Synalpheus pococki Coutière

Fig. 24 a–h

Synalpheus neomeris var. *pococki* Coutière, 1898d, Bull. Soc. Ent. France 1898 (7): 167, fig. 2 [Holothuria Bank, N. W. Australia, Macclesfield Bank, Arafura Sea].

Synalpheus pococki De Man, 1911, Siboga Exped. 39a[1] (2): 234, fig. 32.

Additional Australian Records:

Coutière, 1900, Bull. Mus. Hist. nat., Paris 6 (8): 411, Albany Passage, Torres Straits.

Specimens examined: 1, 19 mm female from AM 67 (near Darwin).

Diagnosis: Rostrum slender, 3.5 times as long as broad at base, reaching to end of first antennular article. Orbital teeth a little shorter with outer margins straight, inner margins concave. Rostral base with orbitorostral process.

Visible part of first antennular article a little longer than second; third a little shorter than second. Stylocerite reaching middle of second antennular article. Squamous portion of scaphocerite not reduced, reaching near end of antennular peduncle; lateral tooth longer than peduncle. Carpocerite 4.0 times as long as broad when viewed from below, slightly longer than antennular peduncle. Inferior spine of basicerite a little shorter than stylocerite, superior spine prominent, acute.

Large chela 2.6 times as long as broad, fingers occupying almost the distal one-third, with acute tooth above dactylar articulation. Merus three times as long as broad, superodistal margin terminating in an acute tooth, inferior margins inermis. Small chela 4.0 times as long as broad, fingers 0.38 the total length. Carpus 0.6 as long as broad, with superodistal margins armed with acute tooth.

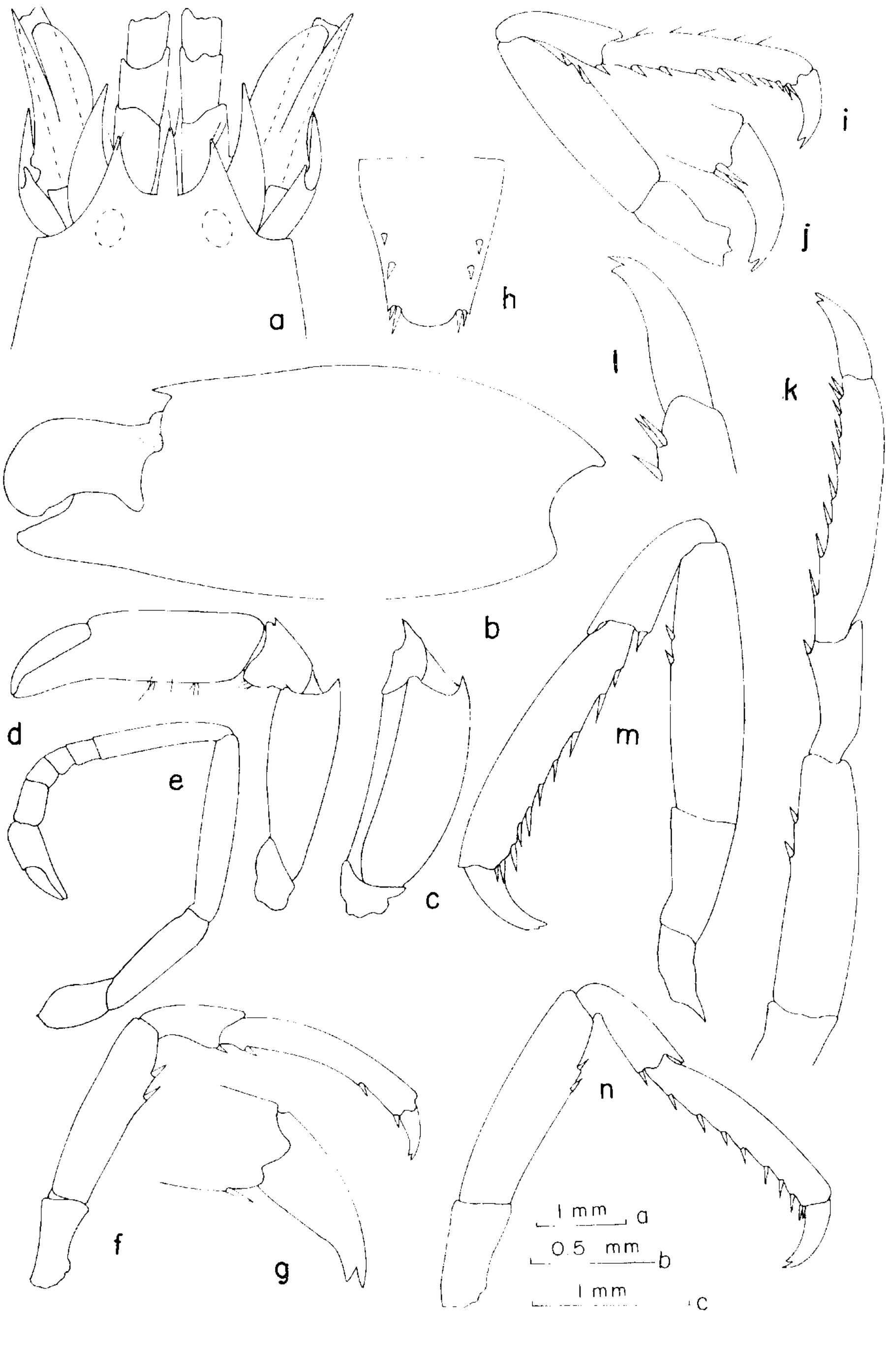
Carpal articles of the second leg with a ratio: 10:1:1:1:3; third article about as long as broad.

Merus of third leg four times as long as broad, bearing two short strong spines on distal half, but distal margins unarmed. Carpus 0.4 as long as merus, distosuperior margin terminating in obtuse projection, distoinferior margin with spine. Propodus distinctly curved, bearing one spine proximally and one at about three-quarters length along inferior margin; one distal spine. Dactylus one-fourth as long as propodus, unguis about one-eighth as long as entire dactyl; inferior unguis thicker at base and a little shorter than superior unguis.

Telson 2 times as long as wide, posterolateral angles slightly projecting and acute.

OPPOSITE

Fig. 24.—*Synalpheus pococki* Coutière and *Synalpheus iocosta* De Man. *Synalpheus pococki*: 11 mm male from AM 67; a, Anterior region, dorsal view; b, c, large chela and merus, inner face; d, small cheliped; e, second leg; f, g, third leg and enlarged dactylus; h, telson. *Synalpheus iocosta*, 14 mm male from AM 13: i, j, third leg and dactylus. 13 mm female from WM 94 65: k, l, third leg and dactylus. 13 mm female from WM 290-65: m, third leg. Superior unguis. In reduction the roughness where the unguis was attached no longer may be seen. 12 mm female from WM 69-65: n, third leg. a, b, c, d, e, f, h, scale a: g, j, l, scale b: i, k, m, n, scale c.


a
h
i
j
l
k
b
d
e
c
m
n
f
g
1 mm a
0.5 mm b
1 mm c

Discussion: The only difference between this species and *S. iocosta* De Man is the nature of the third leg (*see below*). Our specimen agrees well with Coutière's original description as well as De Man's specimen from Indonesia.

Biological notes: Our specimen was taken from a "growth on a pearl shell", and that of De Man's was captured in a dredge at 13 metres. Coutière did not make any remarks about possible habitats of his specimens, but his specimens from Albany Passage were dredged at 10 fathoms. We suggest that the unique propodus of this species may be an adaptation for a special environment, similar to the hooked dactylus of the small chela of *S. comatularum*, and the strange ungui of the third legs of *S. charon*; however, no available data suggests what this habitat might be.

Australian distribution: Darwin, Arafura Sea and Torres Straits.

General distribution: De Man's specimen from the east coast of Aru Islands in Indonesia is the only record from other than Australia.

Synalpheus iocosta

De Man

Fig. 24 i–n

Synalpheus iocosta De Man, 1909a, Tijdschr. ned. dierk. Vereen. II, 11 (2): 119; 1911 Siboga Exped. 39a[1] (2): 235, fig. 33.

Specimens examined: 1 specimen from AM 13; 1 specimen each from CS 19, 20, 21; 1, WM 69–65; 1, WM 94–65; 1, WM 290–65.

Discussion: As this species is almost exactly the same as *S. pococki* Coutière (p. 366) except in the propodus of the third leg we are not offering a separate description. In the propodi, that of *S. pococki* is distinctly curved, more curved than any other synalpheid, and bears but three spines while in this species it is almost straight and bears 7–8 spines along the inferior margin. We have pictured the legs from four specimens and show how consistent they are in proportion and armature. De Man in his original description of this species, with a series of 42 specimens, points out that the dactylus of the third leg is longer, less heavy and has smaller ungui than in *S. pococki*, but that these characteristics are variable. Our specimens of the two species are in excellent agreement with the original descriptions. One might question the separation of the two species, but certainly nothing in the present collections nor from those previously reported would indicate that the separation of the species is other than valid.

Biological notes: This species has only been collected in dredges from many types of bottoms in water up to 72 fathoms. The three specimens dredged from Cockburn Sound were found associated with sponges and bryozoans. Our specimens ranged from 9–12 mm in length.

Australian distribution: From Cape Naturaliste to Carnarvon in Western Australia and one specimen from the Gulf of Carpentaria.

General distribution: This species has not been reported since De Man's original specimens from the Aru Islands.

Synalpheus charon (Heller)

Fig. 25

Alpheus charon Heller, 1861, Sbr. Akad. Wiss. Wien 44 (1): 272, pl. 3, fig. 21, 22; 1865, Reise Novara Crust. 2 (3): 107. Paulson, 1874, Invest. Red Sea Crust., 1: 104, pl. 8, fig. 4.

Synalpheus charon De Man, 1911, Siboga Exped. 39a[1] (2): 245, figs. 37. Banner, 1953, Pacif. Sci. 7 (1): 37, fig. 11. Banner & Banner, 1967, Bishop Mus. Occ. Pap. 23 (12): 262.

Synalpheus charon charon Banner, 1956, Pacif. Sci. 10 (3): 331.

Synalpheus charon obscurus Banner, 1956, Pacif. Sci. 10 (3): 329, fig. 5.

Synalpheus prolificus Bate, 1888, Challenger Rept. 24: 556, pl. 99, fig. 4.

Synalpheus helleri De Man, 1911, Siboga Exped. 39a[1] (2): 245, fig. 37.

Additional Australia Records: Patton, 1966, Crustaceana 10 (3): 281, 289. Willis, I., Coral Sea and Wistari Reef, Queensland.

Specimens examined: 1 specimen from AM 123: 1, BAU 33.

Diagnosis: Rostrum with margins of proximal section usually parallel, distal section forming an acute triangle, not reaching to end of visible part of first antennular article. Orbital teeth acute, a little shorter and much broader at base than rostrum. Rostral base with orbitorostral process.

Antennular peduncles stout, articles subequal. Stylocerite reaching slightly past middle of second antennular article. Squamous portion of scaphocerite reaching end of antennular peduncle, lateral spine longer, reaching to end of carpocerite which is at least half the length of the third article past that article. Carpocerite 3.5 times as long as broad. Inferior spine of basicerite not quite as long as stylocerite, superior margin rounded.

Large chela 2.6 times as long as broad, fingers occupying the distal third; slight protrusion above dactylar articulation. Merus 2.3 times as long as broad; superodistal margin terminating in acute tooth, distal ends of inferior margins inermous. Small chela almost three times as long as wide, finger 0.4 of total length. Merus 2.3 times as long as broad, superodistal margin terminating in small acute tooth.

Carpal articles of the second leg with a ratio 10:1.7:1.7:1.7:5. First article as long as four following; second to fourth article broader than long.

Merus of third leg inermis, three times as long as broad, carpus 0.4 as long as merus with superior margin projecting as tooth, inferior bearing heavy spine. Propodus 0.8 as long as merus, bearing on its inferior margin 3-4 short heavy spines, with a pair distally. Dactylus stout, ungui about a third of total length. Inferior unguis obtuse, only slightly curved, inferior surface with excavate "pocket". Superior unguis thin and composed of an acute tip and a lateral flange. (*See* Banner, 1956, fig. 5.)

Telson as usual for *Synalpheus*, 2.3 times as long as posterior margin is broad; distolateral margins not projecting, nor acute. Posterior margin arcuate. Anterior pair of dorsal spines located in the middle.

Discussion: This species is readily recognized by the dactyli of the thoracic legs which have the heavy inferior unguis with the pocket-like cavity in the lower side and the smaller acute upper unguis with the lateral flange. No other species of the genus *Synalpheus* bears a similar dactylus.

The great variation in the rostral front has lead to the separation of one new species and one new subspecies, *S. helleri* De Man and *S. charon obscurus* Banner. We placed these in synonymy in 1967 (Banner & Banner, 1967: 262). We have figured the rostral front of both of our specimens because they show the range of variation (figs 25 a and h). The rostrum in the specimen from AM 123 is of the type with the straight proximal portion which was considered as characteristic of *S. helleri* and *S. charon obscurus*. The rostrum of the specimen from BAU 33 is the more typical.

The review of the Hawaiian alpheids (Banner, 1953) discussed *S. prolificus* (Bate), known only from a single specimen from "Off Honolulu, Sandwich Islands". We suggested that if the ungui of the third legs were similar to *S. charon*, then the two species were closely related. However, we remarked that "the nature of the second legs and of the stylocerite would be valid characteristics for the separation of the two species". The British Museum (Natural History) afforded us the opportunity to re-examine the type specimen of Bate's species. None of the supposed differences between *S. prolificus* and *S. charon* are valid. The rostrum is of the type with parallel sides proximally; the stylocerite reaches the middle of the second antennular article; the first carpal article of the second legs is only slightly longer than the sum of the four following, therefore within the range of variation; and, most important, the ungui of the dactyli of the third legs have development characteristic of *S. charon*. *S. prolificus*, a species unreported since it was described in 1888, is plainly a synonym of *S. charon*. We have added figures of Bates's holotype to our figures of Australian specimens.

Biological notes: This species appears to live largely, if not entirely, on living coral. It has been commonly collected from heads of *Pocillopora meandrina* Verrill in association with *Alpheus lottini* Guérin, and crabs of the genus *Trapezia* (Banner, 1953: 38). All three crustaceans are orange-red in colour. In Australia it has also been found in *Stylophora pistillata* (Esper) and *Seriatopora* sp. (Patton, 1966). The specimen from BAU 33 was taken from a living *Porites* sp. In non-Australian waters, it has been collected from dead coral heads in shallow water and Bate's specimen was dredged from 33 metres. The Australian specimens are small, 10–13 mm in length, but it has been reported up to 22 mm in length.

Australian distribution: Heron Island and Wistari Reef in the Capricorn Group, Rudder Reef, off Port Douglas, and Willis I., Coral Sea.

General distribution: This species has been reported from the Red Sea to Mexico, and from Japan to the Great Barrier Reef. We have seen specimens in the American Museum of Natural History in New York from Ecuador and Columbia, South America.

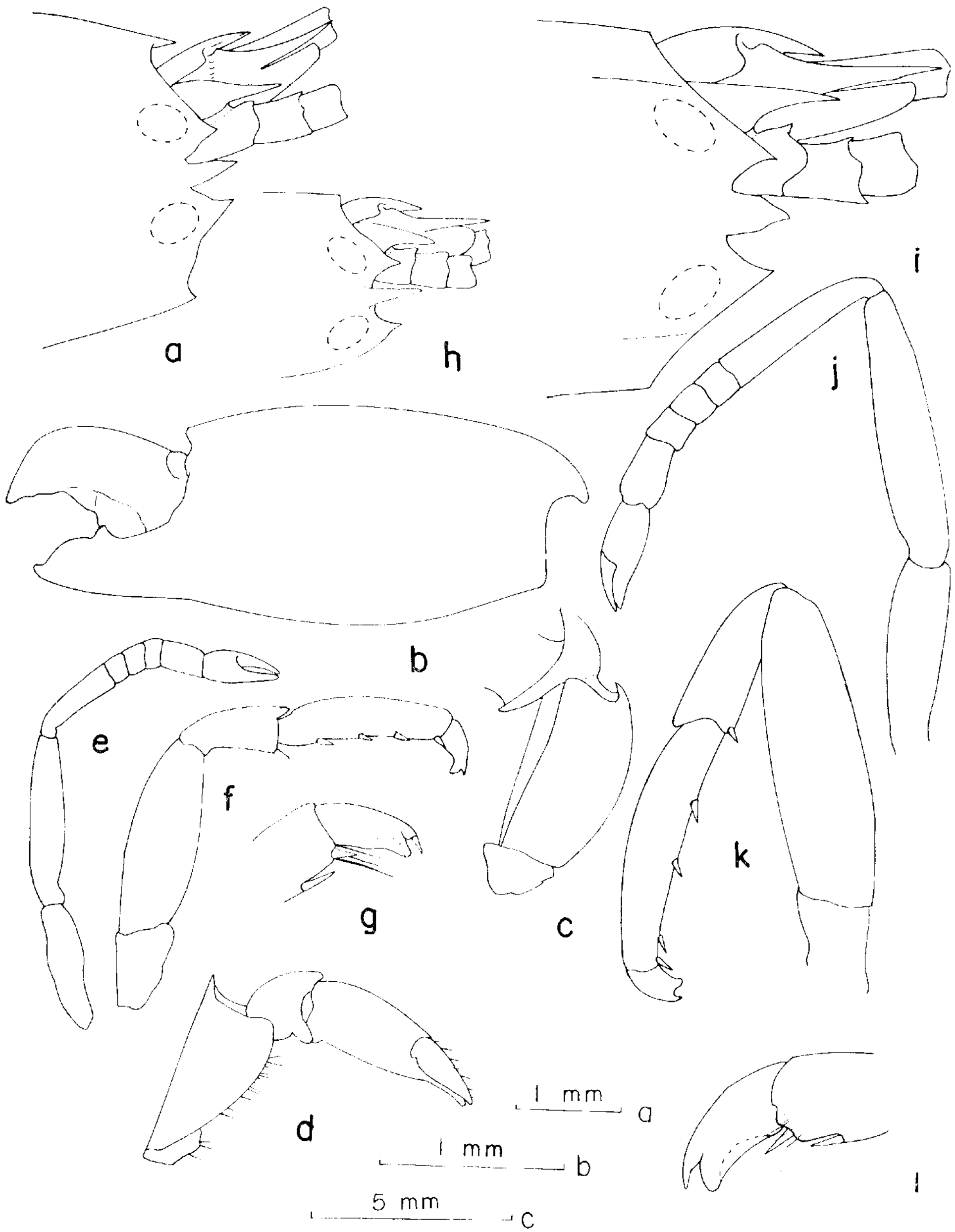


Fig. 25. *Synalpheus charon* (Heller). 13 mm female from AM 123: a, anterior region, dorsal view; b, c, large chela and merus; d, small cheliped; e, second leg; f, g, third leg and dactylus. 10 mm female from BAU 33: h, anterior region, dorsal view. *Alpheus* (*Synalpheus*) *prolificus* Bate, from "Off Honolulu". Holotype: i, anterior region, dorsal view; j, second leg; k, l, third leg and dactylus. a, b, c, d, e, f, h, j, k, scale a; g, l, scale b; i, scale c.

Synalpheus gracilirostris De Man

Fig. 26

Synalpheus gracilirostris De Man, 1910b. Tijdschr. ned. dierk. Vereen: 11 (4): 291; 1911, Siboga Exped. 39a[1] (2): 269, fig. 49.

Specimens examined: 1, 11 mm male from BAU 44.

Diagnosis: Rostrum awl-shaped, reaching to middle of second antennular article. Orbital teeth narrow and acute, reaching to middle of visible part of first antennular article. Rostral base with orbitorostral process.

Visible part of first antennular article 1.5 times longer than second, second and third articles equal. Second antennular article as broad as long. Stylocerite reaching to last quarter of second antennular article. Squamous portion of scaphocerite narrow, reaching to end of third antennular article, lateral spine much longer reaching about length of third article past that article. Carpocerite 4.0 times as long as broad, reaching about half way from end of third article to end of squame. Basicerite with inferior spine as long as stylocerite, superior spine acute and prominent.

Large chela 2.8 times as long as wide with fingers one-third total length, with acute tooth above dactylar articulation. Merus 2.7 times as long as broad, superior margin terminating in an acute tooth, other margins inermous. Small chela three times as long as broad, fingers shorter than palm. Carpus cup-shaped, 0.2 as long as chela, merus similar to that of large chela.

Carpal articles of second leg with a ratio: 10:1:1:1:5.

Merus of third leg five times as long as broad. Carpus 0.5 as long as merus, with superior margin terminating in an obtuse tooth, inferior margin terminating in a heavy spine. Propodus as long as merus and bearing on inferior margin seven spines and a pair distally. Dactylus biunguiculate, superior unguis a little longer but equal in thickness at base to inferior unguis.

Telson 2.6 times as long as posterior margin is broad. Posterolateral angles slightly projecting and acute, about half as long as outer posterior spine.

Discussion: De Man based his description on two specimens. We have one specimen from Australia and two from Zamboanga, Philippines; the species has not otherwise been reported. Our three specimens are similar to each other, and differ from De Man's description in four ways: 1) the inferior spine of the basicerite is almost equal in length to the stylocerite instead of "much shorter than the stylocerite". 2) The superior spine of the basicerite of our specimen is prominent and acute while De Man states "upper angle subacute, but not spiniform". 3) The anterior margin of the chela terminates in an acute tooth rather than a "small, rather obtuse tubercle". 4) The lateral angles of the telson in our specimens are more produced.

All four characteristics are known to be somewhat variable in the genus, but in combination, especially with the marked difference in the inferior spine of the basicerite, they may indicate a new species. However, with a total of five specimens known and with variability so common among many species of synalpheids, we are deferring the application of a new name.

Biological notes: De Man's specimens were dredged from 54 metres, but our three specimens have come from dead coral in waters up to 2 metres deep. It is a small species with none of the known specimens longer than 11 mm.

Australian distribution: Our specimen came from Hayman Island in the Whitsunday Group, Queensland.

General distribution: Timor in Indonesia; southern Philippines.*

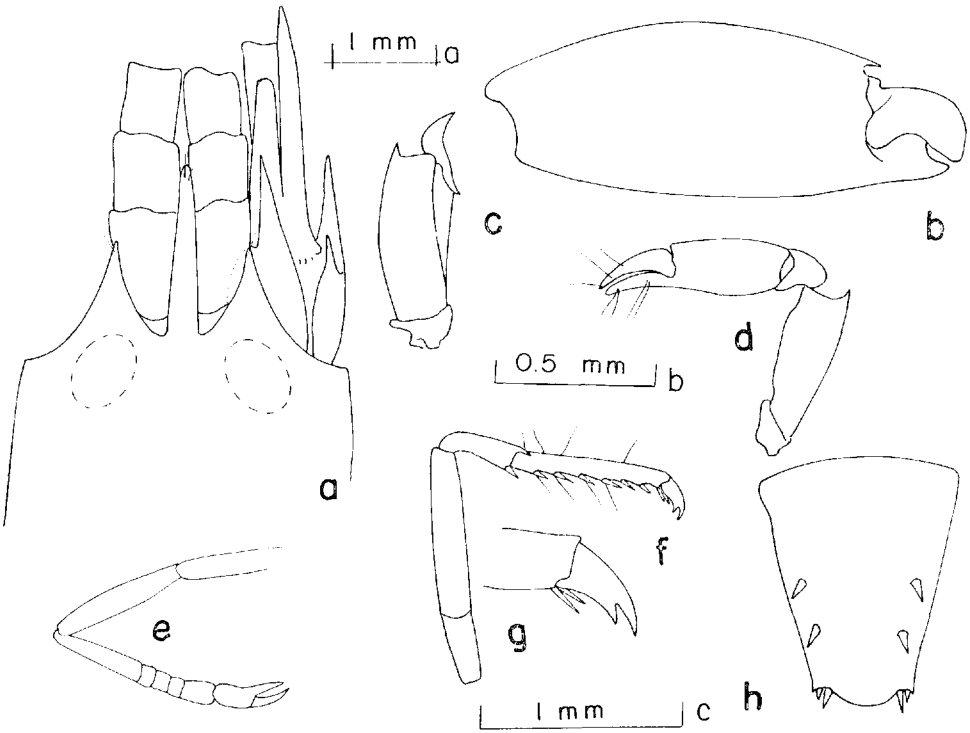


Fig. 26.—*Synalpheus gracilirostris* De Man. 11 mm male from BAU 44: a, anterior region, dorsal view; b, c, large chela and merus; d, small cheliped; e, second leg; f, g, third leg and enlargement of dactylus; h, telson. b, c, d, e, f, scale a; g, scale b; a, h, scale c.

Synalpheus echinus sp. nov.

Fig. 27

Holotype: 17 mm female from Trigg Island, near Perth, Western Australia, collected by W. H. Butler, 20/14/61 (WM 92–65).

Paratypes: 1, 14 mm incomplete female from same location as type; 1, 28 mm ovigerous female from Carnac Is. collected by E. P. Hodgkin (WM 51–65); 1, 17 mm male and 1 large mutilated female from Rottnest Is. (WM 12822/12823); 3 males and 3 females, 16–20 mm from Lancelin Is., (BAU 3 and BAU 4). All localities are near Perth, Western Australia.

Diagnosis: Rostrum narrow almost 3 times as long as broad at base, reaching to end of first antennular article. Orbital teeth also slender, but slightly more than half as long as rostrum; teeth divergent. Rostral base with orbitorostral process.

Visible part of first antennular article 1.7 times as long as second article; second and third article of same length. Stylocerite reaching to near middle of second antennular article. Squamous portion of scaphocerite narrow, as long as antennular peduncle, outer spine longer than carpocerite. Carpocerite subequal to antennular peduncle, 4.0 times as long as broad. Inferior spine of basicerite as long as stylocerite, superior spine reaching to level of tips of orbital teeth.

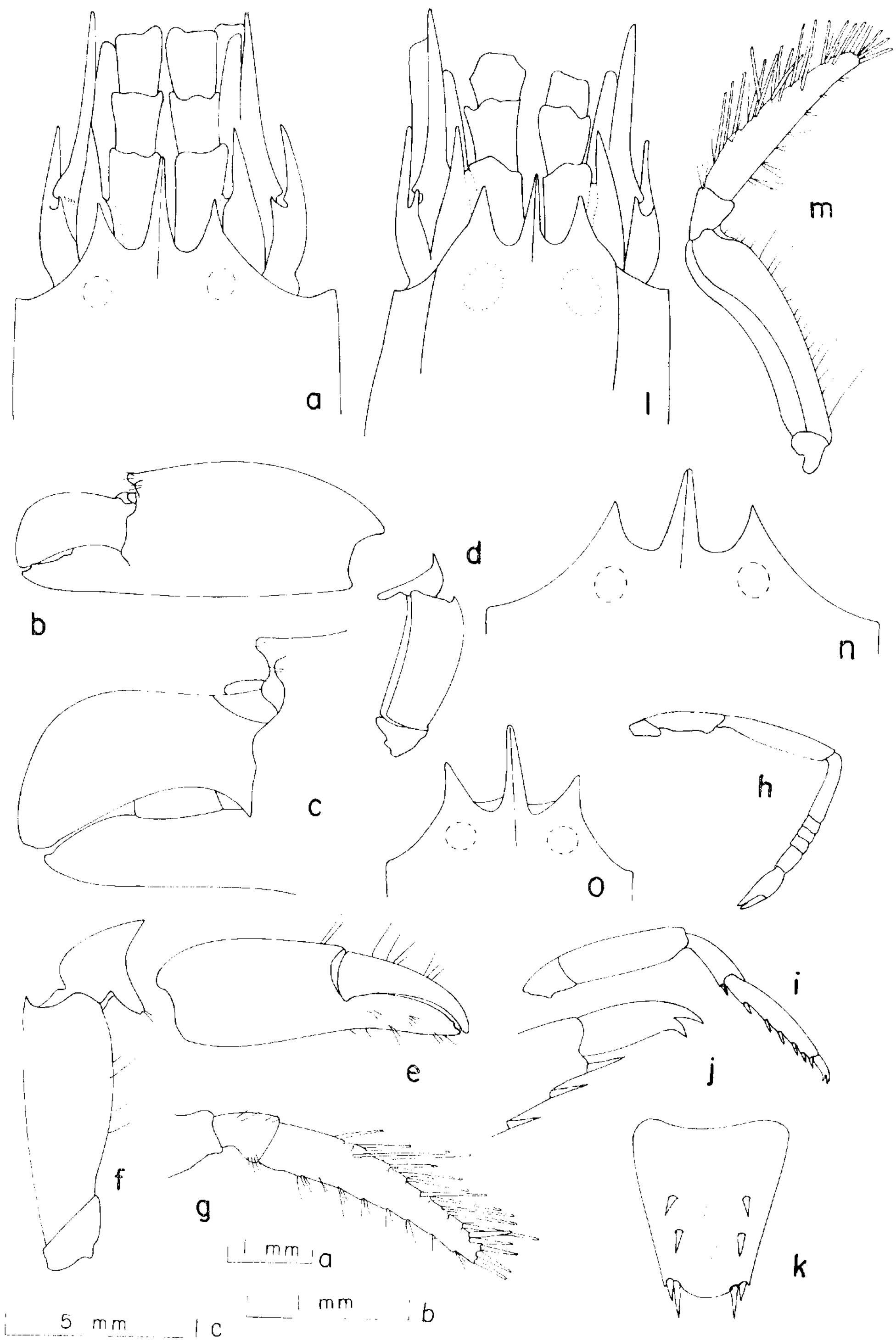
Distal article of third maxilliped bearing on distal two-thirds of superomedial face an armature of 10–20 strong but elongate spines with blunt or acute tips (the spines with blunt tips may represent longer spines that have been broken). Tip of article carrying a circlet of five spines, shorter and heavier than those of face.

Large chela stout, 2.8 times as long as broad, fingers occupying the distal third. Margin of palm above dactylar articulation terminating in two rounded projections, the superior larger. Merus 2.6 times as long as broad, fingers a little shorter than palm; fingers with random setae only; tips of both dactyl and pollex bearing two low cusps. Merus 2.7 times as long as broad, distosuperior margin bearing triangular tooth.

Carpal article of second leg with a ratio: 10:2.0:1.5:1.5:4.0, middle articles broader than long.

OPPOSITE

Fig. 27. *Synalpheus echinus* sp. nov. Holotype, 17 mm female from WM 92-65: a, anterior region, dorsal view; b, c. large chela and enlargement of distal section; d, merus large chela; e, f, small chela, merus and carpus; g, distal article of third maxilliped of holotype, lateral view (setae on medial face omitted); h, second leg; i, j, third leg and enlargement of dactyl; k, telson. Paratype, 17 mm male from BAU 44: l, anterior region, dorsal view; m, third maxilliped of specimen from BAU 4 (setae on medial face omitted). Paratype, 27 mm female from WM 51-56: n, anterior region, dorsal view. 14 mm female from BAU 4: o. anterior region of carapace, dorsal view. a, e, f, g, h, l, m, n, o, scale a; c, j, scale b; b, d, h, i, scale c.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1 mm b
5 mm c

Merus of third leg 3.7 times as long as broad, inermous. Carpus 0.4 as long as merus, superodistal margin extending as obtuse tooth, inferodistal margin terminating in strong spine. Propodus subequal in length to merus, bearing on its inferior margin five strong spines and a pair distally. Dactylus biunguiculate, ungui equally thick at bases, but with superior unguis a little longer than inferior. Apex between ungui "V"-shaped.

Telson 1.6 times as long as posterior margin is broad; posterolateral angles acute and projecting, but much shorter than adjacent spine. Dorsal surface of telson slightly concave along midline.

Discussion: If Coutière's groups are to be used, this species would probably best be placed in the Paulsoni Group.

As far as we can determine this species differs from all other species of *Synalpheus* in the armature of the third maxilliped. While most synalpheids have spines on the tip of the maxillipeds, they have short bristles or long hairs on the inner face, but this species has spines also on the inner face. Unfortunately, the maxillipeds are usually not mentioned in specific descriptions, so we cannot state conclusively that this is a unique characteristic in the genus. Certainly no condition like this was reported by Coutière in his thesis (1899: 171) or in any species description that we have seen; moreover, we have examined all those species in our collections and in the collections of the Smithsonian Institution and found no parallel development. The species has two other characteristics which, while not unique, are rare enough to be noteworthy: the narrowness of the rostrum, and the shortness of the carpocerite. The plate illustrates some of the differences we have noted in the development of the rostral front.

The specific name is from the Greek *echinos* and refers to the spines on the maxillipeds. The holotype and four paratypes will be deposited at the Western Australian Museum. Six paratypes will be placed at the Australian Museum.

Biological notes: There are no notes in the collection which indicate any unique habitat; all came from coral heads from 3 metres or less deep; the specimen from Carnac Island came from "reef platform". The specimens range from 17–28 mm.

Australian distribution: All specimens in the collection came from near Perth, Western Australia.

Synalpheus tumidomanus (Paulson)

Fig. 28

Alpheus tumidomanus Paulson, 1875, Invest. Crust. Red Sea (1): 101, pl. 13, fig. 2.

Synalpheus tumidomanus Coutière, 1905a, Fauna and Geog. Mald. and Laccad. 2 (4): 876, pl. 73, fig. 14; 1909, Proc. U.S. natn. Mus. 36: 24, fig. 5. Banner & Banner, 1968, Micronesica 4 (2): 275.

Synalpheus tumidomanus exilimanus Coutière, 1909, Proc. U.S. natn. Mus. 36: 10 [note: the combination was proposed by Coutière without explanation, and the name "*exilimanus* Paulson" evidently was substituted in error for Paulson's *gracilimanus*, 1875: 102].

Synalpheus hululensis Coutière, 1908a, Bull. Soc. Philomath., Paris 11 (5): 202.

Synalpheus hululensis hululensis Crosnier & Forest, 1966, Rés. Sci. Camp. Calypso 27 (19): 297, fig. 30.

Synalpheus mac-cullochi Coutière, 1908a, Bull. Soc. Philomath., Paris IX, 11 (5): 203. Hale, 1927b, Trans. R. Soc. S. Aust. 51: 308.

Synalpheus theophane De Man, 1911, Siboga Exped. 39a[1] (2): 261, pl. 10, fig. 44.

Synalpheus anisocheir Stebbing, 1915, Ann. S. Afr. Mus. 15: 86, pl. 23. Barnard, 1950, Ann. S. Afr. Mus. 38: 736, figs 139 a–d.

Synalpheus japonicus Yokoya, 1936, Jap. J. Zool. 7: 133, fig. 3.

Nec. Synalpheus tumidomanus Kubo, 1940a, J. Imp. Fish. Inst., Tokyo 34 (1): 90, text fig. 11, 12 (*S. hastilicrassus* Coutière).

Nec Synalpheus anisocheir Fourmanoir, 1958, Naturaliste malgache 10 (1–2): 116, fig. 4 (identity unknown).

Additional Australian Records: McNeill, 1968, Gt Barrier Reef Exped. Sci. Rep. 7 (1): 17. Low Isles.

Specimens examined: 3 specimens from AC 29; 1, AC 30; 2, AC 35; 4, AM 1; 1, AM 16; 1, AM, 31; 4, AM 35; 1, AM 60; 1, AM 65; 7, AM 75; 1, AM 101; 2, AM 115; 6, AM 122; 1, AM 131; 2, AM 158; 2, AM 187; 4, AM 189; 2, AM 210; 2, AM 220; 2, AM 251; 1, AM 253; 1, AM 255; 1, AM 256; 1, AM 264; 2, AM 273; 1, AM 305; 2, AM 396; 1, AME 4495; 14, AM P 858; 2, AM P 2149; 1, AM P 3956; 2, AM P 4837; 1, AM P 4863; 2, AM P 5491; 1, AM P 6308; 1, AM P 6353; 1, AM P 6488; 3, AM P 6527; 1, AM P 6825; 6, AM P 8266; 2, AM P 8701; 2, AM P 8970; 1, AM P 9072; 2, AM P 11187; 1, AM P 11272; 3, AM P 13562; 3, AM P 13565; 3, AM P 13582; 6, SMC 805; 17, VM 33; 17, VM 35; 1, WM 47 65; 1, WM 52 65; 3, 76 65; 3, WM 99–65; 2, WM 105–65; 3, WM 112–65; 2, WM 117–65; 1, WM 125 65; 4, WM 141 65; 1, WM 155–65; 3, WM 164–65; 11, WM 175–65; 2, WM 177–65; 8, WM 181–65; 2, WM 240–65; 4, WM 268 65; 3, WM 297 65; 1, WM 173 60.

Table 5. *Variations in* Synalpheus tumidomanus (*Paulson*)

Characteristic	*S. tumidomanus* (from Paulson's description and figures)	9 specimens from Torres Straits, BAU 27	27 specimens from around Australia
Length, rostrum to antennular articles	Approaching end of first	Three-fourths first to one-fourth second.	From one-half first to one-quarter second.
Length, orbital teeth to rostrum	0·7 length, (from plate)	From 0·5 to 0·8 length.	From 0·5 to 0·9 length.
Length, stylocerite to antennular articles	Middle of second	Middle to near end of second.	Middle to near end of second.
Length, squame to antennular articles	End of second (from plate)	Base to three-fourths length of third.	Base to end of third.
Length, lateral spine of scaphocerite to antennular articles.	End of third	Slightly shorter to slightly longer than third.	Slightly shorter to slightly longer than third.
Length, carpocerite to antennular articles	End of third	Surpasses by one-fourth to one-half length of third.	Surpasses by entire length of third.
Length breadth ratio of carpocerite (viewed laterally).	5·2 (from plate)	4·5–6·0.	4·0–6·0.
Length, inferior tooth basicerite to antennular articles.	(Not clear from plate)	Three-fourths length to end first.	From three-fourths length first to middle second.
Superior tooth, basicerite	Short, acute	Acute angle, slightly projecting.	From rounded to projecting acute tooth.
Length breadth ratio of large chela	2·7 (from plate)	2·5–2·8.	2·3–3·0.
Nature of protrusion above dactylus, large chela.	Strong, rounded	From no protrusion to acute tooth.	From no protrusion to acute tooth.
Length breadth ratio of small chela	Not given	3·0 3·4.	2·7–3·4.
Second leg carpus, ratio of first article to 4 following.	First longer than sum of four following.	First article from slightly shorter to slightly longer than sum of four following.	First article from slightly shorter to slightly longer than sum of four following.
Length breadth ratio of merus of third leg.	Not stated	4·0–4·8.	3·5–5·0.
Posterolateral angles of telson	Angular teeth half length of adjacent spines.	Acute angle only slightly projecting.	From almost a right angle to acute projecting teeth.

Diagnosis: Table V sets forth the major diagnostic characters of *S. tumidomanus* with three exceptions: 1. The rostral base has an orbitorostral process. 2. The meri of the large and small chela are characterized by an acute tooth on the distosuperior margin. 3. The biunguiculate dactyli of the third legs have the superior unguis a little longer and thicker at the base than the inferior, and the notch between the ungui is "V"-shaped, almost acute.

Discussion: The long and rather confused application of names to specimens of this species or species complex had been discussed originally by Coutière in several papers (1899, 1905, 1909), reviewed by De Man (1911), Holthuis (1952), Crosnier and Forest (1966), Banner & Banner (1968) and Miya (1972). The problem appears to resolve itself at this time to the consideration of the appropriate name for, and extent of variation in populations of, three possibly separate species found in three separate faunal realms: The Indo-Pacific, the tropical eastern Atlantic, and the tropical and subtropical eastern Pacific. Holthuis has discussed the eastern Pacific form and has applied the name *S. spinifrons* (H. Milne-Edwards) to the species that Coutière had once lumped under the name *S. tumidomanus* and later named *S. latastei*. Holthuis did not discuss *S. lockingtoni* which may be related. Crosnier and Forest, considering the tropical Atlantic specimens, established two subspecies of *S. hululensis* Coutière and established a lectotype for the parent species from Coutière's Maldive and Laccadive specimens. We, working with twenty-two specimens from the Marshall Islands and other central Pacific collections, pointed out the wide range of variation in characteristics previously considered to be of worth for specific identification and placed *S. hululensis* and *S. theophane* De Man in synonymy under *S. tumidomanus* (Banner & Banner, 1968: 275).

Because of the difficulties that have been found in this group of nominal species, we have decided to use this large Australian collection to determine if our conclusions from the Marshall Islands were correct. We have augmented the study with a collection of twenty specimens from the Red Sea, Paulson's type locality. However, as we have no specimens from either the Atlantic or eastern Pacific, we do not extend our conclusions to the species complexes of these other realms.

In our 1968 paper, we reported on the variation in six characteristics. Here we have considered 15 characteristics and selected nine specimens each from New South Wales, northern Australia, West Australia and southern Australia. The nine specimens from northern Australia were taken from a single collection from the Torres Straits to determine variation within a limited population; the others were to determine if there were enough differences in geographically separated populations to warrant their consideration as subspecies. The results are given in Table V.

The specimens from the Red Sea conformed well to Paulson's description in all points and did not show variation as great as did the specimens from Australia. Most had a strong superior tooth on the basicerite above the dactylar articulation of the large chela, and relatively strong posterolateral teeth on the telson. However, in this small collection variation was noted—for example, the posterolateral teeth on the telson varied from as long as Paulson depicted to as short as the longest from Australia. Thus, we believe that the population in the Red Sea shows the potential of variation we are reporting, but the variation is more muted.

These results confirm our earlier opinion that the species is very variable, and that *S. hululensis* is a synonym of *S. tumidomanus*. The variation easily encompasses the lectotype established for *S. hululensis hululensis* by Crosnier and Forest. We will leave to those authors the decision on the best way to treat their two Atlantic subspecies, whether they should be continued as subspecies of *S. tumidomanus* or raised to specific rank. (We regret we were unable to refer to the important paper of Crosnier and Forest in our 1968 study, for we received our copy of their work when our paper was at the publisher in Japan.)

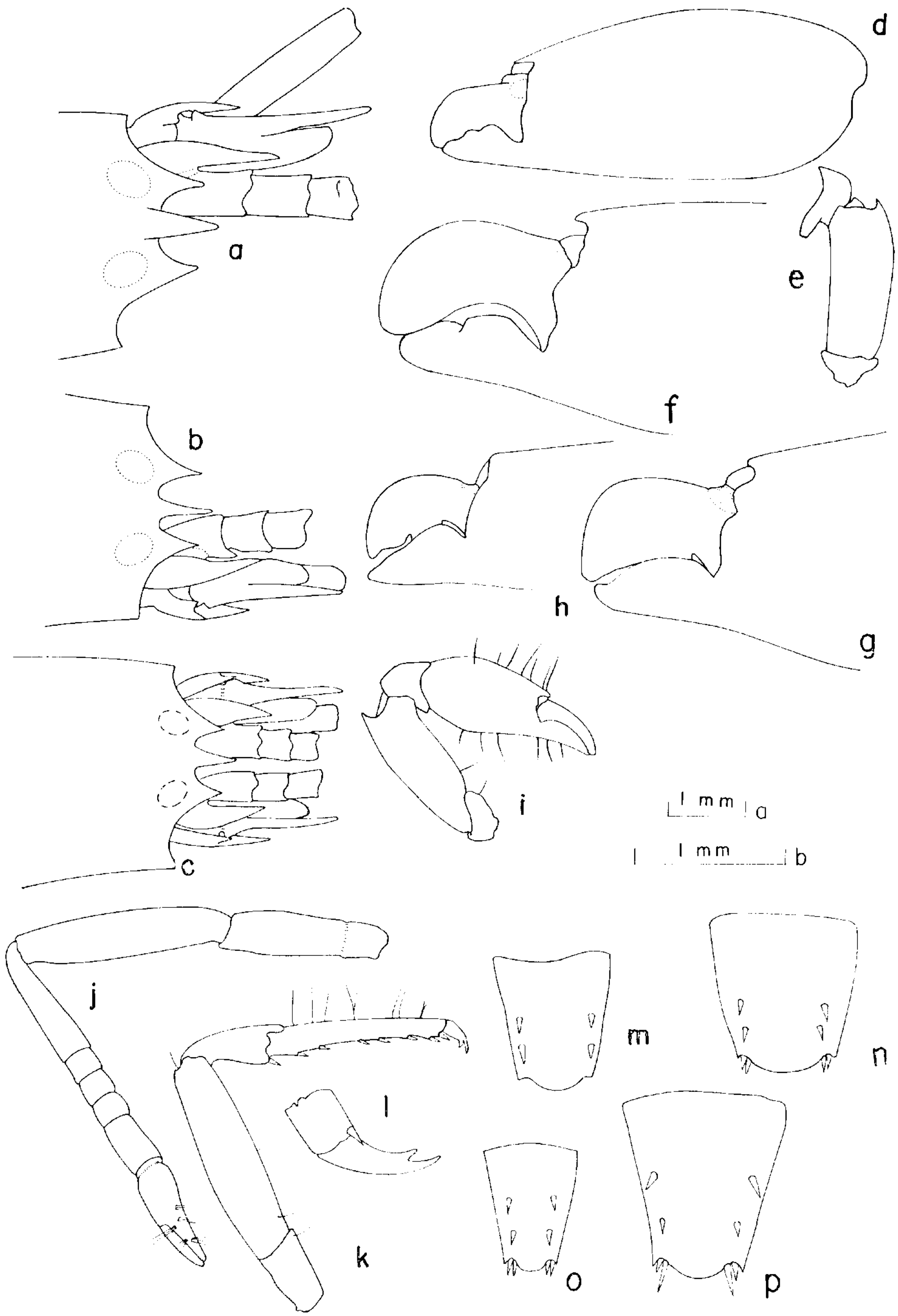
Two other nominal species should be considered. The first was described as *Synalpheus maccullochi* by Coutière from the coast of "S. W. Australia". This species was distinguished from *S. paulsoni* Nobili by having eggs of greater volume and from *S. tumidomanus* by the lack of strong tooth on the basicerite and the lack of teeth on the posterolateral angles of the telson. Through the courtesy of Mme. Laurent of the Muséum National d'Histoire Naturelle in Paris we were able to examine seventeen specimens from Australia that Coutière had identified as *S. maccullochi;* six came from the type locality, five came from Nelson's Bay, and six came from an unspecified area in South Australia. We have also examined six female specimens loaned to us by the South Australian Museum that Hale (1927b: 308) had reported as this species from Kangaroo Island, South Australia. All specimens fell within the range of variation we have discussed for *S. tumidomanus* and the species has been placed in synonymy to *S. tumidomanus*. We should also note that the use of egg size is not a good criterion for species separation, for as Brooks and Herrick (1891: 377) first noted, poecilogony exists in the Alpheidae, and as we point out (1968: 277) the eggs grow both larger and more elongate as the embyro matures. We observed this difference in both Coutière's specimens and in Hale's; in the latter of the five ovigerous females, two specimens had conspicuously larger eggs and in those eggs the eyespots were large and dark.

The other species is *S. anisocheir* Stebbing (1915: 86) from South Africa. Barnard (1950: 736) suggested that it was closely related to *S. hululensis*. We could find no characteristics in the descriptions or figures that would separate this species from the range of variation that we had found for *S. tumidomanus*. The two characteristics somewhat emphasized by Stebbing (he compared his species to no other) were the disproportionate sizes of the large and small chelae and the proportions of the articles of the second leg. These cannot be used to distinguish his form from *S. tumidomanus*. Barnard (1950: 736) described and drew the orbitorostral process "Rostrum with ventral prolongation (fig. 139e)" as a specific characteristic; we have compared his description to the process in our specimens and found them to be similar, if not identical (Banner & Banner, in preparation).

On the basis of the figures given by Fourmanoir of specimens he identified as *S. anisocheir*, we cannot determine the species he was studying, but the form of the orbital teeth and chela indicate it may be in the genus *Alpheus* which precludes the possibility that it is *S. tumidomanus*.

OPPOSITE

Fig. 28. *Synalpheus tumidomanus* (Paulson). Variation in specimens from Australia. a, b, c, anterior region of carapace; d, e, f, g, h, large chelae (d and e same specimen); i, small cheliped; j, second leg; k, l, third leg and dactylus; n, m, o, p, telsons. a, b, c, d, e, f, g, h, i, j, k, m, n, o, scale a; l, p., scale b.


a
b
c
d
e
f
g
h
i
j
k
l
m
n
o
p
1 mm a
1 mm b

Upon studying specimens of *S. tumidomanus* in Japan, Miya (1972: 65) reached the conclusion that *S. japonicus* was also a synonym; he further accepts the variation we had described in 1968 as applying to the Japanese specimens.

Biological notes: Our specimens have been collected from the intertidal zone to waters up to slightly over 81 fathoms deep, from the heads of dead coral and from sponges. Our specimens ranged in size from 10–25 mm.

Australian distribution: *S. tumidomanus* has been found off all shores of Australia and at Norfolk Island and Lord Howe Island, Tasman Sea.

General distribution: In the Indo-Pacific the species is known (under various names) from South Africa; Red Sea; Persian Gulf; Ceylon; Maldive Archipelago; Singapore; Thailand; Indonesia; Philippines*; Japan and across the central Pacific to the Phoenix Archipelago. It has also been found on the Mediterranean coast of Israel. Whether it or closely related species occur in the Atlantic and eastern Pacific remains to be determined.

Synalpheus paraneomeris Coutière

Fig. 29

Synalpheus paraneomeris Coutière, 1905a, Fauna and Geog. Mald. and Laccad. 2 (4): 872, pl. 71, fig. 7. Banner, 1953, Pacif. Sci. 7 (1): 40, fig. 13, 14; 1956, Pacif. Sci. 10 (3): 331, fig. 6.

Synalpheus paraneomeris halmaherensis De Man, 1909a, Tijdschr. ned. dierk. Vereen 11 (2): 122.

Synalpheus paraneomeris praedabundus De Man, 1909a, Tijdschr. ned. dierk. Vereen 11 (2): 123.

Synalpheus paraneomeris prolatus De Man, 1911, Siboga Exped. 39a[1] (2): 241 [*cf.* Banner 1953: 43].

Synalpheus paraneomeris prasalini Coutière, 1921, Trans. Linn. Soc. Lond. II, 17 (4): 415, pl. 61, fig. 6.

Synalpheus paraneomeris seychellensis Coutière, 1921, Trans. Linn. Soc. Lond. II, 17 (4): 415, pl. 61, fig. 7.

Synalpheus townsendi Coutière, 1909, Proc. U. S. natn. Mus. 36 (1659): 32 [*partim cf.* Banner, 1953: 44].

Specimens examined: 2 specimens from AM 214; 4, AM 326; 10, BAU 10; 3, BAU 11; 3, BAU 15; 3, BAU 16; 3, BAU 21; 1, BAU 29; 2, BAU 30; 2, BAU 31; 5, BAU 32; 3, BAU 33; 1, BAU 34; 3, BAU 47; 2, BAU 48; 10, BAU 55; 2, BAU 57; 2, BAU 58.

Diagnosis: Rostrum narrow and acute, reaching to near end of first antennular article. Orbital hoods triangular, acute to subacute, variable in length but not reaching beyond end of rostrum. Rostral base with orbitorostral process.

Second and third antennular article equal, slightly longer than broad; visible part of first article slightly longer. Stylocerite reaching from near base to near end of second antennular article. Lateral tooth of scaphocerite variable, longer than antennular peduncle; squamous portion variable in breadth and length, reaching to or beyond middle of third antennular article. Carpocerite usually 5.0 times as long as broad, reaching beyond end of third antennular article. Inferior spine of basicerite a little shorter than stylocerite, superior margin not produced.

Large chela subcylindrical, 2.6 times as long as broad, fingers occupying distal 0.3. Superodistal margin of palm at most slightly produced. Merus 3.0 times as long as broad, superior margin often produced into a small acute tooth. Small chela three times as long as broad, fingers shorter than palm, dactylus not broadened. Merus similar to that for large chela.

Carpal article of second legs with ratio: 10:1:1:1:3.

Merus of third legs four times as long as broad, unarmed. Carpus 0.4 as long as merus, distosuperior margin projected as tooth, inferodistal margin bearing spine. Propodus almost equal to merus, bearing 4–5 slender spines on inferior margin and two distally. Dactylus biunguiculate, with inferior tooth usually a little shorter and broader at base than superior unguis. Dactylus often slightly expanded with inferior margin convex proximal to inferior unguis, as if it were a vestige of a third unguis.

Telson 2.2 times as long as posterior margin is broad, posterolateral margin forms right angles or slight rounded projections, inner pair of posterolateral spines long and slender, over twice length of outer pair. Spinules on upper surface small and lying posterior to middle.

Discussion: Although Coutière in his original description remarked on the variation in some of the characteristics, he described two additional varieties and De Man described three varieties of the species. All were described on the basis of but few specimens. The junior author, first with 100 specimens from Hawaii (1953) and later with 90 specimens from the Marianas (1956) pointed out the wide range of variation found within the populations of this species and discarded the varietal names as they appeared to be merely designations of individuals within the normal span of variation. Collections studied later made no changes in this assessment. In his earliest paper, the junior author also reported that the single broken specimen that Coutière had reported from Hawaii as *S. townsendi*, an Atlantic species, appeared to be *S. paraneomeris*.

The Australian specimens also show similar variability in proportions and have several not previously remarked upon. Thus, some from Australia have a slight rounded projection above the dactylar articulation on the large chela, a characteristic not reported from Hawaii or the Marianas. Two characteristics, variable in other populations, appear to be more fixed in the Australian specimens: first, the superior margin of the meri of the large and small chelae always projected as a small acute tooth in the Australian specimens, but only occasionally did so in the Hawaiian specimens; second, the inner pair of spinules of the posterior margin of the telson was consistently much longer than the outer pair in the Australian specimens, while in other collections studied the inner pair at times was only slightly longer than the outer pair.

Miya (1972: 54) pointed out that in the Japanese specimens of *S. paraneomeris* the posterolateral corners of the telson were spiniform; a characteristic we have not observed in our collections. Further, his specimens do not appear to have the inferior margin of the dactylus of the third legs slightly convex proximal to the inferior unguis. Perhaps this may indicate a geographically isolated subspecies.

Biological notes: All the Australian specimens were taken from dead coral heads in water up to 15 ft, except for two specimens that were taken by trawl at 11 fathoms. The deepest record for the species was the one identified by Coutière as *S. townsendi*, taken by trawl in Hawaii at 69 fathoms; however, as it was without major thoracic appendages, its identification was not certain.

Banner reported (1953: 41) "Colour typically olive brown to grey, but those living in heads of *Pocillipora meandrina* reddish". Yaldwyn in field notes (AM 326) stated "Body and appendages greenish, transparent with scattering of small red chromatophores. Eyes black; tips of fingers green and eggs green". Our specimens ranged from 7–15 mm in length, most specimens being around 10 mm.

Australian distribution: All Australian specimens were collected from north eastern Australia and the Great Barrier Reef from near Cairns southward to off Cape Moreton, near Brisbane.

General distribution: Maldive Archipelago; Indonesia; Japan; Philippines*; Mariana; Caroline; Marshall; Gilbert; Fiji; Samoa; Line and Hawaiian Islands. The species was not found in our Malayo-Thai collections.

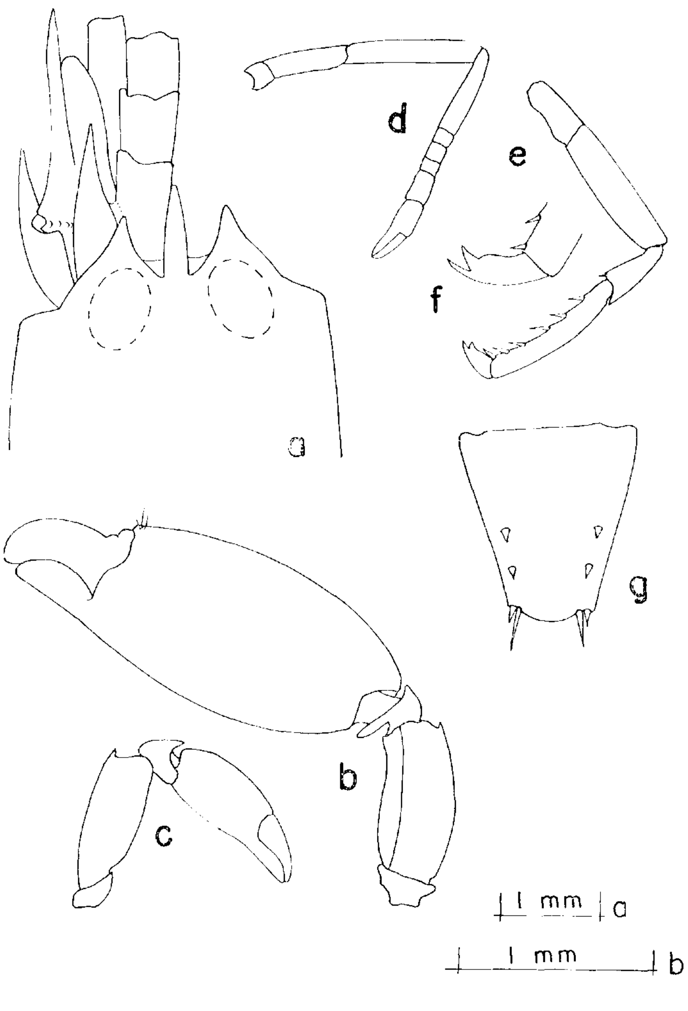


Fig. 29. *Synalpheus paraneomeris* Coutière. 10 mm female from BAU 55. a, anterior region, dorsal view; b, large cheliped; c, small cheliped; d, second leg; e, f, third leg and enlarged dactylus; g, telson. b, c, d, e, scale a; a, f, g, scale b.

APPENDIX

Alpheids Associated with Crinoids

A number of species of alpheids, mostly synalpheids of the Comatularum group, are known to live upon the comatulid crinoids or feather stars. Some appear to be obligate symbionts; others appear to prefer the symbiotic association but may live freely; some appear to be on the crinoids by a matter of chance. As we have remarked in the Introduction (p. 277) we suspect that collection data may not show the true association, for the shrimp may be dislodged from the crinoid in the collecting, particularly in the hauling of a dredge. In some cases the collector may have even separated the shrimp from the host without noting the association in his locality notes.

The following Australian species are known to be associated with crinoids (for synonymy, see main text):

Athanas indicus (Coutière)

Synalpheus comatularum (Haswell)

Synalpheus stimpsoni (De Man)

Synalpheus carinatus (De Man)

Synalpheus demani Borradaile

In addition the Australian *S. tropidodactylus* which is morphologically closely associated with the first three species of *Synalpheus* may also be associated with crinoids, for the only two specimens known were collected by dredging and may have been dislodged from a crinoid in the process. Of the non-Australian members of the specialized Comatularum group, *S. odontophorus* was reported originally by De Man (1911: 208) from Indonesia and later by Miya (1972: 51) from Japan in dredge hauls without any indication of symbiotic associations; however we have specimens yet unreported, from the South China Sea which came from crinoids. Thus in the Comatularum group of Coutière, five of the six presently recognized species are definitely, or may be, associated with crinoids. The sixth species of the group, *S. albatrossi* Coutière, probably is not in such an association for it is known only from the Hawaiian Archipelago where shallow-water crinoids do not occur.

Of the two species reported from crinoids not in the Comatularum group, *Athanas indicus* (Coutière) and *Synalpheus demani*, little can be said. *Athanas indicus* is normally associated with echinoids (see Part I, p. 329), but a specimen collected from Swains Reefs (AM 392) was reported to be taken from a crinoid. *Synalpheus demani* in Australian waters is known only from dredge hauls, but we (Banner & Banner 1968: 274) have reported it from crinoids in the Marshall Islands. Miya (1972: 62) has recorded that all of his Japanese specimens "were living in association with *Comanthina schlegeli* (Carpenter)".

It should be noted that Johnson (1962a: 49) lists *Athanas jedanensis* De Man, *Synalpheus acanthitelsonis* Coutière, *Synalpheus quadrispinosus* De Man, and *Alpheus paralcyone* Coutière as occurring in "crinoid grounds" and he suggests they may be symbionts upon the echinoderms; these species have not elsewhere been so reported. Finally a specimen of *Alpheus edwardsi* (Audouin) was reported by C. Smalley (CS 31) as being upon a crinoid in Western Australia; we have not considered it here because obviously this is not the normal habitat for this well-known and often-collected species.

A number of authors have remarked on the association of the shrimp with the crinoids, most especially Potts (1915a, b) working in Torres Straits, and A. H. Clark (1921) who not only reviewed all previous reports, but also added his own personal observations. Most of the observations were limited to *S. stimpsoni* (named by Potts *S. brucei*) and *S. comatularum*. According to Clark the shrimp are "semiparasitic commensals" which have "to a greater or less extent adopted the sucking up of food particles from the streams flowing down the ambulacral grooves of the crinoids to the mouth." Potts pointed out that the shrimp are afforded protection from predators by the crinoid which folds its arms over the disc—and the shrimp—when disturbed. Clark stated that the most heavily infested family of the crinoids are the large and shallow water comastreids of the Indo-Pacific, which, unlike many other families of crinoids, lack plates and spines to cover the ambulacral grooves and thus protect their food supply.

While Potts was primarily concerned with color patterns, he had other observations on the biology of the shrimp (1915a): They live as mated pairs, normally on the disc facing towards the mouth. When disturbed they take refuge on the underside of the arms. They resist displacement by digging into the flesh of the host with the hook-shaped dactylus of the small chela of *S. comatularum* and by the sharp, curved biunguiculate dactyli of the third to fifth thoracic legs of *S. stimpsoni*. When displaced, they will attempt to return immediately to their host, but if it is not available, they will shun light and approach any other objects, whether living subjects or not. If a group of them are kept in a glass dish, all will cling together. Potts also remarked on zonation in the Torres Straits, with *S. stimpsoni* occupying the upper zone in the reef and *S. comatularum* being dominant below 5 fathoms. (We have records of the latter species being collected intertidally.)

Potts pointed out that both species inhabit two species of crinoids, *Comanthus timorensis* and *Comatula purpurea*; the former crinoid species is extremely variable in color, ranging from pale green through banded to a dark green; the latter species is red. Potts observed that the shrimp had bright red and dark purple, almost black, chromatophores, and that (presumably by contraction of the chromatophores) the shrimp could become almost transparent. In almost all cases the color of the shrimp on any individual crinoid was adjusted to blend completely with the color of the host, usually in the form of pigmented longitudinal stripes against the transparent, or white, background. In a few cases he observed contrasting coloration which he interpreted to be that of a new arrival from a crinoid of a different color. He remarked that in his preservative mixture of formalin and glycerine, the purple pigment dissolved, but the red color remained fixed in the specimens. Clark gave other similar examples of protective coloration.

Key to the species of alpheids known to live on or or suspected of living on crinoids as symbionts

1. Eyes dorsally and laterally exposed .... *Athanas indicus* (pt. I, p. 327)

— Eyes covered by orbital hoods...................... (*Synalpheus*)

2. (1) Dactylus of third leg biunguiculate; without orbitorostral process.... 3

— Dactylus of third leg triunguiculate; with orbitorostral process...... .... *S. demani* (p. 324)

3. (2) Distoinferior margin of third leg with tooth 4

Distoinferior margin of third leg inermous 6

4. (3) Dactylus of small chela crescentric, strongly hooked .... *S. comatularum* (p. 289)

— Dactylus of small chela straight 5

5. (4) Fixed finger of large chela bearing strong, flat tooth on medial side.... .... *S. odontophorus*

— Fixed finger of large chela with medial edge rounded, not projecting.. .... *S. stimpsoni* (p. 292)

6. (3) Rostral carina strong and continued almost to posterior end of carapace .... *S. carinatus* (p. 283)

— Rostral carina slight and terminating anterior to eyes .... *S. tropidodactylus* (p. 286)

Note: We recently were loaned a specimen of *Synalpheus* from a crinoid collected near Lizard Island, Queensland that is apparently new. We plan to describe it in Part III of this study.

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(iv) A list of contents may be included if the paper is very long.

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(vi) The main text of the paper.

(vii) Acknowledgments.

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In taxonomic papers the short form (taxon, author, date, page) should be used in synonymies and the full reference taken to the end of the paper. In synonymies a period and dash (.—) should separate the name of the taxon and the name of the author except in the case of the reference to the original description. Where new species are described the location of the type material must be indicated and Article 73 and associated recommendations of the International Code of Zoological Nomenclature should be followed. Dichotomous keys with contrasting parts of couplets adjacent to each other are recommended. In these only the first part of the couplet should be numbered and the beginning of the second indicated with a dash at the left-hand margin. Keys must not use serially indented couplets.

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Tables should have the very minimum number of horizontal and vertical lines. Very large or complex tables should be submitted in a form suitable for direct preparation of line blocks; such tables should not exceed 14 cm x 20 cm and numbers and letters should be as large as practicable.

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Schöne, H., 1961. Complex behaviour. In T. H. Waterman (ed.), The physiology of Crustacea. Vol. 2: 465–520, 22 figs. Academic Press, New York.

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