Contributions to the Knowledge of the Alpheid Shrimp of the Pacific Ocean

Part X. Collections from Fiji, Tonga, and Samoa[1]

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THIS IS THE SECOND PAPER in a series on the collections made by the senior author in 1954 while on a Yale University–University of Hawaii–Bishop Museum Grant; it deals with those shrimps collected in the Fiji, Tonga, and Samoa archipelagoes.

The study of these shrimps was supported in part by a series of grants from the National Science Foundation (G-1754, G-3863, G-9937). The collection in 1963 was made in part under National Science Foundation Grant GB-796, and under a special grant from the University of Hawaii.

This paper was prepared in final form in December 1961, complete with plates, maps, locality records, etc., but it was destroyed in the fire at the Hawaii Marine Laboratory (see Banner and Banner, 1962). Lost also in the fire were the specimens in the collection and the field notes. The sections of the paper dealing with Fiji, Tonga, and Western Samoa were salvaged in part from the partially burned original study notes and in part from the first draft of the text; for American Samoa we were able to make another collection which partially replaced the lost collection. Certain ambiguities in the preliminary notes could not be resolved for this final completed paper by reference to the original specimens, as is normally done. More harmful to the completed study were the loss of the plates and the data on collections. It is with many misgivings that we publish this paper, especially the descriptions of new species, without the specimens, plates, and data; however, because the alpheid fauna of the central Pacific is so little known, we felt that this paper would be of use to future workers. It is hoped that when other workers find specimens agreeing with our new species and subspecies from near the type areas, they will designate them as neotypes and deposit them in a museum or other institution.

During the summer of 1963 we were able to spend about two weeks in collecting again from Tutuila. On this second trip we revisited some of the places where collections were made in 1954 and also collected from localities not reached on the previous trip.

The studies made with this grant attempted to investigate the zoogeographic distribution of the alpheid shrimp in the central Pacific—presuming that with extensive sampling an accurate picture of the shrimp fauna of an archipelago could be obtained. The two series of collections made nine years apart on the small island of Tutuila in American Samoa give an opportunity to assess the reliability of our samplings as indicators of the total alpheid fauna. In 1954 the collections were made at Tutuila along the windward (southern) coast on the narrow fringing reefs and within Pago Pago harbor; then, to complete the picture of the Samoan alpheids, further collections were made along the lee or northern coast of Upolu, on the wide fringing to barrier reef. During the 1963 trip to Tutuila (it was not possible to make additional collections on Upolu) some of the localities sampled in 1954 were again visited. However, no collection could be made at some of the earlier localities because of changes in topography. For example, Tafuna in 1954 was a sandy beach and in 1963 it was an airport. Furthermore, because better transportation was available, additional localities were visited. Therefore, the two collections are not strictly comparable, but they give some indication of how well the fauna was sampled in each case. The collections are summarized in Table 1.

[1] Contribution No. 239, Hawaii Institute of Marine Biology. Manuscript received January 22, 1963.

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TABLE 1

NUMBERS OF SPECIES AND SPECIMENS COLLECTED IN SAMOA

COLLECTIONS	UPOLU 1954	TUTUILA 1954	TUTUILA 1963
Species and subspecies	32	38	34
Specimens	705 (approx.)	715 (approx.)	523
Species and subspecies not found on Tutuila (both years)	4		
Specimens in these species and subspecies	13		
Percent* of total specimens	0.67		
Species and subspecies not collected from Tutuila, 1963		17	
Specimens in these species and subspecies		63	
Percent of total specimens		3.2	
Species and subspecies not collected from Tutuila, 1954			13
Specimens in these species and subspecies			117
Percent of total specimens			6.0

* Percentages are based on a total of about 1,950 specimens.

Two conclusions may be drawn from Table 1. First, a single series of collections, such as that made at Tutuila, or on both Samoan islands (or in Fiji and Tonga, or most of the other archipelagoes that have been or will be reported upon), does not approach a complete account of the shallow water fauna, even if different types of environment are deliberately sought. Thus, it is estimated that the combined Samoan collections, listing 58 species and subspecies, lack somewhere between 25 and 50% of the species found in the archipelago. Second, if the number of species is far from the total number that could be recorded, those specimens not collected are relatively rare in the environments that could be sampled. For example, of the 47 species collected on both trips to Tutuila, 17 or almost 33% were collected on the first trip but not on the second, yet these 17 species were represented by only 83 specimens of the 1240 collected, or 6.9% of the total for the island.

COLLECTION LOCALITIES

All copies of detailed field records of the collecting localities were destroyed in the fire, but fortunately maps showing geographical location of the field stations were in the hands of the staff artist. These field locations were sufficient to recall to the senior author some details of the collecting sites. Dates were obtained from personal letters.

Stations in Fiji, Viti Levu

BF 1–18. At Korolevu, on the southern coast, during the week 14–20 March 1954. Here the reef investigated was of fringing type lying along the shore, well within the barrier reef complex of the archipelago. The beach was of beach rock and sand; the immediately adjacent water was the "lagoon," perhaps 2 or 3 ft deep at low tide. Seaward the reef platform rose to be exposed at low tides, but with the numerous potholes and cracks bearing living coral; the

outermost edge of the reef was of coral and coralline algae. A few hundred yards away from the collecting area was the mouth of a small stream; the coral reef did not extend across its mouth, but dropped off abruptly to a sandy bottom about 20 or more ft deep. The stations were on a line crossing the reef from the innermost lagoon to the seaward edge (no diving was done off the seaward edge because of storm waves) and at the edges of the stream basin; the exact location of the individual stations cannot be recalled.

BF 19–20. On the barrier reef protecting Suva Harbor, 11–13 April 1954. Here the barrier reef surface was largely exposed at low tide but, except for the seaward edge, was almost devoid of living coral, being composed instead of broken coral fragments. The first station was on the seaward sector of the reef, the second on the lagoon side.

Stations in Tonga

All collections were made on Tongatabu between 27 March and 7 April 1954.

BT 1, 2, 4, and 6. On the sandy shore and bottom of the harbor of Nuku'alofa (near the point marked on U. S. Army Map Service Map [x622, 1943 ed.] as "Mine Layers' Pier") and the specimens were collected from dead coral heads between the intertidal zone and water about 8 ft deep.

BT 3 and 14. Off Nukunuku Island near the mouth of the large brackish lagoon; most specimens were collected under dead coral boulders lying on the broad sand and dead coral flats, and were exposed at low tide.

BT 7 and 8. On the Nuku'alofa side of Pangaimotu in relatively protected waters, BT 7 being from living and dead coral slightly below the intertidal zone, BT 8 being somewhat deeper. A moderate amount of growing coral was found in this area.

FIG. 1. Map of the area of the South Pacific covered by these collections.

BT 9. On the channel (northern side) of Pangaimotu, where the currents were strong and living coral was flourishing; most specimens came from coral heads that could be collected by diving 6–10 ft.

BT 10 and 11. On the south coast of Tongatabu, south of Tokomololo village. Here the island coast was bold, in places with sharp cliffs. The shore margin when under the influence of southern storms may have extreme surf. The reef was marked by a narrow, shallow "lagoon," knee- to waist-deep, inshore from the marginal living coral and coralline ridge; the seaward edge of the ridge was serrate with surge channels, and the bottom drops off almost immediately into deep blue water. The collections were made from encrusting coral and coralline algae from the "lagoon"; no collections could be made from the ridge because of heavy surf.

BT 12 and 13. In the district of Kologna on the fringing reef in water up to several feet below the low tide zone. Here waves sweeping across the outer reef promoted the growth of coral, and coral sand occurred only in pockets.

BT 15. In the lagoon, Fanga Uta, near Havelu village. The lagoon was shallow, brackish, in large part with a mud bottom, and surrounded by halophilic plants such as mangroves. Some of the specimens were collected from the mud substrate, and some were from old and decaying heads of dead coral.

BT 16. The inner margin of a seaward reef protecting the harbor of Nuku'alofa near Lahi passage in a region of vigorous coral growth; specimens came from coral heads from the intertidal zone down to about 20 ft deep.

BT 17. An area south of the village, Houma, along the cliffed shore, similar ecologically to BT 10 and 11; these specimens also came from coral heads in the "lagoon" behind the coralline ridge.

FIG. 2. Map of Tongatabu showing collecting stations.

Stations in American Samoa, Tutuila

Collections were made from 18 to 24 April 1954.

BAS 1, 2, 3, and 4. The Utelei section of Pago Pago harbor, made on a transect from low tide zone (station BAS 1) across the narrow reef to water about 10 ft deep (station BAS 4).

BAS 6, 7, and 8. On a similar transect in the Fagaalu section of Pago Pago Harbor. BAS 6, the innermost station, was made at low tide zone, BAS 7 in a dredged depression about 8 ft deep, and BAS 8 on the outer portion of the fringing reef.

BAS 9. On the opposite shore of Pago Pago harbor, on a vigorously growing reef. Specimens were collected from coral by diving in 6–20 ft of water.

BAS 5, 13, and 14. At "Lion's Head" (the Samoan name is not available). Here the fringing reef was narrow and wave-swept; the collecting was done in the protection of a rock set on the reef (30 or more ft high, and possibly 100 or more ft wide at the base), in water about 2–4 ft deep at low tide, with moderate to strong surge. Specimens were collected from encrusting and massive corals.

BAS 10, 11, and 12. Off Tafuna (a collecting area now largely destroyed by the new airport). BAS 10 and 11 were in shallow water which evidently could become brackish at times of heavy rainfall. The bottom was largely sand. BAS 12 was farther from shore but still in wading depth of water.

Stations in American Samoa, Tutuila

Collections were made from 14 August to 1 September 1963. (References are to U. S. Coast and Geodetic Survey Chart #4190, 1962 ed.).

BP 1. The same as BAS 5, 13, 14.

BP 3. On Tower Rock Reef (sometimes called Flower Pot Rock) at the western side of the entrance to Pago Pago bay in about 2–3 ft

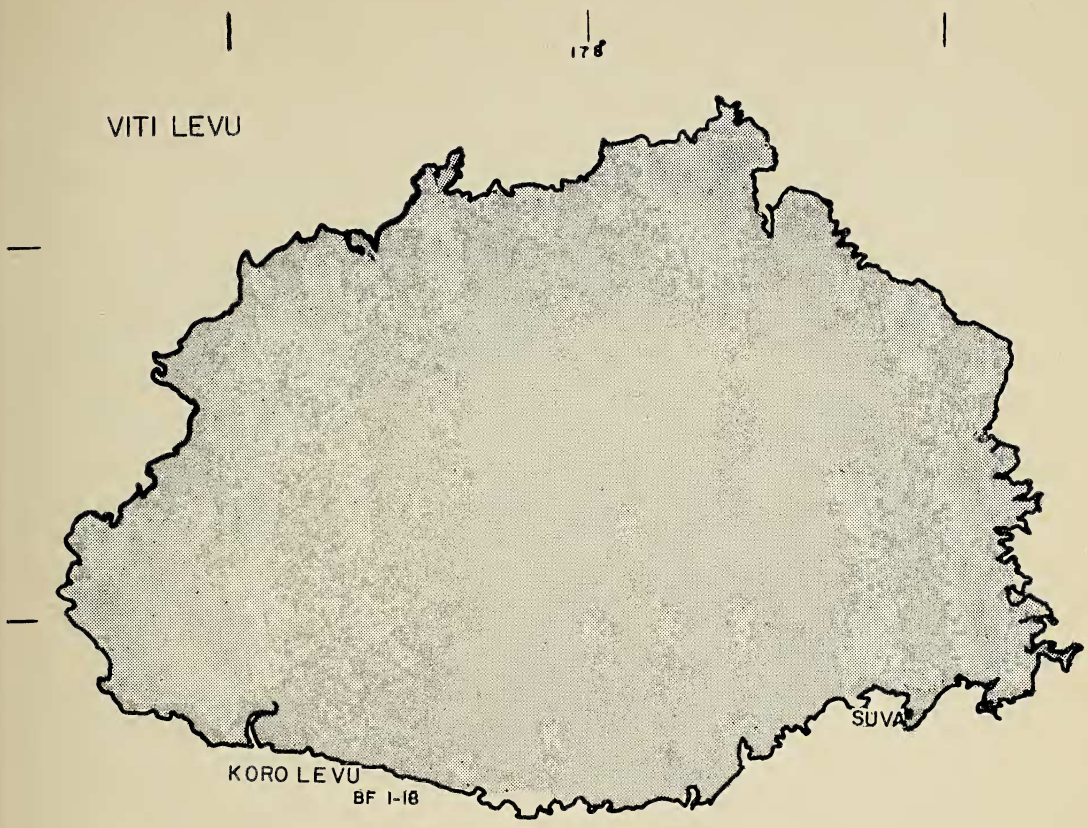

FIG. 3. Map of Viti Levu showing collecting stations.

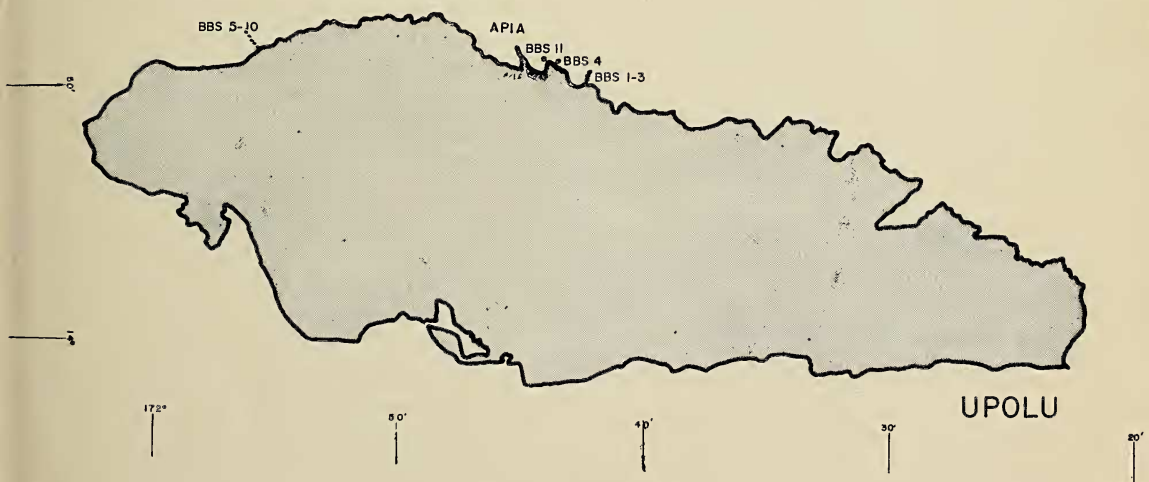

FIG. 4. Map of Upolu showing collecting stations.

of water. Specimens were collected from dead and live coral which was found in depressions at the inner edge of the reef which is several hundred yards wide.

BP 4. At Alofau on Fagaitua Bay on the outer face of the fringing reef in water approximately 3–10 ft deep. Specimens were collected from living and overgrown heads of dead coral.

BP 5. At Utumea on the southeastern side of the island, from the middle reef flat, at about 0 ft tide level. Collections were made from old, rather solid, heads of dead coral.

BP 6, 6a, 7, 8, and 9. Various localities on the reef flat at A'umi (east of Lauli'i). BP 6 was the inner area of the reef; BP 6a was located in an encrusting tube; BP 7 was from corals taken in a protected portion of reef flat; BP 8 and 9 were located in the surge zone.

BP 10. At Leone on the southwestern side of the island. Specimens were collected from heads of dead coral from the reef flat in water 2–3 ft deep. The water was brackish and carried silt from the land; the bottom was fine sand and mud mixed with a great deal of organic detritus.

BP 11. At Pago Pago between Aua and Breaker Point. Specimens were collected from heads of coral lying near the surf zone.

BP 12, 12a, 13. At Lauli'i, in water 2–3 ft deep; BP 12 was near the middle reef; the specimen from BP 12a was found commensal with a brittle star; and BP 13 was near the reef edge.

BP 14 and 15. In the entrance to the lagoon near the airport (Cocoanut Point on the chart). The area was subject to more than the usual amount of fresh water run off. BP 14 was taken from dead coral heads in about 3 ft of water from a shallow broad flat where the bottom was of silty sand with organic debris. BP 15 was located under boulders on the shore at about middle tide zone, in very fine sand.

BP 16. At Fangasa'a, located on a deep inlet on the leeward side of the island. Specimens were collected from dead coral heads on the outer face of a flourishing reef on the west side of the bay in about 3–15 ft of water.

Stations in Western Samoa, Upolu

Collections were made from 25 April to 12 May 1954.

BBS 1–3. On a transect across a broad fringing reef at Fagalii east of Apia. BBS 1 was the most inshore; BBS 3 was almost at the surf zone.

BBS 4. An inshore area at Vaiala a short distance east of Apia.

BBS 5–10. On a transect across the broad fringing reef at Vailutai in the Fasito'outa district; here the reef was several miles broad, but without a boat lagoon as is found closer to Apia. The maximum depth on the reef was approximately 8 or 10 ft, rising again to a shoal reef front; the submerged reef flat was sandy with scattered coral; the reef front consisted of vigorously growing coral. The stations ranged from the shore, where there were freshwater springs below the low tide zone, to the outer face of the reef front. The stations were not in numerical order.

BBS 11. On a vigorously growing coral reef, in depths to about 20 ft, on the eastern side of Apia Harbor near Matautu.

AUTOMATE de Man

Automate gardineri Coutière

Automate gardineri Coutière, 1902. Mus. Hist. Nat., Bull. 8(5):337; 1903. Soc. Philomath. Paris, Bull. 5(2):1–4, figs. 1–8.

Automate johnsoni Chace, 1955. U. S. Nat. Mus., Proc. 105(3349):13, fig. 7.

LOCALITIES: Tonga: 1 specimen from BT 8. Samoa: 1 specimen from BAS 1; 1 from BAS 11; 1 from BP 5.

DISCUSSION: In addition to these specimens, and those previously reported from Saipan and under the name *A. johnsoni* (Banner 1956: 321), there are some in the collections from the Cook, Society, and Marshall islands to be reported upon in later papers, a total of 17 specimens. Unfortunately many of these specimens are small and broken, and most are lacking their chelae.

This series of specimens appears to bridge all but one of the criteria used by Chace to separate *A. johnsoni* from *A. gardineri.* He stated that the rostrum in the form found in the Marshall Islands was triangular instead of rounded; in this series both types of rostrums occur, and in one large specimen from Eniwetok the rostrum is rounded. In *A. johnsoni* the second antennular article is 2.5 times as long as broad, while in *A. gardineri* the same article is 4 times as

FIG. 5. Map of Tutuila showing collecting stations.

long in the male, 3.5 times as long in the female; in these specimens it varies from about 2 times to more than 3.5 times as long as broad. The stylocerite is supposed to reach slightly beyond the distal margin of the proximal segment in *A. johnsoni.* In the Saipan specimens none reached to the end. In the others two did not reach to the end; four reached to the end; and five reached beyond the end of this article. The antennal scale in *A. johnsoni,* instead of extending to the middle of the second antennular article, is supposed to reach to the distal fifth; in these specimens both conditions are found, as well as intergrading steps between. In the Saipan study a difference was noted in the length of the carpal articles of the second legs, with the second article 1.8 in *A. gardineri,* 1.2 in *A. johnsoni,* and 1.3 times the length of the first article in the Saipan specimens; in these newer specimens the ratio has been found to vary from 1.2 to 1.5, but most specimens were lacking their second legs. The only remaining difference remarked by Chace is the occurrence of slight grooves in the carapace on either side of the rostrum which are present in *A. gardineri* alone. These grooves were not seen on any of these specimens, but because of the thin, transparent nature of the exoskeleton in this region of the body it is very difficult even to see the rostrum. Moreover, since the exoskeleton is rather soft, these folds may actually be artifacts. In any case they do not appear to be a valid criterion for the separation of the two species.

Unfortunately, there are not enough specimens from any one locality, and those we have are not complete enough to permit evaluation of their differences from other species of this genus described from the Indo-Pacific. "*A.* species" of de Man probably is this species; moreover, this species is possibly a synonym of *A. dolichognatha* de Man, for the principal difference between the two species is the form of the large chelae of the male and female, a difference that may be the result of maturity. *A. anacanthopus* de Man and *A. salomoni* Coutière appear to be distinct species.

ATHANAS Leach[3]

Athanas djiboutensis Coutière

For full citation see Banner and Banner (1960:140).

LOCALITIES: Samoa: 1 specimen from BP 5; 2, BP 7; 2, BP 8; 2, BP 10; 3, BP 11; 4, BP 13. Specimens were also taken from Western Samoa, Tonga, and Fiji.

Athanas parvus de Man

For full citation see Banner and Banner (1960:141).

LOCALITIES: Tonga: 7 specimens. Samoa: 4 specimens.

Athanas rhothionastes Banner and Banner

Athanas rhothionastes Banner and Banner, 1960. Pacific Sci. 14(2):142–146, fig. 2.

LOCALITIES: Samoa, Tonga, and Fiji.

Athanas areteformis Coutière

For full citation see Banner and Banner (1960:138).

LOCALITY: Samoa: 1 specimen from BP 11.

Athanas indicus (Coutière)

For full citation see Banner and Banner (1960:149).

LOCALITY: Samoa: 1 specimen from BP 11.

Athanas borradailei (Coutière)

Fig. 6

Arete borradailei Coutière, 1905. Fauna and Geog. Mald. and Laccad. 2(4):861, fig. 133.

LOCALITY: Samoa: 1 specimen from BP 8.

DISCUSSION: Our specimen agrees with Coutière's with the exception of the rostrum. The rostrum reaches only to the first quarter of the visible part of the first antennular article instead of to the end of the second. We believe that this is a growth anomaly and, unless other specimens are collected which show this difference, we assume that our specimen belongs to Coutière's species.

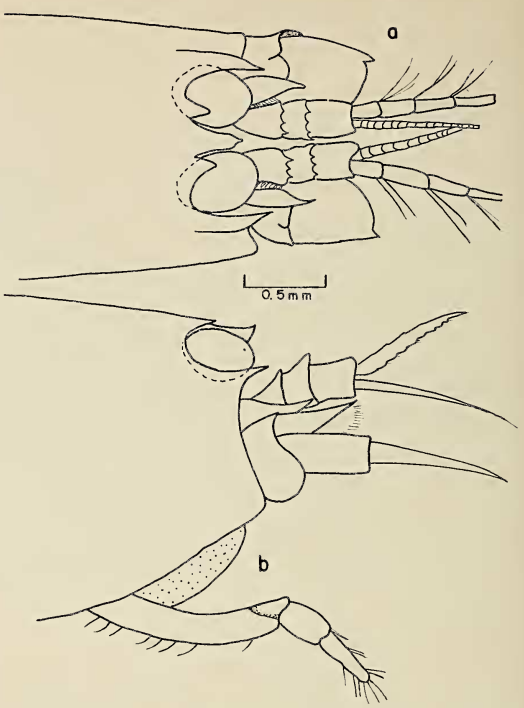

FIG. 6. *Athanas borradailei* Coutière. 7 mm female from station BP 8. *a, b,* Anterior body region.

Athanas dorsalis (Stimpson)

For full citation see Banner and Banner (1960:151).

LOCALITY: Fiji: 1 specimen.

Athanas polynesia sp. nov.

Fig. 7

TYPE: A 7-mm male collected at Alofau (BP 4) on the island of Tutuila from a head of dead coral collected in the outer reef area in water about 3–10 ft deep. Two other males were collected at the same locality.

DESCRIPTION: Rostrum reaching to end of second antennular article with distal portion of dorsal margin gradually curved upward, but with all of inferior margin curving upward toward tip; inferior margin bearing small tuft of setae in small, sharp notch about halfway from

[3] The sheets recording the collection data for the members of this genus were destroyed in the fire of the Hawaii Marine Laboratory, and the records cited below (with the exception of those for the five species in the new collections from Tutuila) are taken from Banner and Banner (1960:138–154).

eyes to tip. Supracorneal teeth short, triangular, reaching about two-thirds the visible length of cornea; extracorneal teeth longer, reaching beyond cornea, almost to end of first antennular article.

Antennular peduncle short, with visible part of first antennular article the longest, second and third articles subequal. Superior distal margins of first and second antennular articles bearing 4 teeth. Stylocerite heavy and acute with tip reaching end of second antennular article. Scaphocerite with outer margin straight and with broad squame reaching slightly beyond end of antennular peduncle; lateral spine only slightly longer than squame. Carpocerite thick and as long as antennular peduncle. Basicerite broadened, without spine.

Mouthparts protrudent, with inflated labrum; incisor lobe of psalistome of mandible also expanded, dish-shaped with fine teeth and molar portion reduced.

Chelae similar in form, but with large chela 1.3 times the length of the small chela. Large chela about 1.5 times as long as broad, with fingers occupying the distal third. Inner face convex, outer face only slightly convex, distal portion of superior margin flattened, leaflike, and bearing strong, forward-directed papillae from middle of chela to dactylar articulation, each papilla bearing one heavy seta. Outer and inner face without papillae. Lower margin opposite dactylar articulation flattened, leaflike, and bearing six setiferous papillae similar to those of upper margin. Outer and inner faces smooth. Dactylus heavy, curved, with tip crossing at fixed finger; without papillae but with fine setae. Ischium heavy, about half as long as merus, bearing six to eight movable spines on both the inferior and superior margin, with three final spines on either margin on distal shoulder. Merus unarmed, 1.7 times as long as broad at its widest point, flattened where it joins the ischium but inflated, almost cylindrical in section, at about two-thirds of its length and most narrow where it joins the carpus. Carpus 1.3 times as long as merus, proximally very thin and narrow, and curved to admit flexure, distally greatly expanded. Inner side excavate with leaflike projections to encompass basal portion of palm where joint is flexed. Small cheliped of similar configuration but with fewer setae, ischium with fewer spines.

Merus of second leg 1.3 times longer than ischium. Carpus of four articles with ratio of 10:6:3:7.

Third leg robust. Ischium unarmed, 0.5 length of merus. Merus inermous, 2.5 times as long as broad; carpus 0.5 as long as merus, armed with single strong movable spine on distal end of inferior margin. Propodus 1.3 times as long as merus. Inferior margin bearing four pairs of movable spines, and two strong spines on the inferior side of the dactylar articulation. Dactylus simple, curved, 0.4 as long as merus.

Telson slender, 3.5 times as long as broad at its posterior margin. Anterior margin twice as wide as posterior margin. Posterior margin extended and rounded.

DISCUSSION: In the key published in the revision of the genus *Athanas* (Banner and Banner, 1960:138) this species shows a relationship to *Athanas verrucosus* Banner and Banner, *Athanas borradailei* (Coutière), and *Athanas ghardaquensis* (Ramadan). It may be separated from *A. verrucosus* by a series of characteristics, probably the most reliable being the four articles of the carpus of the second leg, and the lack of papillae on the face of the palm of the chelae. A difference is also found in the greater breadth of the large chela of *A. verrucosus,* which is 2.2 times as long as broad, while in *A. polynesia* it is 1.5 times as long. This species is similar in frontal region and carpus of the second leg to *A. borradailei* (Coutière) (1905: 861) but the chelae of *A. borradailei* are more slender and without papillae, and the ischia and meri of the chelipeds are without spines. *A. ghardaquensis* (Ramadan) (1936:15) may be separated from this species by its lack of marginal papillae on the chelae, and by the fact that in *A. ghardaquensis* the chelae are symmetrical.

SALMONEUS Holthuis

Salmoneus tricristata Banner

Salmoneus tricristata Banner, 1959. Pacific Sci. 13(2):131, fig. 1.

LOCALITY: Samoa: 2 specimens from BAS 10.

DISCUSSION: The larger female of these two

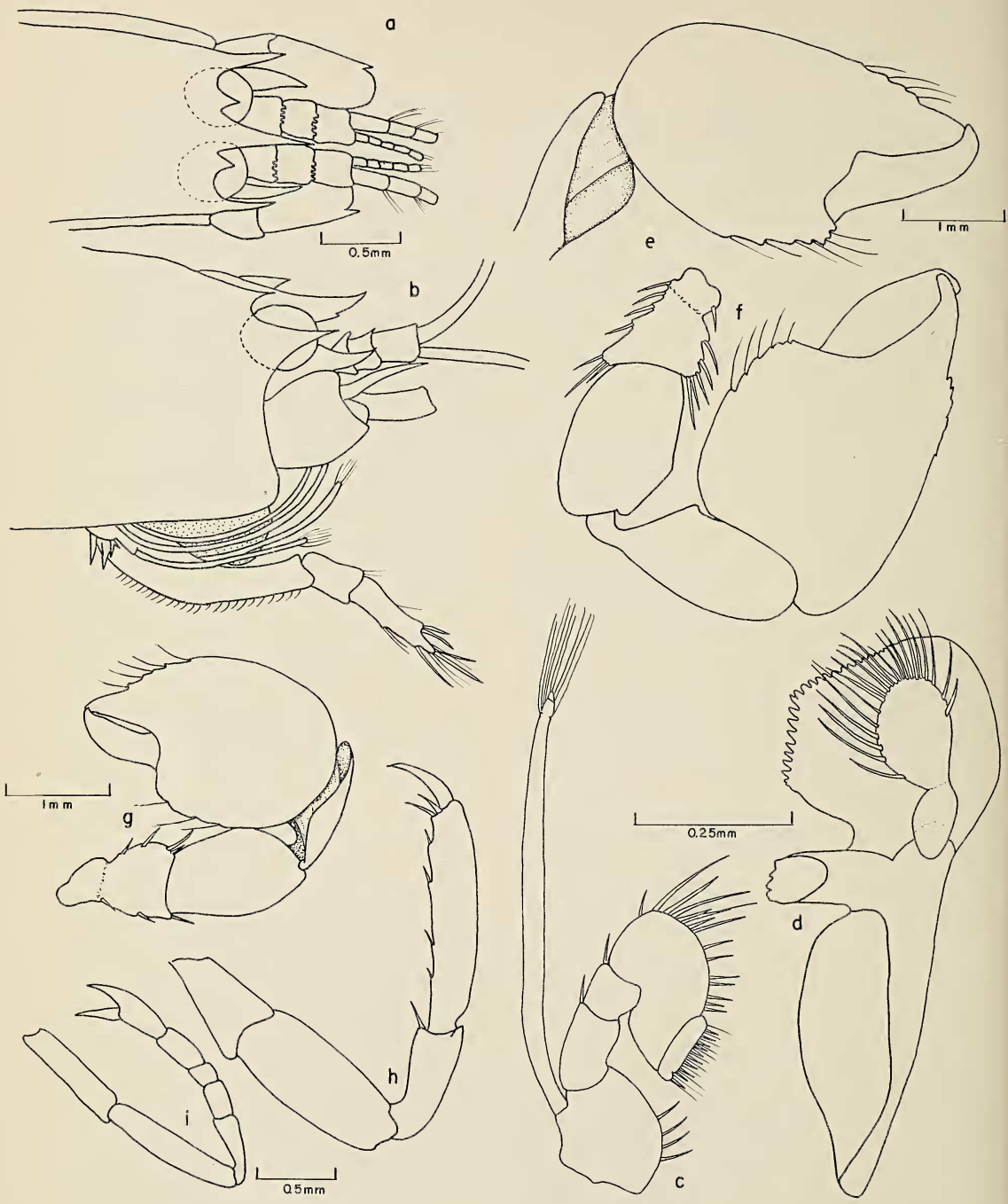

FIG. 7. *Athanas polynesia* sp. nov. Type. 7 mm male from station BP 4. *a, b,* Anterior body region; *c,* second maxilliped; *d,* mandible; *e,* large cheliped inner face; *f,* large cheliped outer face; *g,* small cheliped inner face; *h,* third leg; *i,* second leg.

specimens has both chelae intact; they appear to be identical with those of *S. sibogae* (de Man). The chelae will be described in a later paper of this series.

Salmoneus sibogae (de Man)

For full citation see Banner and Banner (1964:86).

LOCALITIES: Fiji: 2 specimens from BF 2; 2, BF 4; 1, BF 5; 1, BF 12; 1, BF 18; 2, BF 19; 2, BF 20.

DISCUSSION: These specimens and some from other localities, especially Eniwetok, were examined closely to determine the extent of variation in certain of the taxonomically important characteristics. The telson is quite uniform, and in all normal specimens the notch is trapeziform; in those few specimens where the notch is not of this shape, the telson is definitely malformed, with poorly developed posterolateral lobes and lacking in some cases the terminal spines on the malformed side. The rostrum, however, is quite variable. The tip may reach from the end of the second antennular article to the end of the third. The breadth usually is equal to the length (the triangle measured with the baseline at the most posterior portion of the notch between the rostrum and the orbital teeth), and its sides are concave; but in some specimens the length is up to 1.5 times the breadth of the base. The orbital teeth are somewhat variable, but never reach to the end of the first antennular article. The stylocerite, scaphocerite, and carpocerite are surprisingly uniform, with the stylocerite reaching to the middle of the third antennular article, the scaphocerite reaching to or slightly beyond the end of the third antennular article, and the carpocerite reaching only to the middle of the second antennular article. Inasmuch as the stylocerite remains rather constant and the rostrum variable, in some specimens the stylocerite is longer, and in others shorter, than the rostrum. No variation was noted in the thoracic legs, although they were not studied closely. There is no marked sexual dimorphism in the form and size of the large or the small chela.

This species is closely related to *S. latirostris* (Coutière), *S. hilarula* (de Man), and *S. mauiensis* (Edmondson). Whether it is distinct from Coutière's inadequately described and figured specimen cannot be ascertained until the type specimen is redescribed. It is distinguished from *S. hilarula* by a longer scaphocerite, which in *hilarula* reaches only to the end of the second antennular article, and by different shape in the orbital teeth and different proportions in the third legs. *S. mauiensis* does not have the trapeziform notch in the telson, but has instead a shallow to almost nonexistent "v" that reaches from corner to corner.

Salmoneus tafaongae sp. nov.

TYPE SPECIMEN: A fragmentary ovigerous female, carapace length 3.2 mm, total length 8.8 mm, collected on outer portion of fringing reef, shoreward of surf zone, about one ft below low water, 3 miles east of Apia, Upolu, Western Samoa; collected by A. H. Banner, 24 April 1954.

DESCRIPTION: Body slender and relatively elongate for shrimp of this genus. Rostrum triangular, elongate, 3 times as long as broad at base (base considered as at end of straighter portion of margins); margins with only slight concavity anterior to eyes; tip acute, reaching almost to end of antennular article, bearing small tooth. Supracorneal spines acute, upturned, reaching half the length of visible portion of first antennular article. Corneas visible dorsally between supracorneal spines and rostrum, and most of corneal hemisphere visible laterally. Anterior carapace without trace of carinae or grooves.

Antennular peduncle elongate, with second article about 1.3 times as long as broad, subequal in length to third article and shorter than first. Stylocerite acute, reaching to end of second antennular article. Secondary ramus of upper flagellum short and bearing numerous heavy setae. Basicerite bearing slight superior and stronger inferior teeth. Scaphocerite not reaching to end of third antennular article; squamous portion broadly rounded, slightly exceeding lateral spine in length. Carpocerite short, not reaching to middle of second antennular article.

Large chela lacking. Small chela with form typical of small chelae in *Salmoneus,* with ratio

of articles (starting from ischium) as 10:10:11:10:3 (the last two ratios referring to palm and fingers, respectively).

Carpus of second legs with first article 5 times length of second, second slightly shorter than fifth, third and fourth subequal and shorter than second.

Third to fifth legs elongate and slender. Ischium of third leg 5 times as long as broad, 0.66 as long as merus, and armed with two movable spines; merus 6.7 times as long as broad, unarmed. Carpus 0.8 length of merus, almost 10 times as long as broad distally, distally armed with movable spine on inferior margin. Propodus slightly longer, slightly thinner than carpus, bearing three slender spines on inferior margin, with the longest spine distal. Dactylus simple, slightly curved, tip acute, 7 times as long as broad at base, half the length of the carpus, and bearing a tuft of fine setae two-thirds of distance to tip. Brush on fifth legs poorly developed.

Telson 5.6 times as long as posterior margin is broad, 2.6 times as broad anteriorly as posteriorly; posterior cleft trapeziform, narrow, and shallow; terminal spines heavy, middle pair 1.6 times as long as posterior margin is broad; cleft bearing single pair of setiferous bristles; dorsal spinules slight. Uropods slender, longer than telson; tooth on outer uropod heavy, reaching to end of squamous portion.

DISCUSSION: It was unfortunate that this single specimen was not more nearly intact, and that the small chela and second legs were lost after the initial examination. However, because its form is so distinctive we have decided to describe it as a new species.

All of the characteristics available—the general body form, the development of the rostrum and supraorbital teeth, the form of the smaller chela, and the form of the telson—indicate that the species belongs to the genus *Salmoneus*. It also lacks the anal tubercles and has the articulated pleura of the sixth abdominal segment, as is characteristic of *Salmoneus*, and it has a branchial formula (5–1–8) of the genus. But without the final confirmation that can be obtained only from examination of the large chela, this assignment to genus must be provisional.

Within the genus it is similar to no species in that the rostrum is so much longer than broad, in the exposure of the corneas dorsally and laterally, in the angle of the orbital teeth, and in the extreme elongation of the third legs. While the form of the posterior notch of the telson and the lack of carinae on the carapace is similar to *S. sibogae*, not enough is known about the members of this genus to hazard a guess as to interspecific relationship.

This species is named in honor of Miss Tafaonga Uitime (now Mrs. Stewart), then a school teacher at Vailutai, Upolu, who served as an interpreter in the village and arranged for helpers and outrigger canoes during the collecting there.

ALPHEOPSIS Coutière

Alpheopsis equalis Coutière

For full citation see Banner and Banner (1960:86).

LOCALITIES: Fiji: 3 specimens from BF 13; 1, BF 16; 3, BF 17. Tonga: 1 specimen from BT 17. Samoa: 2 specimens from BAS 6; 1, BAS 7; 1, BAS 8; 2, BAS 9; 4, BAS 13; 1, BBS 1; 4, BP 8; 1, BP 13.

Alpheopsis species

Related to:

Betaeus trispinosus Stimpson, 1860. Acad. Nat. Sci. Philadelphia, Proc. 12:32.

Alpheopsis trispinosus Hale, 1941. Rep. B. A. N. Z. Antarct. Exped. 4(9):266, fig. 4.

Alpheopsis species de Man, 1922. Siboga Exped. $39a^4(5)$:24, pl. 3, fig. 12.

LOCALITY: 1 fragmentary specimen from Samoa.

DISCUSSION: Because this specimen, the only one of this species in the collection, has only one third and one fourth leg intact posterior to the maxillipeds, it cannot be identified except tentatively. However, in those parts which are intact it agrees well with both Stimpson's original description, with Hale's short note, and with the description of *Alpheopsis* species by de Man. The chief difference between this specimen and that described by de Man is that in this one the telson is 3.5 times as long as the posterior margin is broad, and de Man states

that in his the ratio is 10:1. However, if the figure stated by de Man is correct then his specimen must have had an extremely attenuated telson; it is possible that his ratio may have been in error.

The identity of *A. trispinosus* needs to be established by the description of a neotype. Stimpson's description, while more full than those of many later workers, is so ambiguous that the identity of his species is questionable. His type came from Port Jackson, Sidney, Australia; yet Coutière (evidently with only Atlantic specimens) published many figures of what he believed to be this species. Because Coutière's drawings and descriptions of the Atlantic specimens did not agree perfectly with a single broken, and possibly immature, Indonesian specimen, de Man did not use the name *A. trispinosus.* It is not known whether our specimen from Samoa, de Man's from Indonesia, Hale's from Tasmania, and the specimens from the Atlantic are or are not the same species.

On the basis of the distributional patterns common in the family, it is likely that the specimens described by Stimpson and Hale represent a temperate Pacific species, that this specimen from Samoa and the specimens of de Man from Indonesia are a tropical Pacific species, and finally that the specimens of Coutière and Sollaud from the tropical and subtropical Atlantic represent a third species. Holthuis (1951:94) expressed similar doubts about the identity of the Atlantic species with the Pacific species, although he accepted Hale's hesitant view that de Man's and Stimpson's specimens are of the same species. Obviously no certain identification can be made until many more complete specimens from the various parts of this supposed range are studied.

Alpheopsis diabolus Banner

Alpheopsis diabolis Banner, 1956. Pacific Sci. 10(3):325, fig. 3.

Alpheopsis diabolus Banner and Banner, 1964. Pacific Sci. 18(1):86.

LOCALITY: Fiji: 1 specimen from BF 20.

SYNALPHEUS Bate

Synalpheus streptodactylus streptodactylus Coutière

Synalpheus neomeris streptodactylus Coutière, 1905. Fauna and Geog. Mald. and Laccad. 2(4):870, pl. 70, fig. 1.

Synalpheus streptodactylus de Man, 1911. Siboga Exped. 39a[1](2): 226, pl. 7, fig. 29.

Synalpheus metaneomeris streptodactylus Coutière, 1921. Linn. Soc. Zool., Journ. 17(4):414.

LOCALITIES: Tonga: 1 specimen from BT 1; 1, BT 6; 7, BT 7; 2, BT 9. Samoa: 1 specimen from BAS 10; 27, BBS 27.

DISCUSSION: Coutière in 1905 described a form of *Synalpheus* to which he gave the varietal name *Synalpheus neomerus streptodactylus;* this he distinguished primarily by differences in the dactyli of the pereiopods. In 1911 de Man reported that he had examined the types of Coutière's variety as well as a group of related specimens collected by the Siboga Expedition. He found that Coutière's variety was specifically separate from *S. neomeris* on the basis of a series of characteristics which included the proportions of the antennular peduncles, the chelae, the walking legs, and the telson; for his new species he retained the name *S. streptodactylus.*

However, Coutière (1921:414), in reporting additional specimens, accepted de Man's specific separation but stated that there were actually two varieties involved—those with the dactylus of the walking leg as he originally described it, and those with a heavier ventral unguis. Because he accepted the concept that both of these varieties were of a species separate from *S. neomeris,* he proposed to give the name *S. metaneomeris* for the species, retaining the name *S. m. streptodactylus* only for those with the modified dactylus.

This action by Coutière is a violation of the rules of nomenclature. When a named variety or subspecies is raised to specific rank it must continue to bear the name originally assigned; if the new species be divided into subspecies, the subspecies that contains the types for the species bears as a subspecific name the duplicated specific name, and the differing subspecies bears a new name. Therefore the correct name of this species is *S. streptodactylus* Coutière; the subspecies originally described by Coutière must be *S. streptodactylus streptodactylus,* and the

subspecies with the other type of dactylus must bear a new name. For this subspecies the name *metaneomeris* is not available, as it was attached by Coutière to the type for *S. streptodactylus* and is a synonym. Therefore we here give to the subspecies described and named by Coutière as *S. metaneomeris streptodactylus* (1921:414) the new name of *S. streptodactylus hadrungus* (from the Greek *hadros,* thick).

The difference between the two subspecies lies in the proportions of the ungui of the dactylus of the walking legs. In *S. s. streptodactylus* the ventral hook is 2.5–3.6 times as long as thick at its base, its base is twice that of the dorsal, and its length is 1.5 that of the dorsal; in *S. s. hadrungus* the latter proportions are 2.0 and 3.6. (The proportions of the ventral hook alone were not reported, but, according to Coutière's 1921 figures, it should be about 2.5 times as long as thick.) In spite of this slight and subtle difference, and in spite of the variation in proportions usually found in this family and genus, none of the specimens in our collection was intermediate between two subspecies. In these specimens the range of proportions on the diagnostic characteristics are as follows (15 specimens from 4 localities were measured; the average measurements are given in parentheses): ventral hook, length–breadth, 1.7–3.0, (2.2); length ventral hook–length dorsal hook, 1.0–1.2, (1.1); thickness ventral hook—thickness dorsal hook, 1.7–2.0, (2.0). Therefore all of our specimens are *S. s. streptodactylus.*

Since the paper dealing with the additional reports on the Hawaiian alpheids appeared we have discovered *S. s. streptodactylus* in Hawaii. Here the species is abundant on the spongocoel of a large sponge, *Zygomycale parishei* (Bowerbank) (de Laubenfels, 1950: 25). Previous reports on the species do not note any association with sponges, and if the non-Hawaiian specimens in the collection were associated with a sponge, the sponge was not a distinct massive sponge but was one found in the branches of dead coral heads.

Synalpheus paraneomeris Coutière

For full citation see Banner and Banner (1964:86).

LOCALITIES: Fiji: 19 specimens from BF 16; 1, BF 19; 7, BF 21. Tonga: 1 specimen from BT 9; 6, BT 10; 1, BT 11; 2, BT 17. Samoa: 2 specimens from BAS 5; 1, BAS 7; 1, BAS 9; 1, BAS 10; 1, BAS 13; 2, BBS 6; 1, BBS 7; 1, BBS 8; 8, BBS 11; 2, BP 4; 6, BP 8; 1, BP 13; 12, BP 16.

Synalpheus hastilicrassus Coutière

Synalpheus hastilicrassus Coutière, 1905. Fauna and Geog. Mald. and Laccad. 2(4): 875, pl. 72, fig. 12.

LOCALITIES: Fiji: 1 specimen from BF 8; 1, BF 14; 1, BF 18; 1, BF 20.

Synalpheus coutierei Banner

Synalpheus coutierei Banner, 1953. Pacific Sci. 7(1):36.

LOCALITIES: Fiji: 1 specimen from BF 7; 1, BF 8; 1, BF 11; 1, BF 14; 2, BF 16. Tonga: 2 specimens from BT 4; 4, BT 5; 1, BT 8; 2, BT 9; 2, BT 16. Samoa: 1 specimen from BAS 9; 2, BBS 7.

Synalpheus anceps Banner

Synalpheus anceps Banner, 1956. Pacific Sci. 10(3):334, fig. 8.

LOCALITIES: Fiji: 1 specimen from BF 7; 1, BF 13. Samoa: 1 specimen from BAS 12; 1, BBS 5.

Synalpheus laticeps Coutière

Synalpheus laticeps Coutière, 1905. Fauna and Geog. Mald. and Laccad. 2(4):874, pl. 72, fig. 11.

LOCALITIES: Samoa: 4 specimens from BBS 1; 3, BP 8.

Synalpheus charon charon (Heller)

Alpheus charon Heller, 1861. K. Akad. Wiss. Wien, Sitzung. 44:272.

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

LOCALITY: Samoa: 2 specimens from BBS 11.

Synalpheus nilandensis oxyceros Coutière

Synalpheus nilandensis oxyceros Coutière, 1905. Fauna and Geog. Mald. and Laccad. 2(4):871, pl. 70, fig. 5.

LOCALITY: Samoa: 1 specimen from BAS 9.

Synalpheus heroni Coutière

Synalpheus heroni Coutière, 1909. U. S. Nat. Mus., Proc. 36:42, fig. 24.

LOCALITY: Fiji: 1 specimen from BF 16.

Synalpheus tumidomanus (Paulson)

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

LOCALITY: Samoa: 1 specimen from BP 4.

ALPHEUS Fabricius

MEGACHELES GROUP

? *Alpheus lanceostylus* Banner

Alpheus lanceostylus Banner, 1959. Pacific Sci. 13(2):136, fig. 3.

LOCALITY: Samoa: 1 specimen from BAS 5.

DISCUSSION: This specimen is lacking both the large and small chelae, and cannot be assigned to this species with certainty. When compared with the type specimen for *A. lanceostylus,* no points of difference were found except for very slight differences in proportions; however, it also agrees quite well with *A. edmondsoni* (Banner). The specimen has been placed in this species because it has a slightly thicker antennular peduncle than is normal for *A. edmondsoni.*

Alpheus collumianus medius Banner

Alpheus collumianus medius Banner, 1956. Pacific Sci. 10(3):340, fig. 11.

LOCALITIES: Fiji: 1 specimen from BF 12; 4, BF 13; 6, BF 15; 1, BF 16; 1, BF 20. Tonga: 1 specimen from BT 9; 4, BT 10; 13, BT 11; 3, BT 13. Samoa: 1 specimen from BAS 3; 1, BAS 6; 2, BAS 7; 2, BAS 9; 2, BAS 12; 2, BAS 13; 1, BBS 5.

Alpheus collumianus probabilis Banner

Alpheus collumianus probabilis Banner, 1956. Pacific Sci. 10(3):338, fig. 10.

LOCALITIES: Fiji: 1 specimen from BF 2; 1, BF 13; 2, BF 14; 2, BF 17; 3, BF 20. Tonga: 2 specimens from BT 9; 2, BT 12. Samoa: 1 specimen from BAS 4; 2, BAS 6; 5, BAS 9; 1, BAS 13; 3, BBS 5; 2, BBS 8; 2, BP 4; 2, BP 12; 2, BP 13.

Alpheus collumianus inermis Banner

Alpheus collumianus inermis Banner, 1956. Pacific Sci. 10(3):342, fig. 12.

LOCALITIES: Fiji: 2 specimens from BF 5; 1, BF 21. Samoa: 1 specimen from BAS 7; 15, BP 4.

Alpheus crockeri Armstrong

Crangon crockeri Armstrong, 1941. American Mus. Nov. (1137):8, figs. 2, 3.

Crangon tuthilli Banner, 1953. Pacific Sci. 7(1):63, fig. 19 a–d.

Alpheus tuthilli Banner, 1956. Pacific Sci. 10(3):338, fig. 9.

LOCALITIES: Samoa: 1 specimen from BAS 13; 4, BBS 3.

DISCUSSION: Careful comparison of the descriptions of *A. crockeri* and *A. tuthilli,* and of these specimens from Samoa with the specimens from Hawaii, leaves no doubt that *A. tuthilli* is a synonym.

Alpheus deuteropus Hilgendorf

Alpheus deuteropus Hilgendorf, 1878. Monats. Berlin Akad. Wiss. p. 834, taf. 4, fig. 8. Banner and Banner, 1964. Pacific Sci. 18(1):88.

Crangon deuteropus Banner, 1953. Pacific Sci. 7(1):70, fig. 22.

LOCALITY: Samoa: 1 specimen from BP 1.

MACROCHIRUS GROUP

Alpheus paragracilis Coutière

Alpheus paragracilis Coutière, 1897b. Paris Mus. Hist. Nat., Bull. 3(7):303.

LOCALITIES: Tonga: 1 specimen from BT 5; 6, BT 9; 17, BT 10; 17, BT 11; 10, BT 13; 12, BT 17. Samoa: 1 specimen from BAS 9; 7, BAS 12; 10, BAS 13; 3, BBS 6; 4, BP 6; 1, BP 8.

Alpheus clippertoni (Schmitt)

For full citation see Banner and Banner (1964:89).

LOCALITIES: Tonga: 4 specimens from BT 17. Samoa: 2 specimens from BAS 12; 2, BBS 11; 3, BP 4; 1, BP 16.

Alpheus macrochirus Richters

Alpheus macrochirus Richters, 1880. Meeresfauna der Insel Mauritius und der Seychellen, Decapoda, p. 164, taf. 17, figs. 31–33.

LOCALITY: Fiji: 1 specimen from BF 20.

Alpheus lottini Guérin

For full citation see Banner and Banner (1964:88).

LOCALITIES: Fiji: 3 specimens from BF 1; 1, BF 8; 3, BF 9; 2, BF 10; 1, BF 12; 2, BF 13; 2, BF 15. Tonga: 1 specimen from BT 5; 8, BT 9. Samoa: 6 specimens from BAS 2; 1, BAS 5; 6, BAS 10; 9, BAS 12; 2, BAS 14; 2, BBS 1; 1, BBS 7; 2, BBS 10; 2, BBS 11; 2, BP 1; 5, BP 11; 5, BP 13.

Alpheus gracilis Heller

Alpheus gracilis Heller, 1861. K. Akad. Wiss. Wien, Sitzung. 44(1):271, taf. 3, figs. 19–20.

LOCALITIES: Tonga: 1 specimen (collection data lost). Samoa: 3 specimens (collection data lost); 5, BP 8.

Alpheus acutofemoratus Dana

Alpheus acutofemoratus Dana, 1852*a*. U. S. Explor. Exped. 13: 550, pl. 35, fig. 2. De Man, 1902. Senckenb. Naturf. Gesell., Abhandl. 25:886, pl. 27, fig. 63.

nec Alpheus acutofemoratus Spence Bate, 1888. Challenger Rpts. 24:545, pl. 97, fig. 2.

Alpheus parabrevipes Coutière, 1898*a*. Soc. Ent. France, Bull. 1898(6):151, fig. 2.

LOCALITIES: Fiji: 2 specimens from BF 4. Tonga: 2 specimens from BT 8; 3, BT 9; 3, BT 12. Samoa: 2 specimens from BBS 1; 8, BBS 2; 1, BBS 7; 7, BBS 9; 1, BBS 10; 1, BP 3; 2, BP 9; 37, BP 14.

DISCUSSION: These specimens agree almost perfectly with the description given by de Man except that in only one does the small chela bear a trace of the longitudinal groove he described, and the second carpal article of the second legs is usually about 3 times the length of the first, instead of about 2.5 times as long. Possibly also the large and small chela bear more dense hair, but de Man's description is a little ambiguous on that point.

Alpheus tungii sp. nov.

TYPE SPECIMEN: A male 15.5 mm long (carapace length 5.5 mm) collected from the south coast of Tongatabu, Tonga, in head of dead and overgrown *Acropora,* at outer edge of fringing reef near surge channel, on March 31, 1954 by A. H. Banner. Only specimen known.

DESCRIPTION: Body sturdy and covered on almost all parts, including the carapace, abdominal terga, dorsal side of telson, and larger appendages, with scattered fine setae; setae nowhere dense enough to obscure form of exoskeleton.

Anterior portion of carapace bearing a low rounded medial crest extending from tip of rostrum to middle of carapace, carina not bearing tooth. Rostrum triangular with concave margins, tip reaching about two-thirds length of first antennular article; lateral margins bearing three strong setae; rostrum and anterior carapace depressed when seen in lateral view. Orbital hoods inflated, rounded, demarked from surrounding carapace, and carrying on medial surface, above frontal edge of carapace, strong teeth which reach about half length of rostrum. Orbital hoods bearing setae only around margins, hood not fully transparent because of scattered opaque limy spots (in preservative); eyes black, of normal size and development.

Stylocerite short, broad, with tip of tooth not reaching beyond end of first antennular article. Second antennular article with low rounded lateral crest; article 1.5 times as long as broad, about equal in length to basal article, and 1.4 times length of distal article. Basicerite heavy with strong lateral spine reaching beyond middle of second antennular article. Scapho-

cerite with acute, narrow tip extending considerably beyond end of antennular peduncle; lateral margin curved, proximally provided near articulation with strong tooth at right angles to margin; squamous portion short and narrow reaching only slightly beyond end of second antennular article. Carpocerite equal in length to scaphocerite.

Middle article of third maxilliped with strong rounded projection on inferior external margin.

Merus of large cheliped less than 0.3 length of chela; superior margin projecting but not acute; inferior internal margin with several slight rounded protuberances and bearing short, soft setae and two short spines distally; article otherwise without setae except on superior distal margin. Chela heavy, compressed, 2.1 times as long as broad at maximum breadth, with fingers occupying only distal 0.2 of entire length.

Palm with sharply delimited superior groove extending full length of chela; superior crest terminating in heavy rounded projection above dactylar articulation. Projection especially conspicuous on inner face. Plaque crest flat, margins sharp, terminating in two rounded teeth flanking adhesive plaque. Palmar groove shallow but well delimited distally. Inferior crest flattened, ending in small acute tooth. Inferior depression rounded. Dactylar articulation also flanked with strong tooth on superiomedial side. Dactylus heavy and rounded. Upper portion of superiomedial face papillose, papillae bearing short and mostly light setae; other portions of chela with at most scattered setae; chela not conspicuously hirsute.

Small cheliped heavy. Superior margin of merus projecting distally into low rounded tooth; inferior internal margin armed with three small spines carried on heavy protuberances. Carpus with superior distal margin projecting as strong tooth over base of chela. Chela 3 times as long as broad, with fingers occupying distal 0.45. Palm with superior groove and crest similar to those of large chela, except shallow and poorly developed; superior crest projecting above dactylar articulation as small, acute tooth; opposite margin of dactylar articulation bearing similar but smaller tooth; superior and internal surface of palm papillose with papillae bearing heavy but not long setae. Fingers heavy, with dactylus slightly curved and fixed finger bearing cutting flange on internal edge; tips hooked, pointed, and crossing.

Carpal articles of second leg with ratio: 10:4.1:3.0:2.6:9.9.

Third leg with ischium bearing heavy movable spine; merus 2.9 times as long as broad, inferior margins bearing a series of setiferous notches and strong terminal tooth; carpus 0.56 as long as merus, with superior margin bearing setae and both superior and inferior margins projecting distally into acute teeth; propodus 0.75 as long as merus, bearing setae on superior margin and five pairs of spines on inferior margin and two on terminal margin; dactylus curved, 0.27 as long as merus, biunguiculate with lower unguis small.

Outer uropod with strong lateral spine; inner uropod with a series of strong movable spines. Telson 2.7 times as long as broad posteriorly, 1.5 times as broad anteriorly as posteriorly; lateral margins almost straight, posterior margin shallowly arcuate; dorsal and terminal spinules of moderate size.

DISCUSSION: This species belongs to the Macrochirus group, and within the group it is obviously most closely related to *A. villosus* (Olivier). Like *A. villosus* this species has hairs over the body surface, a carinate carapace, orbital teeth, a strong spine on the basicerite, grooves and teeth on the large chela, an acute tooth on the merus, and a biunguiculate dactylus on the third legs, etc.

Without a full description of *A. villosus,* point for point comparisons are difficult. The differences between the illustrations of Coutière (1899, *seriatim*), taken from Olivier's type, and Bate's drawings of *Paralpheus diversimanus* (Olivier) (Chall. Rept., pl. 102, fig. 1), which Coutière states is identical with *A. villosus* (1898*b*:204), are especially confusing. Without any actual specimens of *A. villosus* for comparison, we have presumed the drawings and fragmentary description of Coutière to be more accurate and have used them as much as possible in Table 2.

There is evidently a difference in the large chela, especially around the articulation of the dactylus, but Coutière's sole figure (1899:220, fig. 266) is difficult to interpret.

Other species given by Coutière as being related to *A. villosus* can be separated by a number of characteristics. *A. malleator* Dana differs in the form of the rostrum and orbital hoods and in the large chela; *A. rugimanus* A. Milne-Edwards differs in the large chela; *A. socialis* Heller lacks the tooth on the merus of the third legs; and *A. macrochirus* Richters lacks the orbital teeth and differs in the form of the large chela.

This species has been named in honor of Prince Tungi of the Kingdom of Tonga, who was most cooperative during the field work on Tongatabu.

OBESOMANUS GROUP

In the Obesomanus group a large number of species have been described based upon few specimens; as in other groups rather subtle differences in form of rostral front and chelae, and slight to major differences in proportions of articles have been used as criteria for the differentiation of the species. Inasmuch as it has become apparent in the study of our collections, which contain relatively large numbers of some species, that these species are possibly the most variable of all the species of *Alpheus,* we have decided to study the extent of variation in characteristics used as criteria to separate the described species.

This paper has been chosen as the logical one of the series in which to discuss this variation and to evaluate the validity of the Indo-Pacific species placed in this group. For this study all of the specimens in the collections available, those already reported, those reported in this paper, and those to be listed in future papers, were carefully examined.

Of the numerous species attributed to this group we now recognize only six in our Central Pacific collections: *A. obesomanus* Dana, *A. malleodigitus* (Bate), and *A. microstylus* (Bate), all with numerous specimens, and *A. perplexus* Banner, *A. chamorro* Banner, and *A. samoa* (described below) with but few specimens. In our reconsideration of the group we have decided that the genus *Thunor* is not valid and we have placed its species also within the Obesomanus group, thereby adding two more central Pacific species, *A. idiocheles* Coutière and *A. microscaphis* (Banner).

In only the first three species could variation be studied. For these three species samples were compared from all parts of the range represented. Because no significant differences were found from one locality to another, figures on their variations were combined. A total of 80 specimens of *A. obesomanus,* 87 specimens of *A. malleodigitus,* and 9 specimens of *A. microstylus* (all of them reasonably intact) were measured. To show the normal form of the three species, the anterior body region and the

TABLE 2

DIFFERENTIATING CHARACTERISTICS OF *A. villosus* AND *A. tungii*

A. villosus	*A. tungii*
1. Median crest of carapace bearing tooth posterior to the orbital hood.	1. Median crest without tooth.
2. Secondary teeth between orbital teeth and rostrum.	2. Secondary teeth lacking.
3. Orbital hoods covered with an enmeshment of hairs ("entrêmelées de poils") and corneas of eyes "dépigmentées et de couleur crayeuse."	3. Orbital hoods with hair light and scattered; corneas of normal pigmentation.
4. Third leg with carpus armed with 5 movable spines and only slight superior distal tooth; propodus armed on inferior margin with over 8 pairs of spines; secondary unguis of dactylus heavy.	4. Third leg with carpus lacking movable spines, superior distal tooth heavy; propodus with 5 pairs of spines; secondary unguis of dactylus slight.
5. Inner uropod with outer distal margin unarmed.	5. Inner uropod with outer distal margin bearing a row of movable spines.

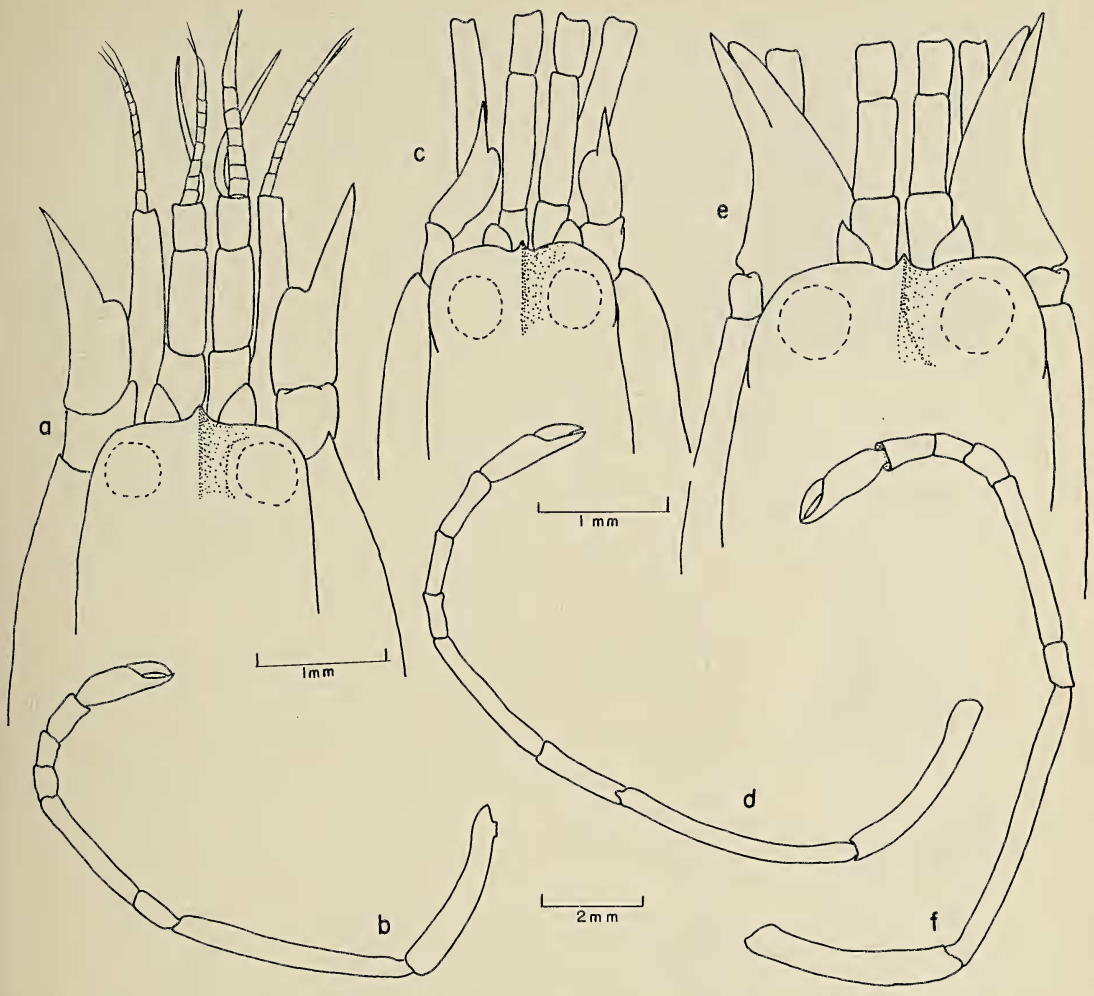

FIG. 8. *Alpheus obesomanus* Dana. 18 mm male from station BP 10. *a*, Anterior body region; *b*, second leg. *Alpheus malleodigitus* (Bate). 20 mm male from station BP 4. *c*, Anterior body region; *d*, second leg. *Alpheus microstylus* (Bate). 23 mm male from station BP 13. *e*, Anterior body region; *f*, second leg.

second leg are presented in Figure 8.

Orbital hoods and rostral front. As previously reported the anterior body region is variable; the rostrum itself in all three species is present, but may be exceedingly minute (de Man and Coutière both reported specimens in which it was lacking); and the frontal margin of the carapace between the orbital hoods varies from straight to bent inwards towards the rostrum.

Antennular peduncles (Figs. 9 and 10). No sexual dimorphism was found in this characteristic; therefore figures for male and female were combined. The curves for the relative lengths of the first and second antennular articles show that while there is a statistical difference between *A. obesomanus* and *A. malleodigitus* there is so much overlap that the characteristic cannot be used for species differentiation; *A. microstylus* also falls within the same range. The length-breadth ratio of the second article shows a greater contrast between *A. obesomanus* and *A. microstylus* on one hand and *A. malleodigitus* on the other, but again the difference is not clear-cut. It will be noted that in the wide variation in these characteristics

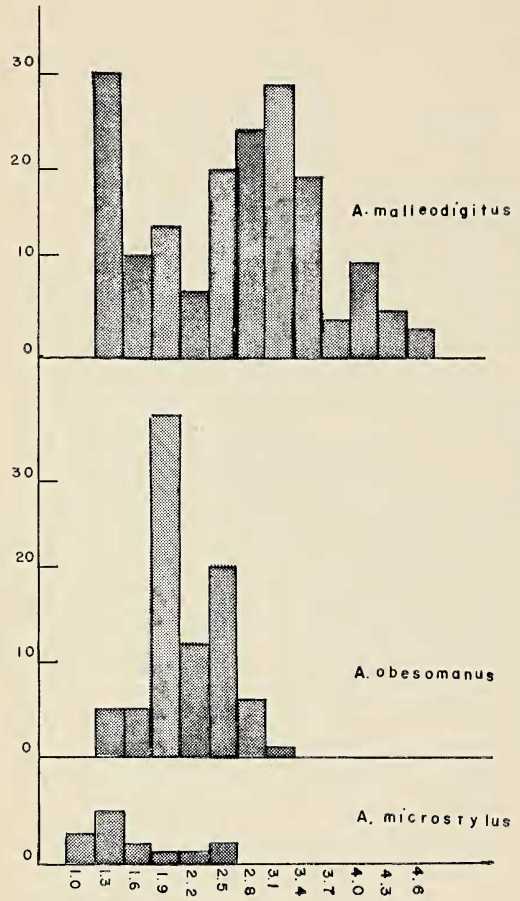

FIG. 9. Obesomanus group; variations in proportions of antennular articles in three species. *Ordinate:* length of second article divided by length of first article. *Abcissa:* number of specimens.

attributed to *A. malleodigitus* there appears to be a bi- or even tri-modal curve which could indicate two or three separate species with overlapping variation; however, in careful correlation with other characteristics we could find no related differences that could separate these groups. Therefore, we have interpreted this as a probable difference in geographically separated populations.

Antennal peduncle (Figs. 11, 12, and 13). In this appendage there is a clear differentiation between *A. obesomanus* and *A. malleodigitus* in the relative lengths of the scaphocerite and carpocerite when compared with the antennular articles, the scaphocerites being definitely shorter in the latter species; *A. obesomanus* and *A. microstylus,* similar in their carpocerites and scaphocerites, are differentiated by the lengths of the squamous portion. In *A. microstylus* the squame reaches to near the end of the third, and in *A. obesomanus* it reaches only to the middle of the second antennular article.

Large chela. On this appendage emphasis has been made on the degree of sculpturing. In most specimens the chitin of the body of the chela is relatively soft, being stiff only where muscles or ligaments are attached; as a consequence the process of preservation alters the extent of the depressions and grooves, and no great significance should be attached to either their depth or breadth. However, all had some indentations, and none closely approached the smooth condition reported by Dana for his species *A. obesomanus* (his drawing appears to be of the medial face, which is smooth in most species of this group).

Small chela (Fig. 14). This characteristic has been used by de Man (1911:313) as a distinguishing characteristic in his key ("fingers of small chela of the male much shorter than palm, the proportion between the length of the

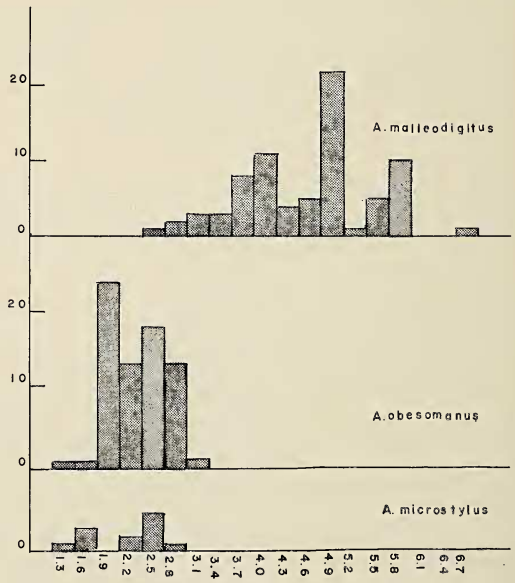

FIG. 10. Obesomanus group; proportions of second antennular article in three species. *Ordinate:* length of second antennular article divided by its breadth. *Abcissa:* number of specimens.

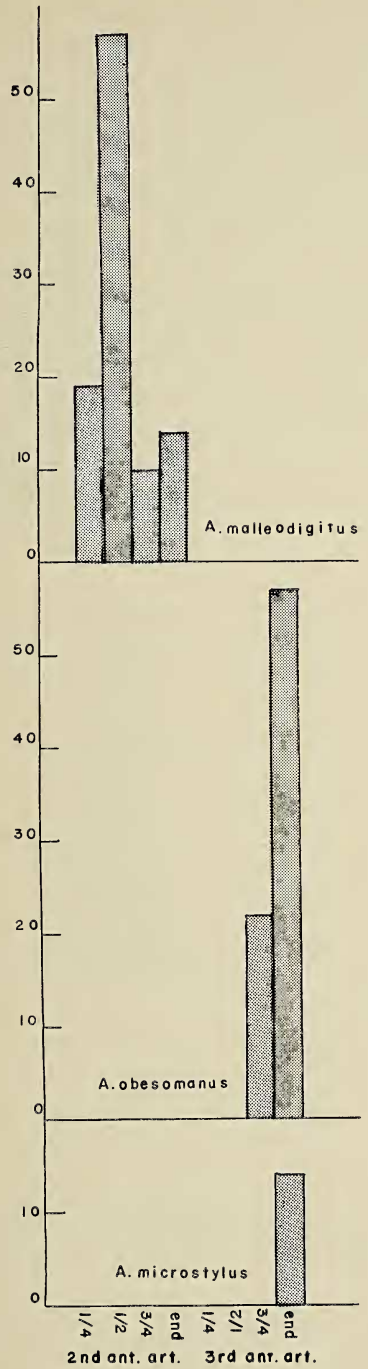

FIG. 11. Obesomanus group; relative proportions of scaphocerite and antennal peduncle in three species. *Ordinate:* length of scaphocerite in relation to second and third antennular article. *Abcissa:* number of specimens.

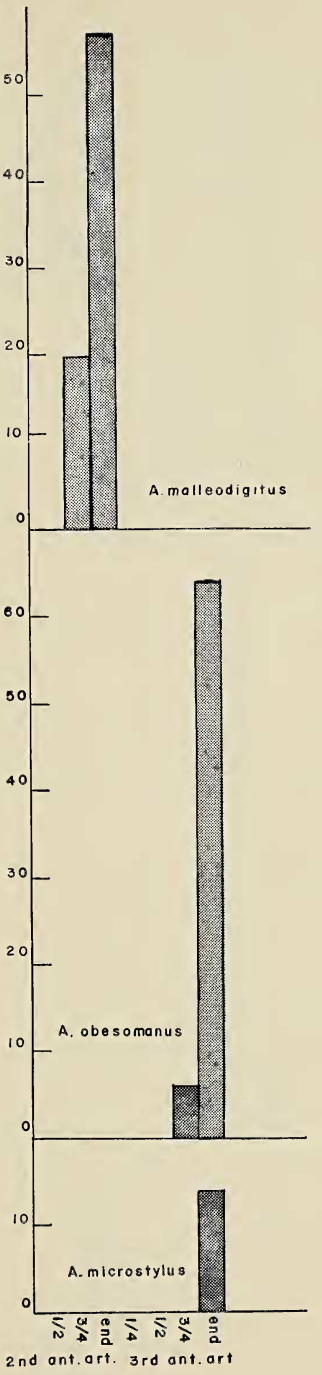

FIG. 12. Obesomanus group; relative proportion of the carpocerite to the antennal peduncle in three species. *Ordinate:* length of carpocerite in relation to second and third antennular peduncle in three species. *Abcissa:* number of specimens.

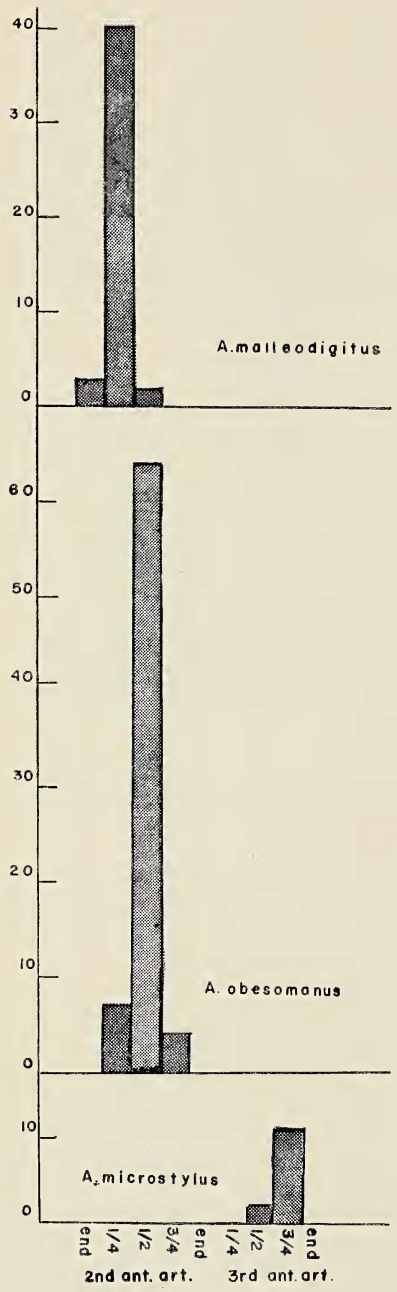

FIG. 13. Obesomanus group; relative proportions of the squame to the antennal peduncle in three species. *Ordinate:* length of squame in relation to the second and third antennular article. *Abcissa:* number of specimens.

chela and that of the fingers more than 3 as opposed to a little shorter than the palm. . . less than 3"). The graphs show that, while there may be statistical differences, this characteristic cannot be used for separation of individual specimens. Analysis showed no differences between the sexes, and so these are not differentiated on the graph.

Second leg (Fig. 15). Between the two species, *A. malleodigitus* and *A. obesomanus,* the characteristic that seems to give the best differentiation is the ratio of the first two carpal articles: in *A. malleodigitus* the ratio is less than 1:2 (usually about 1:1.5), while every specimen of *A. obesomanus* has a ratio of more than 1:2 (usually about 1:3). The few specimens of *A. microstylus,* however, seem to fall into the range of *A. obesomanus.*

Third leg (Figs. 16 and 17). In these the length-breadth relationship of both the merus and the carpus are graphed and no sharp differentiation is found.

Telson (Fig. 18). When the length of the telson is contrasted with the breadth of the tip, a measurement often used in this genus as a specific characteristic, extreme variation is noted; it is doubtful if this should ever be used as a characteristic within this group.

With this knowledge of the variation in these three species, the separation of the Indo-Pacific species and varieties has been reviewed. The characteristics of those species not represented in the collection were derived entirely from the litrature. These species are listed in the order of their consideration in the section which follows.

A. obesomanus japonicus Ortmann, 1890:478.

A. microstylus (Bate), 1888:566, pl. 101, fig. 6; Coutière 1899: Figs. 270–272, 400 (listed as *A. obesomanus* or *A. malleodigitus*); Coutière, 1905:884, pl. 76, fig. 23; de Man, 1911:344.

A. microstylus var *?* de Man, 1911:345, pl. 14, fig. 68.

A. lutini Coutière, 1905:885, pl. 76, fig. 24; de Man, 1911:346, pl. 14, fig. 69.

A. species 2 Banner, 1956:351, fig. 15.

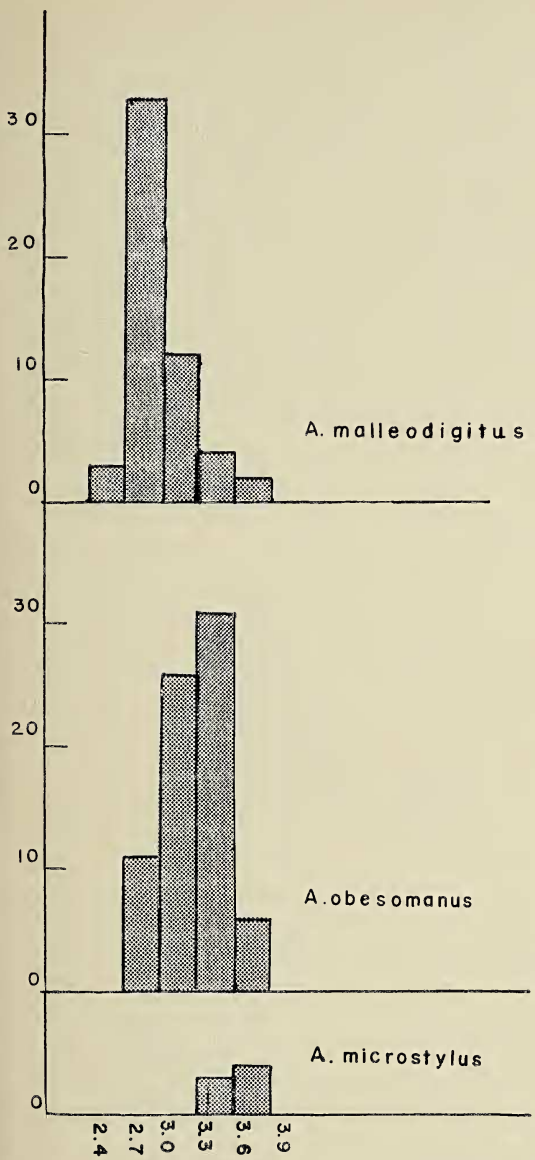

Fig. 14. Obesomanus group; relative proportions of the palm and fingers of the small chela of three species. *Ordinate:* ratio of the length of fingers to length of palm, the fingers being considered as 1. *Abcissa:* number of specimens.

A. malleodigitus (Bate), 1888:565, pl. 101, fig. 5; de Man, 1902:866; de Man, 1911:347, pl. 14, fig. 70–70d.
A. malleodigitus var. *gracilicarpus* de Man, 1909b:99; 1911:349, fig. 70.
A. phyrgianus Coutière, 1905:886, pl. 77, fig. 25.

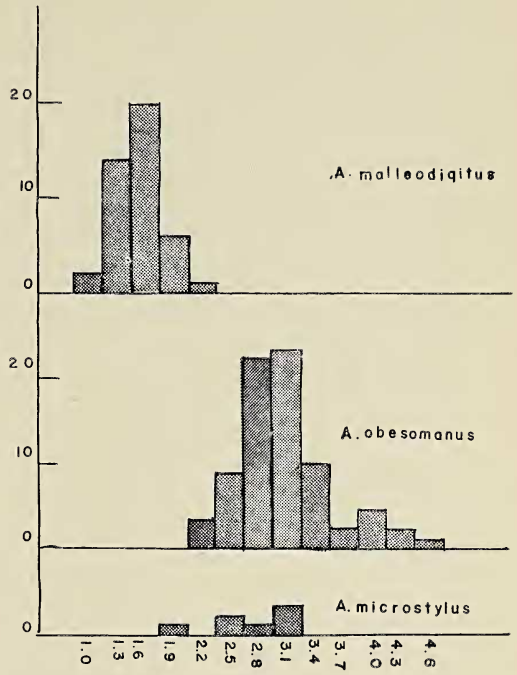

Fig. 15. Obesomanus group; proportions of first and second article of the second leg in three species. *Ordinate:* length of the second article of the second leg divided by the first. *Abcissa:* number of specimens.

A. danae Coutière, 1905:887, pl. 77, fig. 26.
A. persicus Nobili, 1906:33.
A. samoa (below).
A. species Nobili, 1906:34.
A. perplexus Banner, 1956: 349, fig. 14.
A. species de Man, 1911:349, pl. 15, fig. 71.
A. chamorro Banner, 1956:349, fig. 14.

In addition to those species previously placed in the Obesomanus group, we are adding those species previously placed in *Thunor,* the relegation of *Thunor* to synonymy being discussed under *A. samoa* (below). These species are:

A. rathbunae (Schmitt), 1924:74, pl. 1, figs. 1–10. (Originally described as *Crangon rathbunae,* and later placed in the genus Thunor.)
A. idiocheles Coutière, 1905:883, pl. 75, fig. 21. Later named *Thunor idiocheles* [Coutière] (Banner, 1956:367, fig. 22).
A. baculifer Coutière, 1908:16.
A. microscaphis (Banner), 1959:151, fig. 13.

In the summation of the characteristics of the species given below, the original description was used wherever possible; for some characteristics, especially proportions, the original figures were used; only where both of these were insufficient were the later redescriptions used (of the type or supposedly similar specimens). The species have been divided into four groups for the purpose of this discussion:

I. Those species with a strong articulation of the outer uropod.
   A. Those with simple dactyli on the posterior legs, and with elongate second articles in the carpus of the second legs.

1. *A obesomanus* Dana. This species, the first one described in the group, was characterized by having the second article of the antennular peduncle 1.5 times the length of the first, and 3 times as long as broad; the scaphocerite and the carpocerite barely reaching to the end of the second antennular article, and the squamous portion of the scaphocerite reaching to the middle of the second antennular article (according to Boone, 1935); the large chela smooth (although Boone described depressed areas); the palm of the small chela

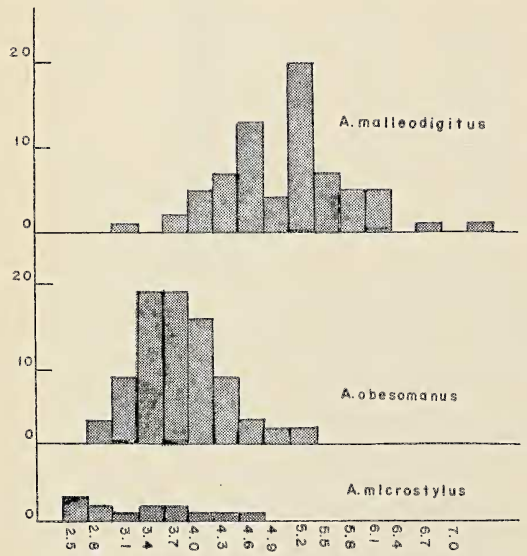

FIG. 16. Obesomanus group; proportions of the carpus of the third leg of three species. *Ordinate:* the length of the carpus of the third leg divided by the breadth. *Abcissa:* number of specimens.

was described as 3 times as long as the fingers but illustrated as 2.5 times as long; the first two carpal articles of the second leg with the ratio of 1:4. (Dana's figures show a ratio of about 1:3.4 with the merus of the third leg armed, the dactylus simple.)

This species, the most common one in our collections, was identified originally in this series of papers as *A. lutini* Coutière (for characteristics see below), since almost all the specimens had longer scaphocerites and carpocerites than those described by Dana (Figs. 11 and 12). However, a few specimens of those measured approached the described condition of *A. obesomanus,* and other individuals not in the sample measured showed a gradation between these and the condition described by Dana. Of seven specimens in a single collection from Tahiti (BD 13), one has the scaphocerite and carpocerite not quite reaching to the tip of the second antennular article; one specimen has them reaching to the end of this article; in two the parts reach to the first quarter of the third antennular article; and in another two, to the middle of this article; in the remaining specimens they reach almost to the tip of the article.

This leaves the ratio of fingers to palm of the small chela as means of distinguishing between the two nominal species. These ratios were reported to be 1.0:2.5 in *A. obesomanus* and 1:1.5 in *A. lutini.* However, Dana's figures show a ratio of 1:2.5, and the measured specimens show a ratio of 1:1.5 to 1:2.5. Thus there is no differentiation. Other characteristics set forth by Coutière are also bridged by the variation reported above.

A neotype should be established from Fiji for this species, but all of the Fijian specimens at hand were more like the form described for *A. lutini* and none closely approached the characteristics given by Dana.

2. *A. obesomanus japonicus* Ortmann. Ortmann's original description is very inadequate to characterize this species. The second antennular article is more than twice as long as the first; the scaphocerite is "sehr schmal, fast so lang wie die Stiele der äusseren, kürzer die der inneren Antennen." The fingers of the small

chela are "somewhat shorter" than the palm; the second carpal article of the second leg is twice as long as the first.

This may be a distinct species, but because the only characteristic that is definitely stated is the relative length of the second carpal article, and as this relative length lies merely on the extreme margin of the normal curve for the supposed parent species (see Fig. 15), the subspecies must be regarded as indistinguishable from *A. obesomanus.*

If later study shows this to be a distinct species or subspecies the name will have to be changed, as Coutière (1905:886) has already remarked, because the name *A. japonicus* has already been used by Miers (1879:53) for a species in the Edwardsii group.

3. *A. microstylus* (Bate), when compared with *A. obesomanus,* appears to have slightly shorter and thicker second articles in the antennular peduncle 1.2 times the length of the first, and 2 times as long as broad. Most important, the end of the scaphocerite and carpocerite reach beyond the end of the antennular peduncle, and the squamous portion of the scaphocerite reaches almost to the end of the third article; the sculpturing of the large chela is deep and pronounced, and the palm of the small chela varies from 1.5 to 2.1 times the length of the fingers; the first two carpal articles of the second legs bear the ratio of 1:3, the third legs are similar to those of *A. obesomanus* and vary from 3.0 to 4 times as long as broad. There seems no doubt that this species is valid and distinct from *A. obesomanus,* as shown by the differences in the antennal peduncle, small chela, and second legs; it is probable that the differences in the large chela are constant and discernable as well.

4. *A. microstylus* var? de Man. This possible variety was separated by de Man from the parent species solely on the basis of the thinner second segment of the second legs, 9–14

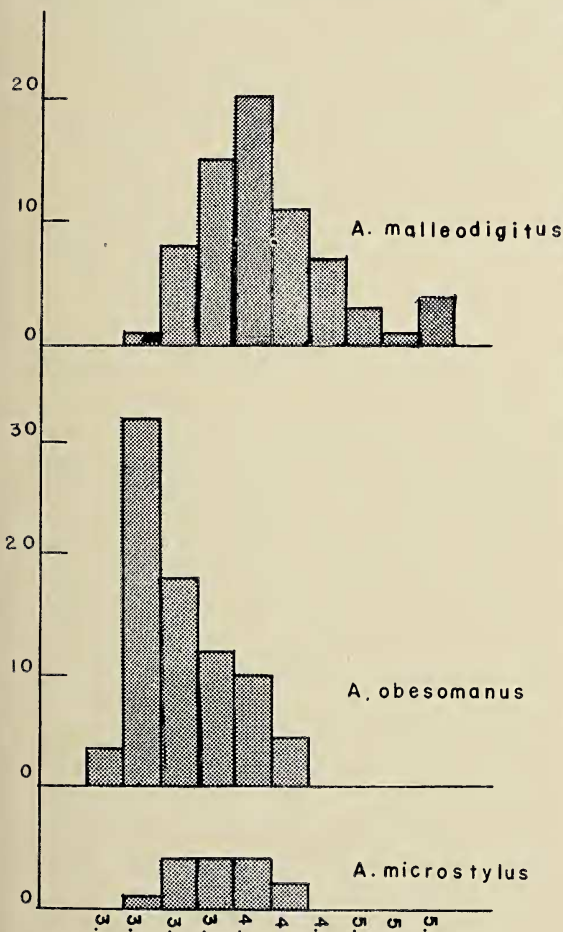

FIG. 17. Obesomanus group; proportions of the merus of the third leg in three species. *Ordinate:* the length of the merus of the third leg divided by the breadth. *Abcissa:* number of specimens.

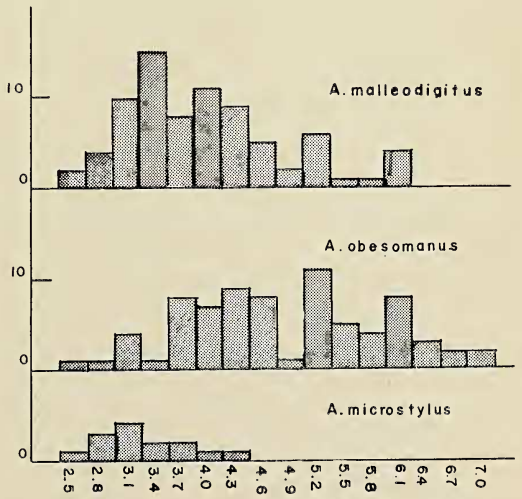

FIG. 18. Obesomanus group; proportions of the telson in three species. *Ordinate:* the length of the telson divided by the breadth of the posterior portion. *Abcissa:* number of specimens.

times as long as broad, instead of 7–10 times as long as broad (as taken from Bate's figures), and a more narrow posterior margin of the telson, with the telson in the variety 6 times as long as broad, instead of 3–4 times. Not enough specimens of *A. microstylus* were available to ascertain the full extent of variation on the carpus of the second legs, but in those available the length divided by the breadth of the second article varied from 6 to 8, and the telson, as illustrated by the wide span in the related *A. obesomanus,* must also be extremely variable. Therefore, this variety does not appear to be distinct, and the name should be listed in synonymy.

5. *A. lutini* Coutière. This species was characterized by having the second antennular article 1.5–2.0 times the length of the first, and 2.4–3.0 times as long as broad; the scaphocerite and carpocerite being equal, and slightly shorter than the antennular peduncle, but with the squamous portion of the scaphocerite reaching only to the middle of the second article; the grooves of the large chela being deep and pronounced, the palm of the small chela 1.5 times the length of the fingers; the second carpal article of the second legs between 2.5 and 3.5 times as long as the first; the configuration of the third legs like that of *A. obesomanus;* and the telson 6 times as long as the posterior margin is broad. As discussed above, this form is the more common type of the variable *A. obesomanus.*

6. *A.* species 2, Banner. This sole specimen from Saipan has the antennular peduncle about the same as that described for *A. lutini,* but while the carpocerite reaches to the end of the antennular peduncle, the scaphocerite reaches only to the end of the second antennular article; the palm of the second leg is twice the length of the fingers; the second and third legs are very much like those of *A. obesomanus,* and the telson is 4.1 times as long as broad. (Note: the description [Banner, 1956:352] is in error on this point; it is 4.1 times as long as the posterior margin is wide and anteriorly 2.7 times as broad as posteriorly.)

Almost all of the specimens of *A. obesomanus* in the collection have the carpocerite and scaphocerite equal in length; however, in a few they differ in length, with the scaphocerite being shorter. Intergrading series were found in different collections that bridged the difference between a usual *A. obesomanus* and the characters noted for this species. In this provisional species, however, the orbital hoods were confluent, without a trace of rostrum, rostral keel, or orbitorostral grooves. In *A. obesomanus* there is usually a short rostrum with a short keel that is separated from the orbital hoods by a shallow concave region, but this characteristic is not constant, and in a few the rostrum is almost entirely lacking, the carina has disappeared, and the orbital hoods are almost confluent. Our present interpretation, therefore, because of the condition on the Saipan specimen, is that it merely shows an unusual variation or possibly a congenital defect.

B. Those with simple dactyli on the posterior legs, but with the second carpal article of the second leg not more than twice the length of the first.

1. *A. malleodigitus* (Bate). This species has been described twice, the original description by Bate on the basis of a fragmentary specimen, and a later redescription by de Man on a complete but smaller specimen. Unfortunately, the descriptions do not agree, and in the following synopsis the changes by de Man are put in parentheses: First antennular article equal to the sum of the following (second article 2–3 times length of visible portion of the first); spine of scaphocerite described as reaching to the end of the first antennular article, and shown as reaching to the middle of the third article (reaching from near the middle to the end of the second antennular article); squamous portion of scaphocerite narrow, tapering, two-thirds length of lateral spine (squamous portion not tapering into spine); carpocerite twice as long as scaphocerite, reaching beyond end of antennular peduncle (reaching from end of second antennular article to middle of third); fingers of small chela "about half" the length of the palm according to the description, but measuring

0.65 in the figure (a little shorter than the palm); first two carpal articles described as "subequal" and shown to have the second article about 1.5 times the length of the first (the second article varying from 1.1 to 1.6 times the length of the first); walking legs lacking from type (but described by de Man to be like those of *A. obesomanus)*; telson shown to be about 3 times as long as the posterior margin is wide (4 times as long). De Man accounted for the difference by saying that his specimens were smaller and were not broken. Moreover, Bate's descriptions and figures were inaccurate.

We believe that inasmuch as Bate's type specimen was defective, as his descriptions were inadequate and did not match his drawings, and as de Man's excellent figures and descriptions agree with those of Bate on many points, the characteristics of this species should be established on the basis of the redescription by de Man. In any case, the species is well separated from those placed in Group I above by the length of the scaphocerite and by the length relationship of the first and second carpal articles of the second leg. The name *A. malleodigitus* is the oldest name in Group B.

2. *A. malleodigitus* var. *gracilicarpus* de Man. This variety was separated by de Man solely on the basis of the length: breadth relationship of the articles of the second and third legs, as given in Table 3, using figures for both the parent species and the variety as given by de Man (1911:348).

The only appendages upon which length: breadth relations were taken in our study were the second antennular article and the merus and carpus of the third legs. These show that length: breadth ratios are very variable. The graph on the merus of *A. malleodigitus* (Fig. 17) shows what might have developed into a bimodal curve, had hundreds of specimens been measured, but there is no reason to believe that those with the more slender appendages would have shown a valid specific separation from those with the heavier. Therefore we consider this variety to be merely an extreme found in a normal population.

TABLE 3

Length: Breadth Ratio of Articles

Article	*A. malleo-digitus*	*A. m. gracili-carpus*
Second leg,		
fourth carpal article	2.4–3.9	5.0–5.3
Third leg,		
merus	3.7–4.0	4.5
carpus	4.4–4.8	5.6

3. *A. phyrgianus* Coutière. This species was characterized by having the second antennular article 3 times the length of the first, about 4 times as long as broad; the carpocerite reaching to the end of the second antennular article; the scaphocerite to the middle of the same article, with the squamous portion only one-third the length of this article; the sculpturing of the large chela slight; the palm of the small chela about 1.2 times the length of the fingers; the second carpal article of the second legs varying from 1.1 to 1.6 times the length of the first; the length of the merus of the third leg 4 times its breadth, and feebly armed; and the telson 4.5 times as long as broad.

The actual differences between this species and *A. malleodigitus* lie in the slight differences in proportions of the appendages, which are now shown to be variable; therefore, *A. phyrgianus* must be considered a synonym of *A. malleodigitus.*

4. *A. persicus* Nobili. In this species the second antennular article was described as being 3 times as long as the first, 3 times as long as broad; the carpocerite reaching almost to the end of the third antennular article; the scaphocerite reaching to the end of the second antennular article, with the squamous portion to the middle of the same article; the chelae "concerdent avec celles de phyrgianus"; the second carpal article of the second legs being 1.1 times as long as the first (obviously there is a typographical error in Nobili's paper [1906:34], as it reads "1.31" instead of 1.13); the third legs being similar to those of *A.*

phyrgianus; and the telson being more than 3 times as long as broad.

Nobili distinguished his species from *A. phyrgianus* in that the second antennular article was shorter and the scaphocerite was longer; however, both of these characteristics are variable, and the proportions stated for *A. persicus* fall within the range of *A. malleodigitus.* Therefore *A. persicus,* also, should be considered a synonym.

5. *A. danae.* The characteristics set forth by Coutière are: second antennular article 2.5 times the length of first, and 4.2 times as long as broad; scaphocerite and carpocerite equal in length, reaching to the middle of the second antennular article, with the squamous portion of the scaphocerite reaching only a quarter the length of that article; the large chela lost; the palm of the small chela 2 times the length of the fingers; the second carpal article of the second leg 1.3–1.5 times the length of the first; the third leg almost identical to that of *A. phyrgianus;* the telson slightly broader than in *A. phyrgianus,* about 3.7 times as long as broad.

This species, too, is very close to *A. malleodigitus* but may be separated by the very short carpocerites; none of the specimens measured in our study approached the condition described for *A. danae.* It may be that this is merely an extreme variation, but at present this is not indicated.

6. *A. samoa* (described below). As stated below, this species is unique within the Obesomanus group in that the scaphocerite is almost vestigial, not reaching to the end of the first antennular article; otherwise the species also approaches *A. malleodigitus.*

7. ***A. nobili*** (nom. nov.) = *A.* species Nobili. The few characteristics given by Nobili for this specimen were: antennular and antennal peduncles like those of *A. microstylus* (therefore with the scaphocerite and carpocerite reaching beyond end of the antennular peduncle), but with the squamous portion of the scaphocerite reaching only to end of the second antennular article; the ratio of the first two carpal articles were 10:14 to 10:13; and the carpus of the third legs a little longer than the propodus.

The combination of the characteristics of the antennal peduncles and second legs is unlike any other species in the group and, if the description is accurate, the specimen probably represents a new species; at least, it does not appear to be a variety of *A. microstylus* as Nobili suggested. We have assigned the name *A. nobili* to the tentative species.

C. Species with biunguiculate dactyli on posterior legs.

1. *A. perplexus* Banner. This species is unique within the Obesomanus group in having, in addition to the biunguiculate dactylus, crests and depressions on the large chela that are similar to those of the Megacheles group; otherwise it is similar to *A. obesomanus* and *A. malleodigitus.*

2. *A.* species, de Man. This is probably the same as *A. perplexus* (see Banner, 1956: 349).

3. *A. chamorro* Banner. This species, too, has a biunguiculate dactylus, but in general approaches the species of the Crinitus group in most characteristics, although the large chela still retains a diminished hammer-shaped dactylus.

II. Species without strong transverse articulations on the outer uropods.

1. *A. rathbunae* (Schmitt). This Caribbean species can be characterized within this subgroup by the complete absence of a rostrum and the extreme elongation of the second antennular article, as well as the narrow tip of the telson. The dactylus of the large chela does not have a strong superior (or proximal) projection.

2. *A. idiocheles* Coutière. This species has a rostrum. The scaphocerite reaches to about the middle of the second article; large and small chelae are elongate, with dactylus of the large chela formed like a single-headed, not double-headed, hammer.

3. *A. baculifer* Coutière. This species, previously known only by a female specimen, will

be shown in a later paper to be merely a female of *A. idiocheles.*

4. *A. microscaphis* (Banner). This species can be easily characterized by the extreme reduction of the scaphocerite, reaching only to or slightly past the end of the first antennular article, and by the dactylus of the large chela, which has the form of a two-headed hammer.

In summation, the following species have been retained:

A. obesomanus Dana. Synonyms: *A. lutini* Coutière, *A.* species 2 Banner
A. microstylus (Bate). Synonym: *A. microstylus* var. *?* de Man
A. malleodigitus (Bate). Synonyms: *A. malleodigitus* var. *gracilicarpus* de Man, *A. phyrgianus* Coutière, *A. persicus* Nobili
A. danae Coutière
A. samoa (sp. nov.)
A. nobili nom. nov. Synonym: *A.* species Nobili

KEY TO THE SPECIES OF THE OBESOMANUS GROUP

1. Outer uropod with articulation 2
Outer uropod without articulation 9

2(1). Dactylus of third legs simple 3
Dactylus of the third legs biunguiculate 8

3(2). Second carpal article of second legs more than twice as long as first 4
Second carpal article less than twice as long as first, usually less than 1.5 times as long 5

4(3). Squamous portion of scaphocerite reaching only to middle of second antennular article ..... *A. obesomanus* Dana
Squamous portion of scaphocerite reaching to near end of third antennular article ..... *A. microstylus* (Bate)

5(3). Scaphocerite and carpocerite reaching to near end of third antennular article ..... *A. nobili* nom. nov.
Scaphocerite reduced, with tip reaching only to middle of second antennular article or less; carpocerite various but usually reduced 6

6(5). Scaphocerite reaching to near middle of second antennular article 7
Scaphocerite not reaching to end of first antennular article ..... *A. samoa* sp. nov.

7(6). Carpocerite markedly longer than scaphocerite, reaching at least to end of second antennular article ..... *A. malleodigitus* (Bate)
Carpocerite subequal to scaphocerite, reaching only to middle of second antennular article ..... *A. danae* Coutière

8(2). Large chela with crests and grooves, like those found in Megacheles group; without rostrum ..... *A. perplexus* Banner
Large chela smooth, without crests and grooves; with rostrum ..... *A. chamorro* Banner

9(1). Without rostrum (Caribbean species) ..... *A. rathbunae* Schmitt
With rostrum 10

10(9). Scaphocerite reaching to middle of second antennular article; dactylus of large chela without superior projection ..... *A. idiocheles* Coutière
Scaphocerite reaching only to near end of first antennular article; dactylus of large chela with characteristic double-headed hammer shape of Obesomanus group ..... *A. microscaphis* (Banner)

A. perplexus Banner
A. chamorro Banner
A. rathbunae (Schmitt)
A. idiocheles Coutière. Synonym: *A. baculifer* Coutière
A. microscaphis (Banner)

Alpheus obesomanus Dana
Fig. 8

Alpheus obesomanus Dana, 1852*a*, Acad. Nat. Sci. Philadelphia, Proc. 12:21; 1852*b*, U. S. Explor. Exped. Crust. 13:547, pl. 34, fig. 7. —Boone, 1935. Vanderbilt Mar. Mus., Bull. 6:135, pl. 35.
Alpheus lutini Coutière, 1905. Fauna and Geog. Mald. and Laccad. 2(4):885, pl. 76, fig. 24.
Alpheus species 2 Banner, 1956. Pacific Sci. 10(3):351, fig. 15.

LOCALITIES: Fiji: 2 specimens from BF 3; 1, BF 4; 6, BF 11; 1, BF 13; 2, BF 14; 5, BF 15; 3, BF 21. Tonga: 4 specimens from BT 4; 1, BT 11; 9, BT 12; 1, BT 13. Samoa: 12 specimens from BAS 1; 2, BAS 2; 4, BAS 3; 9, BAS 5; 25, BAS 6; 23, BAS 7; 9, BAS 8; 3, BAS 9; 24, BAS 10; 12, BAS 12; 12, BAS 13; 18, BAS 14; 5, BBS 1; 54, BBS 2; 4, BBS 3; 7, BBS 4; 2, BBS 7; 6, BBS, 8; 20, BBS 9; 2, BBS 11; 1, BP 1; 22, BP 4; 1, BP 6; 5, BP 8; 4, BP 10; 15, BP 11; 2, BP 12; 2, BP 13; 69, BP 14.

DISCUSSION: One specimen from Samoa is noteworthy. While normal in all other respects, it is entirely lacking in antennular flagella, carpocerites, and more proximal articles of the antennal flagellar base, and the scaphocerite is degenerate, somewhat similar to that of *A. malleodigitus*. The other specimens from the same locality are normal. This has been interpreted as a possible congenital defect.

Alpheus microstylus (Bate)
Fig. 8

Betaeus microstylus Bate, 1888. Challenger Repts. 24:566, pl. 101, fig. 6.
Alpheus obesomanus de Man, 1888*b*. Arch. Naturg. 53:520; 1902. Senckenb. Naturf. Gesells., Abhandl. 25:867.
Alpheus malleodigitus Coutière, 1899. Les Alpheidae, p. 223, 316, figs. 270–272, 400. [*nec: A. malleodigitus* (Bate).]
Alpheus microstylus Coutière, 1905. Fauna and Geog. Mald. and Laccad. 2(4):884, pl. 76, fig. 23.

LOCALITIES: Samoa: 1 specimen from BAS 10; 1, BBS 10; 1, BP 13.

Alpheus malleodigitus (Bate)
Fig. 8

Betaeus malleodigitus Bate, 1888. Challenger Repts. 24: 565, pl. 101, fig. 5.
Alpheus malleodigitus de Man, 1902. Senckenb. Naturf. Gesells., Abhandl. 25: 866.
Alpheus malleodigitus var. *gracilicarpus* de Man, 1909. V. Ned. Dierk. Ver., Tijdschr. 11(2):99.
Alpheus phyrgianus Coutière, 1905. Fauna and Geog. Mald. and Laccad. 2(4): 886, pl. 77, fig. 25.
Alpheus persicus Nobili, 1906. Bull. Sci. France et Belgique 40: 33.

LOCALITIES: Fiji: 1 specimen from BF 4; 4, BF 6; 1, BF 8; 2, BF 11; 2, BF 12; 4, BF 13; 1, BF 20. Tonga: 1 specimen from BT 9; 1, BT 10; 3, BT 11; 1, BT 12; 38, BT 13; 1, BT 16. Samoa: 3 specimens from BAS 5; 6, BAS 6; 9, BAS 7; 3, BAS 12; 2, BAS 13; 5, BAS 14; 1, BBS 2; 4, BBS 4; 2, BBS 5; 2, BBS 7; 20, BP 4; 6, BP 12.

DISCUSSION: For a discussion of this species see page 170.

Alpheus samoa sp. nov.

TYPE SPECIMEN: A male, carapace length 3.5 mm, collected at BAS 5. Paratype, a second male, carapace length 3.0 mm, collected at BAS 14. (Specimens and drawings lost.)

DESCRIPTION: Orbital hoods rounded, with second antennular article 5 times as long as broad, over 3.5 times as long as first and 2.7 times as long as third. Upper antennular flagellum broad, 1.2 times as long as peduncle, 1.3 mm long, without any subterminal bifurcation, lower or inner flagellum 2.2 mm long. Stylocerite reaching scarcely beyond margin of carapace, rounded. Basicerite unarmed; scapho-

cerite degenerate, triangular, acute, with tip reaching only slightly beyond end of first antennular article; carpocerite reaching to past middle (in type) or to near end (in paratype) of second antennular article; flagellum about 6 mm long. (In both specimens the antennal peduncle and most of the scaphocerite are carried under the antennular peduncle, and so they are not fully visible in dorsal view.)

Large cheliped lost in both specimens; small cheliped present only on type. Merus unarmed, slender, 4.3 times as long as broad; carpus slender; chela 5.0 times as long as broad, slightly curved; fingers slender, tapering to acute tips, 0.4 as long as chela; setae on appendage short and scattered.

Second legs asymetrically developed, with merus of the right only 2.4 mm long, that of the left 4.0 mm long (0.5 mm longer than carapace). Carpal articles of left leg with ratio: 10:12.5:4.5:5.0:6.5; of right leg: 10:14.8: 4.3:5.0:6.7; on the remaining one leg of the paratype (evidently the longer leg): 10:17.2: 4.4:6.4:6.8. Ischium strongly curved (almost broken on larger leg), merus with slight proximal curving.

Third leg with ischium unarmed; merus 3.9 times as long as broad, armed on distal inferior margin with acute tooth; carpus and propodus so rotated that dactylus lies at 90° to plane of merus, similar to *A. malleodigitus,* carpus with marked twist immediately beyond meral-carpal articulation; carpus about 0.6 as long as merus, armed on distal superior and inferior margins with acute teeth; propodus slender, tapering, slightly shorter than carpus and bearing five movable spines on inferior margin, two distally; dactylus curved and simple. Fourth legs similar except meral tooth of lesser development. Fifth legs with well developed brush on propodus.

Telson 4.7 times as long as distal margin is broad, 2.5 times as broad anteriorly as posteriorly, lateral margins slightly convex, tip shallowly arcuate; medial pair of terminal spines almost as long as posterior margin is broad; dorsal spinules of moderate development. Telson without anal tubercles. Outer uropod with definite articulation.

DISCUSSION: Unfortunately, the large chela is not present on either specimen; however, we believe it would be safe to predict that the chela will be similar to those of the Obesomanus group or similar to those species previously placed in the genus *Thunor.* The species plainly belongs to the Obesomanus group. Within the group it is closest to the species previously placed in *Thunor,* which also have vestigal scaphocerites, but it may be distinguished from them by the presence of the tooth on the merus of the third legs, the form of the telson, and the presence of an articulation on the outer uropods.

The characteristics of this species demand a reconsideration of the separation of Armstrong's genus *Thunor* from the genus *Alpheus.* In a previous paper (Banner, 1956:365) the criteria for the genus *Thunor* were reviewed, and the conclusion was reached that two characteristics only would serve to separate the two genera: the lack of anal tubercles and the lack of an articulation on the outer uropod, both found in the genus *Thunor.* This species has the articulation but lacks the anal tubercles; therefore, the only criterion remaining is the articulation of the uropod. On the other hand, the species in the Obesomanus group and in *Thunor* present a somewhat uniform transition in other characteristics between a typical *Alpheus*-form as found in other groups, and the extreme of *Thunor,* such as *T. microscaphis* Banner or *T. rathbunae* (Schmitt). We do not believe that this single criterion is sufficient to separate *Thunor* from *Alpheus;* thus the name *Thunor* should be put into synonymy. *Thunor* could be retained, if desired, as an infrageneric group, but here again the group would be difficult to define. Therefore we are placing the species previously attributed to *Thunor* into the Obesomanus group, including *A. idiocheles* Coutière, in spite of the fact that Coutière placed it in the Macrochirus group.

CRINITUS GROUP

Alpheus frontalis H. Milne-Edwards

Alpheus frontalis Milne-Edwards, 1837. Hist. Nat. Crust. 2:356.

LOCALITIES: Fiji: 1 specimen from BF 2; 3, BF 13; 5, BF 17. Samoa: 2 specimens from BAS 1; 4, BAS 4; 12, BAS 14; 1, BBS 7; 1, BP 1; 1, BP 6a.

DISCUSSION: The Samoan specimens came from tubes of felted blue-green alga, *Lyngbya majuscula,* collected at 1–3 ft below low tide level, behind the surf zone but where the wave action was strong, at "Lions Head" on the coast east of Pago Pago Harbor (stations BAS 5, 13, 14 and BP 1).

Alpheus pachychirus Stimpson

Alpheus pachychirus Stimpson, 1860. Acad. Nat. Sci. Philadelphia, Proc. 12:30.

LOCALITIES: Fiji: 3 specimens from BF 13; 3, BF 17. Tonga: 2 specimens from BT 15. Samoa: 1 specimen from BAS 1; 5, BAS 5; 4, BAS 10; 1, BAS 13; 9, BAS 14.

Alpheus alcyone de Man

Alpheus alcyone de Man, 1902. Senckenb. Naturf. Gesell., Abhandl. 25:870, Taf. 27, fig. 61.
Alpheus aculeipes Coutière, 1905. Fauna and Geog. Mald. and Laccad. 2(4):892, pl. 79, fig. 31.

LOCALITIES: Fiji: 3 specimens from BF 2; 6, BF 4; 1, BF 8; 3, BF 9; 20, BF 11; 8, BF 13; 6, BF 16; 5, BF 17; 3, BF 20; 2, BF 20. Tonga: 1 specimen from BT 5. Samoa: 4 specimens from BAS 1; 1, BAS 2; 2, BAS 3; 4, BAS 6; 2, BAS 7; 22, BAS 10; 3, BAS 11; 3, BAS 12; 1, BAS 14; 11, BBS 1; 5, BBS 2; 1, BBS 3; 9, BBS 4; 2, BBS 8; 13, BBS 10; 1, BP 1; 1, BP 6; 9, BP 8; 1, BP 13; 4, BP 14.

DISCUSSION: These specimens agree very well with the descriptions of de Man and Coutière (the latter using the name *A. aculeipes),* with a single exception. Both authors state that the dactylus of the third leg bears a small but definite accessory hook; in most of these specimens a similar hook was found, but showing considerable variation in size; however, in several specimens, including two from Fiji, the accessory hook was reduced to a very slight shoulder on the inferior surface of the dactylus, a projection so slight that it was difficult to see. A similar variation was noted by Coutière for *A. spongiarum* Coutière.

Alpheus ovaliceps Coutière

Alpheus ovaliceps Coutière, 1905. Fauna and Geog. Mald. and Laccad. 2(4):888, pl. 77, fig. 27.

LOCALITIES: Tonga: 5 specimens from BT 10; 20, BT 17. Samoa: 5 specimens from BAS 5; 1, BAS 10.

Alpheus bucephalus Coutière

For full citation see Banner (1957:201).

LOCALITIES: Fiji: 1 specimen from BF 13; 1, BF 16; 1, BF 17; 1, BF 18. Tonga: 1 specimen from BT 4; 4, BT 5; 2, BT 10; 10, BT 11; 5, BT 12; 1, BT 16. Samoa: 1 specimen from BAS 5; 4, BAS 6; 1, BAS 7; 1, BAS 8; 2, BAS 9; 2, BBS 2; 1, BBS 10.

Alpheus bradypus Coutière

Alpheus bradypus Coutière, 1905. Fauna and Geog. Mald. and Laccad. 2(4):891, pl. 78, 79, fig. 30.—Banner, 1956. Pacific Sci. 10(3):355, fig. 17.

LOCALITIES: Tonga: 27 specimens from BT 10. Samoa: 4 specimens from BAS 4; 4, BAS 7; 4, BAS 12; 2, BBS 11.

DISCUSSION: In this group of specimens some further variations were noted. The differences between the specimens from Saipan and those described by Coutière were discussed in Banner's 1956 paper. Most of the differences can be accounted for by the variation noted in this collection. For example, in 10 specimens with the small chela intact, 5 had a slightly broadened dactylus with a fringe of hairs, as described by Coutière, and 5 had the more slender and unadorned chela as described from Saipan. Further variation was noted in the length of the squamous portion of the scaphocerite, with the tip in a few reaching almost to the end of the second antennular article, and others variously between this maximum and a minimum length of less than half the length of the article; a few were asymetrical in the development of the scale. As is common in this

group, there were variations in the relative lengths of the articles of the carpus of the second legs, in the rostral front, and in other characteristics.

Alpheus brevipes Stimpson

Alpheus brevipes Stimpson, 1860. Acad. Nat. Sci. Philadelphia, Proc. 12:30.

Crangon brevipes Banner, 1953. Pacific Sci. 7(1):103, figs. 35–37. [Neotype established.]

? *A.* species Banner, 1958. Pacific Sci. 12(2):167.

LOCALITIES: Tonga: 2 specimens from BT 2; 1, BT 9; 4, BT 10; 2, BT 11; 2, BT 13; 1, BT 17. Samoa: 1 specimen from BAS 9; 1, BP 4.

DISCUSSION: This species has previously been reported to be quite variable, both from Hawaii (Banner, 1953:103) and from other localities in the Pacific (Banner, 1956:354). Most of the specimens from these islands and other areas represented in the collection fall within the established limits of variation; however, four specimens are remarkably different.

One of the specimens is from BAS 9. The specimen is defective with most of the appendages gone. However, in all parts remaining, except for the chela, the characteristics are those of *A. brevipes;* the large chela is similar in general form, but has a more hammer-shaped dactylus, a shorter fixed finger, and has the palmar adhesive plaque set at a slight angle, and has a definite rounded transverse depression behind the adhesive plaque.

The three other specimens came from other areas. Two have been already reported from Onotoa, Gilbert Islands, as *A.* species in the Obesomanus group (Banner, 1958:167). The third specimen (carapace length 3.4 mm) came from collections of the Bernice P. Bishop Museum from Palmyra Island (data not available); it has not been reported before. The two Gilbertese specimens are incomplete; the Palmyra specimen is intact. The three specimens are quite constant among themselves and, with the specimen from Samoa, would be placed in *A. brevipes* without question if it were not for the form of the chela. The one intact small chela, from the Palmyra specimen, also is similar to that of *A. brevipes;* however, the large chela is unlike any chela in the Crinitus subgroup, and has the appearance of an Obesomanus-type chela. The palm is subcylindrical and tapering toward the finger; the fixed finger is short and distally curved abruptly towards the appositional face; the dactylus is definitely hammer-shaped, closing beyond and over the fixed finger, and flexed far back on the face of the palm where the adhesive plaque is set low and at an angle.

None of the other specimens in the collection show variations approaching the conditions found either in these chelae or in the chela of the specimen from Samoa; therefore, it appears unlikely that these are of the same species as the common *A. brevipes* with its massive cylindrical chela. However, as *A. brevipes* is such a variable species, and because these specimens are so few, so incomplete, and from such widely different areas, and especially because they could not be distinguished from *A. brevipes* were the chelae missing, they have been retained in this species until a more adequate series can be studied.

Alpheus cloudi Banner
Fig. 19

Alpheus cloudi Banner, 1956. Pacific Sci. 10(3):352, fig. 16.

LOCALITIES: Fiji: 2 specimens from BF 13; 2, BF 18.

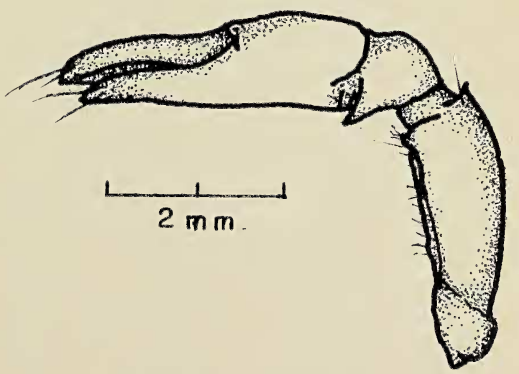

FIG. 19. *Alpheus cloudi* Banner. Small chela, outer face from a 5.5 mm (carapace length) female from station BF 18.

DISCUSSION: *Alpheus cloudi* was described on the basis of a single ovigerous female from Saipan, lacking the small chela. The four specimens above appear to belong to this species. Also incorporated in this discussion are two specimens from Ifaluk in the Caroline Islands. All six specimens were paired, male and female; the pairs from Fiji are rather badly broken.

First, in the shape of the rostral front, the specimen from Saipan had the anterior margin of the carapace proceeding in a gradual concave curve from the front of the orbital hoods to the tip of the undemarked rostrum; in the male from Ifaluk the shape is almost the same except that the area starts in front of the orbital hoods as a slight flattened projection. The female from Ifaluk has a marked projection before the orbital hoods, but the frontal margin is almost straight, instead of projecting further, and the very slight rostrum is demarked from this straight area. The specimens from Fiji strike a compromise between the two. All specimens have similar orbital hoods and a similar, rather marked, dorsal carinae before and between the eyes.

In two specimens from Fiji the second antennular article is more elongate, 3.5 times as long as broad, instead of 2.5 times in the other specimens from Fiji and Ifaluk; moreover, in one male from Fiji, the tip of the scaphocerite reaches only slightly beyond the end of the second antennular article, but the matching female is like the other specimens.

In the Ifaluk specimens there appears to be a strong sexual dimorphism in the large chela, with that of the female similar to the female from Saipan, but in the male of almost the same body length the chela is about 1.5 times the length and twice the thickness of that of the female, with the merus correspondingly more heavy. In one pair of specimens from Fiji there is not over 10% difference in size between the male and the female, with the male chela more like the female chela from Ifaluk and Saipan; in the other pair only the female bears large and small chelae.

The small chela was lost in the Saipan specimen; in the five specimens where it is present it shows no sexual dimorphism except a slight difference in the relative size found in those of the Ifaluk specimens. In all specimens the fingers are about equal in length to the palm or slightly shorter, the movable finger is strongly curved, the fixed finger is flattened except on the upper edge where there is a sharp cutting ridge; on the lower margins of both fingers is a fringe of short, stiff bristles. The proximal portion of the palm has a slight but well defined shoulder. The distal portion of the inferior internal margin of the merus is either unarmed or bears a slight projection.

The second and third legs are basically similar, but in the male from Fiji again the legs are relatively thinner. Both specimens from Ifaluk have a small accessory tooth on the dactylus similar to that found in the type specimen, but none of the Fijian specimens have more than a slight rounded protuberance where the tooth would be expected.

Possibly, when additional specimens are found and examined, the specimen showing the characteristics of those from Fiji may be considered to be a separate subspecies, with slightly different rostral fronts and the lack of secondary unguis on the third legs; however, for the present it seems wiser to leave these obviously related forms in the same species and without subspecific separation.

Alpheus paralcyone Coutière

Alpheus paralcyone Coutière, 1905. Fauna and Geog. Mald. and Laccad. 2(4):895, pl. 80, 81, fig. 34.

Crangon paralcyone Banner, 1953. Pacific Sci. 7(1): 99, fig. 34.

LOCALITIES: Fiji: 2 specimens from BF 17. Samoa: 1 specimen from BBS 7.

Alpheus clypeatus Coutière

Alpheus clypeatus Coutière, 1905. Fauna and Geog. Mald. and Laccad. 2(4):897, pls. 81, 82, fig. 36.

LOCALITIES: Samoa: 1 specimen from BAS 13; 6, BP 1; 2, BP 6.

DIADEMA GROUP

Alpheus gracilipes Stimpson

Alpheus gracilipes Stimpson, 1860. Acad. Nat. Sci. Philadelphia, Proc. 12:31.

LOCALITIES: Fiji: 14 specimens from BF 5; 14, BF 7; 22, BF 9; 1, BF 10; 5, BF 11; 2, BF 12; 32, BF 13; 10, BF 14; 2, BF 16; 12, BF 17; 3, BF 18; 15, BF 20. Tonga: 9, BT 12; 2, BT 13; 2, BT 14; 2, BT 15; 1, BT 16. Samoa: 8 specimens from BAS 8; 3, BAS 4; 2, BAS 5; 6, BAS 6; 1, BAS 8; 4, BAS 10; 5, BAS 12; 4, BAS 13; 3, BAS 14; 4, BBS 1; 4, BBS 2; 10, BBS 3; 5, BBS 5; 8, BBS 6; 3, BBS 7; 5, BBS 8; 13, BBS 9; 3, BBS 10; 1, BP 1; 4, BP 3; 1, BP 5; 7, BP 7; 2, BP 8; 6, BP 11; 4, BP 13.

Alpheus diadema Dana

For full citation see Banner, 1956.

LOCALITIES: Fiji: 1 specimen from BF 3; 2, BF 12; 2, BF 13; 2, BF 14; 2, BF 20. Tonga: 27 specimens from BT 11; 4, BT 12. Samoa: 3 specimens from BAS 1; 1, BAS 2; 1, BAS 8; 16, BAS 10; 4, BAS 12; 2, BAS 13; 5, BBS 10; 2, BP 4; 1, BP 12.

Alpheus ehlersi de Man

Alpheus ehlersi de Man, 1909*a*. Zool. Soc. London, Proc. 1909:663, pl. 70.

LOCALITIES: Tonga: 5 specimens from BT 5. Samoa: 5 specimens from BAS 10; 10, BBS 2; 11, BBS 3; 1, BBS 10.

DISCUSSION: These specimens agree very well with the original descriptions of de Man. The specimens show some variation, notably in the length of the stylocerite, the tip of which may reach to anywhere in the basal half of the second antennular article, in the merus of the large chela which varies from 2.2 to 2.8 times as long as broad, in the large chela itself, which varies from 2.5 to 2.8 times as long as broad, in the dactylus of the large chela which varies from rounded to a pointed tip, and in the telson, the length of which varies from 2.7 to 3.1 times the breadth of the posterior margin.

In two ways there may be slight differences between these specimens and those described by de Man. First, he describes the orbitorostral grooves as "rather deep, though narrow, grooves"; in these specimens we would prefer to call them at most moderately deep. This may be merely a matter of word usage. Second, in no specimen was the margin of the telson as convex in the basal half as shown by de Man for his specimens, although the telsons of the females are broader than those of the males; this probably is only a minor variation.

The specimens of de Man lacked their third and fourth legs; these are intact on most of the specimens available. They are sufficiently similar to the fifth leg, drawn by de Man, that further description is unnecessary, except to add that the propodus carries five spines of moderate development.

This species is surprisingly similar to *A. gracilis simplex* (Banner) of the Macrochirus group. When the specimens are laid side by side they may be distinguished by the differences in the orbital teeth, the orbitorostral groove, the telson, and usually by the black spine of the uropods, but the relationship of the parts of the antennular and antennal peduncles, the configuration of the thoracic appendages, including the maxillipeds and chelae, are almost the same. No intergrading specimens were found in the present collections.

Alpheus paracrinitus Miers

Alpheus paracrinitus Miers, 1881. Ann. Mag. Nat. Hist. V, 8:365, pl. 16, fig. 6.

LOCALITIES: Fiji: 4 specimens from BF 2; 14, BF 5; 6, BF 7; 3, BF 8; 12, BF 9; 3, BF 10; 3, BF 11; 17, BF 13; 3, BF 14; 18, BF 18; 3, BF 19; 5, BF 20. Tonga: 1 specimen from BT 11; 7, BT 12; 4, BT 14; 6, BT 17. Samoa: 3 specimens from BAS 1; 2, BAS 2; 3, BAS 3; 9, BAS 5; 2, BAS 7; 2, BAS 8; 2, BAS 9; 30, BAS 10; 6, BAS 12; 8, BAS 13; 9, BAS 14; 13, BBS 1; 6, BBS 2; 10, BBS 3; 7, BBS 4; 1, BBS 6; 3, BBS 8; 20, BBS 9; 2, BBS 10; 1, BP 1; 3, BP 3; 10, BP 5; 2, BP 6; 6, BP 7; 6, BP 8; 4, BP 9; 1, BP 11; 6, BP 13.

Alpheus alpheopsides Coutière

Alpheus alpheopsides Coutière, 1905. Fauna and Geog. Mald. and Laccad. 2(4):901, pl. 83, fig. 40.

LOCALITY: Samoa: 2 specimens from BAS 12.

BREVIROSTRIS GROUP

Alpheus rapax Fabricius

Alpheus rapax Fabricius, 1798. Suppl. Ent. Syst. p. 405.

LOCALITY: Tonga: 1 specimen from BT 14.

DISCUSSION: This sole female agrees almost perfectly with the specimens from Hawaii and with the descriptions of the species, except that the rostrum reaches to the end of the first antennular article. However, in the Hawaiian specimens the rostrum was found to vary in length and this specimen does not greatly exceed the longest in that series.

Alpheus savuensis de Man

Alpheus savuensis de Man, 1908. Leyden Mus., Notes 30:110. 1911. Siboga Exped. 39*a*[1](2):392, pl. 20, fig. 90.

LOCALITY: 2 specimens from BP 13.

DISCUSSION: Our specimens agree very well with de Man's, except that the stylocerite is a little longer and it does have a definite spine which reaches to the end of the first antennular article. In de Man's specimens the "acute point of stylocerite curved inward, [and was] not spiniform" (1911:392).

EDWARDSI GROUP

Alpheus coutierei de Man

Alpheus coutierei de Man, 1909*b*. V. Ned. Dierk. Ver., Tijdschr. 11(2):107. 1911. Siboga Exped. 39a[1](2):409, pl. 22, 23, fig. 97.

LOCALITIES: Fiji: 2 specimens from BF 19; 4, BF 20. Tonga: 1 specimen from BT 18. Samoa: 9 specimens from BBS 10.

DISCUSSION: In this species the rostrum is pronounced and triangular, broader than is usual for this group, and reaches at least to the middle of the first antennular article. Its lateral margins are a continuation of the front of the orbital hoods, and are at most set off by an indistinct triangle. The carina is sharp but variable in length, extending in some specimens to slightly posterior to the orbital hoods and in others to the anterior cardiac region.

The ratio of the antennular articles in these 16 specimens runs from 1: 1.8: 0.9 to 1: 2.0: 1. The outer margin of the squame is sharply curved and its spine reaches to the end of the last antennular article.

The large chela is a little over 2 times as long as broad. Its merus, also more than 2 times as long as broad, has along its inferior internal margin a row of small tubercles and terminates in a small sharp preapical spine. The small chela is 3 times as long as broad, carries a row of tubercles along the inferior internal margin of the merus but lacks the terminal spine. The second legs are absent in all the specimens. The third legs, available in only three specimens, show a length-breadth ratio from 4.1 to 5.0. There is no spine on the inferior margin of the merus.

These specimens agree well with de Man's original description except for two characteristics. First are the tubercles on the inferior internal margin of the merus of the large and small chela, which de Man pictures as prominent (1911: Fig. 97 d–e), while those of our specimens are very small. Second, de Man states that the abdominal pleura are all produced into angles. In the males only the first pleura were cordiform and produced into obtuse angles, with the more posterior pleura being rounded; in the females all pleura were rounded. These differences may be of systematic importance, but without a more extensive group of specimens it is impossible to determine whether these are an individual variation or subspecific differences.

A. coutierei was separated by de Man from *A. bouvieri hululensis* Coutière on the basis of several characteristics which include length of the rostral carina. This group of specimens has shown the rostral carina to be variable in length, and *A. coutierei* appears to be the

same as *A. bouvieri hululensis*. In Banner and Banner (1964), *A. bouvieri* has been placed in synonymy under *A. leviusculus* Dana, leaving standing the "variety" Coutière attributed to *A. bouvieri* as a separate species *A. hululensis*. If *A. hululensis* and *A. coutierei* are deemed to be the same, the name *A. hululensis* will take priority.

Alpheus ladronis Banner

Alpheus ladronis Banner, 1956. Pacific Sci. 10(3):360, fig. 20.

LOCALITIES: Samoa: 1 specimen from BP 3; 1, BP 6; 1, BP 7; 37, BP 10; 2, BP 11; 3, BP 13.

Alpheus crassimanus Heller

Alpheus crassimanus Heller, 1865. Reise der Novara . . . Zool. Theil 2(8):107, pl. 10, fig. 2.—Bate, 1888. Challenger Rpts. 24: 554, pl. 99, fig. 2.—de Man, 1902. Senckenb. Naturf. Gesell., Abhandl. 25: 880, pl. 27, fig. 62.

Alpheus lobidens Coutière, 1897*a*. Leyden Mus., Notes 19:199.

Crangon crassimanus Banner, 1953. Pacific Sci. 7(1):134–138, fig. 49.

LOCALITIES: Fiji: 11 specimens from BF 1; 2, BF 12; 4, BF 13. Tonga: 6 specimens from BT 15. Samoa: 5 specimens from BBS 9; 2, BP 2; 3, BP 13; 8, BP 15.

Alpheus strenuus Dana
Fig. 20

Alpheus strenuus Dana, 1852*a*. Acad. Nat. Sci. Philadelphia, Proc. 6:21; 1852*b*. U. S. Explor. Exped. 13:543, pl. 34, fig. 4.—Coutière, 1905. Fauna and Geog. Mald. and Laccad. 2(4):913, pl. 87, fig. 53.—Pearson, 1911. Spolia Zeyland. 7(28):185, pl. 7, fig. 6.

Alpheus strenuus angulatus Coutière, 1905. Fauna and Geog. and Mald. and Laccad. 2(4): 914.

LOCALITIES: Fiji: 10 specimens from BF 1; 2, BF 3; 14, BF 9; 1, BF 19. Tonga: 4 specimens from BT 8; 4, BT 11; 1, BT 12; 9, BT 14; 2, BT 17. Samoa: 1 specimen from BAS 9; 10, BAS 10; 1, BBS 2.

DESCRIPTION: Body very large, but of normal alpheid proportions, neither heavy nor slender. Rostrum slender, acute, without setae, tip reaching to just beyond end of first antennular article, arising basally from rounded ridge extending posteriorly between orbital hoods. Areas between ridge and orbital hoods in the form of a shallow rounded groove, becoming more shallow posteriorly; portions of frontal margin lying lateral to rostrum are concave. Orbital hoods of normal shape, rounded and without teeth. Profile of anterior dorsal portion of carapace sloping ventrally.

Antennular peduncles with second article 2.3 times as long as broad, 1.6 times as long as visible portion of first and 2.6 times length of third article; second article tapering slightly distally. Upper flagellum about 1.6 times as long as peduncle, with broadened basal portion over half length of flagellum; lower flagellum about 4 times length of peduncle. Stylocerite with narrowed acute tip reaching slightly past end of first antennular article.

Scaphocerite well developed, with lateral spine reaching beyond end of antennular peduncle; rounded squamous portion reaching almost to the end of same peduncle; outer margin slightly curved and concave. Basicerite with acute, slender tooth on inferior internal angle. Carpocerite reaching to level of end of antennular peduncle. Antennal flagellum long, capable of reaching behind telson.

Third maxillipeds with ultimate article 1.7 times length of penultimate; distal article armed on inner side and upper margin with dense, short, stiff setae and only scattered longer setae along margins; terminal bristles considerably shorter than last article.

Ischium of large cheliped unarmed. Merus with outer face 2.4 times as long as broad; superior apex rounded, not projecting; inferior internal angle with a large projection distally, tipped with a small, curved, acute tooth; merus otherwise unarmed. Chela 2.3 times as long as broad, with the fingers occupying 0.38 the length of the entire chela; breadth of chela at point of articulation of the fingers 0.7 that of maximum breadth of palm. Superior margin distally developed into a heavy rounded ridge

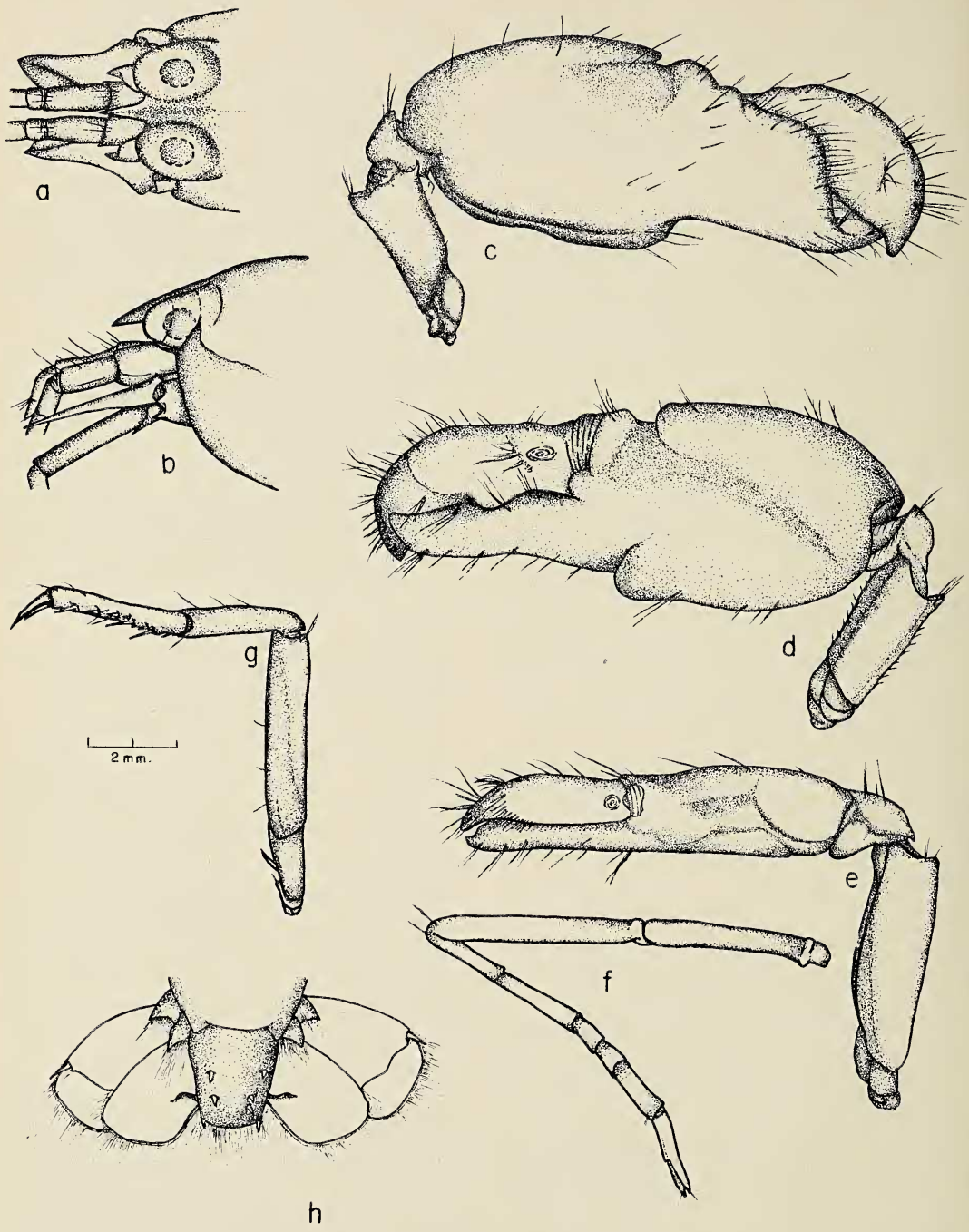

FIG. 20. *Alpheus strenuus* Dana. 10 mm (carapace length) male from BT 14. *a, b,* Anterior region, dorsal and lateral aspects; *c, d,* large cheliped, lateral and medial aspects; *e,* small cheliped, lateral aspect; *f,* second leg; *g,* third leg; *h,* telson and uropods.

that projects as a rounded lobe overhanging the transverse groove. Transverse groove continued into triangular depressed area on outer face; depressed area with margins gradual and rounded, well defined only on inferior side; proximal apex of triangular area continued as a shallow groove that follows the *linea impressa* proximally to near base of palm. Lower shoulder on outer face strong but rounded. On inner face of palm transverse groove continued into two ill-defined depressions, one running inferiorly to form depression before lower shoulder, the other continued proximally towards the middle of the palm face. Dactylus heavy, curved, with its distal portions crossing fixed finger; tip slightly longer than fixed finger. Palmar and dactylar adhesive plaques small. Scattered setae only on distal portion of chela.

Merus of smaller cheliped 2.5 times as long as broad; distal end of superior margin unarmed and rounded; inferior internal margin terminated with a small, acute tooth. Carpus with flat, subacute toothlike projection on superior margin projecting over base of propodus. Chela proper 2.2 times length of merus, 0.7 length of large chela; 3.6 times as long as broad, with the fingers occupying 0.42 the total length. Palm with slight compression, bearing shallow rounded and ill-defined depressions on superior margin and both faces, similar to those of large chela but not as extensive; without any trace of inferior shoulder as found on large chela. Fringe of bristles on dactylus well developed; tip sharp, hooked, and crossing similar tip of fixed finger; both fingers with low, sharp ridge extending along inner margin of appositional surface. Distal portion of inner face of chela with scattered long setae.

Carpal articles of second legs with ratio 10:9:3:3:6, second article 5 times as long as broad; chela subequal in length to second article.

Third legs with ischium armed with a strong movable spine; ischium 0.42 as long as merus. Merus unarmed, 4.4 times as long as broad, with slight distal taper. Carpus 0.5 length of merus, with distal angles not developed into teeth nor bearing spines. Propodus 0.7 length of merus, tapering distally, bearing about 13 spines and spinules along inferior margin. Dactylus curved, acute, simple, 0.23 length of merus and 0.33 length of propodus, bearing several groups of short stiff setae toward tip.

Uropods of normal form, unarmed except for curved spine at shoulder of outer branch. Telson twice as broad at maximum breadth as at posterior tip; length 2.8 times breadth at tip; lateral margins slightly but regularly convex, tip broadly arcuate; lateral terminal spines slight and inconspicuous; dorsal spines well developed.

No apparent sexual dimorphism except in form of abdominal pleura of ovigerous females; large and small chelae in female identical with those of male.

DISCUSSION: *Alpheus strenuus* is a member of a series of species in the Edwardsi group that are separated by subtle differences, often based upon later interpretations of the rather inadequate descriptions and figures of the earliest workers on the family; to evaluate the validity of these species, either the type specimens should be redescribed in detail, or, where the type is lost, a neotype should be designated and described. In addition, a study of the variation within the species should be made, to see if it encompasses other nominal species.

Because Dana's type for this species has been lost, as were so many of the other species of crustaceans that he described, and as the type locality for his species was Tonga, we collected, described, and depicted a specimen as a neotype from Tonga for our original (destroyed) paper. Dana did not specify where on the island of Tongatabu he collected his specimens; our neotypic series was collected within walking distance of the usual landing place at Nuku'alofa, possibly in the exact area where Dana collected his specimens. The neotype-to-be was the largest specimen from Tonga, 37 mm long, and shorter than Dana's, which was 1¾ inches, or about 44 mm. However, specimens from other islands in our collections reached the length of 62 mm. The only difference between the specimen designated as the neotype and the description and

figures of Dana lay in the large chela, which he shows as having the terminal projection of the superior margin at right angles to, but not overhanging, the transverse groove.

Of our efforts to establish a neotype only the description above, and the notes following, remain. Most of the specimens of the neotypic series and the figures of the neotype were destroyed. Of the five specimens from Tonga saved from the fire, four were incomplete and the fifth was too much smaller than Dana's original to be designated as a neotype. This last specimen, taken from BT 14, with the carapace length of 10 mm, we have drawn and are offering to future workers as an example of a small specimen from the type locality.

Alpheus strenuus is a very widespread and common species, and was represented in our study collection by over 150 specimens. At Eniwetok in the Marshall Islands a large number were collected from a single environment so that the extent of variation could be determined. A selection of both sexes and of varying sizes, together with random samples from other archipelagoes, was carefully measured; all other specimens were examined but not measured.

In all, 20 specimens were measured. The form and size of the rostrum and orbital hoods were found to be constant. The ratio of the antennular articles varied as follows (considering the length of the first article to be unity): 1:(1.4–2.1):(0.6–1.0); the second article was from 1.5 to 2.7 times as long as broad. In the specimen described above the second article was 1.6 times the length of the first and 2.3 times as long as broad. The tip of the stylocerite in all cases reached to, and in a few cases slightly beyond, the end of the first antennular article. The relative lengths of the carpocerite and scaphocerite varied only slightly, with the two subequal and slightly longer than the antennular peduncle. The spine of the basicerite was always present and acute. On the large chela the general form remained constant, with the upper margin terminating in an obtuse tooth that overhung the transverse groove. The length of the entire chela varied from 2.0 to 2.8 times the length of the fingers. The merus of the cheliped showed greater variation, ranging from 1.7 to 2.8 times as long as broad (2.4 in specimen described), the larger specimens in general having the broader merus. The tooth on the merus was of constant development. On the small chela all individuals, regardless of size or sex, had the *balaeniceps*-shaped dactylus; however, there was variation in the sculpturing of the palm, with some individuals showing traces of the inferior shoulder. The fingers of this chela were 0.40–0.47 the length of the entire chela. The merus of the small cheliped, like the merus of the large cheliped, was more slender in smaller specimens, ranging from 1.8 to 3.0 times as long as broad; in one specimen the tooth on the inferior internal margin was obtuse rather than acute. The carpal articles of the second legs showed only minor variation, with the range of the ratios as follows: 10:(8–11):(3–4):(3–4):(4–6). On the third leg the ischial spine was always present; the merus varied from 3.3 to 5.0 times as long as broad; the carpus was from 0.5 to 0.8 times the length of the merus, and the propodus 0.6 to 0.7 the length of the same article. The maximum breadth of the telson was from 1.8 to 2.5 times the breadth of the tip.

The smallest specimen in the collection had a carapace length of 3 mm, and was collected with the large number of large *A. strenuus* at Eniwetok; this showed the characteristics of large specimens except for minor differences in the chela. The sculpturing on the large chela was not as pronounced as in mature specimens, and the termination of the upper margin did not overhang the groove; the small chela was heavier in proportion to the length, and the sculpturing was poorly developed.

Two varieties or subspecies of this species have been described: *A. strenuus angulatus* Coutière (1905:914) and *A. strenuus galapagensis* Sivertsen (1934:3). Coutière's subspecies was based on three characteristics: first, a more slender merus of the third legs, being almost 5 times as long as broad; second, a more elongate second article of the carpus of the second legs, being 1.1 times the length of the first; and, third, an inferior margin of the merus of the third leg being "plus rectiligne . . .

et forme à l'apex antèrieur un angle saillant . . ." The first two characteristics fall easily within the range of variation reported above. The third appears to be too subtle and inconstant to be reliable. Therefore we consider Coutière's subspecies to be invalid. On the other hand, the form described by Sivertsen appears to be quite distinct, especially in the form of the rostrum, which in his subspecies does not reach to the middle of the visible portion of the first antennular article. On the basis of its characteristics and its geographic isolation we regard it as a valid subspecies.

This species is separated from all other Edwardsi species, when they are of normal and usual development, by the presence of a *balaeniceps* dactylus on the small chela of both sexes. If the male only is present in a collection, or if the specimens lack intact small chelae, then separation between this and such related species as *A. crassimanus, A. pacificus, A. audouini,* etc. is indeed difficult, but distinction may usually be made by the shape of the proximal margin of the transverse groove and the inferior shoulder on the large chela. Another differentiating characteristic may be found in the setae on the last article of the third maxilliped. However, in two species of the complex some females have been reported as bearing at times setiferous crests on the dactyli of the small chela characteristic of *A. strenuus.* Coutière stated that the females of his species, *A. audouini,* did at times *("n'est pas rare")* have traces of the crests normally found only in the males (1905:914). This species, in that case, may be distinguished from *A. strenuus* only by subtle differences in the form of the large chela, which can be seen by comparing Coutière's figures 52 and 53 (1905: Pl. 87). *A. pareuchirus* Coutière var. *imatrix* de Man (1909*b*:106) was separated from the parent species by the fact that the female bears *balaeniceps* chela. Those females may be distinguished easily in the form of the large chela, which is more elongate and in which the lower shoulder is indicated only by a shallow rounded depression; the third legs are also more slender and tapering.

There has been considerable doubt in our minds, as there has been in the minds of previous workers, about the specific distinctions within this group of related species, which includes *A. strenuus, A. audouini, A. edwardsi, A. pacificus,* and *A. chiragricus.* All are of large size and somewhat similar form. Careful examination, however, has left us convinced that *A. strenuus* at least is a separate and valid species, and that the form of the chela in the female is an excellent specific character.

A. strenuus is of wide distribution in the Pacific, being recorded from numerous islands from the Indian Ocean to Tahiti. Most of the specimens recorded here were collected under rocks on sandy beaches in the lower portion of the intertidal zone.

Alpheus pacificus Dana

Alpheus pacificus Dana, 1852*a.* Acad. Nat. Sci. Philadelphia, Proc. 6:21; 1852*b.* U. S. Explor. Exped. 13:544, pl. 34, fig. 5.

LOCALITIES: Fiji: 5 specimens from BF 3; 1, BF 21. Samoa: 1 specimen from BP 10; 4, BP 11.

Alpheus parvirostris Dana

Alpheus parvirostris Dana, 1852*a.* Acad. Nat. Sci. Philadelphia, Proc. 6: 22. 1852*b,* U. S. Explor. Exped. 13:551, pl. 35, fig. 3.

LOCALITIES: Fiji: 4 specimens from BF 4; 3, BF 5; 2, BF 6; 7, BF 7; 6, BF 8; 1, BF 10; 5, BF 11; 3, BF 12; 3, BF 14; 3, BF 15; 2, BF 16; 1, BF 17; 1, BF 19; 11, BF 20. Tonga: 2 specimens from BT 1; 4, BT 2; 27, BT 4; 13, BT 5; 7, BT 8; 4, BT 9; 2, BT 10; 20, BT 11; 45, BT 12; 2, BT 13; 1, BT 16. Samoa: 13 specimens from BAS 1; 40, BAS 2; 3, BAS 3; 37, BAS 6; 24, BAS 7; 3, BAS 8; 16, BAS 9; 10, BAS 10; 21, BAS 11; 33, BAS 12; 54, BAS 13; 28, BAS 14; 27, BBS 1; 68, BBS 2; 23, BBS 3; 25, BBS 5; 1, BBS 2, BBS 6; 9, BBS 7; 17, BBS 8; 22, BBS 10; 2, BBS 11; 1, BP 3; 3, BP 1; 2, BP 4; 5, BP 5; 8, BP 6; 12, BP 8; 1, BP 9; 9, BP 10; 6, BP 11; 6, BP 12; 11, BP 13; 15, BP 14.

Alpheus hippothoe de Man

Alpheus hippothoe de Man, 1888*a.* Linn. Soc. London, Journ. 22:268, pl. 17, fig. 1–5.

LOCALITIES: Fiji: 1 specimen from BF 13; 2, BF 14. Tonga: 1 specimen from BT 1; 32, BT 7.

DISCUSSION: These specimens, according to our partially burned notes, showed some characteristics that were closer to those of *A. edamensis* de Man than of *A. hippothoe,* especially in slight differences in relative proportions of the appendages. With the loss of the specimens, the characteristics cannot be reviewed.

Alpheus funafutensis Borradaile

For full citation see Banner and Banner (1964:96).

LOCALITIES: Tonga: 2 specimens from BT 10. Samoa: 4 specimens from BP 10.

Alpheus edamensis de Man

Alpheus hippothoe var. *edamensis* de Man, 1888*b*. Arch. für Naturgesch. 53(1): 518. Lenz, 1905. Senckenb. Naturf. Gesell., Abhandl. 27:383.

Alpheus edamensis de Man, 1911. Siboga Exped. 39*a*[1](2):437, pl. 23, fig. 107.

Alpheus acanthomerus Ortmann, 1890. Zool. Jahrb. 5:474, pl. 36, fig. 12.

nec Alpheus hippothoe var. *edamensis* de Man, 1897. Zool. Jahrb. 9:757. 1902. Senckenb. Naturf. Gesell., Abhandl. 25: 891.

LOCALITIES: Fiji: 4 specimens from BF 5; 3, BF 13; 2, BF 15; 2, BF 17; 5, BF 18; 3, BF 20; 2, BF 21. Samoa: 2, BAS 1; 2, BAS 13; 1, BBS 3; 2, BBS 7; 4, BBS 10.

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