylocerite; superior spine prominent and acute.

Third maxillipeds as normal for the genus, with tip bearing cluster of short spines.

Large chela heavy, 2.6 times as long as broad. Palm terminating in three teeth at dactylar articulation; center tooth strong, acute; lateral tooth smaller, obtuse when seen from above, acute in profile; medial tooth projecting from dactylar articular surface and forming a right angle. Dactylus with distal half heavy, with superior margin strongly convex; tip projecting as slight rounded tooth of clear hardened chitin; inferior margin slightly convex with opposite face broad and slightly rounded; plunger well developed. Pollex exceeded by about one-third length of dactylus, tip rounded-obtuse also of hardened chitin, not meeting with hardened portion of dactylus. Merus short, 1.7 times as long as broad, unarmed.

Small chela slender, 3.7 times as long as broad. Dactylus somewhat broadened, with opposite face flattened and broad to tip; tip bearing small acute tooth; distal portion bearing tufts of setae pointing toward margins of pollex. Pollex broadened, with rounded distal margin and flattened opposite face; tip bearing acute tooth at right angles to plane of proximal surface and meshing with tooth of dactylus; margins bearing tufts of setae like those of dactylus. Carpus 0.5 as long as merus. Merus 3.1 times as long as broad, gradually tapering proximally to 0.6 times maximum breadth; inferoexternal margin bearing fine setae.

Second legs stout, with middle three

articles about as broad as long. Ratio of carpal articles: 10:3:3:3:6.

Merus of third leg inermous, 3.2 times as long as broad. Carpus 0.4 as long as merus with superodistal margin projected and inferior margin not projected but bearing a single spine. Propodus 0.7 as long as merus, bearing on its inferior margin 5 spines and a pair distally. Dactylus biunguiculate, ungui curved at right angles to propodus, superior unguis longer and a little thicker at base than inferior; notch between ungui U-shaped.

Telson almost 2 times as long as posterior margin is broad; posterolateral angles of telson extended well beyond arcuate posterior margin, as long as inner pair of spines and with length less than one-third breadth of tip. Dorsal spines heavy. Uropods normal.

Discussion

We believe that the characteristic most valuable in separating this species from all others of the genus is in the great extension of the dactylus of the large chela beyond the tip of the pollex, for we have not been able to find any other species described with this development. This overhang of the dactylus is consistent in the holotype and paratypes. In some species, such as *Synalpheus pescadorensis* Coutière and *S. quadriarticulatus* Banner and Banner, there is a slight extension of the dactylus, but in both of these species the dactylus proximal to the tip is swollen and rounded. A number of species of the genus have excavate fingers on the small chela that bear one or more distal teeth, but in many of these the dactylus is markedly broadened and the teeth may be several in number—these would include again *S. pescadorensis*, *S. quadriarticulatus*, and *S. sciro* Banner and Banner. Finally, there is a group of species within the genus that has the posterolateral angles of the telson acute and projecting to various degrees. The ones with normally slight projections, such as *S. tumidomanus* (Paulson), are never known to grow into long projections, but some aberrant individuals in the species with normally long projections may have slight ones (Banner and Banner 1975: figs. 19, 21, and others).

Nevertheless, it would be well to compare this new species with those known to have long projections. From each in this group it can be easily separated. In *S. thai* Banner and Banner the projecting teeth are much longer than the width of the tip of the telson between them; in *S. fossor* (Paulson) the dactyli of the third legs are triunguiculate; in *S. trispinosus* de Man there are three strong teeth on the posterior margin of the sixth abdominal segment that overhang the telson; in *S. acanthitelsonis* Coutière the rostrum is long and narrow, reaching to well within the limits of the second antennular article; in *S. hastilicrassus* Coutière the dactylus of the small chela does not bear flattened to excavate opposite surfaces; and, finally, in *S. ancistrorhynchus* de Man, which has a small chela like this species, the merus of the third legs bear one to several movable spines, or, if spines are not developed, tufts of setae, and the palm proximal to the dactylar articulation of the large chela bears only one rounded tooth instead of three, with the superior tooth being smaller and less acute in *S. ancistrorhynchus*.

The species is named from the coastline where it was captured.

S. stimpsonii (de Man), 1888. 2 specimens from Andaman Islands, 21 m;* 1 from Thailand (7°34' N, 98°00' E), 77 m.

REMARKS: Field notes on the Andaman specimens state they were taken from a green and purple crinoid.

S. streptodactylus Coutière, 1905. 8 specimens from Gulf of Mannar;* 3 from Maldives; 31 from Somalia (11°11' N, 51°14' E), 47–49 m.*

S. triacanthus de Man, 1910. 1 specimen from Sri Lanka.*

REMARKS: Like specimens collected from the Sulu Archipelago (Banner and Banner 1979:247) this specimen bears 2 spines on the meri of the third legs instead of being inermous.

S. trispinosus de Man, 1910. 5 specimens from Burma (10°37' N, 97°34' E), 75–80 m;

3 from Thailand (7°34' N, 98°00' E), 77 m;* 5 from Maldives.*

S. triunguiculatus (Paulson), 1874. 1 specimen from Red Sea (Strait of Jubal).

S. tumidomanus (Paulson). 1 specimen from Burma (14°07' N, 97°05' E), 69–73 m;* 16 from Gulf of Mannar; 1 from Maldives.

LITERATURE CITED

- BANNER, A. H., and D. M. BANNER. 1966. The alpheid shrimp of Thailand. Siam Soc. Mono. no. 3. v + 168 pp., 62 figs.
- . 1967. Contributions to the knowledge of the alpheid shrimp of the Pacific Ocean. Part XI. Collections from the Cook and Society Islands. Bishop Mus. Occ. Pap. 23(12):253–286.
- BANNER, D. M., and A. H. BANNER. 1975. The alpheid shrimp of Australia. Part II. The genus *Synalpheus*. Rec. Aust. Mus. 29(12):267–389.
- . 1979. Annotated check list of alpheid and ogyridid shrimp from the Philippine Archipelago and the South China Sea. *Micronesica* 14(2):215–257.
- . In press. The alpheid shrimp of Australia. Part III. The remaining alpheids, principally the genus *Alpheus*, and the family Ogyrididae. Rec. Aust. Mus.
- COUTIÈRE, H. 1905. Les Alpheidae. Pages 852–921 in J. S. Gardiner, ed. The fauna and geography of the Maldive and Laccadive Archipelagoes. Vol. 2. University Press, Cambridge, England (Vol. dated 1906).
- . 1921. Les espèces d'Alpheidae rapportées de l'Océan Indien per M. J. Stanley Gardiner. Trans. Linn. Soc. London II Zool. 17(4):413–428. [Also titled: Reports of the Percy Sladen Trust Expedition to the Indian Ocean in 1905 6(10):413–428.]
- HENDERSON, J. R. 1893. A contribution to Indian carcinology. Trans. Linn. Soc. London II 5(10):325–458.
- MAN, J. G. DE. 1911. The Decapoda of the Siboga Expedition. Part II. Family Alpheidae. Siboga-Expeditie 39a¹(2):133–465. Livre 60. E. J. Brill, Leiden.

- . 1915. The Decapoda of the Siboga Expedition. Supplement . . . Explanations of plates of Alpheidae. *Siboga-Expeditie* 39a¹(2):23 pls. Livre 74. E. J. Brill, Leiden.
- WATERMAN, T. H. 1961. Light sensitivity and vision. Pages 1–64 *in* T. H. Waterman, ed. *The Physiology of Crustacea*. Vol. 2. Academic Press, New York and London.