

*Crangon diadema* (Dana)

# The Crangonidae, or Snapping Shrimp, of Hawaii<sup>1</sup>

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## INTRODUCTION

THE DECAPOD FAMILY CRANGONIDAE, or the family Alpheidae of the earlier workers and of the present European workers, is a family of shrimp known popularly as snapping or pistol shrimp. The members of the family seldom exceed 30 millimeters in length, are usually of stout shape, are noticeably laterally compressed, and, though their color is variable, are most often reddish- to grayish-white in color. The outstanding characteristics of the most common genera of the family are the large size and asymmetrical development of the chela of the first pereiopod. It is the violent closure of the enlarged chela that produces the clicking or snapping sound which has given the members of the family their common name.

Considering how common the snapping shrimp are in Hawaii, surprisingly little work has been done on them. The earliest record of members of this family from the Hawaiian Islands was made by Randall in 1839 when he reported *Crangon ventrosa* (Milne-Edwards) as *Alpheus laevis* Randall. Dana in 1852 [this volume was distributed on February 4, 1853, according to Haskell (1942: 79) and therefore for questions of nomenclatorial priority the later date should be used] reported upon the collections made by the United States Exploring Expedition and listed three species, all new, from the Hawaiian Islands. Stimpson in 1860 reported four species from Hawaii. Only two species were reported from Hawaii by Bate in the Challenger Reports in 1888. Lenz in 1901 reported a single species from Laysan

Island, a species previously known from the Hawaiian Islands. Coutière in *The Fauna and Geography of the Maldivé and Laccadive Archipelagoes* (1906) reported five species from the Hawaiian Islands—three on the basis of reports of previous workers, one on a specimen in the Museum of Paris, and one without further reference (the last species is discussed on page 142). In 1909 Coutière, in his treatment of the synalpheids of the United States National Museum, listed four species of the genus *Synalpheus* collected in Hawaiian waters by the steamer "Albatross." By far the most extensive studies on the Hawaiian crangonids were those of Edmondson. In 1925 he reported on 17 species collected by the "Tanager" in the western islands and shoals of the Hawaiian Archipelago; in 1930 he reported two new species of a genus previously unknown to Hawaii; and in 1933 in his book, *Reef and Shore Fauna of Hawaii*, he gives a brief description of 13 species.

The geographical limits of the present study coincide with the geographical limits of the Hawaiian Archipelago (Fig. 1). Most of the collecting has been done around the larger or windward islands of the archipelago, which are, from east to west, Hawaii, Maui, Kahoolawe, Lanai, Molokai, Oahu, Kauai, and Niihau. Extending over a thousand miles to the west and north of these large islands is a chain of shoals and normally uninhabited small islands known as the leeward islands; these are, again in their order from east to west, Nihoa, Necker, French Frigate Shoal, Gardner Pinnacles, Raita Bank, Maro Reef, Laysan, Lisianski, Pearl and Hermes Reef, Midway, and Kure, or Ocean, Island.

The present study was begun in the year 1937-38, when quite extensive collections

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were made of the species that could be collected in the very shallow water of the reef flats (in water up to about 5 feet deep). The specimens in the collections of the Bernice P. Bishop Museum also were examined at that time. My departure from the Islands in the fall of 1938 prevented the completion of the study, and the work was put aside until my return to Hawaii in 1946. At that time a new series of collections was made, the new collection in large part being made in the waters beyond the reef flats, the specimens being taken by "skin-diving" in water up to 20 or 25 feet deep. The specimens taken by the United States Fish Commission Steamer "Albatross" in the Hawaiian Archipelago in 1902 were obtained on loan from the United States National Museum; these were a valuable contribution to the study as they represented to a large extent a deeper fauna that was impossible to collect without dredging. Additional specimens in the Bishop Museum were examined. Some deep-water specimens dredged by the "Makua" of the Territorial Board of Agriculture and Forestry and by the "Salpa" of the University of Hawaii were available. Finally, I was loaned a small but very important collection of crangonids taken off the island of Hawaii by R. W. Hiatt. Several thousand specimens from these various sources were examined.

I believe that this study is quite complete for the crangonid fauna of the Hawaiian Islands. It is true that collections were not made from all the reefs on all the islands, but enough collections were made on Oahu, Maui, Hawaii, and the leeward islands of the archipelago to show that the fauna does not seem to vary to any major extent from island to island. On Oahu all possible types of habitats have been examined, from muddy bays to the clean coral growing on the outer sides of wave-swept reefs. The deep-water dredgings of the "Albatross" and other ships have sampled extensively the deeper fauna from the islands. On the other hand, the several species in the collections that are represented by

a single or several specimens indicate that other rare species not collected may exist in the islands. However, it is unlikely that species not discussed here will be found in the course of routine collecting.

#### Measurements

In the numerous measurements used in this paper, the following standards are adopted. For *total length*, the body is measured from the tip of the rostrum to the end of the telson following the middorsal line of the body. If the abdomen is flexed, a slightly greater measurement is obtained than if it were straight, but the difference is not great. For the *appendages*, the *breadth* is taken at the broadest point unless otherwise specified; the *length* is measured from articular surface to articular surface (this is especially important in the carpal articles, as the articular surface is toward the inferior side of the meral-carpal joint, and, if the maximum length to the edge of the superior portion of the article were taken, it would be found to vary greatly with the degree of flexion of the joint). The *lengths of the antennular articles* are taken in the mid-line of the article in dorsal view, with the exception of the first article, where the length is taken from the most proximal portion visible dorsally to the middle of the distal end. The *height or breadth of the large chela* is taken to be the diameter from superior to inferior surface, the *thickness* as the diameter at right angles to this height, the *length of the chela* as including the fingers; unless otherwise specified the *length of the fingers* is given as a proportion of the length of the entire chela. The *breadth of the merus* of the chelipeds, in those cases where the cheliped was definitely triangular in cross section, is taken as the width of the outer face of the triangle; the *length* as from the middle of the ischial-meral articulation to the meral-carpal articulation. Finally, throughout the paper the *relative lengths of the carpal articles* of the second legs are expressed as ratios based on the length of the first article, to which the value 10 is assigned; it is possible to carry

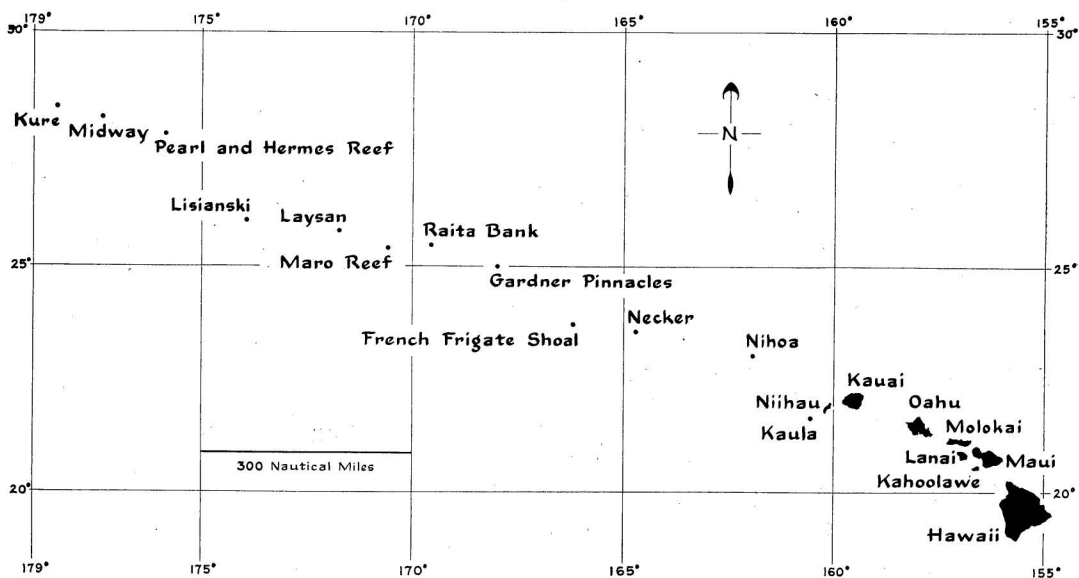


FIG. 1. Map of the Hawaiian Archipelago, showing principal islands, reefs, and shoals.

these ratios to two or more significant places, but in most cases the figures are rounded to the first significant place (for example, 10 : 7 : 5 : 5 : 7) because so much variation was found in the relative lengths of the articles within one species that it is felt that any further refinement of figures would be scientifically inaccurate. The measurements of the telson are self-evident. Throughout the study, fractions are expressed as their decimal equivalents and rounded with the exception of one fourth and three fourths.

#### Acknowledgments

I wish to thank the following institutions and individuals for their assistance in this work: The Bernice P. Bishop Museum; the United States National Museum; Dr. C. H. Edmondson, Professor Emeritus of the University of Hawaii and Curator of Zoology at the Bernice P. Bishop Museum, for his help and cooperation in all phases of the work, especially during the initial year's study; Dr. R. W. Hiatt, Professor of Zoology at the University of Hawaii, for the use of collections of the shrimp made by him; Dr. Fenner A. Chace, Jr., of the United States National Museum for

his cooperation and advice on several points; and Dr. L. D. Tuthill, Editor of *Pacific Science*, for advice on several taxonomic points.

I also wish to acknowledge the help of the following artists employed by the University of Hawaii. Miss Inger Achton drew Figures 6a-f, j-l. Mrs. Florence Lambeth drew Figures 14a-b, 17d-e, 18a-d, f, i, j, m, and 24 a-b. Evan I. Gillespie drew the frontispiece, redrew Figures 1, 12a-c, 42a-b from their original sources, and completed the following drawings after I had delineated them: Figures 16 a-j; 17a-c, f-j; 18e, g, h, k, l; 19a-g; 20a-m; 34a-i; 37; 41g-h; 43a-k; 44a-l; 45 a-g; 46a-i; 47a-k; 48a-h; 50a-i.

#### DISTRIBUTION

The members of the family Crangonidae are commonly circumtropical in distribution although in the Pacific Ocean they have been reported from as far north as Sitka, Alaska (*Betaeus harrimani* Rathbun, 1910), and as far south as Hermite Island, Tierra del Fuego (*Betaeus truncatus* Dana, 1852). The center of distribution for the family in the Pacific appears to be the East Indian Archipelago, from which de Man (1911) reported 113 species and 20

varieties. Though he noted that the members of the family were largely limited to the upper littoral zone of the sea, four species of *Synalpheus* and eight species of *Crangon* were dredged from depths greater than 100 meters during the Siboga Expedition. Two species have been reported from tropical fresh-water lakes.

Like most of the marine fauna of the Hawaiian Archipelago, the crangonids belong to the Indo-Pacific faunal group and not to the Western American. Those species that are not endemic range southward and westward, in many instances as far as the Red Sea. *Crangon ventrosa* (Milne-Edwards) is the only exception to this statement: its range extends from the Red Sea through Hawaii to the Gulf of California.

In the present state of knowledge of crustacea in the Pacific it is useless to speculate on the distributional patterns of the nonendemic species. There are too many islands and archipelagoes where no collecting of marine invertebrates has been done at all; on the few major islands where some collecting has been done, it was done usually in a random fashion, and the lists of species cannot be regarded as even approaching completion. The few exceptions to this in the tropical Indo-Pacific region are the area around the mouth of the Red Sea, those portions of the Indian Ocean that were visited by J. Stanley Gardiner, and the portion of the southwestern Pacific visited by the Siboga Expedition. It is likely that the report on the Bikini collections, now in preparation by Fenner A. Chace, Jr., of the United States National Museum, will add another area. But whether the range of a species extends from Hawaii to the Marianas or to the Marquesas or to New Caledonia is not known.

Without the knowledge of the geographic range of the species, speculation on paths of distribution would be without basis. As the adults are bottom dwellers, and as the larvae are planktonic, it is safe to assume that most of the species that reached Hawaii were carried here as larvae. However, with the preponder-

ance of the currents in this portion of the Pacific flowing from Hawaii toward the western Pacific, it is difficult to understand how these larvae, without any marked powers of locomotion, were able to reach Hawaii from the closest island groups, over a thousand miles away. It is likely that they were carried here by fortuitous combinations of eddies and temporary shifts in the superficial currents in changing weather conditions.

It is likewise fruitless to speculate on the number of endemic species. According to the present records 19 of the 44 species recorded from these islands, or some 45 per cent, are known only from the Hawaiian Archipelago. However, no one knows how many of these species may occur at Johnston Island or Canton Island or in Tahiti or Samoa; no one knows how many of these species may reach to the northern Marianas where conditions somewhat similar to those in Hawaii exist. It is to be expected that the isolated position of Hawaii would produce some speciation, but how much cannot yet be determined.

#### ECOLOGY

In Hawaii the members of the family seem to be confined largely, if not exclusively, to the eulittoral zone, which is deeper in tropical than in temperate waters. Many of the species are found exclusively in the shallow water of reef flats and in waters less than 50 feet deep at the outer side of the reef; a few have never been collected except on the reef flat itself, where at low tide the water varies from only a few inches to several feet in depth. The species inhabiting the more shallow waters are found in five types of habitats: in dead corals, where they live in cracks, folds, old worm holes, or even in tubes of algae which they construct for themselves; in living coral heads, among the branches of the coral; in sandy or muddy portions of the inner reef and of bays, where they hide about the bases of rocks and partially buried objects; in the dense growth of algae found on exposed wave-beaten coasts; and commensally with sponges and

tube worms. Lack of data prevents the tabulation of the habitats of the deeper-dwelling species, but the few I have collected in dredge hauls from deeper water were either living in dead coral boulders or in sponges.

Although the general habitats of the species are known, very little is known of their actual ecology. For example, what are their food habits? They are reported to be carnivorous, yet the digestive tracts of specimens kept in aquaria with *Ulva* turn a bright green. In the case of a dozen species living in one dead coral head, are there zones typical of each species, and, if so, what factors determine this selection? Does a pair found living together in a single tube represent a pair mated for life? What are the food and defensive relationships of this pair in which the smaller male has the larger chela? What is the biological significance of the sexual dimorphism of the small chela of some species? Why are the two closely related species, *Crangon crassimanus* (Heller) and *C. pacifica* (Dana), which seem to inhabit the same type of coral in the same zone, almost never found together in the same coral head? What are the limitations of the distributional range of *C. diadema* (Dana)? To my knowledge, none of these problems has ever been investigated.

#### VARIATION WITHIN SPECIES

A number of species reported upon in this study are noted to show great variation, a variation which transcends the limits previously accepted to be of subspecific and, in some cases, of specific worth. These variations are encountered particularly in the armature and proportions of the appendages, characteristics that have been accepted as stable within quite narrow limits for a single species. Some of the species from Hawaii, especially those that have been collected in large numbers, like *Synalpheus paraneomeris* (Coutière), *Crangon brevipes* (Stimpson), and *C. clypeata* (Coutière), show great variation; many of those that are less plentiful, such as *S. charon* (Heller) and *C. edmondsoni* Banner, show less variation. There

are occasional species that appear to be rather constant and do not show as much variation as would be expected from observation of related species collected in similar numbers, e. g., *C. pacifica* (Dana), *C. nanus* Banner, and *C. collumiana* (Stimpson).

This apparently unusual degree of variation, reported in detail in the text, may be due to three factors:

The first possibility is the lack of discrimination on my part, resulting in my confusing several discrete but narrowly separated species and considering them as a single species. However, whenever during this study any considerable variation of a species was noted, that species was examined critically, and, in instances of complicated variations, tables of measurements were prepared to facilitate the drawing of conclusions. Characters which exhibited a more or less continuous spectrum of variation were not considered as of specific worth. Although other workers have sometimes used a combination of variable characters as a basis for distinguishing species, I do not believe that, even if the procedure is valid, the knowledge of the family is sufficiently advanced to warrant the use of such criteria.

A second possible cause of the variation is a species radiation in Hawaii. This would be caused by the immigration of one or a few species to an isolated location and then the rapid evolution of the species to fit into the unoccupied ecological niches. When sufficient time has elapsed, this process should produce many new but closely related species; when the process is just starting, it should be noticeable as variations within a species. It is true that the Hawaiian Archipelago has fewer species than other parts of the Pacific; for example, de Man (1911) reported 38 species of the genus *Synalpheus* from the area visited by the Siboga Expedition, whereas in Hawaii the genus is represented by only six species, three of which are common. Therefore, those three species in Hawaii may be in the process of evolution to fit the ecological niches filled by the 38 species of the Nether-



lands Indies. In Hawaii this type of species radiation has been observed in groups as diverse as the birds, the drosophilids, and the land snails. However, possibly because the marine forms have not been as completely isolated, or possibly because the marine animals have not been as thoroughly studied, the phenomenon has not been especially noted in the animals inhabiting the reefs and shores.

The third possibility is that the variation is not unusual or unique to Hawaii and occurs in all areas but has been overlooked to a large extent by other workers. They may not have had a large enough series of specimens of one species to give a picture of the variation, or, having the specimens, they may have been too imbued with the type-specimen concept to discuss the variations in their papers. It is true that in many cases the earlier workers did discuss these variations; de Man, for example, presented long numerical tables on the variations in some of his species. Yet in his keys, de Man (1911: 192) used characteristics that could easily overlap, e.g.,

- i. Rostrum usually 3-times (2.75-3.25) as long as wide. . . . Dactylus of third legs 3-times as long as thick at the base. . . .
- ii. Rostrum 2 2-times as long as wide. . . . Dactylus of third legs 2.51 times as long as thick at its base. . . .

Coutière has erected species upon differences with even less allowance for variation. De Man states in his introduction (1911: 133): Coutière also first called attention to the great importance of relative measurements . . . and it was just by means of these new characters that often specimens of small size of *Alpheus* and *Synalpheus* proved to be species that were still unknown, while formerly such specimens usually would be regarded as juvenile forms or at most varieties.

Coutière stated (1909: 36) that some of these species were even based largely on "geographic characteristics." For example, "*S. paulsoni* and the other Indo-Pacific forms are not represented [in America] by identical forms, but the differences are at times so slight that, without indication of locality, the identification would be very difficult."

The lack of a sufficient number of specimens of a given species to show the extent of

variation often renders it necessary to erect new species for what may later be found to be divergent members of the same species. This has been done in the past, and I fear that in this paper it may have been done again. For example, *Crangon pseudopugnax* Banner is separated from *C. percyi* (Coutière) chiefly by the differences in the base of the rostrum, and the character seems to be quite clear-cut and decisive. However, of the two species only nine specimens are known from Hawaii, and perhaps, if a large number of specimens were collected, it might be found that the two species described are merely the extremes of a variable single species, with specimens of intermediate form of the rostrum more plentiful.

Only by extensive studies can it be determined which of these postulated causes for the observed variation is the correct one. To arrive at a solution of the problem it will be necessary to study not only a large series of specimens from Hawaii but also many specimens of these species from other portions of their ranges. Specimens from the southwest Pacific especially should be studied, as that area appears to be the center of distribution for the Indo-Pacific members of the family. Through such a study some of the criteria based on small differences in the relative proportions, like those of the antennular or carpal articles, will perhaps have to be discarded. With any such change in the criteria, some of the species now recognized will fall into synonymy. It may also be necessary to find new and more stable characteristics upon which to base specific descriptions.

In any case, the work done in this present study is sufficient to cast doubts on the validity of some of the species that have been described on the basis of slight differences in what appear to be variable characteristics.

#### Family CRANGONIDAE Weber

Carapace smooth, provided with cardiac grooves; rostrum reduced, antennal and branchiostegal spines always absent; in known Hawaiian species carapace more or less project-

ing over eyes. Antennular base cylindrical, with basal article not longer than sum of other two; scaphocerite rarely longer than peduncles. Mandible always bipartite, with palpus of 2 articles. Distal article of first maxilla bifurcate at its extremity. Epipodites of first and second maxillipeds always undivided. Chela of first thoracic leg predominant, always large. (In the Hawaiian species the chelae are usually asymmetrically developed.) Carpus of cheliped short, cup-shaped or hemispherical. Second legs chelate, weakly developed. (The multiarticulate carpus in Hawaiian species is always composed of four to five articles.) Following legs short, compressed, with spinous propodi (in Hawaiian species the dactyli are either simple or biunguiculate). Propodus of the fifth leg with more or less well-developed "brush" of bristles placed in transverse-oblique rows. Abdomen usually with gradual curve, without any pronounced bending at third segment; sixth segment broad and short; size and shape of pleura showing sexual dimorphism. Pleopods of usual form, showing only slight sexual dimorphism. The branchial formula always includes five pleuro-branchs. (Description adapted from Coutière, 1899.)

Of the 18 (?) previously known genera of the family Crangonidae, only 4 are represented in the fauna of the Hawaiian Archipelago. In addition, one new genus has been described; this genus, however, is not endemic to the Hawaiian Islands, as it includes one species from the southwest Pacific which de Man tentatively placed in the genus *Alpheopsis* Coutière. The great majority of the species in Hawaii are members of the genus *Crangon* Weber as they are in all other investigated regions of the Indo-Pacific.

The generic name *Crangon* and the family name Crangonidae replaced the widely used names *Alpheus* and Alpheidae as the result of the work of Rathbun in 1904. At that time she published the results of an examination of a paper by Weber, published in 1795, in which

he used the name *Crangon* for species called *Alpheus* by Fabricius in 1798. Her interpretation of this, according to the International Rules of Zoological Nomenclature, made it necessary to change the genus previously known as *Alpheus* Fabricius to *Crangon* Weber and the genus known as *Crangon* Fabricius to *Crango* Lamarck. She presented the case to the International Commission on Zoological Nomenclature, and they confirmed her views in Opinion 17: "Weber's *Nomenclator Entomologicus* 1795 complies with the requirements of Article 25, hence the genera in question are to be accepted. . . ." Apstein in 1915 proposed that the name *Alpheus* be a *nomen conservandum*, but the proposal was rejected (although not specifically for *Alpheus* versus *Crangon*) by the International Commission's Opinion 74. The whole controversy is reviewed by Hult (1938). As a result of these rulings most American and Australian workers are using the name *Crangon* instead of *Alpheus*, whereas most European workers are still using the name *Alpheus*. As this paper goes to press there is an appeal to the International Commission for a suspension of the rules to permit the re-establishment of the name *Alpheus*.

The position of the family Crangonidae differs but slightly in the various modern systems of classification of the lower decapods. However, because the names and definitions applied to the subsidiary classifications differ with the various schemes, that of Balss (1927) has been selected arbitrarily for use in this paper. Balss followed, with only minor changes, the scheme of classification earlier devised by Borradaile. In it the Crangonidae are placed in the suborder Natantia, the division Eucyphidae (which seems to be the equivalent of the tribe Caridea of others), and the tribe Palaemoniida (equivalent to the superfamily of the same name used by other workers). Except for differences in names as pointed out above, all present workers appear to be in accord on the classification of the Crangonidae to this point.

Within the tribe Palaemoniida there is a difference of opinion as to the relative position

of the family with respect to the three or four other families. Primarily on the basis of the characteristics of adults of the lower genera of the family, Coutière (1899) placed the crangonids below but adjacent to the Hippolytidae. Gurney (1938), on the basis of characteristics of the larvae, concluded that the family was most closely related to the Palaeomonidae and of higher phylogenetic position.

#### KEY TO THE HAWAIIAN GENERA

1. Eyes at most only partially concealed by projection of margin of carapace, and visible at least anteriorly; large chela without a plunger on the dactylus fitting into a cavity on the finger opposite, but instead usually bearing a series of strong teeth. . . . . 2  
 Eyes completely concealed by projection of anterior carapace and visible only in anteroventral aspect; large chela almost always with a plunger that fits into a cavity on the finger opposite, never serrate. . . . . 4
2. Sixth abdominal segment without articulated pleura; large chela carried flexed toward body, with the palm excavate to accommodate merus; telson with tip emarginate. . . . .  
 . . . . . *Jousseumea* (p. 10)
- Sixth abdominal segment usually with pleura articulated; if large chela is carried flexed, then merus is flattened to accommodate palm; telson with tip either straight, slightly convex, or extended to form a triangle. . . . . 3
3. Large chela carried extended; posterior margin of telson straight to slightly arcuate. . . . . *Alpheopsis* (p. 14)  
 Large chela carried flexed; posterior margin of telson projecting as a strong triangle. . . . . *Neopalpheopsis* (p. 20)
4. With pterygostomial margin produced into a definite angle; without anal tubercles; with only 2 epipodites. . . . . *Synalpheus* (p. 26)  
 With pterygostomial margin rounded,

not angular; with anal tubercles; with 7 to 8 epipodites. . . . . *Crangon* (p. 46)

#### JOUSSEAUMEA Weber

Carapace extending forward as rostrum of variable size and as orbital teeth forming broad eave-like projection that conceals eyes in dorsal view.

Antennular peduncle with strong stylocerite. Scaphocerite broad, oval, with squamous portion equal to or longer than lateral spine. Carpocerite of antennular peduncle short and broad, sometimes shorter than merocerite.

First chela very asymmetrical, carried flexed at carpus so that distal end approaches body. Fingers of large chela serrate with large teeth joining exactly. Merus long.

Carpus of second legs composed of 5 articles. Following legs robust with merus unarmed, ischium bearing 2 spines, dactylus simple. Sixth abdominal segment without articulated pleura. No anal tubercles on telson. Posterior margin of telson emarginate.

Branchial formula: 5 pleurobranchs, 1 arthrobranch, 8 epipodites.

DISCUSSION: The nine species recorded for the world by de Man (1911, 1922) have been increased to eleven by the addition of the two Hawaiian species described by Edmondson (1930). Of these, three species occur in the Red Sea and the Gulf of Aden, two species in the Banda Sea south of the Celebes Islands, one "from the coasts of America," one from Puerto Rico, and the other two species from the Hawaiian Islands. There are no records indicating the occurrence of any of the species at other than the type locality.

#### HAWAIIAN SPECIES OF JOUSSEAUMEA

1. Rostrum long and broad, extending from basal angles anterior to middle of eyes to apex beyond end of second article of antennular peduncle. . . . .  
 . . . . . *J. mauiensis* (p. 12)  
 Rostrum short, extending from base between eyes to or slightly beyond end of first antennular article. . . . .  
 . . . . . *J. brevirostris* (p. 12)

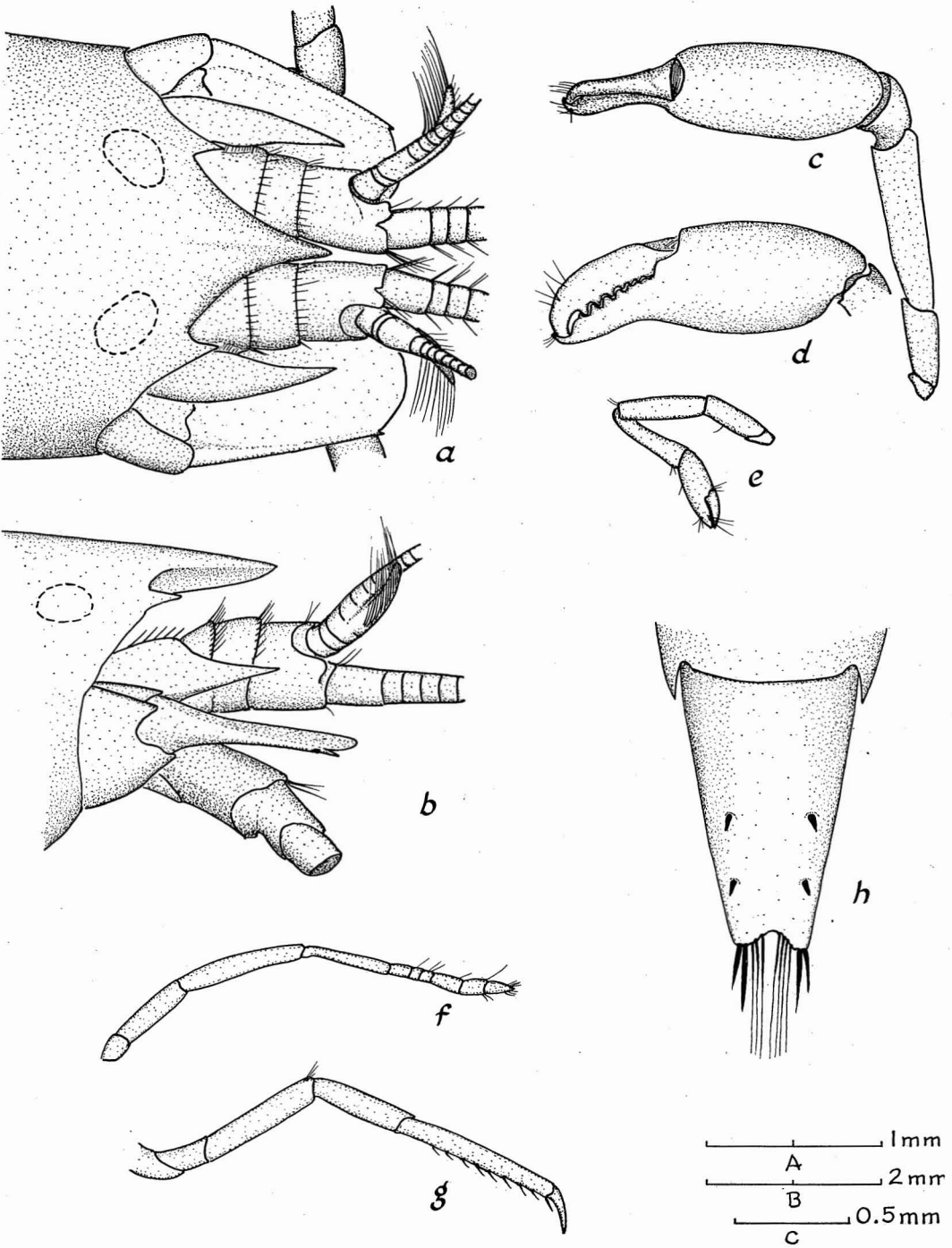


FIG. 2. *Jousseaumea mauiensis* Edmondson. *a*, *b*, Anterior region, dorsal and lateral aspects; *c*, large cheliped, lateral aspect; *d*, large chela, ventral aspect; *e*, small cheliped; *f*, second legs; *g*, third legs; *h*, telson. (*a*, *b*, scale A; *c*-*g*, scale B; *h*, scale C.)



***Jousseaumea mauiensis* Edmondson**

Fig. 2 a-b

*Jousseaumea mauiensis* Edmondson, Bernice P. Bishop Mus., Occas. Papers 9(10): 5-7, fig. 2a-g, 1930.

DESCRIPTION: Rostrum nearly equilaterally triangular, with base arising anterior to cornea of eye and only slightly shorter than concave lateral margins; tip reaching to middle of third antennular article. Orbital teeth acute and about 0.2 to 0.25 as long as rostrum. Rostrum with a rounded keel extending back to its base. Pterygostomial angle rounded.

Antennular peduncle short and heavy, with third article longer than visible portion of either first or second article; second article almost twice as broad as long. Stylocerite acute, reaching slightly beyond end of rostrum. Bifurcation of outer flagellum occurring near base; secondary flagellum short.

Antennal peduncle with basicerite bearing a poorly developed lateral tooth. Scaphocerite slightly longer than antennular peduncle, with squamous portion exceeding poorly developed lateral spine in length. Carpocerite short and heavy, reaching almost to end of antennular peduncle. Flagellum large in diameter basally, only as long as carapace.

Large chela 0.3 length of body, with basal articles almost as long as chela. Chela large, subcylindrical, with palm 1.3 to 1.5 times length of fingers. Fingers curved and compressed, with faces in opposition armed with 4 large and 2 smaller exactly fitting teeth; tips curved, acute, and crossing each other. Merus flattened on side toward palm. Small chela about 0.25 length of larger chela, not swollen, and without teeth.

Carpal articles of second legs with ratio 10 : 2.6 : 1.6 : 1.6 : 3.3.

Merus of third legs 3.5 times length of ischium, 1.3 times length of carpus, 0.75 times length of propodus, 2.7 times length of dactylus. Merus over 4 times as long as broad, unarmed; propodus bearing about 8 movable spines and about 6 shorter tufts of bristles;

dactylus moderately heavy, curved, simple, with acute tip.

Telson 1.5 times as long as broad at base; tip 0.4 as broad as base. Terminal emargination 0.1 total length of telson, rounded and bearing 3 to 4 pairs of plumose setae. Both pairs of terminal spines almost as long as width of tip.

DISCUSSION: (See discussion under *J. brevirostris*).

DISTRIBUTION: The type specimen came from the island of Maui; additional specimens have been collected about Oahu at Hanauma Bay, Kahala Beach, off Waikiki Reef, off Nanakuli, and at Kawela Bay, at depths from the reef flat to about 20 feet. Edmondson (1946: 256) states that this species is commensally associated with a large polychaete of the genus *Eurythoe*.

***Jousseaumea brevirostris* Edmondson**

Fig. 3 r-g

*Jousseaumea brevirostris* Edmondson, Bernice P. Bishop Mus., Occas. Papers 9(10): 7-9, figs. 2a-e, 1930.

DESCRIPTION: Carapace with dorsal keel for over 0.5 its length, continuous anteriorly with rostral carina. Rostrum triangular, reaching slightly beyond end of first antennular article. Eyes normally concealed by orbital hoods in dorsal and lateral view; orbital hoods continued as small acute orbital teeth, teeth about 0.3 length of rostrum. Area between base of orbital teeth and dorsal carina slightly concave.

Antennular peduncle short and heavy, with visible portion of first and second articles subequal in length, about 1.5 times as long as broad. Heavy stylocerite with acute tip, reaching almost to end of second antennular article. Flagella short, with shorter branch of bifurcated upper flagellum not as long as last 2 antennular articles together.

Basicerite heavy, bearing acute lateral tooth and short spiniform process (in lateral view) above articulation of scaphocerite. Scaphocer-

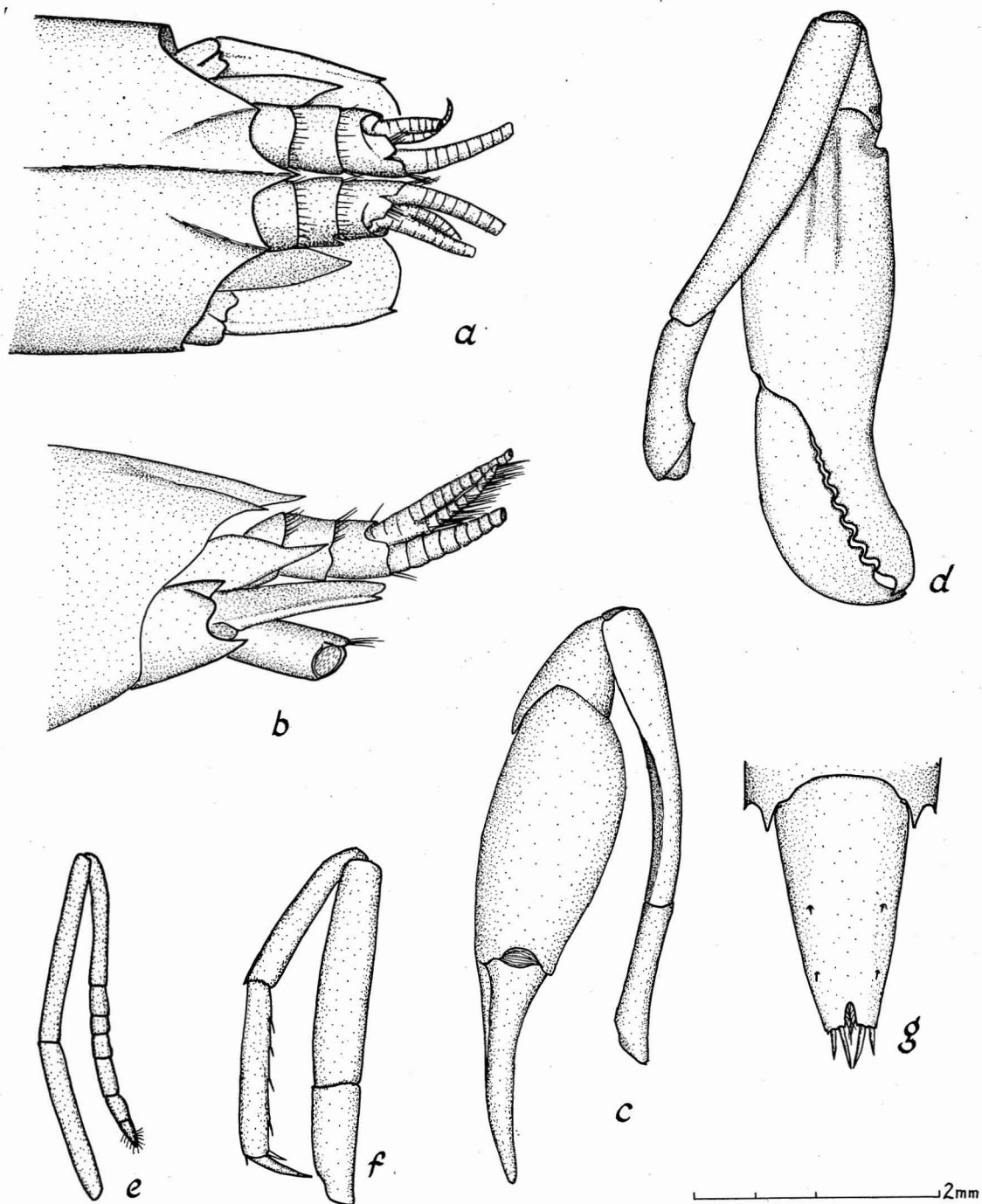


FIG. 3. *Jousseaumea brevirostris* Edmondson. *a*, *b*, Anterior region, dorsal and lateral aspects; *c*, *d*, large chela, lateral and ventral aspects; *e*, second legs; *f*, third legs; *g*, telson.

ite short and broad, with weak lateral spine just reaching end of antennular peduncle, with squamous portion noticeably longer. Carpocerite short, heavy, reaching slightly beyond end of second antennular article.

Large chela rounded, subcylindrical, length about 3.3 times breadth at maximum diameter; surface of palm toward merus excavate permitting flexure of appendage. Fingers over 0.4 length of chela, distally compressed and somewhat curved; dactylus and fixed finger with 8 large triangular teeth in opposition, tips acute and crossing. Merus slightly longer than palm, slender, rounded on outer side, flattened on side toward carpus and chela. Ischium also slender, 0.5 as long as merus.

Small chela lacking.

Carpal articles of second legs with ratio 10 : 3 : 2 : 2 : 4.

Third legs with ischium 0.5 length of merus; merus 4.1 times as long as broad, unarmed; carpus over 0.6 length of merus, with superior margin projecting, acute; propodus 0.75 length of merus, with 3 weak spines and several bristles; dactylus 0.25 length of merus, somewhat curved, slender, simple.

Telson almost twice as long as broad at base; tip almost 0.4 breadth of base; anterior surface strongly convex, posterior surface more flattened. Terminal cleft of telson about 1.5 times as deep as wide, only 0.1 of total length of telson. Inner terminal spines equal in length to breadth of tip.

DISCUSSION: The description given above and the figures are those of the type specimen previously described and figured by Edmondson. The slight differences to be noted on a point by point comparison of the two descriptions are merely differences in interpretation.

The two species of this genus from Hawaii, *J. brevirostris* and *J. mauiensis*, can best be separated by two characteristics. First is the nature of the rostrum, which in *J. brevirostris* is short, reaching only to near the end of the first antennular article and correspondingly narrow at its base (rostrums of both species approach the dimensions of equilateral triangles),

whereas in *J. mauiensis* it is long, reaching beyond the end of the second antennular article, and broad at its base. Furthermore, in *J. brevirostris* the rostrum and anterior carapace carry a carina that is lacking in *J. mauiensis*. Second is the nature of the terminal cleft of the telson, which in *J. brevirostris* is narrow and deep, about 1.5 times as deep as broad at the outer edge, whereas in *J. mauiensis* it is broad, less than half as deep as broad at the outer edge. Other slight differences can be found in the length of the stylocerite, the ratio of the lengths of the articles of the antennular peduncles, the merus of the third legs, and other characteristics.

DISTRIBUTION: The two specimens known were collected from Waikiki Reef (the type locality) and from the nearby reef at Kahala, Oahu.

#### ALPHEOPSIS Coutière

Frontal border of carapace produced into rostrum and projection that screens eyes from above; orbital teeth present or absent. Cornea of eyes visible from front and maybe from sides.

Antennular peduncle short and stout; stylocerite variable. Scaphocerite usually broad without heavy lateral spine. Carpocerite long.

Large chela carried extended, without grooves or sheaths. Carpus globular, merus roughly triangular. Chelae show slight asymmetry; either entire and subcylindrical or with lines and depressions. Fingers compressed, either without teeth or with simple arrangement of exactly fitting teeth.

Second thoracic legs with carpus of three articles (*A. idiocarpus* Coutière) or five.

Following legs robust, without teeth on merus; propodus weakly spinose; dactylus biunguiculate or simple. Propodus of fifth legs with or without "brush" of bristles.

Sixth abdominal segment without articulated pleura only in *A. biunguiculatus* Banner. Posterior border of telson rounded.

Branchial formula: 5 pleurobranchs, 1 arthrobranch, 8, 7, or 6 epipodites.

DISCUSSION: The description of this genus as given by Coutière (1899: 330) is modified to accommodate those species described subsequently and further to permit the assignment of a new species of doubtful relationship, *A. biunguiculatus* Banner, thereto.

The genus is confined largely to the west Pacific and the Indian Oceans; aside from *A. chilensis* Coutière, found off South America in the Pacific, the two species listed below are the only members of the genus that have been recorded as far east as the central Pacific Ocean.

#### HAWAIIAN SPECIES OF ALPHEOPSIS

##### 1. Dactyli of third to fifth legs simple. . .

..... *A. equalis* (p. 15)

Dactyli of third to fifth legs biunguiculate. . . . . (?) *A. biunguiculatus* (p. 18)

#### *Alpheopsis equalis* Coutière

Fig. 4 a-o

*Alpheopsis equalis* Coutière, Paris Mus. d'Hist. Nat., Bul. 2(8): 380, 1896.

*Alpheopsis equalis* var. *truncatus* Coutière, Soc. Philomath. Paris, Bul. IX, 5(2): 89, 1903.

*Alpheopsis equalis* and *Alpheopsis equalis* var. *truncatus* Coutière, Fauna and Geog. Mald. and Laccad. 2(4): 868, 1905. [A fuller description and discussion, with figures, of both forms.]

*Alpheopsis aequalis* de Man, Siboga Exped., 39a<sup>1</sup> (2): 177, 1911.

DESCRIPTION: Frontal border of carapace produced into acute rostrum extending about 0.7 length of visible portion of first antennular article. Termination of rostrum, in lateral view, varying from acute to obliquely truncate. Frontal border projecting beyond corneas of eyes, masking them entirely in dorsal view and almost or entirely in lateral view; marked by 2 pairs of slight convexities, one pair dorsad, one pair laterad of eyes. Pterygostomial angle rounded or produced into acute tooth.

Antennular peduncle short and heavy with second article shorter than visible portion of

either first or third. Stylocerite with tip extending almost to end of second article of antennular peduncle.

Scaphocerite short and broad, as long as antennular peduncle, slightly shorter than peduncle of antenna. Lateral spine of scaphocerite not pronounced and equal in length to squamous portion. Lateral spine of basicerite acute but not well developed.

Basal articles of third maxilliped with strong spiniform bristles.

Chelae almost symmetrical in size and shape, not showing more than 10 per cent difference in size; rounded and without grooves. Fingers compressed, with slight irregularities on opposing faces; usually with stiff recurving hairs. Carpus elongate with outstanding flange into which proximal end of propodus fits, with slight constriction before this flange. Merus with upstanding collar on outer distal side into which proximal end of carpus fits, with rounded edges, with variable set of long stiff bristles on inner lateral and superior margins. Ischium also with bristles on superior distal face.

Carpal articles of second thoracic leg with ratio 10 : 6 : 4 : 4 : 5.

Third legs relatively long and slender, with ischium 0.5 as long as merus; merus 6.5 times as long as wide; carpus slightly less than 0.5 as long as merus; propodus slightly longer than merus; dactylus about 0.3 length of propodus. Merus without spines or teeth; carpus with long slender spine on distal portion of inferior margin; propodus bearing 4 or 5 spines on inner margin. Appendage glabrous except several setae on distal end of merus, distal end of propodus, and middle of dactylus. "Brush" of fifth thoracic legs of 10 rows of weak bristles.

Species small, maximum length about 12 mm.; color in life not noted.

DISCUSSION: In the collections available from Hawaii there are 13 specimens of this species, some broken and some entire. These specimens vary in a series of points, yet plainly all are members of the same species for they



show essentially the same structure. The points of variation are as follows:

1. The nature of the tip of the rostrum (Fig. 4*b, c, d*). In his three specimens Coutière was able to distinguish between the species *A. equalis*, which had a rostrum with a uniform taper, and the variety, *A. equalis* var. *truncatus*, which had an abruptly truncate rostrum. Specimens approaching both conditions are represented in the Hawaiian collections; however, in those with the pointed rostrum it is a little less pointed than in those described by Coutière, and in those in which the rostrum is truncate it is a little less abruptly so than in his variety. In addition to the two extremes, there are a series of intergrading individuals which show various degrees of truncation. A number of these specimens have a very slight tooth at the lower side of the terminal truncation. I conclude, therefore, that the variety described by Coutière is merely an individual variation.

2. The presence of a tooth on the pterygostomial angle of the carapace (Fig. 4*c, d*). In most specimens in the Hawaiian collections the carapace below the base of the antennae is rounded, as Coutière shows for *A. equalis*; in a few it has a tooth somewhat similar to that shown for *A. equalis* var. *truncatus*. However, among the specimens possessing the tooth, it is not always at the same stage of development, and in one specimen there is a tooth on one side but none on the other. Therefore this too must be considered an individual variation.

3. The coverage of the eyes by the carapace (Fig. 4*b, d*). In lateral view, the eyes of most specimens are completely obscured by the carapace which may project beyond the corneas for a varying distance; in several, however, the anterior portion of the corneas of the eyes projects beyond the margin of the carapace.

4. The size and the armature of the chelae (Fig. 4*e-k*). In most of the specimens with

both chelae attached, the larger is only about 10 per cent longer than its mate, but in several the larger chela was at least twice the size of the smaller. It is presumed that in these asymmetrical specimens the smaller chela was in the process of regeneration. Some of the specimens, moreover, had their fingers armed with a dense covering of recurving bristles; in others the bristles, while present, were neither dense nor conspicuous. Finally, all of the meri of the chelipeds had spine-like bristles, but in some they were conspicuous and strong and in others they were inconspicuous and weak. Between the specimens showing the extremes of variation of the chelipeds were intergrading individuals.

If these variations were constant, so the truncated rostrum was always found with a pterygostomial spine and a spiny merus, etc., and if there were no intergrading individuals, the differences would be sufficient for the erection of a new species; as it is, the species must be considered merely as one in which rather great variation occurs.

**DISTRIBUTION:** The species has been reported from the Hawaiian Islands by Edmondson (1946). Specimens in the present collection have been collected on Oahu as follows: on algal holdfasts in the intertidal zone near Koko Head and Kawela Bay; in water from 10 to 20 feet deep at Hanauma Bay, Waikiki, and Nanakuli. On Maui it was collected at three localities between Lahaina and Kalama Park in 3-8 feet of water. On Hawaii it was collected by Hiatt from a tidal pool on Keaoi Island, Kau Coast.

Three specimens were collected by the "Albatross" in Auau Channel, in water from 32 to 43 fathoms deep (U. S. N. M. 63454, 63455, 63456, "Albatross" Stations 3873, 3876, 3872).

Either the species proper or its variety has been reported from Djibouti and Permin at the mouth of the Red Sea, from the Maldives in the Indian Ocean, and from New Caledonia and Samoa.

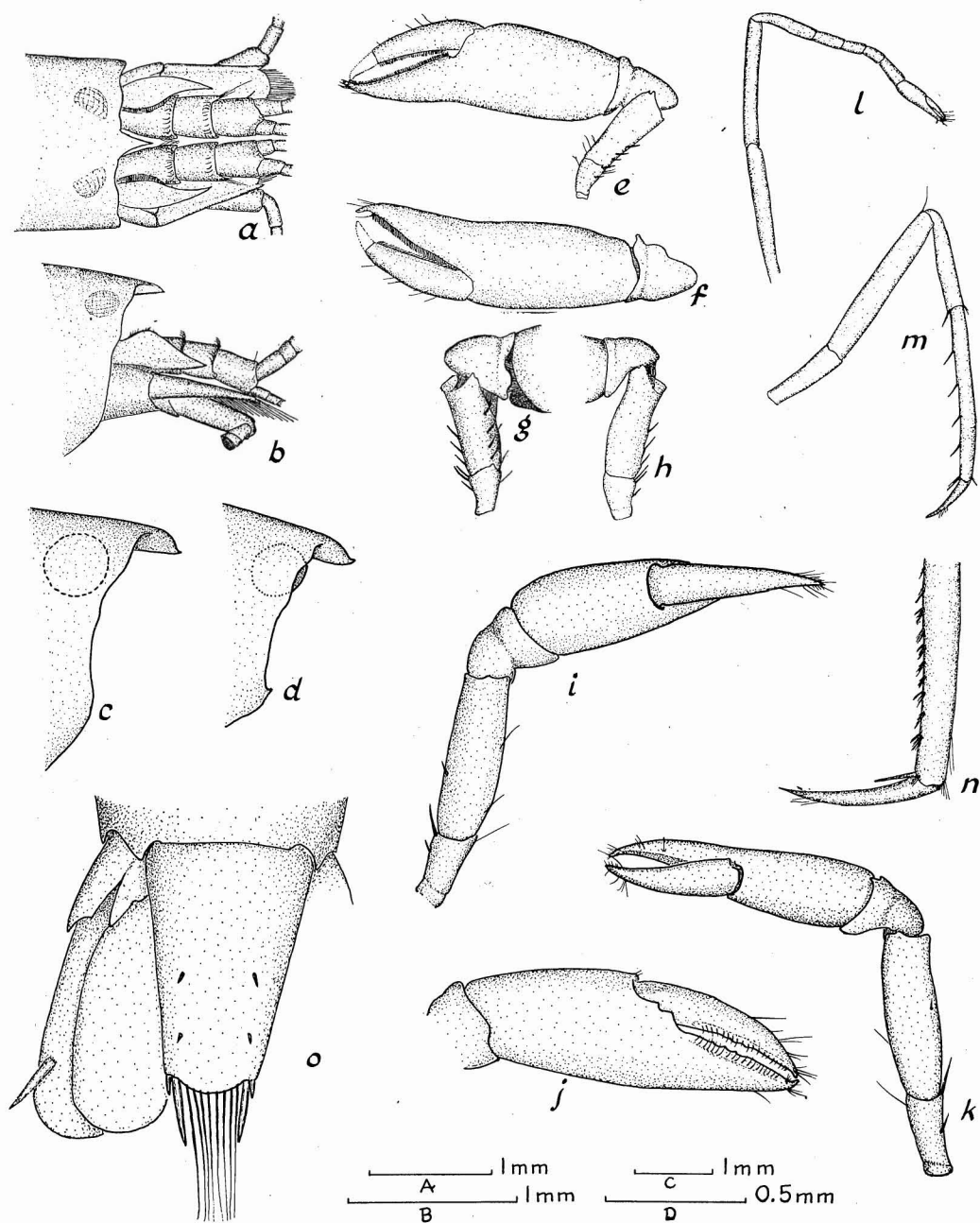


FIG. 4. *Alpheopsis equalis* Coutière. *a, b*, Anterior region, dorsal and lateral aspects; *c, d*, variations in anterior carapace; *e, f*, large chela, lateral and medial aspects; *g, h*, merus, large cheliped, lateral and medial aspects; *i, j*, variations in large chela; *k*, small chela of same specimen as chela *i*; *l*, second leg; *m*, third leg; *n*, fifth leg; *o*, telson and uropods of specimen shown in *c*. (*a, b, l, m*, scale A; *c, d, i-k*, scale B; *e-h*, scale C; *n, o*, scale D.)

(?) *Alpheopsis biunguiculatus* sp. nov.

Fig. 5 a-b

TYPE SPECIMEN: A male 8.4 mm. long collected from a head of *Pocillopora meandrina* Verrill from the intertidal zone at Halape, Kau Coast, Hawaii, by R. W. Hiatt. This is the only specimen of this species in the collection (U. S. N. M. 93451).

DESCRIPTION: Front of carapace projecting over eyes but abruptly truncate and flattened dorsally; without keels, ridges, or grooves. Rostrum, in dorsal view, very small, narrow and acute, reaching only 0.7 of length of first article of antennular peduncle; ventral keel and abrupt truncation in lateral view. Hoods over eyes slightly inflated, without teeth or other projections. Eyes extending slightly beyond margins of hoods in lateral view. Pterygostomial angle rounded.

Antennular peduncle short and heavy, with visible portion of first and second article each 0.2 mm. long, with third article 0.25 mm. long; second article 0.23 mm. wide. Stylocerite short, rounded, with short acute spine arising abruptly from lower margin, tip not reaching to end of first antennular article. Secondary bifurcation of outer flagellum well developed. All flagella broken before tip.

Lateral spine of basicerite acute, short, not reaching to end of broad portion of stylocerite. Scaphocerite broad, with lateral spine poorly developed, about as long as squamous portion. Scaphocerite and antennular peduncle equal in length, both considerably longer than carpocerite. Antennular flagella lost.

Third maxillipeds with basal article (ischiomereus) 0.68 mm. long, 0.17 mm. broad; carpus 0.30 mm. long, 0.12 mm. broad; third article (propodactylus) 0.30 mm. long, 0.10 mm. broad. Appendages with scattered hairs along basal joints, 8 rows of short stiff bristles on terminal article, 2 spiniform bristles on end of first article, and 4 on second article. Exopod reaching to middle of carpus.

Large chelipeds lost.

Second thoracic legs 3.2 mm. long. Carpal articles with ratio 10 : 8 : 6 : 6 : 10. Length of first secondary article 5.8 times breadth.

Third legs moderately heavy, 3.1 mm. long. Ischium 0.34 mm. long, with strong movable spine. Merus 0.95 mm. long, 0.23 mm. broad (4.1 times as broad as long), with 2 movable spines. Carpus 0.45 mm. long, 0.16 mm. broad, unarmed. Propodus 1.04 mm. long, 0.14 mm. broad, with 6 small movable spines, 2 on distal end. Dactylus 0.29 mm. long, 0.09 mm. broad, with strong secondary unguis.

Fifth legs similar to third with slight differences in proportions. Propodus with no semblance of "brush," but with 4 feeble spines. Secondary unguis of dactylus poorly developed.

Basiopodites of first 4 pairs of pereopods with rudimentary exopodites(?) (Fig. 5b).

Pleura of sixth abdominal segment not articulated.

Telson 1.18 mm. long, 0.55 mm. broad at base (2.1 times as long as broad), with tip 0.25 mm. broad. Lateral margins slightly convex; terminal margin more markedly convex. Four pairs of long setiferous bristles between 2 terminal spines. Dorsal spines 0.5 and 0.8 mm. from anterior end. Anal tubercles absent.

Branchial formula: 5 pleurobranchs, 1 arthrobranch (rudimentary), 7 epipodites (mastigobranch on seventh leg poorly formed; setobranch lacking on eighth).

DISCUSSION: Unfortunately, this most perplexing species is represented by a single broken specimen, so any conclusions about it must be tentative. It was placed in this genus because in most characteristics it is very much like *A. equalis* Coutière. However, the lack of articulation of the pleura of the sixth abdominal segment and the presence of exopodites on the pereopods raise serious doubts as to its relationship to this genus. The second characteristic may not be of any worth, possibly being merely a persistent larval characteristic or an atavism. Because the specimen is incom-

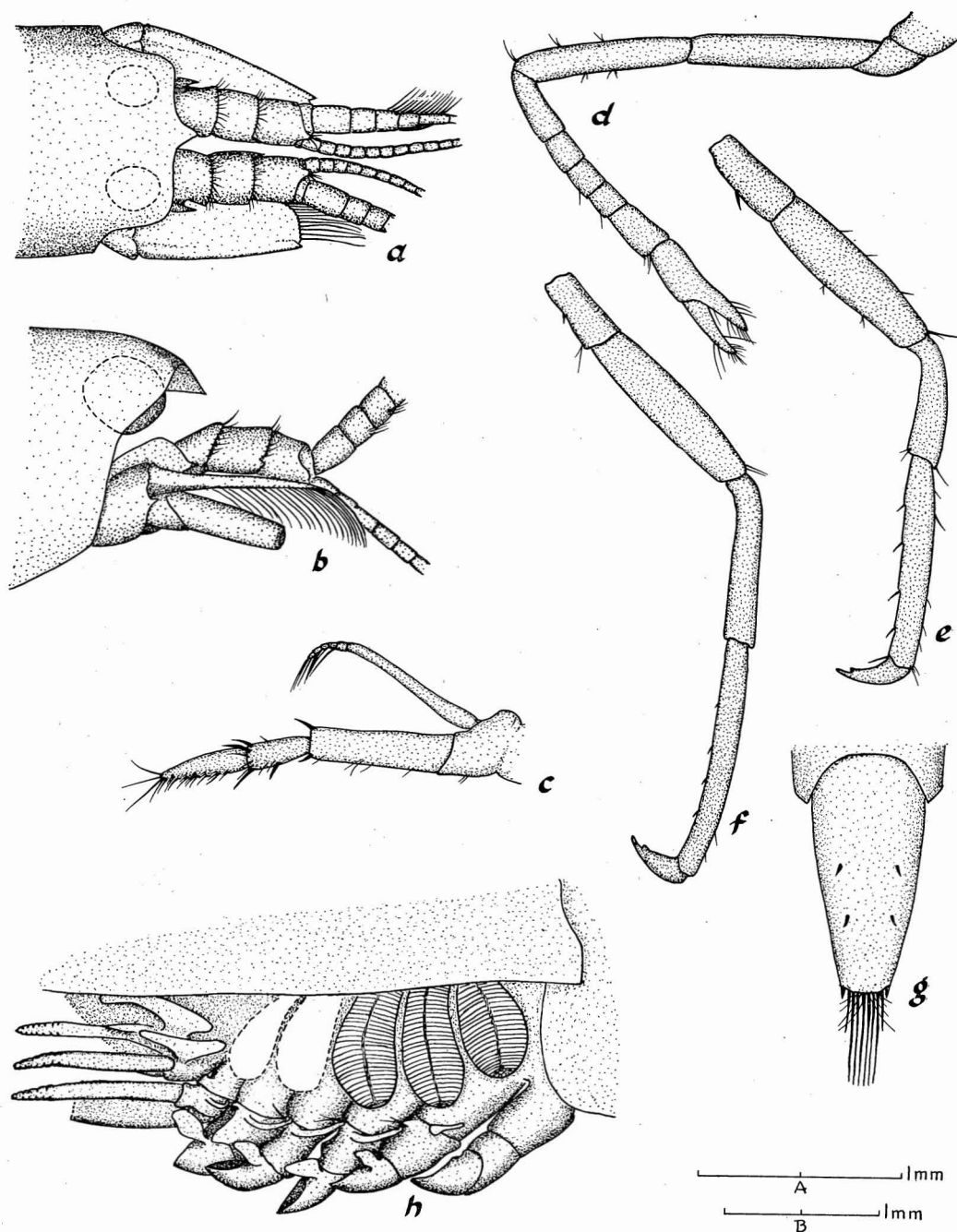


FIG. 5. (?) *Alpheopsis biunguiculatus* sp. nov. *a, b*, Anterior region, dorsal and lateral aspects; *c*, third maxilliped; *d*, second leg; *e*, third leg; *f*, fifth leg; *g*, telson; *h*, lateral view of the branchial cavity, the two anterior pleuro-branchs shown only in outline. (*a-g*, scale A; *b*, scale B.)



plete and because of the dubious worth of the exopodites as a diagnostic character, it has seemed advisable not to create a new genus for this specimen. When another specimen, complete with the large chelipeds, is found it may be necessary to remove this species from this genus.

RELATIONSHIP: If *A. biunguiculatus* belongs to this genus, it can be separated from all other species by the lack of articulated pleura on the sixth abdominal segment; it can be separated from all species save *A. fissipes* Coutière by the presence of the biunguiculate dactyli on the third to fifth legs, and from *A. fissipes* (Coutière, 1908, and more completely, 1921), by the characteristics presented in the following tabulation:

<i>A. biunguiculatus</i>	<i>A. fissipes</i>
Rostral tip without hairs	Rostral tip with hairs
Stylocerite shorter than first antennular article	Stylocerite almost as long as second antennular article
Carpocerite shorter than antennular peduncle	Carpocerite longer than antennular peduncle
Terminal article of third maxillipeds with bristles	Terminal article of third maxillipeds without bristles
Ratio of carpal articles of second legs 10 : 8 : 6 : 6 : 10	Ratio of carpal articles of second legs 10 : 5 : 5 : 4 : 6
Ratio of articles of third legs: ischium, 0.75; merus, 2.1; carpus, 1.0; propodus, 2.3	Ratio of articles of third legs: ischium, 0.8; merus, 1.4; carpus, 1.0; propodus, 1.6

NEOALPHEOPSIS gen. nov.

Carapace projecting to form rostrum and orbital teeth which obscure eyes, in dorsal view; corneas may or may not extend slightly beyond edge of carapace in lateral view. No pterygostomial tooth or even acute angle.

Antennule with heavy peduncle, basal article nearly as long as both distal articles. Stylocerite broad, acute tip reaching distal portion of second antennular article. Inner flagellum as long as carapace, outer somewhat shorter and with setiferous bifurcation on basal portion.

Antenna with spine of basicerite broad, but apically acute. Scaphocerite broad, rounded with lateral spine not longer than squamous

portion. Carpocerite normal. Flagellum almost as long as body.

Last article of third maxilliped with transverse rows of short setae on inner side, similar to that of *Crangon*.

First pair of chelae well developed, large, approaching bilateral symmetry, without sexual dimorphism. Chela can be folded back against merus, merus triangular, somewhat excavate and twisted to accommodate chela; merus without spines or teeth. Carpus cyanthiform, more elongate than in *Crangon*. Chela proper rounded, smooth, tapering, without crests or lobes, rotated so dactylus rests against merus when flexed. Cutting surface of dactylus with serrations that meet exactly with similar serrations on fixed finger, or developed as knife-like ridge. Palmar and digital adhesive plaques poorly developed.

Second legs with carpus of 5 articles, first secondary article slightly shorter than remaining 4 together.

Third legs with proximal articles with movable spinules; propodus with few weak spines; dactylus simple. Fifth legs with usual brush on inner side of propodus poorly developed.

Abdomen of usual form. Pleura of sixth abdominal segment articulated. Uropods of usual form. Telson tapering, convex dorsally. Tip of telson with 2 pairs of spines, medially to them margin projects markedly as acute triangle; triangle with 3 or 4 pairs of setiferous bristles. No anal tubercles.

See Table 1 for branchial formula.

This genus is distinguished from almost all other genera of crangonids by a series of characteristics, the more conspicuous of which are given here.

It is distinguished from *Athanas* Leach, *Athanopsis* Coutière, *Arete* Stimpson, *Areteopsis* de Man, *Automate* de Man, *Pterocaris* Heller, and *Ogyris* Stimpson by the covering of the eyes, in dorsal view, by the projecting carapace; from *Betaeus* Dana and *Parabetaeus* Coutière by the presence of a projecting rostrum; from *Synalpheus* Bate and *Crangon* Weber by

TABLE 1  
BRANCHIAL FORMULA OF THE GENUS *Neoalpheopsis*

	PLEURO-BRANCHS	ARTHRO-BRANCHS	EPI-PODITES*
Maxillipeds			
1			1
2			1
3			$\alpha$
Thoracic legs		1	
1	1		$\alpha, \beta$
2	1		$\alpha, \beta$
3	1		$\alpha, \beta$
4	1		$\alpha \dagger, \beta$
5	1		

\* The designations  $\alpha$  and  $\beta$  are used here as they are applied by Coutière (1899: 268–286), where  $\alpha$  refers to the arm-like mastigobranch, and  $\beta$  refers to the small setiferous lobe-like setobranch.

† This epipodite reduced to a small protuberance.

the lack of the well-developed plunger and adhesive plaques on the dactylus of the large chela.

*Neoalpheopsis* bears a superficial resemblance to *Jousseaumea* Coutière as both the frontal border of the carapace and the teeth on large chela are similar and there is a general similarity of form. However, they can be distinguished easily by the modification for the flexure of the large chela, as the merus is grooved in *Neoalpheopsis* and the chela is grooved in *Jousseaumea*; by the pleura of the sixth abdominal segment which are articulated in *Neoalpheopsis* and not in *Jousseaumea*; by the telson, the posterior margin of which projects as a triangle in *Neoalpheopsis* but which is posteriorly cleft in *Jousseaumea*. The two can be distinguished further by the branchial formula which is 5–1–7 in *Neoalpheopsis* and 5–1–8 in *Jousseaumea*.

In all ways *Neoalpheopsis* shows a close relationship to *Alpheopsis* Coutière. The form of the carapace is similar in the two genera; the cephalic appendages are similar; the walking legs of the thorax are similar; the pleura of the sixth abdominal segment are similar. The chelae and the telson differ, however. The chelae in *Neoalpheopsis* are carried folded back against

the merus, the fingers are serrate or toothed, and the chelipeds are almost symmetrical; whereas in *Alpheopsis* the chelae are carried extended, the fingers are usually without serrations, and the chelipeds usually have marked asymmetry. The telson in *Neoalpheopsis* projects terminally to form a large and acute triangle, whereas in *Alpheopsis* the terminal margin is either straight or slightly arcuate.

TYPE SPECIES: *Neoalpheopsis biatti* Banner.

#### SPECIES OF NEOALPHEOPSIS

1. Rostrum reaching to near middle of second antennular article; merus of third legs 4.5 times as long as broad. . . .  
*N. biatti* (p. 21)
- Rostrum reaching only to distal third of first antennular article; merus of third legs 7.5 times as long as broad. . . .  
*N. euryone* (p. 25)

*Neoalpheopsis biatti* sp. nov.

Fig. 6 a–l

TYPE SPECIMEN: A male 13.5 mm. long collected from a head of coral in 20 feet of water, Hanauma Bay, Oahu. (Sizes and places of collection of paratypes listed below.) (U. S. N. M. 93452.)

DESCRIPTION: Rostrum broadly triangular with tip reaching to initial third of second article of antennular peduncle; rostrum slightly convex dorsally, with ventral keel. Orbital teeth broadly triangular with rounded tips; length 0.3 of rostrum. Carapace slightly inflated over eyes. No pterygostomial angle.

Eyes concealed in dorsal view; in lateral view slightly visible ventrad and anterior to margin of orbital hood.

First antennular article 0.85 mm. long from base, with visible portion 0.30 mm. long; second article 0.30 mm. long; third article 0.40 mm. long; all about 0.35 mm. in diameter. Stylocerite broadly acute, not spiniform, extending to end of second antennular article. Internal crest of first article well developed, with acute tooth extending to end of article.

Inner flagellum 4.1 mm. long; outer flagellum 3.7 mm. long, with base thickened for 0.30 mm. and produced as secondary lobe 0.35 mm. long.

Lateral margin of basicerite of antennal peduncle with broad, acute tooth extending to middle of first article of antennular peduncle. Scaphocerite reaching to end of antennular peduncle, almost 0.5 as broad as long, with setae around rounded distal and inner margins; lateral spine poorly developed, shorter than squamous portion. Carpocerite not reaching to end of the scaphocerite. Antennal flagellum 8.0 mm. long.

Basal article of endopod of third maxilliped (ischio-merus) 1.5 mm. long, with basal 0.7 flattened and curved (not shown in aspect drawn), straight and subcylindrical distally. Carpus 0.46 mm. long, cylindrical. Third article (propodo-dactylus) 0.7 mm. long, circular in cross section, tapering; with 8 transverse rows of spinules.

Chelipeds well developed, 7.5 mm. long, quite symmetrical, usually carried partially or completely folded back on merus. Ischium short, delimited from merus by slight groove. Merus 2.9 mm. long, 0.45 mm. broad; convex-concave distally in cross section, concavity accommodating chela; edges of concavity produced as low ridges distally, outer ridge obsolete proximally, inner ridge distinct to base. Merus without spines or setae, inferior internal margin produced as small tooth. Carpus conical, 0.7 mm. in length and distal breadth, unarmed. Upon flexion of both carpal articulations chela rests against merus. Propodus 3.6 mm. long, fingers 1.3 mm. Palm somewhat flattened, curved, without keels or sharp angles, 1.0 mm. high. Maximum width of fixed finger 0.3 mm.; dactylus slightly thinner (0.25 mm.). Proximal 0.75 of fixed finger of right chela with 11 large flattened triangular teeth, larger distally. These alternate with corresponding smaller teeth on dactylus. Dactylus of left chela with knife-like crest showing minor irregularities homologous to teeth of right dactylus. Distal 0.25 of fixed finger of

both chelae with ridge, armed with fine serrations, apposable to bare spot on dactylus opposite; both fingers taper to unarmed, curved, acute tip that crosses opposite member. Palmar and digital adhesive plaques poorly developed.

Second legs 4.3 mm. long. Articles of carpus with ratio 10 : 2 : 2 : 2 : 4. Propodus almost twice as long as last article of carpus, fingers 0.5 of length.

Third legs with ischium 0.8 mm. long; merus, 1.6 mm. long, 0.35 mm. broad; carpus, 0.7 mm. long, 0.2 mm. broad; propodus, 1.3 mm. long, 0.2 mm. broad; dactylus, 0.35 mm. long, 0.06 mm. broad. Ischium unarmed; merus with strong movable spine on middle of inferior margin, usually pressed against the article; carpus with single small movable spine at articulation of propodus; propodus with 4 spines, 3 proximal less than 0.5 width of propodus, fourth 0.7 width of adjacent propodus. Dactylus with uniform taper to acute tip, slightly curved.

Fourth leg similar to third. Fifth leg with armature of propodus reduced to 2 short spines, usual "brush" on distal portion of article reduced to 4 small bunches, not rows, of bristles, each composed of at most 6 or 7 individual bristles.

Anterior 5 abdominal pleura rounded. Pleura of sixth abdominal segment acute, triangular, with margins slightly convex, 0.42 mm. long, 0.32 mm. broad at base. Uropods of normal form, broad, rounded.

Telson convex dorsally, concave ventrally; sides straight with marked taper. Proportions as follows: Total length, 1.80 mm.; width at base, 0.74 mm.; width at tip, 0.32 mm.; thickness at base, 0.42 mm.; width of base of terminal triangle, 0.14 mm.; length (or height) of terminal triangle, 0.14 mm.; anterior pair of dorsal spines 0.98 mm. from base; posterior pair of dorsal spines 1.40 mm. from base; anterior pair of dorsal spines 0.10 mm. long; posterior pair of dorsal spines 0.14 mm. long; lateral terminal spines 0.09 mm. long; medial pair of terminal spines 0.50 mm. long. Tip of

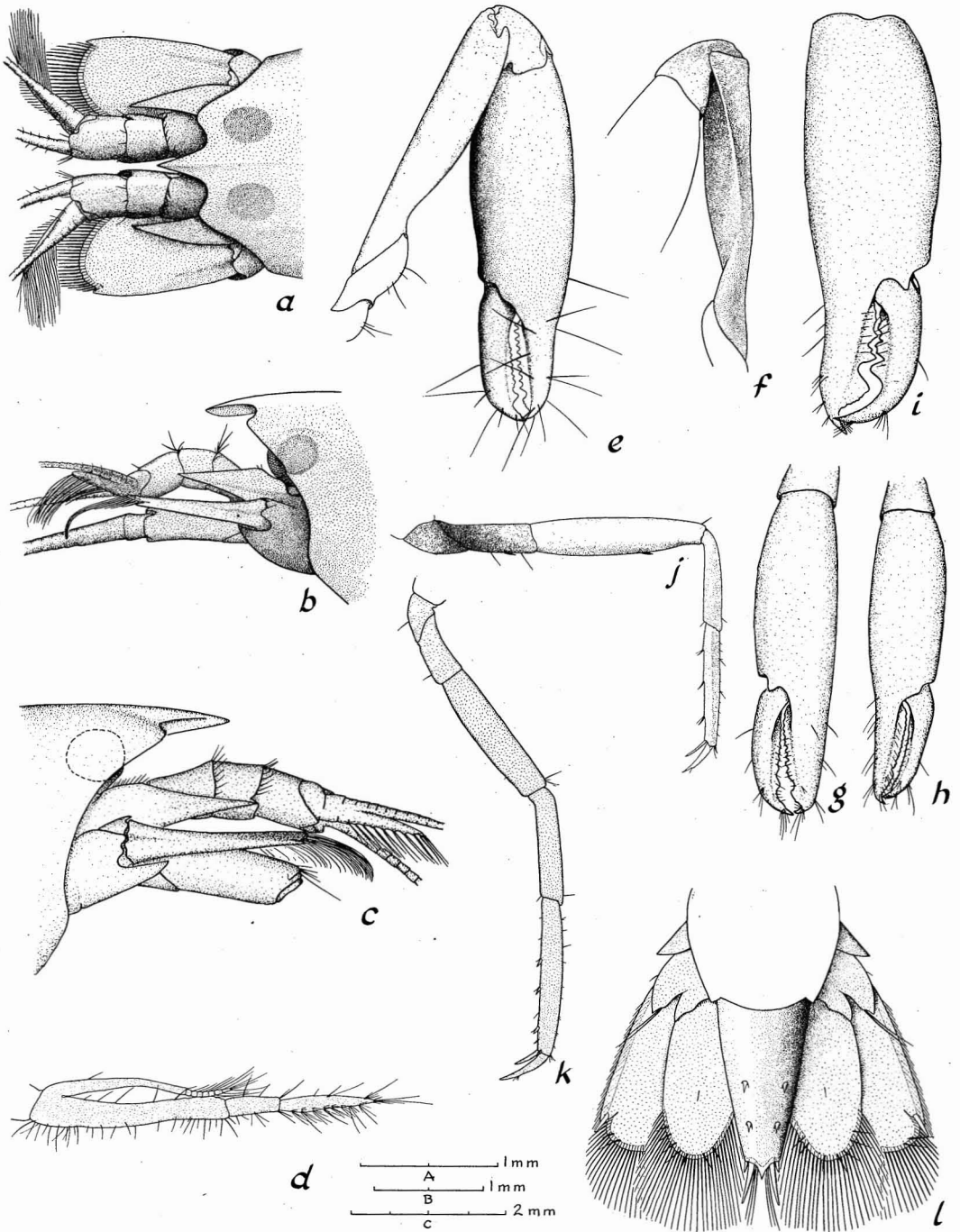


FIG. 6. *Neolpheopsis biatti* gen. et sp. nov. *a, b*, Anterior region, dorsal and lateral aspects; *c*, anterior region of specimen 4; *d*, third maxilliped; *e*, large cheliped; *f*, merus; *g*, left chela; *h*, right chela; *i*, large chela of specimen 3; *j*, third leg; *k*, fifth leg; *l*, telson, uropods, and articulated pleura of the sixth abdominal segment (drawing foreshortened). (*a, b, d-f, j-l*, type specimen; *c, g, h*, specimen 4; *i*, specimen 3.) (*a, b, d-f*, scale A; *c, j-l*, scale B; *g-i*, scale C.)

telson with 3 additional pairs of long setae. Anus at anterior end of ventral side of telson; no anal tubercles.

Color variable, with red and brown chromatophores.

DISCUSSION: In addition to the type specimen, this series is represented in the collections by four other specimens:

1. An ovigerous female, 27 mm. long, collected off Waikiki Reef, Oahu, from a coral head in water about 20 feet deep.

2. A male, 21 mm. long, collected in Hanalei Bay, Oahu, from a coral head in about 10-15 feet of water (chela lacking).

3. An ovigerous female, 20 mm. long, collected offshore at Halape, Kau Coast, Hawaii, from a head of *Porites* in 8-9 feet of water by R. W. Hiatt. The eggs borne by this specimen were near hatching and contained larvae in the protozoal stage of development; the eggs were 0.25 mm. by 0.72 mm. in diameter.

4. A male, 17.2 mm. long, collected at the same place as specimen 3 by R. W. Hiatt.

The four specimens agree well with the type in almost all characteristics except for minor variations in proportions, e.g., the chela varies from a little over 3 to a little less than 4 times as long as broad, and the length-breadth relationship of the telson varies by 10-15 per cent. These differences are well within the range of normal and expected variation.

Specimen 4 shows greater differences from the type than do 1 and 2. In 4 the anterior region of the carapace, while bearing the same proportions as that of the type in respect to the length of the rostrum, etc., is more closely pressed to the bases of the antennae; in consequence, the eyes are almost entirely concealed in lateral view, so that at first glance the rostrum appears to be longer than that of the type (Fig. 6c). The chelae also show a series of finer teeth and generally longer and thinner proportions (Fig. 6g-h).

However, it is specimen 3 that shows the greatest differences. In this specimen the chela (only one is present) bears few and conspicu-

ous teeth on both fingers instead of fine teeth on the fixed finger in opposition to the blade of the movable finger (Fig. 6i). Some of the teeth appear to be blunted or broken.

It may well be that this last specimen represents another species. However, inasmuch as all other characteristics are well within the range of expected variation, it must be assumed, until other specimens are studied, that this is an extreme variation from the normal. Another reason for this conclusion is the fact that this specimen and specimen 4 were collected from the same habitat and are of different sexes. It is possible that these two specimens were mates living in the same burrow, as is common among the crangonids.

The species is named in honor of Robert H. Hiatt, the collector of some of the specimens of this species and of other specimens valuable to the study.

RELATIONSHIP: There is only one other species in this genus, *N. euryone* (de Man). If the specimens discussed above all belong to *N. hiatti*, then apparent differences between this species and *N. euryone* in the chelae, second legs, etc., are within the range of variation of the species. However, there are four sets of characteristics that exceed the range of variations noted and which will serve for the separation of the two species. In *N. hiatti* the rostrum reaches beyond the end of the first antennular article; the stylocerite reaches to the end of the second antennular article; the merus of the third legs is 4.5 times as long as broad, 2.3 times as long as the carpus, and 4.5 to 5.5 times as long as the dactylus; the telson is 13 times as long as the terminal triangle. On the other hand, in *N. euryone* the rostrum does not reach past the middle third of the first antennular article; the stylocerite reaches only to the middle of the second antennular article; the merus of the third legs is 7.5 times as long as broad, 1.6 times as long as the carpus, and only 3.0 times as long as the dactylus; the telson is 10 times as long as the terminal triangle.



**Neolpheopsis euryone** (de Man)

Fig. 7 a-g

*Alpheopsis ? euryone* de Man, Ned. Dierk. Ver., Tijdschr. (2), 11(4): 308, 1910.

*Alpheopsis ? euryone* de Man, Siboga Exped. 39a<sup>1</sup>(2): 184, pl. 5, fig. 19, 1911. [This description is more available, more complete, and is provided with plates.]

Rostrum triangular, acute, tip extending over 0.7 of length of visible portion of first article of antennular peduncle. Rostral base and rostrum without dorsal keel, not distinct from gradual curvature of carapace; rostrum with ventral keel. Orbital teeth strongly reduced, hence frontal border of carapace lateral to rostrum almost straight in dorsal view; apex of slight teeth rounded. No pterygostomial angle.

Eyes concealed in dorsal view, partially visible in lateral view.

First article of antennular peduncle 0.74 mm. long; second 0.44 mm. long and as broad as long; the third 0.37 mm. long. Stylocerite broad, tip acute, reaching more than 0.7 length of second article. Inner flagellum 8.5 mm. long; outer 7.3 mm. long, with secondary flagellum reaching over 1 mm. from base of flagellum.

Lateral angle of basicerite produced and truncate [however, as in the specimen available, it ends in such abrupt truncation on both sides that it may have had a strong and acute tip broken off.] Scaphocerite broad, flat, almost as long as antennular peduncle; lateral spine shorter than rounded portion. Carapocerate of antenna extending only to middle of last article of antennular peduncle; flagellum 15.3 mm. long, extending to fifth abdominal segment.

Third maxilliped lacking.

Chelipeds quite symmetrical in development, over 11 mm. long from base, capable of being folded back against merus. Ischium similar to *N. biatti*. Merus 3.4 mm. long, 0.6 mm. broad, with diagonal longitudinal excavation accommodating propodus when ap-

pendage is flexed; inner and outer inferior distal corners of merus project slightly as rounded teeth. Chela proper 5.4 mm. long, 1.3 mm. broad (3 times as long as broad), 1.1 mm. thick, oval in cross section. Palm smooth without ridges or depressions. Fingers 2.0 mm. long; fixed finger with narrow crest along inner face, with 11 teeth; ridge depressed distad of teeth, then produced as small crest with poorly defined teeth; apex curved, strong, acute. Dactylus similarly with narrow crest, but knife-like except for small portion in middle with feeble teeth, bidentate crest opposite depressed area on fixed finger, knife edge diminishing to acute, curved tip. Cheliped glabrous except for several setae near end and sparse row of short stiff bristles along knife ridge of dactylus. Palmar and digital adhesive plaques poorly developed.

Second legs 6.8 mm. in total length. Carpal articles with ratio 10 : 1.9 : 1.7 : 1.7 : 3.8.

Third legs slender and elongate, 7.8 mm. long. Ischium 1.5 mm. long, with 2 movable spines on inferior surface. Merus 2.2 mm. long, 0.29 mm. broad (7.6 times as long as broad), with 2 movable spines on inferior edge. Carpus 1.4 mm. long, without spines or teeth. Propodus 2.0 mm. long, with 4 movable spines. Dactylus long and slightly curved, 0.7 mm. long, 0.09 mm. broad, with 2 tufts of bristles on convex surface.

Articulated pleura of sixth abdominal segment well developed, triangular, with free corner acute.

Telson 2.95 mm. long, 1.17 mm. broad at base, 0.48 mm. broad at tip. Anterior portion strongly convex dorsally, but posteriorly almost flat; lateral margins almost straight. Posterior margin produced as large triangle, 0.25 mm. broad at base and 0.29 mm. long, with straight sides and acute tip. Two pairs of terminal bristles, inner slightly shorter than triangle (0.28 mm. long), outer about 0.3 as long as inner. Triangle with 4 pairs of setose bristles. First pair of dorsal spinules of telson 0.4 distance from base (1.1 mm.); second pair about 0.7 of distance from base (1.9 mm.).

DISCUSSION: De Man's specimen came from the Netherlands Indies; because it was lacking in chelipeds, he referred it to the genus *Alpheopsis* "with some doubt."

The specimen here described agrees very well with de Man's description and plates except in a few small details. In his specimen the rostrum was shorter, only one third the length of the visible portion of the first antennular article instead of two thirds. He also states that the carapace on his specimen had its upper surface finely punctate, whereas that on this specimen was smooth. The inner pair of spines on the tip of the telson are longer than the projecting triangle in de Man's specimen, whereas in this they are shorter; however, the ones in this specimen appear to be broken. The lateral tooth of the basicerite in his specimen is described as strong and acute, whereas in this it is short and truncate, but it probably has been broken. Finally, the merus of the third leg in the type is 6 times as long as broad instead of 7.5 times.

Most, if not all, of these differences could easily be individual variation, or they could be subspecific differences due to geographic isolation. The only difference that could be of specific importance is the sculpturing of the carapace in the original specimen, and this difference, also, is too slight to warrant specific separation without any other strong differences in nonvarying characteristics, especially as only two specimens of the species are known.

For a comparison of this species and *N. biatti* Banner see the discussion under the latter.

DISTRIBUTION: De Man's species came from the Karkaralong group, south of Mindanao (about 5°N, 125°30'E); the specimen described here is a male 20 mm. long collected by R. W. Hiatt at Halape, Kau Coast, Hawaii, from a head of *Porites* in the intertidal zone, west end of Keaoi Island.

#### SYNALPHEUS Bate

*Synalpheus* Bate, Challenger Rpts. 24: 572, 1888.

*Synalpheus* Coutière, Les Alpheidae, p. 334, 1899 [redefined].

Anterior portion of carapace with rostrum and orbital hoods which completely envelop eyes except on anteroventral side. Anterolateral margin of carapace produced as distinct pterygostomial angle or tooth.

Antennules with basal articles preponderant, stylocerites large and well formed. Antennular flagellum with weak bifurcation. Squamous portion of scaphocerite shorter than lateral spine. Basicerite bearing one or more teeth.

Large chela carried extended, entire and smooth, ovaloid, much larger than small chela; dactylus very short, with cylindrical process that penetrates into corresponding cavity on fixed finger. Small chela simple, with fingers joining exactly, palm entire, carpus frequently elongate.

Second pereopods with carpus composed of 4 or 5 articles. Following legs short and compressed. In all Hawaiian species merus unarmed, propodus armed with weak spines, dactylus biunguiculate. No anal tubercles.

Branchial formula: 5 pleurobranchs, 1 arthrobranch, 2 epipodites.

The generic description has been altered to accommodate *Synalpheus redactocarpus* Banner described below, which has only four instead of the usual five articles in the carpus of the second legs.

This genus, represented by over 60 species in the Indo-Pacific and more than 25 from the coasts of the Americas, is represented in the Hawaiian Archipelago by only seven species. As most of the Indo-Pacific forms have been collected from off-shore waters up to about 100 meters deep but not from the shallow reef flats, it is possible that more extensive dredging around the Hawaiian Islands may produce more species. However, considering

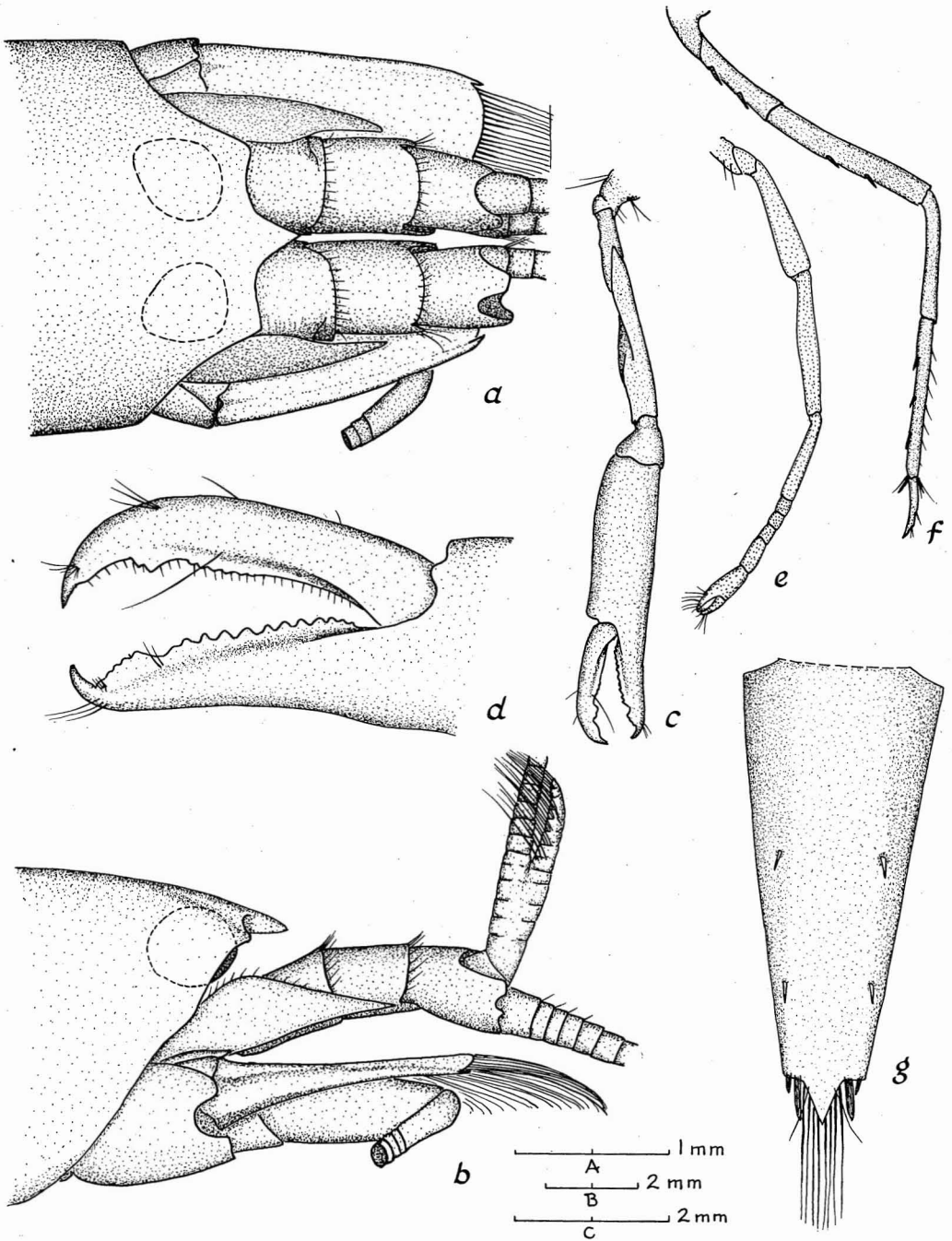


FIG. 7. *Neolpheopsis euryone* (de Man). *a, b*, Anterior region, dorsal and lateral aspects; *c*, large cheliped; *d*, distal end of large chela; *e*, second leg; *f*, third leg; *g*, telson. (*a, b, d, g*, scale A; *c*, scale B; *e, f*, scale C.)

that the collections made by the "Albatross" with its extensive dredging and that the collections made by diving have produced only two new species, it is likely that the present list comprises almost all the species found in these waters.

At least one species of this genus, *S. paraneomeris* Coutière, manifests a remarkable variation. If this condition has been correctly interpreted, it casts doubts upon many species of this genus that are separated by relatively fine distinctions in the proportions of the various parts. In fact, the perusal of the descriptions of Coutière in particular (as for example in his 1909 publication) would make one wonder about the validity of some of the described species and varieties, even without such an example as that of *S. paraneomeris* in mind. Coutière, too, was doubtful of the validity of some of the species he described and suggested that some of them be raised in "pure cultures" to determine the amount of variation found in a homogenous group. Certainly many of the described species have been established on criteria so fine that almost no variation could exist without destroying the validity of the species.

Coutière (1909) divided the genus into six groups (not subgenera, but groups which are without standing under the International Rules of Zoological Nomenclature). With only the small group of species studied for this paper it is impossible to decide how adequate and helpful these groups are. However, it appears that there are so many exceptions to the definitions as they were drawn up that the groups are of scant value. For example, *S. albatrossi* Coutière, which was placed by that author in the Comatularum Group, violates the following parts of his definition of the Group:

"Supraorbital spines insignificant compared to the rostrum . . ."—the supraorbital spines and the rostrum are of equal size.

" . . . spines of the basicerite almost equal . . ."—even in *S. albatrossi*, where the spines approach equality more closely than do the

spines of most other species of the group, the spines are not even subequal.

" . . . first segment of the carpus of the second pair of feet very long . . ."—the first article of the carpus is about 1.2 times as long as the sum of the following, when compared to the usual 1.0 times as long found in both *S. paraneomeris* and *S. charon* and 1.7 times as long as in *S. prolificus*, all of which belong to other groups which are defined as having a short carpus.

" . . . following feet cylindrical . . ."—I do not know what is meant here, but at least the articles of the legs of *S. albatrossi* are as flattened as were the corresponding articles of other synalpheids examined.

" . . . ventral hook of the dactyl obsolete . . ."—the ventral hook of the dactylus is no more obsolete in *S. albatrossi* than is the supposedly well-developed hook of *S. townsendi brevispinis* Coutière of the Paulsoni Group (*op. cit.*, p. 35).

" . . . telson with an oval median lobe . . ."—the median lobe of the telson is no more oval than any other Hawaiian species of this genus.

A similar critique could be applied, I believe, to most of the other characteristics listed in the key to the groups given by Coutière. Even Coutière did not seem to distinguish between the groups, let alone the species, for a specimen from Hawaii (fragmentary, it is true) in the United States National Museum which he determined as *S. townsendi* in the Paulsoni Group appears to me to be well within the range of variation found in *S. paraneomeris* of the Neomeris Group. In other words, the groups that were established to show relationships and to be of aid to the classification of the genus appear to show only dubious relationships and are of almost no aid in classification. As a consequence, in this paper the groups are not accepted.

If later workers wish to use these groups, the Hawaiian species may be divided as follows:

## Comatularum Group

*S. albatrossi* Coutière*S. biunguiculatus* (Stimpson)

## Neomeris Group

*S. charon* (Heller)*S. prolificus* (Bate)*S. paraneomeris* Coutière*S. macromanus* Edmondson

For the other species described in this paper, *S. redactocarpus* Banner, a new group should be established. With the shifting of *S. biunguiculatus* on the basis of its new description below from the Biunguiculatus Group to the Comatularum Group, it would be advisable to change the name of the former group.

## HAWAIIAN SPECIES OF SYNALPHEUS

1. Carpus of second legs with 4 articles . . . . . *S. redactocarpus* (p. 29)  
Carpus of second legs with 5 articles . . . . . 2
2. Inferior hook of dactylus of third legs reduced in size, shorter and smaller in diameter than superior hook . . . . . 3  
Inferior hook of dactylus of third legs larger than superior hook in basal diameter and usually longer . . . . . 4
3. Stylocerite reaching only to end of first antennular article . . . *S. albatrossi* (p. 30)  
Stylocerite reaching to end of second antennular article . . . . .  
 . . . . . *S. biunguiculatus* (p. 32)
4. Inferior hook of dactylus of third legs 3 to 5 times diameter of distal hook, broad and blunt at tip . . . . . 5  
Inferior hook of dactylus of third legs twice diameter of distal hook, acute at tip . . . . . 6
5. First article of carpus of second legs approximately as long as rest combined . . . . . *S. charon* (p. 37)  
First article of carpus of second legs 1.7 times length of rest combined . . . . .  
 . . . . . *S. prolificus* (p. 38)
6. Palm of large chela tapering only slightly to fingers; fingers equal to 0.3 length of palm . . . *S. paraneomeris* (p. 40)

Palm of large chela inflated, with diameter at fingers 0.5 maximum diameter; fingers less than 0.25 length of palm . . . . . *S. macromanus* (p. 45)

*Synalpheus redactocarpus* sp. nov.

Fig. 8 a-i

TYPE SPECIMEN: A male 5.1 mm. long, collected at Halape, Kau Coast, Hawaii, from coral heads in the intertidal zone on Keaoi Island by R. W. Hiatt (U. S. N. M. 93454).

DESCRIPTION: Rostrum narrow and acute, reaching to near middle of second antennular article; in lateral view tip slightly depressed but higher than orbital teeth. Orbital hoods slightly inflated; orbital teeth acute, 0.7 as long as rostrum.

Antennular peduncle short and heavy with visible portion of first article subequal to both second and third. Second article slightly broader than long. Flagella also short and heavy, outer slightly longer than peduncle, inner twice length of outer. Stylocerite reaching nearly to middle of second antennular article.

Lateral spine of basicerite feebly developed, reaching only to base of spine of stylocerite; basicerite otherwise inermous. Scaphocerite with lateral spine heavy and broad at base, tip exceeding antennular peduncle and carpocerite; squamous portion broad, about 0.9 length of lateral spine. Carpocerite as long as antennular peduncle. Antennal flagella lost.

Distal article of third maxilliped rounded in section, heavily spinose.

Large chela showing compression and some torsion, without grooves, ridges, or other sculpture. Chela almost 3 times as long as broad, with arcuate finger occupying distal 0.23. Carpus short, broad, expanded. Merus without spines but with superior distal angle produced into small tooth; article 2.2 times as long as broad, less than 0.3 length of chela.

Small chela less than 2.5 times as long as broad with fingers subequal to palm. Fingers

with strong tufts of setae. Carpus as large as propodus, expanded, on some sides almost forming collar for base of palm; article twice as broad as long. Merus without spines, twice as long as broad, and equal in length to chela.

Second legs very heavy and short, 2.3 mm. long, merus 0.16 mm. in maximum width. Ischium 0.48 mm. long, 0.13 mm. broad. Merus 0.71 mm. long, 0.16 mm. broad. Only 4 secondary carpal articles with ratio 10 : 3.6 : 2.8 : 7.6; fourth secondary article 1.5 times as long as broad. Chela 0.6 as long as carpus, slightly broader than carpus; fingers 0.5 length of chela.

Third legs also relatively heavy, 2.1 mm. long. Ischium 0.33 mm. long, inermous. Merus 0.76 mm. long, 0.22 mm. broad, unarmed. Carpus 0.29 mm. long, with superior distal margin produced as rounded tooth. Propodus slightly curved, 0.77 mm. long, 0.14 mm. broad, bearing 4 feeble spines on inferior margin. Dactylus 0.20 mm. long, 0.07 mm. broad at base, biunguiculate, with superior or distal claw not as broad at base as inferior, about 1.5 times as long as inferior; superior claw more acute than inferior. Fourth legs similar.

Fifth legs with "brush" feebly developed, consisting of but 3 tufts of 3 bristles each. Dactylus with superior unguis thinner than on preceding legs.

Telson 1.2 times as long as broad at base, with tip 0.5 as broad as base. Lateral margins convex distally; distal margin strongly arcuate and bearing 4 plumose setae. Large pair of terminal spines approximately 0.5 as long as breadth of tip of telson. Dorsal surface slightly convex, without any trace of usual 2 pairs of dorsal spinules.

DISCUSSION: This species, in spite of the four-jointed carpus of the second legs, plainly belongs to the genus *Synalpheus*. The shape and development of the anterior region of the carapace, including the pterygostomial angle, are similar to other species of the genus; except for the second legs, the appendages in their development parallel the development

found in *Synalpheus*. The important branchial formula is the same as that of other members of the genus.

The unique four-jointed carpus will separate this species from all other members of the genus, however. Other genera of crangonids have fewer articles than the usual five, e.g., *Pterocaris* Heller, *Ogyris* Stimpson, *Arete* Stimpson, and *Alpheopsis* Coutière. Moreover, in *Alpheopsis* there are species with both three and five articles to the carpus. However, the other characteristics of this species do not fit these genera.

To my knowledge the lack of dorsal spinules on the telson is a characteristic that is unique among the Pacific synalpheids, although Coutière states (1899: 316) "Quelques espèces [of the genus *Synalpheus*] . . . montrent une réduction très grande des épines, ou même leur disparition totale."

This species does not fit the subgeneric groups created by Coutière very satisfactorily. It apparently belongs to either the *Neomeris* or *Paulsoni* group. From the former it differs in that the two hooks of the third and fourth dactyli are subequal; from the latter in that the rostrum has no ventral prolongation that "embraces the ocellary beak" (Coutière 1909: 4). Should other species with similar development of the carpus be described, they should be included with this species in a special group; however, the creation of a new group does not seem practical for this single species.

Of the Hawaiian specimens studied, *S. redactocarpus* appears to be most closely related to *S. biunguiculatus* (Stimpson), but it differs from this species in the length of the spines of the stylocerite and basicerite, in the large and small chela, and in the dactyli of the third to fifth legs.

#### *Synalpheus albatrossi* Coutière

Fig. 9 a-i

*Synalpheus albatrossi* Coutière, U. S. Natl. Mus., Proc. 36: 89, fig. 54a-k, 1909.

DESCRIPTION: Rostrum acute, narrow, projecting to 0.3 of second article of antennular



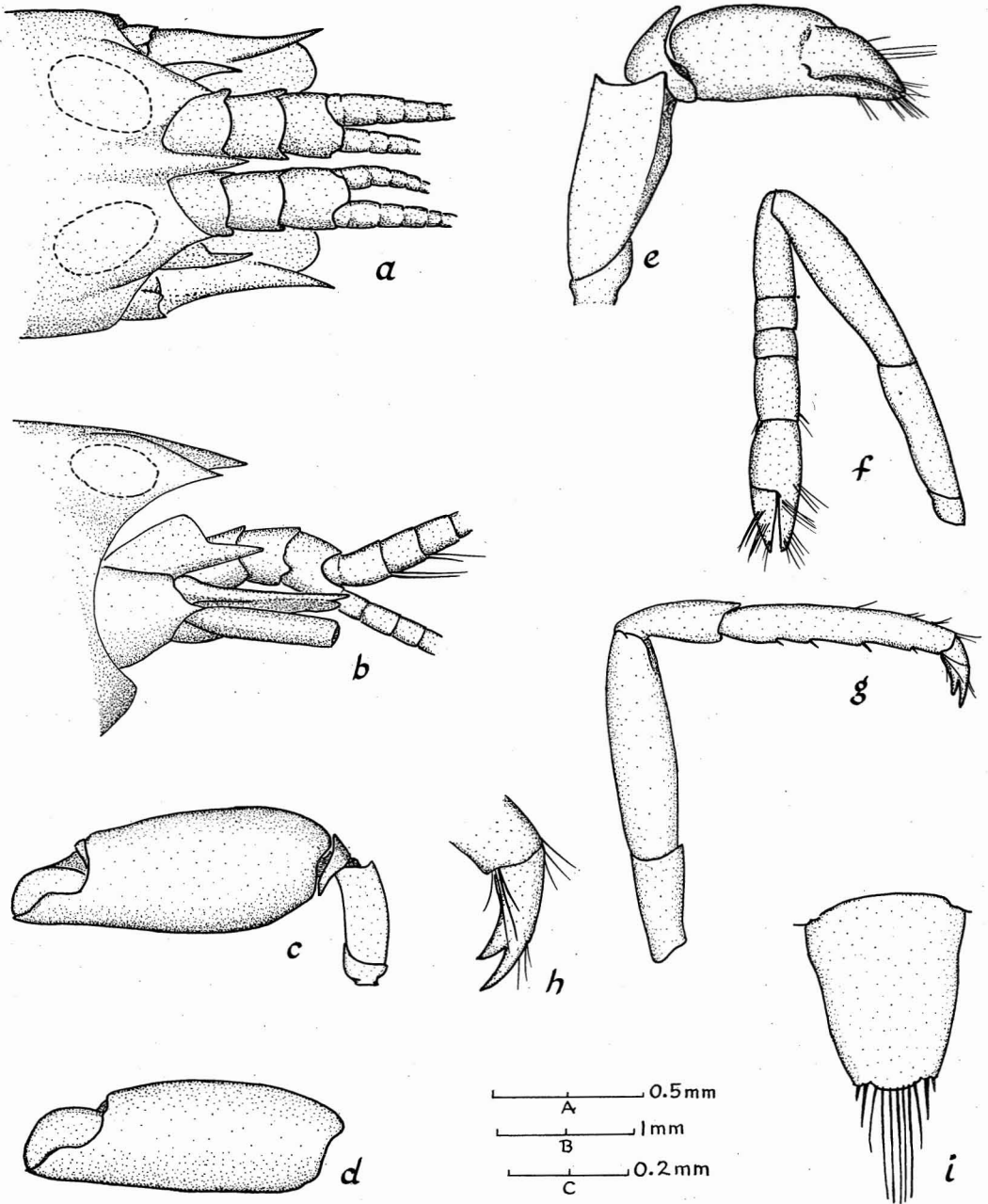


FIG. 8. *Synalpheus redactocarpus* sp. nov. *a, b*, Anterior region, dorsal and lateral aspects; *c*, large cheliped, lateral aspect; *d*, large chela, dactylus flat; *e*, small cheliped; *f*, second leg; *g*, fourth leg; *h*, fourth leg, dactylus; *i*, telson. (*a, b, e-g, i*, scale A; *c, d*, scale B; *h*, scale C.)

peduncles. Orbital teeth acute, elongate, between 0.4 and 0.5 as long as rostrum. Margin between orbital teeth and rostrum U-shaped.

Antennule with visible portion of basal article 1.2 times length of second and 1.3 times length of third. Second article about as long as broad. Distal ends of articles without conspicuous setae. Stylocerite reaching end of first antennular article.

Basicerite with both upper and lower outer spines developed and acute, lower considerably longer than upper, reaching beyond base of spine of stylocerite. Outer spine of scaphocerite acute, reaching to middle or near end of last article of antennular peduncle; squamous portion relatively broad and well developed. Carpocerite reaching past base of antennular peduncle.

Large chela only slightly compressed, margins rounded. Palm twice as long as wide, with strong tooth above articulation of dactylus. Dactylus 0.3 as long as palm, strongly arcuate. Carpus of cheliped short. Merus slightly more than 0.4 as long as chela, twice as long as broad; superior distal margin extended as slight rounded projection. Small chela with fingers 0.5 as long as palm, narrow, acute; palm slightly over twice as long as broad. Carpus somewhat smaller than chela; merus almost as long as chela, 3 times as long as broad.

Carpal articles of second legs with ratio 10 : 1.3 : 1.3 : 1.5 : 3.0.

Third legs with ischium unarmed, slightly over 0.3 as long as merus. Merus also unarmed, 4.3 times as long as broad. Carpus slightly over 0.5 as long as merus, with tooth on superior margin and 2 movable spines on inferior margin. Propodus 1.1 times as long as merus, with 9 single and double spines along inferior margin. Dactylus 0.2 as long as propodus, 3 times as long as wide, inferior claw much smaller in diameter at base and much shorter than superior or distal claw.

Telson less than 1.1 times as long as broad at base, tip 0.3 breadth of base. Tip strongly arcuate between lateral spines, with 8 setifer-

ous bristles; inner pair of lateral spines almost as long as width of tip. Dorsal spinules located near margins, at 0.5 and 0.75 length of telson posterior to articulation.

Colors in life not observed.

DISCUSSION: The two specimens studied were both males 8 mm. long. These specimens agree well with Coutière's description and plates except for two characteristics: First, the rostrum is described as equal in length to the orbital spines and shorter than the first article of the antennular peduncle, whereas in these specimens it is longer than both. Second, the figures of the type specimen show the articles of the antennular peduncle to be relatively more broad than the articles in these specimens. However, as these characteristics were found to be very variable in *S. paraneomeris* Coutière, and as the specimens agree on other points, they are referred to this species.

For a discussion of the points of difference between this species and the related *S. biunguiculatus* (Stimpson) see the discussion under the latter.

DISTRIBUTION: This species has been collected only twice, once by the "Albatross" off Laysan in 10-18 fathoms (the type locality), and by myself (the two specimens described here) from off Waikiki Reef, Oahu, from coral in 20 feet of water.

### *Synalpheus biunguiculatus* (Stimpson)

Fig. 10 a-j

*Alpheus biunguiculatus* Stimpson, Acad. Nat. Sci. Phila., Proc. 1860: 31.

(Nec) *Alpheus biunguiculatus* de Man, Arch. f. Naturgesch. 53: 502, figs. 6, 6a, 1887.

(Nec) *Alpheus biunguiculatus* Bate, Challenger Rpt. 24: 562, pl. 51, figs. 4, 4o, 4z, 1888.

(Nec) *Synalpheus biunguiculatus* Coutière, Soc. Ent. de France, Bul. 11: 232, figs. 1-4, 1898b.

(Nec) *Synalpheus biunguiculatus* Coutière, Fauna and Geog. Mald. and Laccad. 2(4): 873, pl. 71, fig. 8, 1905.

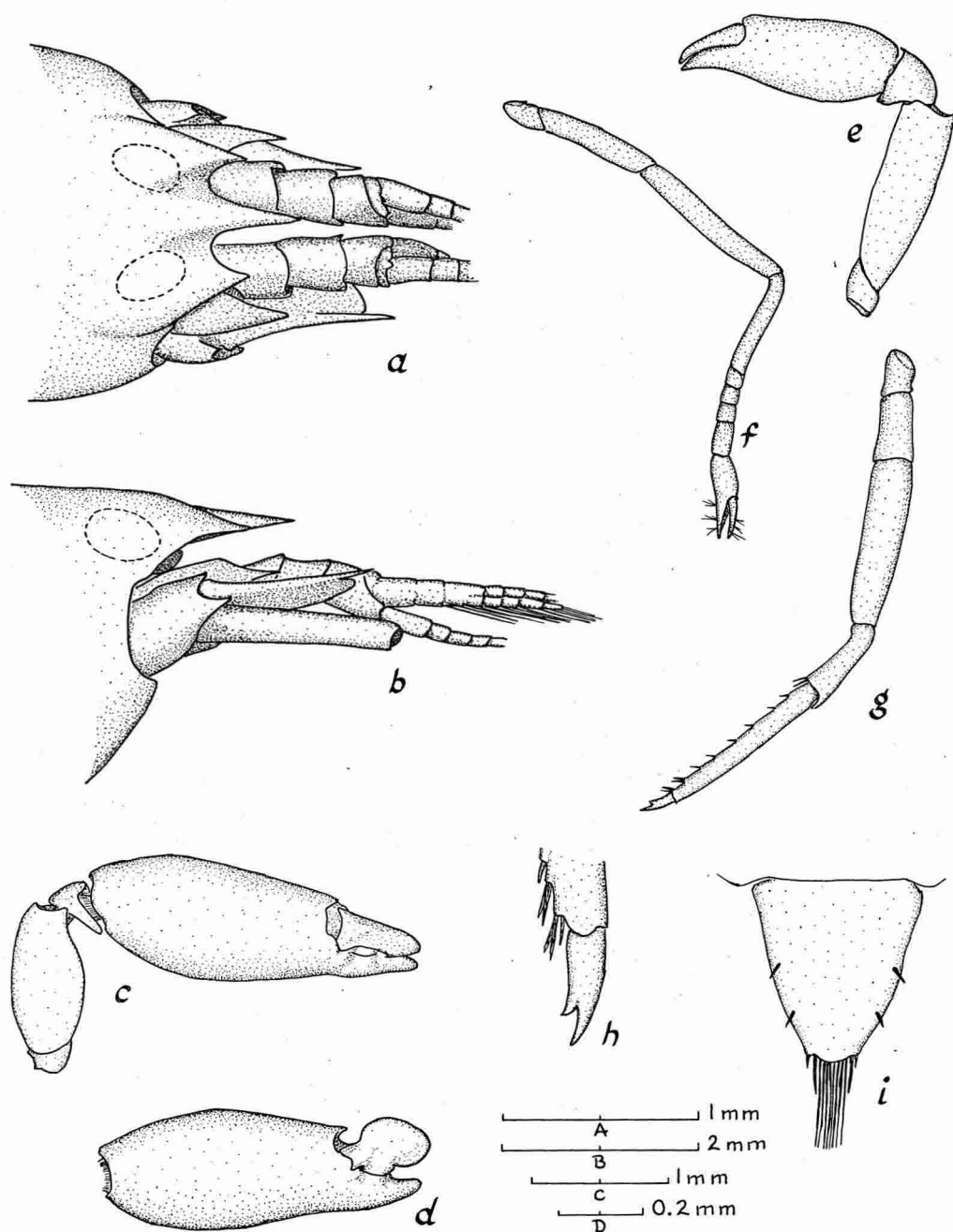


FIG. 9. *Synalpheus albatrossi* Coutière. *a*, Anterior region, dorsal aspect (note: specimen lacking bilateral symmetry in the scaphocerite); *b*, anterior region, lateral aspect; *c*, large cheliped, lateral aspect; *d*, large chela, dactylus flat; *e*, small chela; *f*, second leg; *g*, third leg; *h*, third leg, dactylus; *i*, telson. (*a*, *b*, *i*, scale A; *c*, *d*, scale B; *e*–*g*, scale C; *h*, scale D.)

NEOTYPE: A female 10.5 mm. long, collected from coral in about 10 feet of water in Hanauma Bay, Oahu (U. S. N. M. 93453).

DESCRIPTION: Rostrum acute, narrow, about 1.5 times as long as broad at base, tip reaching slightly beyond end of first antennular article; lateral margins concave. Orbital teeth reaching almost to end of rostrum, considerably broader than rostrum at base; with concave lateral margins. Dorsal surface of carapace and orbital hoods uniformly rounded; both rostrum and orbital teeth somewhat depressed toward tip, in lateral view.

Antennular peduncle relatively broad and heavy, with second and third articles of approximately equal size, slightly broader than long; visible portion of first article slightly longer than others. Outer flagellum with thickened basal portion about as long as antennular base. Stylocerite strong, lateral spine reaching end of second antennular article.

Scaphocerite with lateral margin slightly concave, lateral spine strong, tip reaching beyond ends of antennular peduncle and carapocerite. Squamous portion well developed, reaching end of antennular peduncle. Upper teeth of basicerite entirely lacking, lower tooth acute but not reaching beyond end of first antennular article.

Terminal article of third maxillipeds rounded, with usual strong spines.

Large chela compressed but with rounded and entire margins. Palm slightly less than twice as long as high, 0.7 as thick as high. Fingers slightly less than 0.3 length of palm; dactylus strongly arcuate and closing at 90° to plane of chela. Merus of cheliped 3 times as long as broad, with small terminal tooth on superior distal margin. Small chela less than 0.5 as long as large chela, with palm about 1.3 times length of fingers, twice as long as broad.

Carpal articles of second legs with ratio 10 : 2.0 : 2.0 : 1.7 : 4.2.

Merus of third legs 4.3 times as long as broad, twice length of ischium; both ischium and merus unarmed. Carpus slightly over 0.5

as long as merus, with terminal rounded tooth on superior margin, with terminal movable spine on inferior margin. Propodus as long as merus, 7 times as long as broad, with 6 movable spines. Dactylus relatively long and thin for genus, almost 4 times as long as wide at point of maximum breadth, not strongly curved. Lower unguis only slightly divergent from axis of dactylus, conical, acute, markedly smaller than superior unguis, length only 0.3 and basal diameter 0.7 that of superior unguis. Superior unguis acute and lying on axis of basal portion of dactylus; about 0.3 as long as entire dactylus. Fourth legs similar to third. Fifth legs similar to but thinner than anterior legs, with no trace of "brush."

Telson about 1.3 times as long as broad at base, tip 0.5 as broad as base. Posterior margins with usual 2 pairs of spines, length of longer over 0.5 width of posterior margin. Margin strongly arcuate between spines. Anterior pair of dorsal spinules over 0.3 distance from articulation, posterior pair slightly over 0.7.

DISCUSSION: The name *Alpheus* (now *Synalpheus*) *biunguiculatus* was applied by Stimpson to a specimen from an unspecified locality in the Hawaiian Islands. He described it as follows (1860—translated from the Latin): Closely related to *Alpheus neptuna*, yet having front short-toothed; spine at the base of the dactylus of large chela missing; posterior foot small, dactylus two-clawed, secondary claw ventral. The merus of the third and fourth legs without spines on the lower side. Length .5 inch. Habitat: Hawaiian Islands; in coral.

This description was without plates. Evidently Stimpson planned to publish more than this preliminary account, as he did for the other groups (the descriptions of the *Brachyura* and *Anomura* of the expedition were published posthumously in 1907 by the Smithsonian Institution). However, nothing further on the *Macrura* was ever published.

The type specimen is now lost—whether or not it was destroyed in the fire of the Philadelphia Academy of Science could not be ascertained—so there is nothing left but the description, which will fit many *synalpheids*

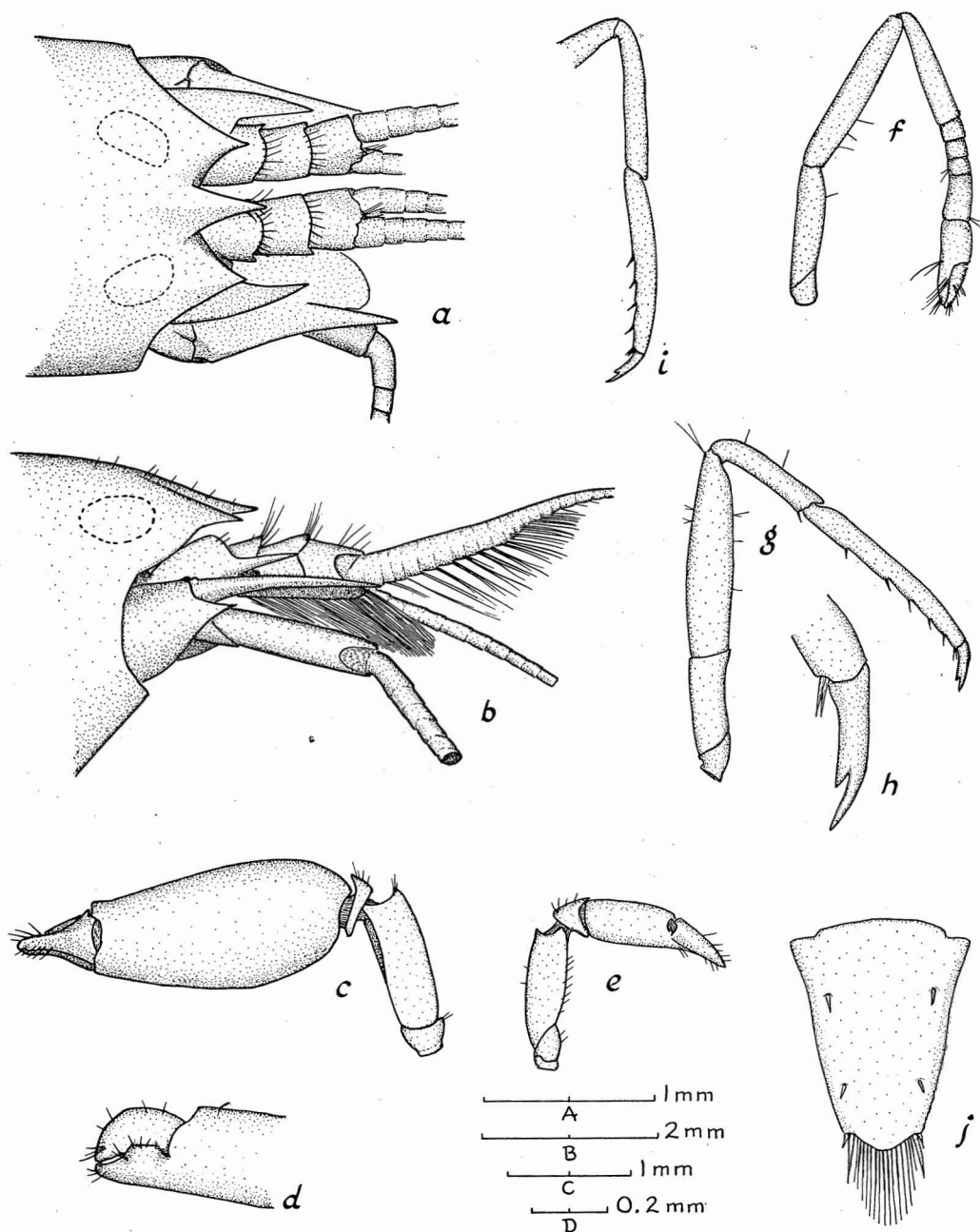


FIG. 10. *Synalpheus biunguiculatus* (Stimpson). *a*, *b*, Anterior region, dorsal and lateral aspects; *c*, large cheliped, lateral aspect; *d*, large chela, dactylus flat; *e*, small cheliped, lateral aspect; *f*, second leg; *g*, third leg; *h*, third leg, dactylus; *i*, fifth leg, distal end; *j*, telson. (*a*, *b*, *j*, scale A; *c*–*e*, scale B; *f*, *g*, *i*, scale C; *h*, scale D.)

with equal ease. In 1898 and 1905 Coutière redescribed the species on the basis of specimens from the Indian Ocean. Coutière evidently did not establish a neotype.

Unfortunately the species Coutière describes has not been found in the Hawaiian Islands. This confirms de Man's doubts about the validity of redescribing a species from such a distant locality (1911: 202-203). Coutière's specimens do not, then, meet the one definite characteristic given in the original description: "Habitat: Hawaiian Islands." Moreover, the original description states that the tooth at the base of the dactylus of the large chela is missing, but Coutière's plates clearly show his specimens to have this tooth or projection. Finally, the statement in the original description that the dactyli of the third and fourth legs had their "secondary claws ventral" would imply that the ventral claw is not as heavy as the distal or superior claw, a condition contrary to that found in Coutière's specimens. For these reasons Coutière's description of *Synalpheus biunguiculatus* must be discarded and a neotype selected from the fauna of the Hawaiian Islands.

The name *biunguiculatus* has priority over all names of synalpheids from the Hawaiian area, and Stimpson's description can be interpreted to apply to any local species with greater or less precision. For example, it could be applied to *S. paraneomeris* Coutière with ease. However, if it were applied to that species, the entire literature would be thrown into an even greater snarl. To avoid such further confusion, the name has been applied to this, the third most common synalpheid in these waters, a species that has not been named previously. It agrees with the few characteristics given in the original description, especially with the portions discussed above. The only difference is in the indefinite statement of the original description: "... having front short-toothed . . .". It would appear that this description possibly was of a different species, but one cannot tell what Stimpson meant by "short." Perhaps, having the rostrum reach-

ing only to the end of the first antennular article was short in Stimpson's opinion. Moreover, when more specimens are examined, this characteristic will perhaps be found to be variable, as it is in *S. paraneomeris*.

This species is most closely related to *S. albatrossi* Coutière of those known from the Hawaiian Islands. They can be separated by the characteristics shown in the following tabulation:

<i>S. biunguiculatus</i>	<i>S. albatrossi</i>
Rostral base narrower than base of orbital teeth	Rostral base broader than base of orbital teeth
Third antennular article as long as second antennular article	Third antennular article shorter than second antennular article
Stylocerite reaching to end of second antennular article	Stylocerite reaching slightly beyond end of first antennular article
Basicerite without upper spine, lower spine reaching end of first antennular article	Basicerite with acute upper spine, lower spine 0.5 length of first antennular article
Scaphocerite longer than antennular peduncle	Scaphocerite shorter than antennular peduncle
Large chela without tooth over dactylar articulation or on superior margin of merus	Large chela with tooth over dactylar articulation and small tooth on distal end of superior margin of merus
Dactylus of third legs with lower unguis almost parallel to upper unguis	Dactylus of third legs with upper and lower ungui divergent
Telson with posterior margin strongly convex	Telson with posterior margin "very little convex" (Coutière, 1909)

In addition, there are differences in proportions of several of the appendages, especially in the merus of the large cheliped and of the small chela. Of these characteristics, probably the most important are the relative lengths of the stylocerites and the presence or absence of the upper spine of the basicerite. It will be noted that the characteristics of *S. albatrossi* in the tabulation are derived from Coutière's original description, and that the first, second, and eighth points do not apply well to the specimens placed in *S. albatrossi* in this paper.

It is necessary to assign a new name to Coutière's species. I propose, therefore, *Synalpheus coutierei* nom. nov. to replace *Synalpheus biun-*



*guiculatus* Coutière (1898b: 232, figs. 1–4), non *S. biunguiculatus* (Stimpson) (1860: 31). All previous records under the names *Alpheus*, or *Synalpheus*, *biunguiculatus* other than the original description should be attributed to *S. coutièrei*, with the possible exception of the record made without description by Lenz in 1901 wherein he reported the species from Laysan. However, it is impossible to know exactly upon which species he was reporting.

**DISTRIBUTION:** As stated above, the type locality was not designated. The neotype came from the deeper water along the west side of Hanauma Bay, Oahu; other specimens have been collected on Oahu off Waikiki in 18 feet of water and off Nanakuli in 15 feet of water; at Maui off Kalama Park in 8 feet of water; and by R. W. Hiatt off Hawaii at Halape, Kau Coast, near Keaoi Island, from *Pocillopora meandrina* Verrill in 25–30 feet and 40–45 feet of water.

### *Synalpheus charon* (Heller)

Fig. 11 a–k

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

**DESCRIPTION:** Rostrum acute, narrow triangle with straight margins, tip reaching nearly to end of first antennular article. Acute tip of orbital hoods reaching to near tip of rostrum; outer margins of orbital hoods convex, inner margins slightly concave and separated from base of rostrum by shallow depression.

Antennular peduncle with visible portion of first article longest, third slightly shorter than first, second correspondingly shorter than third; each article about as broad as long. Stylocerite well developed, with tip of lateral spine reaching almost to end of second antennular article.

Lateral spine of scaphocerite slightly longer than squamous portion, approximately as long as antennular peduncle, and somewhat shorter than carpoperite. Superior angle of basiscerite rounded, but lateral angle contin-

ued into strong spine, almost equal in length to stylocerite.

Large chela slightly compressed and twisted, with margins rounded and entire; shape somewhat inflated, 2.5 times as long as broad. Superiolateral edge of face of chela behind articulation of dactylus projecting over articulation as small rounded tubercle. Dactylus strongly arcuate, between 0.25 and 0.3 length of entire chela. Merus with superior distal margin projecting as acute tooth. Small chela likewise rounded and entire, dactylus slightly over 0.3 length of entire chela. Greatest diameter of carpus slightly larger than that of chela proper. Merus similar in form to large chela.

Carpal articles of second legs with ratio 10 : 3 : 3 : 3 : 5.

Third and fourth legs with merus unarmed and 3 times as long as broad. Carpus prolonged as rounded lobe on superior distal margin, armed with spine on inferior distal margin. Propodus curved and armed with 5 or 6 slender spines. Inferior hook of dactylus thick and obtuse, with broad spoon-like excavation on inferior margin. Distal hook, when seen in profile, longer than inferior hook, less than 0.3 as broad at base as ventral hook, tapering to acute tooth. All aspects of distal hook except straight profile showing basal half as broad and flat, paddle-like, with sudden constriction to narrow acute tip (Figs. 11b, i, j; the last is in such rotation that the acute tip is somewhat obscured).

Telson about as long as broad at base, with tip 0.5 width of base. Lateral margins anteriorly concave, then posteriorly convex; tip arcuate.

The largest specimen in the collection is a female 22 mm. long; most specimens are much smaller. The color is often a brilliant orange red.

**DISCUSSION:** Only slight variation was noted in the specimens of this species in the collections at hand, possibly in part because of the small number of specimens available. Only one specimen showed a notable varia-

tion from the specimens described; in this specimen the merus of the third legs was only 2.5 times as long as broad and the basal portion of the superior unguis was only slightly broadened. This specimen had all the other characteristics of the species, including the excavated ventral hook of the dactylus, so it was assigned to this species.

These Hawaiian specimens agree well with Heller's original description and with de Man's redescription of the same species from the East Indies (de Man, 1911). Heller did not remark upon the peculiar superior unguis of the dactylus of the third legs, but it was described fully by de Man. All differences noted were minor ones of proportions, such as the length of the stylocerite, which was found to be quite variable in the closely related *S. paraneomeris*.

This species is very similar to *S. paraneomeris* Coutière in general body form and proportion, especially when the variation of *S. paraneomeris* is considered. However, the nature of the dactyli of the third and fourth legs affords a rapid and certain method of distinguishing the two. To separate this species from *S. prolificus* (Bate) see the discussion under that species. Ramadan (1938) considers *S. helleri* de Man (1911: 194, 245) to be probably a synonym of *S. charon*, but reaches no definite conclusion.

**DISTRIBUTION:** This species appears to occur almost exclusively in living heads of *Pocillopora meandrina* Verrill, which it inhabits with *Crangon ventrosa* (Milne-Edwards) and crabs of the genus *Trapezia*. It therefore could be expected from all reefs and other areas where this coral grows. It has been collected at Mokulua, Waimanalo, Hanauma Bay, Black Point, Waikiki, Nanakuli, Mokuleia, and Kawela Bay on Oahu, and at Lahaina on Maui, in water ranging from a few feet to about 20 feet deep. As reported by Coutière (1909), the "Albatross" collected the species at two stations off Laysan in water from 10 to 30 fathoms deep and off the northeast coast

of Maui in 13 fathoms (Stations 3962, 3955, 4073).

*S. charon* has been reported from many places between the Red Sea and Hawaii, including several localities in the Indian Ocean, South China and southern Japan, Australia, and Thursday Island in the Pacific.

### *Synalpheus prolificus* (Bate)

Fig. 12 a-c

*Alpheus prolificus* Bate, Challenger Rpt. 24: 556-557, pl. 99, figs. 4, 4c, 4m, 1888.

As no specimen of this species was available the original description is given:

Carapace two-thirds the length of the pleon. The rostrum narrow. The orbital lobes pointed, broad and nearly equal in length to the rostrum.

First pair of antennae have the second joint of the peduncle shorter than the first, the third subequal with the second. Stylocerite a little longer than the first joint, flagella subequal and about as long as the carapace.

Second pair of antennae as long as the animal, peduncle longer than that of the first pair, basal tooth as long as the stylocerite and nearly half as long as the scaphocerite, which is subequal with the peduncle.

First pair of pereopoda lost. Second slender, having the carpos five-articulate, the first articular being longer than the four following ones. Third and fourth pairs robust, meros broad, compressed, without distal tooth; carpos anteriorly produced on the upper distal margin; propods curved, furnished with spines on the posterior margin; dactylos stout, bluntly pointed, with a small secondary unguis on the outer surface (fig. 4m).

The pleopods are broad and foliaceous.

Telson broad, smooth, furnished with two spinules on the dorsal lateral surface, tapering and rounded at the extremity.

Length, entire	20 mm. (0.8 in.)
" of carapace	8 "
Depth of carapace	5.5 "
Length of pleon	12 "

*Habitat*—Off Honolulu, Sandwich Island; depth 18 fathoms. One specimen; female.

*Observations*—This species is one of those that approach *Alpheus neptunus* Dana (Pl. CI, fig. 2) and *Alpheus biunguiculatus* Stimpson. It differs from the former in having the carpos of the third and fourth pairs of legs anteriorly produced at the upper distal extremity and in having the dactylos biunguiculate, and from the latter (Pl. CI, fig. 4) in being generally more robust, in having the rostrum and supraorbital teeth less prominent, the carpos of the third pair of pereopoda produced on the upper margin, and the dactylos short and thick, the second unguis being rudimentary and situated behind the larger on the outer margin.

Our specimen is a female and carries a very large mass of ova; hence the name.

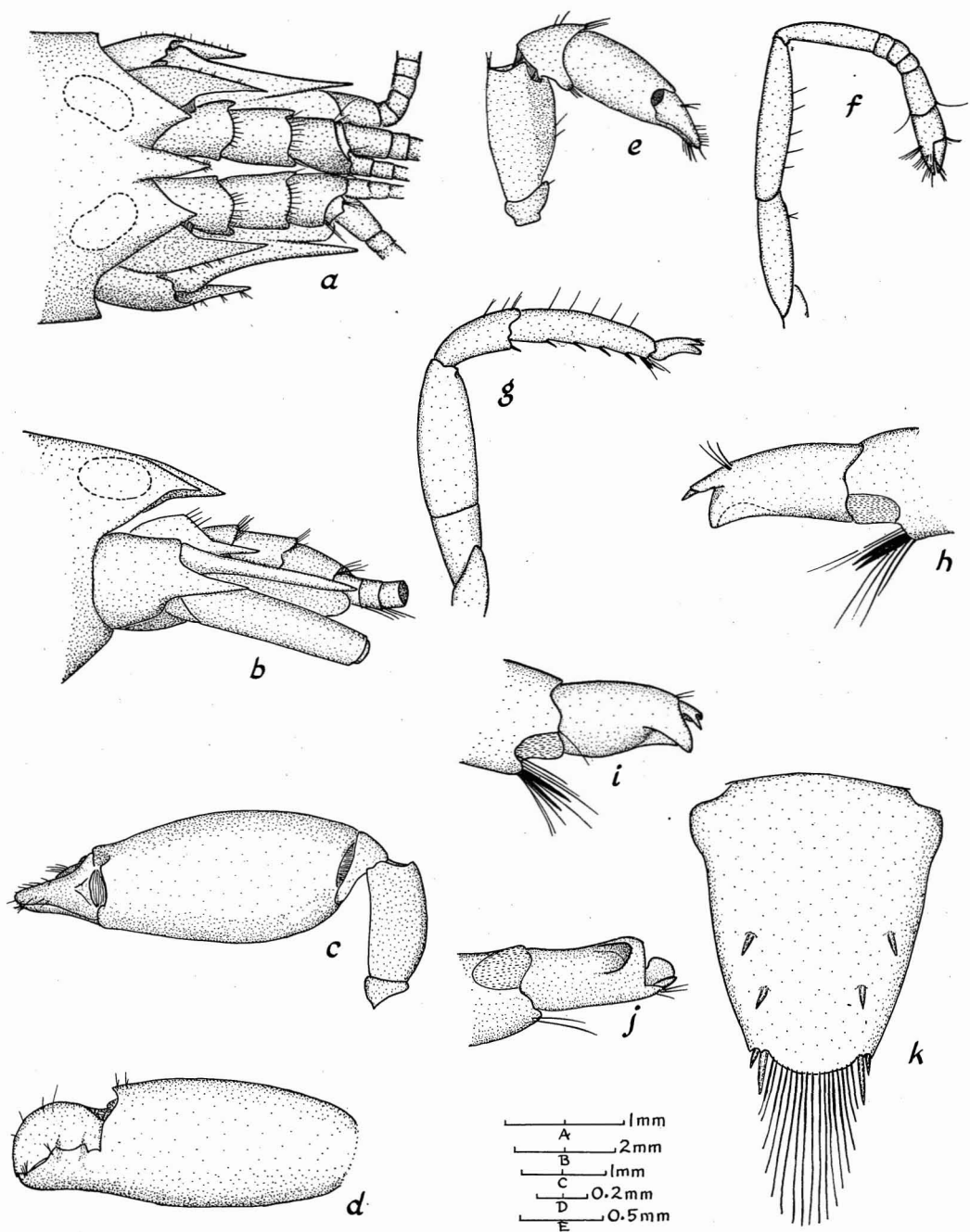


FIG. 11. *Synalpheus charon* (Heller). *a*, *b*, Anterior region, dorsal and lateral aspects; *c*, large cheliped, lateral aspect; *d*, large chela, dactylus flat; *e*, small chela; *f*, second leg; *g*, third leg; *h*, *i*, *j*, dactylus of third leg, anterior, posterior, and posteroventral sides; *k*, telson. (*a*, *b*, scale A; *c*, *d*, scale B; *e*–*g*, scale C; *h*–*j*, scale D; *k*, scale E.)

DISCUSSION: This species appears to be most closely related to *S. charon* (Heller) of all the Hawaiian species. However, to judge from Bate's description and figures, the two species can be separated by a series of characteristics. Probably the most important are in the carpus of the second leg, which has the first article 1.7 times as long as the following four together in *S. prolificus* (according to the figure) and only equal to the sum of the following articles in *S. charon*, and in the biunguiculate dactylus of the third legs, where the base of the superior claw is one sixth and the base of the inferior claw five sixths the diameter of the dactylus in Bate's figures instead of one fourth and three fourths as in *S. charon*. Finally, in the antennules the visible portion of the first antennular article is longer than the second and third, which are subequal, and the tip of the stylocerite reaches only slightly beyond the end of the first article in *S. prolificus*, whereas in *S. charon* the first and second antennular articles are subequal, the third is shorter, and the tip of the stylocerite reaches to the middle of the second antennular article.

Bate makes no mention of, nor shows any detail of, the dactylus of the third leg. If it does show the concavity of the inferior unguis and the basal expansion of the superior unguis characteristic of *S. charon* (and such a small character could easily have been overlooked), the two species are certainly most closely related. However, the nature of the second legs and of the stylocerite would be valid characteristics for the separation of the two species even if the dactyli were similar.

De Man (1911) suggests that *S. prolificus* may be a synonym of *S. biunguiculatus* (Stimpson); the redescription of *S. biunguiculatus* in this paper removes that possibility.

There are no specimens of *S. prolificus* in the present collection; it has not been reported in the literature since its original description except for two specimens recorded by Ortmann which were later re-examined and placed in *S. gravieri* Coutière (de Man, 1911). This lack of distributional records indicates that the

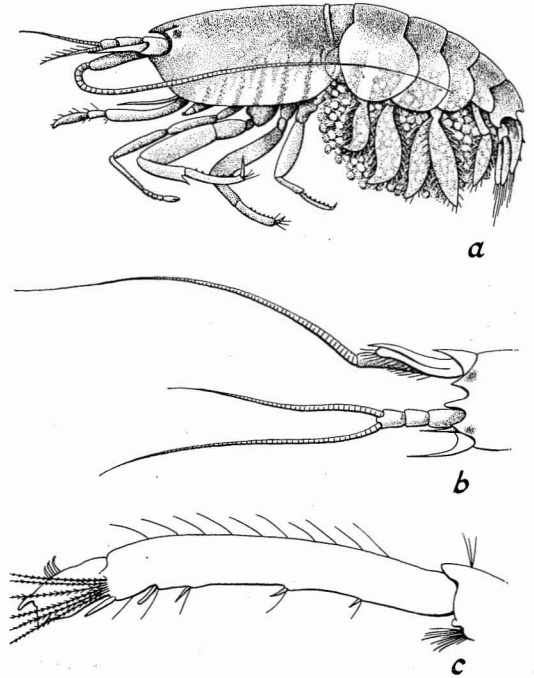


FIG. 12. *Synalpheus prolificus* (Bate). *a*, Lateral aspect (slightly over 3X); *b*, anterior region, dorsal aspect; *c*, third leg, propodus and dactylus. (Redrawn from Bate, *Challenger Rpts.*, Vol. 24; *Plates*, 1888, pl. 99, fig. 4.)

species is probably restricted to the deeper zones and does not reach the reefs; it may also indicate that the species is endemic to the Hawaiian Islands, but insufficient sampling of deeper water in other areas would make such a conclusion questionable.

### *Synalpheus paraneomeris* Coutière

Figs. 13 *a-l*, 14 *a-b*

*Synalpheus paraneomeris* Coutière, *Fauna and Geog. Mald. and Laccad.* 2: 872, 1905.

*Synalpheus townsendi* Coutière (*partim*), U. S. Natl. Mus., Proc. 36: 35, 1909.

DESCRIPTION: Rostrum narrow and acute, not quite reaching to end of first antennular article. Orbital hoods produced into teeth that reach almost to end of rostrum. Depression between rostrum and orbital hoods not extensive, but lateral margins of rostral base so abrupt that rostrum appears separated from anterior carapace in dorsal view.

Antennular peduncles broad and heavy; second article slightly broader than long. Stylocerite reaching almost to end of second antennular article. Scaphocerite slightly longer than antennular peduncle, not reaching to end of carpopocerite. Squamous portion of scaphocerite rounded anteriorly, comparatively broad. External tooth of basicerite only slightly shorter than stylocerite; upper angle not produced into tooth.

Large chela rounded in outline, only slightly compressed, without tubercle at base of articulation of dactylus. Length of fingers somewhat more than 0.3 length of palm; chela more than 3 times as long as broad. Merus curved, without spines, with superior margin obtuse distally.

Small chela 0.3 length of large chela. Carpus greater in diameter than propodus. Merus without spines but produced on upper distal margin as broad dentate process.

Carpal articles of second legs with ratio  $10 : 2.5 : 2.5 : 2.5 : 5.5$ .

Merus of third legs broad, over 3 times as long as wide, inermous. Carpus with movable spine on distal inferior margin, with superior margin produced distally as sharp tooth. Propodus with 6 spines along inferior margin. Dactylus biunguiculate, with inferior tooth solid, conical, and with slightly protuberant tip; distal or superior tooth longer than inferior tooth, 0.5 as broad at base as inferior tooth.

Length of largest specimens 15 mm.; usually 10 mm. or less. Color typically olive brown to gray, but those living in heads of *Pocillopora meandrina* reddish.

DISCUSSION: According to Coutière's description, this species manifests a rather wide variation in the size and shape of the rostral front, in the antennules and antennae with their spines, and in the proportions of the chelae. An examination of almost 100 specimens available showed all of these and other variations. The more important variations observed were in the following characteristics:

1. *The length of the rostrum and of the orbital teeth.* The rostrum itself varied from two to three times as long as broad, and its tip reached variously from two thirds the length of the visible portion of the first antennular article to beyond the end of the same article. In some cases the rostral tip was depressed when seen in side view, with the curve paralleling that of the orbital teeth; in others the rostrum continued straight in the dorsal line of the carapace while the orbital teeth alone were depressed anteriorly. In most specimens the orbital teeth were of the same length as the rostrum; in some they were somewhat shorter, and in a few they were only two thirds the length of the rostrum, a condition that was approached by the specimen Coutière described.

2. *The antennules.* These were depicted by Coutière as being variable in the proportions of the articles. The local specimens were found to parallel this described variability. In addition, the stylocerite also varied in length, but its tip always reached beyond the end of the first antennular article.

3. *The spine of the basicerite.* When the tip of this spine was compared to the tip of the stylocerite, the two were usually found to reach to the same level, but in a few cases the tooth of the basicerite was much shorter.

4. *The breadth of the squamous portion of the scaphocerite.* As shown by Coutière, the squamous portion was two thirds the length of the lateral spine. In these specimens it varied from a narrow blade two thirds the length of the lateral spine to a broad squamous portion five sixths the length of the spine.

5. *The large cheliped.* The variation in the proportions of the large chela were like those noted by Coutière, but, in addition, the shape of the superior distal end of the merus was also found to be variable. In about half the specimens it was rounded, as specified and shown by Coutière; in the rest of the specimens this corner was produced into a somewhat variable but small, acute, triangular tooth.

6. *The carpal articles of the second legs.* These were described as having the first article slightly longer than the sum of the remaining four; however, this ratio was found to vary so that in some the first article was shorter than the sum of the distal articles (as is the case for the specimen described above); on the other hand, the longest article measured was 1.3 times the length of the distal articles.

7. *The dactylus of the third and fourth legs.* This was almost always as described and depicted by Coutière, but some variation was noted. Instead of having the lower unguis markedly larger than the distal unguis, one specimen with three normal dactyli had a dactylus on the fourth legs which had the inferior hook much shorter and only slightly larger in basal diameter than the distal tooth (Fig. 13*k*). Others showed conditions approaching this extreme on one or more legs. The dactyli also varied in the angle between the two hooks; in most the spread was 45 degrees or less (when the main axis of the hooks was projected from the point of meeting); in one specimen the spread was about 60 degrees.

The series of measurements necessary to study the variation in proportions of the appendages and telson were not made, but a simple visual comparison showed these proportions to exhibit a range comparable to that discussed above.

This variation is a mere extension of the variability already noted by Coutière, and these Hawaiian forms agree rather well with the characteristics noted by Coutière, except on one point. In his description of the dactyli of the third and fourth legs Coutière states that the ventral hooks are, "... courbé, obtuse, suivie d'une concavité du bord inférieur parfois assez marquée pour indiquer une ébauche de trianguiculation." Yet his drawing of the dactylus shows the ventral hook far from obtuse and gives no indication of the location of a concavity. The Hawaiian specimens agree with the figure, not the description.

An attempt was made to determine if any of these variable characteristics would be constant and discrete enough to separate the population into either distinct species or varieties. However, all the characteristics seemed to vary within the limits given above. For example, although most of the specimens seemed to be either the form with a long rostrum or the form with the short depressed rostrum, some individuals were intermediate between the extremes. Again, careful measurements were made on a series of specimens from the same location to determine if the length of the squamous portion of the scaphocerite would be a good criterion for separation; in the specimens examined the shortest squamous portion was slightly less than two thirds the length of the lateral spine, the longest was more than five sixths the length, but many were intermediate between the two. It was concluded that neither these nor the other characteristics discussed above were constant enough to be the basis of separation of any subspecific forms.

However, the species has been separated into five varieties by Coutière (1905, 1909) and de Man (1911): *S. paraneomeris* var. *prolatus* de Man, *S. paraneomeris* var. *halmaherensis* de Man, *S. paraneomeris* var. *praedabundus* de Man, *S. paraneomeris* var. *prasalini* Coutière, and *S. paraneomeris* var. *seychellensis* Coutière.

There is confusion about the varietal name *S. paraneomeris* var. *prolatus*, which first appears as a name in Coutière (1909: 9), where he states "*S. paraneomeris prolatus*, new name (= *S. paraneomeris oxyceros* Coutière)," yet there are no references in the Zoological Record or in Coutière's bibliographies to an *S. paraneomeris oxyceros*. A possible clue to the name appears on page 12 of the 1909 work:

*S. lockingtoni* differs from *S. paulsoni* almost solely by the spine of the scaphocerite being longer in the latter and surpassing the carpocerite; with the exception of the place of origin, the second species would correspond to the "*oxyceros*" form so often met with that it appears to be almost a constant variation among the sub-species of a given species.\*

[Footnote]\* . . . in deference to the accepted rule of nomenclature which forbids duplication of names with-



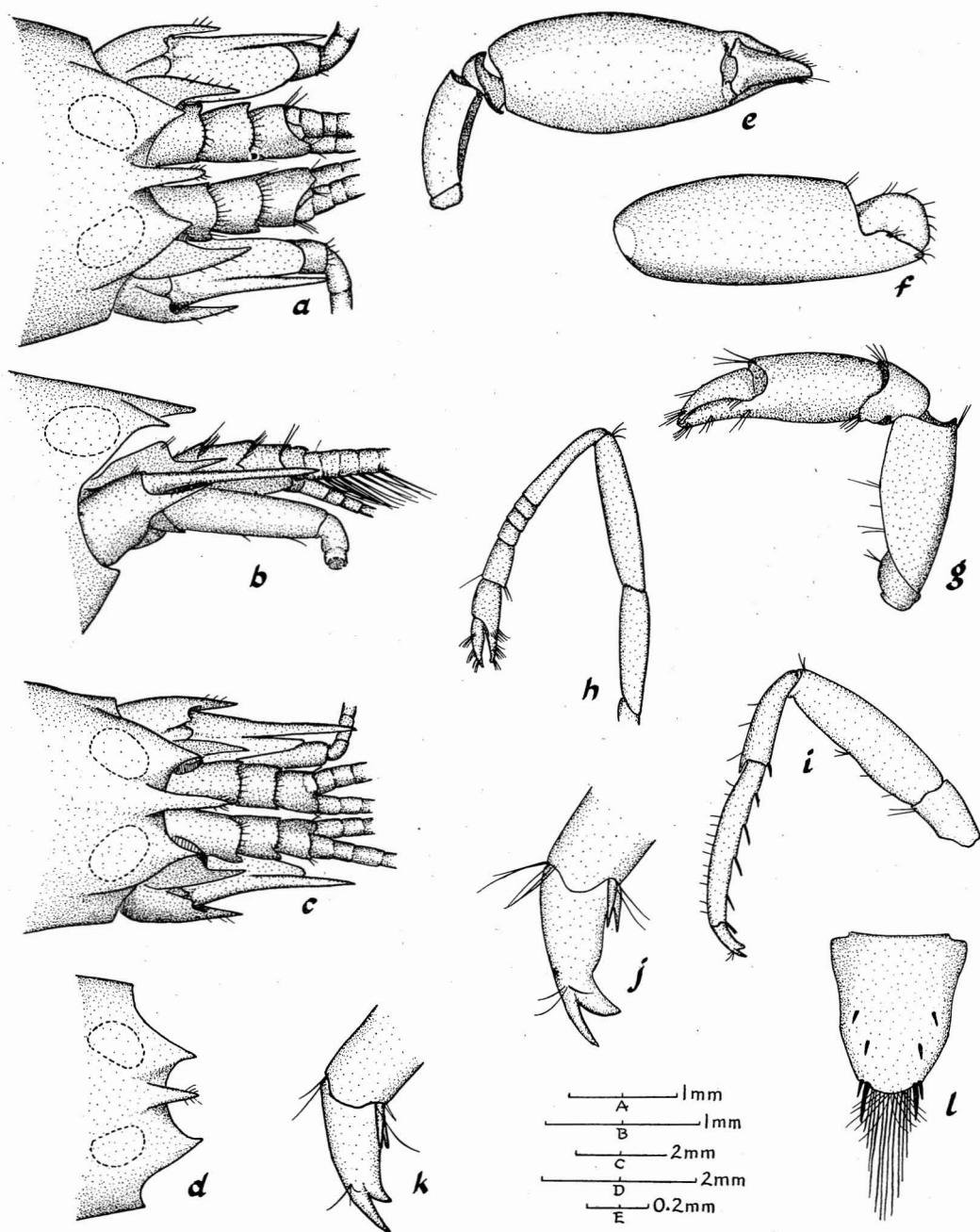


FIG. 13. *Synalpheus paraneomeris* Coutière. *a, b*, Anterior region, dorsal and lateral aspects; *c, d*, anterior region, showing variations; *e*, large cheliped, lateral aspect; *f*, large chela, dactylus flat; *g*, small chela; *h*, second leg; *i*, third leg; *j*, third leg, dactylus; *k*, third leg, aberrant dactylus; *l*, telson. (*a, d, l*, scale A; *c*, scale B; *b, e, f*, scale C; *g-i*, scale D; *j, k*, scale E.)

in a single genus, I have in this paper used different names for *oxyceros* having a similar meaning, as . . . *prolatus*. . . .

Later, de Man describes and depicts two specimens similar to what Coutière meant to be *S. paraneomeris prolatus* (or *oxyceros*). Therefore, it appears to me that if the International Rules were to be applied to these unrecognized names (which are varietal names, not names of subspecies), Coutière merely created a *nomen nudum* and de Man is the true author of the variety.

Only a small number of specimens of each of these varieties was examined: Coutière's original description was based on 14 specimens—one variety upon four specimens and the other four varieties upon only two specimens each. It is evident that such a small number of specimens is not an adequate basis for the separation of varieties. For example, if, of the 100 specimens examined for this study, 10 or 20 were selected and studied carefully, it is likely that at least three seemingly separate and distinct subspecies or even species could be distinguished; it is only the large number of specimens that permits the range of variation to be understood. Consequently in my opinion the varieties described merely fall in the line of normal variation of a large population and are not of taxonomic worth; for this reason the previously named varieties have not been accepted nor have new varieties been proposed in this paper.

Coutière (1909) listed *S. townsendi* as occurring in the Hawaiian Islands; the record was based on a single specimen taken by the "Albatross" on French Frigate Shoal. I have examined the specimen which is in the United States National Museum. It has none of the thoracic legs, and these evidently (from Coutière's notes in the vial) were lacking when it was examined by him. Without the important dactyli and chelipeds it is impossible to identify the specimen positively. However, in view of the facts that the anterior body regions and its appendages and the telson were within the range of variation for the local *S. paraneomeris*,

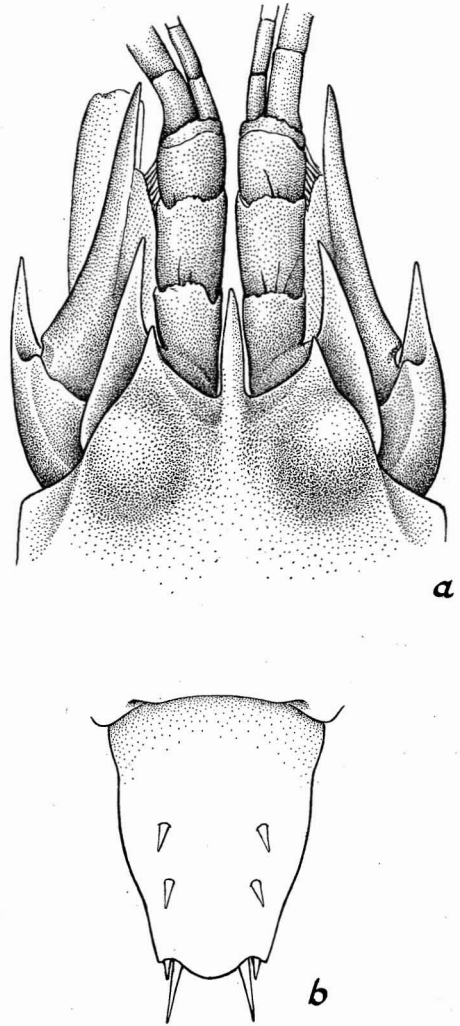


FIG. 14. *Synalpheus paraneomeris* Coutière. Specimen from "Albatross" Station 3969, identified by Coutière as *S. townsendi* Coutière. a, Anterior region, dorsal aspect; b, telson.

that *S. townsendi* is known only from the Americas, and that it has never been reported from these islands nor is it represented in the present large collection of synalpheids, the specimen has been assigned to *S. paraneomeris*.

**DISTRIBUTION:** This species is one of the most common in the Hawaiian Islands. In addition to the usual habitat in dead coral heads, it is found in heads of living *Pocillopora meandrina* Verrill. On Oahu it has been col-

lected from the reef flats and in water to about 20 feet deep at the following localities: Off Mokulua, Waimanalo, Hanauma Bay, Black Point, Waikiki, Nanakuli, Kawela Bay, and Kaaawa. On Maui it has been collected at Makena and at five places along the coast north and south of Lahaina. R. W. Hiatt took some specimens from the intertidal zone at Halape, Kau Coast, Hawaii. C. H. Edmondson (1925) reported the species from Laysan Island, Lisianski Island, and Pearl and Hermes Reef. Collections by the "Albatross" reported by Coutière included specimens from off southwest Oahu in 18–69 fathoms, off Laysan in 19–60 fathoms, and the specimen which he referred to as *S. townsendi* from French Frigate Shoal in 15–16 fathoms.

The species and its varieties have been reported from the Red Sea, the Indian Ocean,

and the Netherlands Indies, and in the central Pacific from Wake and Palmyra Islands.

### *Synalpheus macromanus* Edmondson

Fig. 15 a–g

*Synalpheus macromanus* Edmondson, Bernice P. Bishop Mus., Bul. 27: 9–11, figs. 1a–j, 1925.

DESCRIPTION: Rostrum apparently reaching to near end of first antennular article, orbital teeth acute, about 0.5 length of rostrum.

Antennular peduncle short and heavy with second and third articles about 1.7 times as broad as long. Stylocerite reaching to near end of second article. Lateral spine of basicerite strong, almost as long as stylocerite; dorso-lateral angle rounded. Lateral spine of scaphocerite 1.2 times as long as squamous portion;

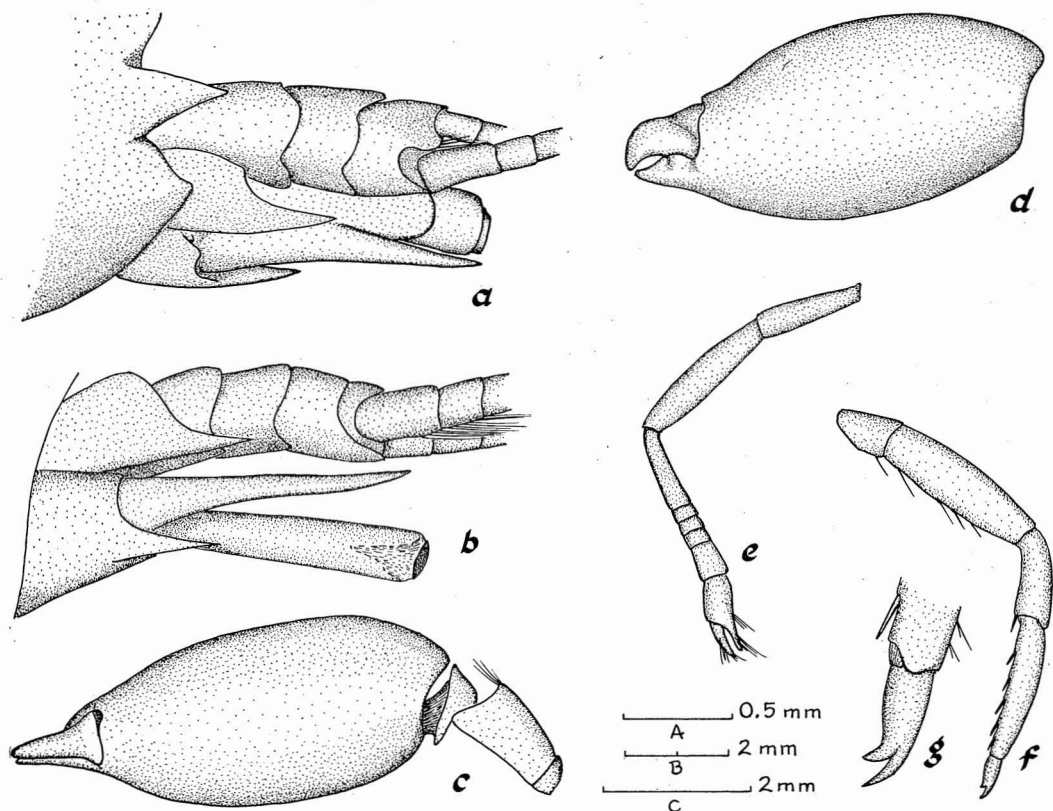


FIG. 15. *Synalpheus macromanus* Edmondson. a, Anterior region, dorsal aspect, left side not shown; b, antennules and antennae, lateral aspect; c, large cheliped, lateral aspect; d, large chela, dactylus flat; e, second leg; f, third leg; g, third leg, dactylus. (a, b, g, scale A; c, d, scale B; e, f, scale C.)

tip reaching beyond end of antennular peduncle. Carpocerite dorsoventrally compressed, as long as scaphocerite.

Large chela very large, inflated, almost circular in section, only twice as long as broad at maximum diameter, with fingers much thinner and lower than palm, occupying distal 0.25 of chela. Carpus of usual form. Merus 0.25 length of chela, twice as long as broad, with subacute tooth terminating superior distal margin.

Small chela of usual configuration, with chela proper compressed and fingers occupying distal 0.3.

Carpal articles of second legs with ratio 10 : 1.7 : 1.7 : 1.9 : 6.5.

Ischium of third legs 0.3 length of merus; merus about 3.5 times as long as broad, unarmed; carpus 0.45 length of merus, superior distal margin projecting as rounded tooth, inferior distal margin not projecting but with slender spine; propodus 0.8 length of merus, somewhat curved, with 5 movable spines on inferior margin; dactylus 0.25 as long as merus, biunguiculate, conical inferior unguis 1.3 times as broad at base and 0.75 as long as curved superior or distal unguis.

DISCUSSION: The description and figures are of the type specimen previously described and figured by Edmondson. In this specimen, the only one known, the frontal regions of the carapace are so distorted as to render accurate determination of the characteristics impossible.

This species approaches *S. paraneomeris* Coutière in almost all characteristics. It is possible that the rostrum and orbital hoods are quite different in the two species, but, as mentioned, the exact condition of the frontal region of the carapace of *S. macromanus* cannot be determined. The articles of the antennules may be broader in this species; the stylocerite may be longer; the relative sizes of the claws of the dactylus of the third legs may be different. As these characteristics are among the most variable in what was interpreted to be *S. paraneomeris*, I believe the range of variation

of that species would easily encompass these differences. However, no specimen of *S. paraneomeris* has been seen with a large chela approaching the inflated condition found in that of *S. macromanus*, and it appears that this is a valid criterion for the recognition of two species. Of course, it may be found that the huge chela of *S. macromanus* is merely a monstrous variation of *S. paraneomeris*, but no specimens in the collection studied would indicate it; it may also be that the gross chela is merely a growth anomaly, for no other specimens have been collected with a similar chela. At the present, in any case, the species appears to be distinct and valid.

DISTRIBUTION: The type specimen, a female 13.5 mm. long, is from Lisianski Island.

#### CRANGON Weber

*Crangon* Weber, Nomen. Ent. Sec. Ent. Syst., 1795.

*Alpheus* Fabricius, Sup. Ent. Syst., 1798.

Carapace developed as orbital hoods which completely enclose eyes except on ventral side. Orbital hoods frequently with spiniform apex and usually demarked from rostral base by more or less pronounced depression. Rostrum often present and carapace usually with at least slight rostral carina. Pterygostomial margin of carapace rounded.

Antennules usually short, frequently with basal peduncular article and stylocerite reduced. Scaphocerite frequently reduced; basicerite either armed with inferolateral spine or rounded; carpocerite usually reaching to or beyond end of scaphocerite.

Chela of first legs very asymmetrically developed. Large chela of variable form, from subconical to compressed and twisted, surfaces from smooth and entire to deeply sculptured with grooves and pronounced "alpheopsidean" lobes. Dactylus usually with piston-like process that fits into cavity on fixed finger and always with digital and palmar adhesive plaques. Chela always carried extended from body. Large cheliped with hemispherical

carpus, with merus at least somewhat triangular in section. Small chela of simple form, at times showing marked sexual dimorphism.

Carpus of second legs of five articles of variable proportions.

Third and following legs robust, compressed; armature and proportions of merus, carpus, and propodus various, dactylus simple or biunguiculate. Fifth legs with "brush" on propodus.

Abdomen usually without lateral compression, with pleura in females larger than those of males and usually without acute projections on margins. Pleura of sixth abdominal segment not jointed. Telson usually with posterior margin convex and lateral angles distinct but not acute. Anal tubercles well developed.

Branchial formula: 5 pleurobranchs, 1 arthrobranch, 8 epipodites, and sometimes a supplementary arthrobranch on first thoracic legs (except in *C. paragracilis* Coutière and *C. nanus* Banner).

This genus, previously known to American systematists and still known to European systematists as *Alpheus*, is by far the largest in the family, not only in Hawaiian waters, but also in the entire Pacific. In 1911 de Man listed 128 species of *Crangon* in comparison with 62 species of *Synalpheus*, the next largest genus. In this paper 31 species from Hawaii are discussed; in addition there are two species reported from Hawaii, the records of which are doubtful.

To facilitate the classification of the genus, Coutière (1899) divided it into five groups, principally on the basis of evolutionary development of the large chela and to a lesser extent on other characters, such as the character of the frontal margins of the carapace, the character of the dactylus of the third legs, etc. Later he divided the third group, *Crinitus*, into three subgroups (1905). These groups as originally defined were sharply distinguished one from another and constituted a valuable aid to the separation of the species.

Many new species were described after the

groups were defined, for example, Coutière (1905) described 23 new species from the Maldives and Laccadives, and de Man (1911) described some 20 new species from the collections of the Siboga Expedition. Since these did not exactly conform to the original descriptions of the groups and subgroups, modifications of the definitions were made.

On the basis of the Hawaiian species it appears that these groups, unlike those of *Synalpheus*, probably are still quite valid in determining the relationships of the species. However, should some future worker have available to him a collection of a large number of species, these groups should certainly be re-evaluated and some of the species be assigned either to others of the present groups or to new groups; by doing this some of the ambiguity of the definitions of the groups could be avoided. If that were done it would be desirable to raise the groups to subgenera.

While the groups in general show close relationships of the species within them, the utility of the groups as redefined by de Man is definitely questionable. Some species could fall into two or three groups, as defined, with equal ease, as the revised definitions often are equivocal and ambiguous. For example, de Man's definition of the *Macrochirus* Group (1911: 307; italics mine):

Lateral (extracorneal) spines *usually* present. Inferior spine of basicerite *sometimes* large. Larger chela *usually* longitudinally grooved or emarginate anteriorly. Merus of third legs *usually* unarmed, dactyli of three posterior legs *biunguiculate or simple*. External spine of exopod of caudal fan *often* black.

Because the groups do seem to follow the natural relationships, they have been used in this paper. However, because the definitions of the groups are not clear and definitive, it has been impossible for the major divisions of the key to the species to follow the groupings. Instead, the key keeps all members of one group in a single series and in the sequence in which they are discussed in the text. For ready reference the Hawaiian species are listed here by groups.

## Megacheles Group

1. *C. hailstonei* (Coutière) var. *paucispinata* Banner
2. *C. brachymerus* Banner
3. *C. albatrossae* Banner
4. *C. tuthilli* Banner
5. *C. oahuensis* Banner
6. *C. collumiana* (Stimpson)
7. *C. deuteropus* (Hilgendorf)
8. *C. paradentipes* (Coutière)

## Macrochirus Group

9. *C. gracilis* (Heller) var. *simplex* Banner
10. *C. edmondsoni* Banner
11. *C. latipes* Banner
12. *C. ventrosa* (Milne-Edwards)
13. *C. amirantei* (Coutière)
14. *C. nanus* Banner
15. *C. hawaiiensis* Edmondson
16. *C. paragracilis* (Coutière)

Crinita Group, Obesomanus Subgroup:  
Not represented.

## Crinita Group, Crinita Subgroup

17. *C. paralcione* (Coutière)
18. *C. brevipes* (Stimpson)
19. *C. clypeata* (Coutière)

## Crinita Group, Diadema Subgroup\*

20. *C. paracrinita* (Miers)
21. *C. paracrinita* (Miers) var. *bengalensis* (Coutière)
22. *C. gracilipes* (Stimpson)
23. *C. pugnax* (Dana)
24. *C. diadema* (Dana)
25. *C. pseudopugnax* Banner
26. *C. percyi* (Coutière)

## Brevirostris Group

27. *C. rapax* (Fabr.)
28. *C. platyungiculata* Banner

\* This name has been changed from *Insignis* to reflect the placement of *C. insignis* (Heller, 1861) as a synonym to *C. diadema* (Dana, 1852); although the rules of zoological nomenclature do not apply to this subgeneric category, it was thought that the change would reduce confusion.

† Two species of this group, *C. audouini* (Coutière) and *C. strenua* (Dana), which have been reported from the Hawaiian Islands, are not included in this list nor in the key because the records are doubtful (see pp. 141 and 142).

## Edwardsi Group†

29. *C. leptochirus* (Coutière)
30. *C. crassimanus* (Heller)
31. *C. pacifica* (Dana)

With the change of the generic name from *Alpheus*, a masculine noun, to *Crangon* (from Gr. *Kpayyon*) a feminine noun, it has been necessary to change the endings of some of the specific names.

It was hoped that in the key to the species it would be possible to avoid the use of all sexually dimorphic characteristics and the large and small chelae which are so often lost. However, it was soon found that such a key would be difficult to use and would throw the species out of their normal sequence. Wherever possible the substitution of other characteristics for these was made, especially for sexually dimorphic characteristics. Finally, accessory characters are given where it was thought that they would be useful.

## HAWAIIAN SPECIES OF CRANGON

1. Anterior margins of orbital hoods with acute teeth. . . . . 2
- Anterior margins of orbital hoods rounded, flattened, or keeled but never bearing acute teeth. . . . . 13
- 2(1). Outer face of large chela with several longitudinal grooves and crests; dactylar articulation of chela flanked with strong teeth. 3
- Large chela rounded, no grooves, crests, or teeth. . . . . 10
- 3(2). Inferior distal margin of merus of third leg rounded. (Some aberrant specimens of some species in this group lack acute teeth on the orbital hoods; they can be recognized easily, however, by the twisted and crested nature of the large chela.) . . . . . 4
- Inferior distal margin of the merus of the third leg produced into an acute or obtuse tooth. . . . . 8
- 4(3). Crest leading to the palmar adhesive plaque on large chela sharp;



- dactylus of large chela with small lobes on inner distal face but not bulbous at tip. . . . . 5
- Crest leading to palmar adhesive plaque on large chela rounded; dactylus of large chela with tip bulbous. . . . . 6
- 5(4). Second carpal article of second leg 0.5 the length of the first. . . . .
- C. hailstonei* var. *paucispinata* (p. 51)
- Second carpal article of second leg almost 1.5 times the length of the first. . . . . *C. brachymerus* (p. 58)
- 6(4). Dactylus of third leg with one or more superior serrations but with no trace of an inferior unguis. . . 7
- Dactylus of third leg with no superior serrations but with a strong inferior unguis. *C. oahuensis* (p. 64)
- 7(6). Crest leading to the superior tooth at the dactylar articulation of the large chela interrupted by a transverse notch. . . *C. albatrossae* (p. 60)
- Crest leading to the superior tooth at the dactylar articulation of the large chela continuous from the superior margin of the palm. . . . . *C. tuthilli* (p. 63)
- 8(3). Tips of the orbital teeth reaching about half the length of rostrum. Dactylus of third leg biunguiculate; inner face of large chela with a moderate growth of setae; lateral spine of basicerite longer than stylocerite. . . . .
- C. collumiana* (p. 67)
- Tips of the orbital teeth reaching at least near the end of rostrum, or beyond. . . . . 9
- 9(8). Tips of orbital teeth not reaching to tip of rostrum. Large and small chelae densely hirsute on inner faces; small chela heavy and with straight fingers; dactylus of third leg simple. . . . . *C. deuteropus* (p. 70)
- Tips of orbital teeth extending beyond rostrum. Inner faces of large and small chelae almost glabrous; small chela slender with fingers bent at right angles and crossing; dactylus of third leg biunguiculate. . . . .
- C. paradentipes* (p. 72)
- 10(2). Dactylus of third leg simple, curved, conical, with acute tip. . 11
- Dactylus of third leg with tip either obtuse or strongly hooked. . . 12
- 11(10). Large chela about 2.5 times as long as high, with depressions on superior and inferior margins. Merus of third leg 3–4 times as long as broad; external spine of uropod usually black. . . . .
- C. gracilis* var. *simplex* (p. 75)
- Large chela 3.0–3.5 times as long as high, without depressions on margins. Merus of third leg 6–7 times as long as broad; external spine of uropod never black. . . . .
- C. edmondsoni* (p. 78)
- 12(10). Dactylus of third leg with abrupt taper and abrupt hook in distal 0.3; tip acute. Second article of carpus of second leg broader than long; mature specimens 8.5 mm. long. . . . . *C. latipes* (p. 82)
- Dactylus of third leg almost straight and very blunt. Second article of carpus of second leg about twice as long as broad; mature specimens up to 42 mm. long. . . . . *C. ventrosa* (p. 84)
- 13(1). Large chela with only 1 or 2 simple longitudinal grooves on outer face extending proximally from articulation of dactylus. . . . . 14
- Large chela with or without grooves, but never with only 1 or 2 longitudinal grooves. . . . . 17
- 14(13). Second article of carpus of second leg over twice length of first. Large chela subcylindrical. . . . .
- C. amirantei* (p. 87)
- Second article of carpus of second

- leg shorter than first. Large chela compressed. . . . . 15
- 15(14). Scaphocerite reduced, not reaching to end of antennular peduncle; merus of third leg unarmed. Margins of large chela entire. . . . . *C. nanus* (p. 90)
- Scaphocerite longer than the antennular peduncle; merus of third leg armed. . . . . 16
- 16(15). Depression on lower margin of large chela with both sides gradual; second carpal article of second leg broader than long. . . . . *C. hawaiiensis* (p. 95)
- Depression on lower margin of large chela proximally delimited by a lobe; second carpal article of second leg longer than broad. . . . . *C. paragracilis* (p. 96)
- 17(13). Dactylus of third leg biunguiculate. . . . . 18
- Dactylus of third leg simple. . . . . 19
- 18(17). First carpal article of second leg about twice as long as second. . . . . *C. hawaiiensis* (p. 95)
- Second carpal article of second leg about 3 times as long as first. Large chela subcylindrical, tapering; margins entire. . . . . *C. paralcione* (p. 99)
- 19(17). Large chela without notches, grooves, or crests, usually quite cylindrical. . . . . 20
- Large chela with either transverse groove, proximal to the dactylus, or pronounced lobes and depressions, especially along upper and lower margins; chela sometimes cylindrical. . . . . 23
- 20(19). Rostrum very small or absent; dorsal carina of carapace not extending to tip of rostrum when present; orbital hoods with narrow to broad vertical keel anteriorly; chela subcylindrical. . . . . 21
- Rostrum reaching about to middle of visible portion of first antennular article, with interorbital carina extending to tip; orbital hoods evenly rounded anteriorly; chela compressed. . . . . 22
- 21(20). Second carpal article of second leg about 1.5–2.0 times length of first; without tooth on basicerite; inferior internal margin of merus of large chela unarmed; no sexual dimorphism in small chela. . . . . *C. brevipes* (p. 103)
- Second carpal article of second leg about equal to first, not over 1.3 times length of first; basicerite with tooth; tooth distally on inferior internal margin of merus of large chela; dactylus of small chela of female broadened, twice as long as broad. . . . . *C. chypeata* (p. 107)
- 22(20). First carpal article of second leg 1.75–1.85 times length of second; merus of both large and small chelipeds with strong tooth. . . . . *C. paracrinita* (p. 110)
- First carpal article of second leg about equal to length of second; tooth on inferior internal margin of merus of large chela reduced, none present on small chela. . . . . *C. paracrinita* var. *bengalensis* (p. 110)
- 23(19). Large chela with only transverse groove proximal to dactylus, without lobes on either margin; chela subcylindrical to compressed. . . . . 24
- Large chela with transverse groove and also marked lobes on both superior and inferior margins and depressed areas on faces; chela always compressed. . . . . 30
- 24(23). Dactylus of third leg conical, large chela subcylindrical. . . . . 25
- Dactylus of third leg triangular in section, inferior surface broad and flat, somewhat twisted, large

- chela strongly compressed. . . . . 29
- 25(24). Merus of third leg without tooth on inferior distal margin. All appendages long and slender; rostral base narrow and flattened dorsally; merus of large cheliped with few movable spines. . . . .  
 . . . . . *C. gracilipes* (p. 115)
- Merus of third leg with strong tooth on inferior distal margin. 26
- 26(25). Second carpal article of second leg twice as long as first. Merus of large cheliped with series of spines, subterminal tooth on inferior internal margin; rostral base very narrow; rostrum not depressed. . . . . *C. pugnax* (p. 116)
- Second carpal article of second leg about as long as first. . . . . 27
- 27(26). Rostral base broad, at least 0.7 as broad as long. Merus of large cheliped without spines; rostrum somewhat depressed. . . . .  
 . . . . . *C. diadema* (p. 118)
- Rostral base narrow, less than 0.5 as broad as long. . . . . 28
- 28(27). Anterior portion of base of rostrum sharply carinate with sloping margins; margins overhanging orbital-rostral grooves only in posterior 0.3. Large chela with depressed areas on superior portion of inner and outer faces; merus of cheliped with few spines but numerous serrations. . . . . *C. pseudopugnax* (p. 122)
- Anterior portion of base of rostrum flattened, with only slight carina; margins of rostral base overhanging orbital-rostral groove for entire length. Large chela without depressed areas as in *C. pseudopugnax*, merus with similar serrations. *C. percyi* (p. 124)
- 29(24). Second carpal article of second leg shorter than first. Propodus of third leg bearing only light setae . . . . . *C. rapax* (p. 126)
- Second carpal article of second leg over twice as long as first. Propodus of third leg with numerous long setae. . . . .  
 . . . . . *C. platyunguiculata* (p. 130)
- 30(23). Length of dactylus of third legs about twice breadth of merus. Large chela with transverse groove across top, connecting triangular depressed area on each face; lower margin with strong lobe; small chela of male probably "balaeniceps-shaped" . . . .  
 . . . . . *C. leptochirus* (p. 133)
- Length of dactylus of third legs about equal to breadth of merus. 31
- 31(30). Posterior margin of groove behind dactylus of large chela sloping back gradually (best seen in profile), not projecting over floor of groove; with more or less conspicuous tooth distally on inferior internal margin of merus of large cheliped; small chela "balaeniceps-shaped" in male, slender in female; usually with spine on ischium of third legs. . . . .  
 . . . . . *C. crassimanus* (p. 134)
- Posterior margin of groove behind dactylus of large chela overhanging floor of groove (best seen in profile); no tooth on inferior internal margin of merus of large cheliped; small chelae of both sexes with slender conical fingers; usually without ischial spine on third legs. . . . .  
 . . . . . *C. pacifica* (p. 138)

## Megacheles Group

*Crangon bailstonei* (Coutière) var. *paucispinata* var. nov.

Fig. 16 a-j

*Alpheus bailstonei* Coutière, Fauna and Geog. Mald. and Laccad. 2(4): 879, pl. 74, fig. 18, 1905.

TYPE SPECIMEN: A 16 mm. ovigerous female, "Albatross" Station 4128, off Kauai, 68-90 fathoms, U. S. N. M. 91602.

DESCRIPTION: Rostrum well developed, reaching almost to end of first antennular article and almost twice as long as broad at base; top rounded, not carinate. Orbital hoods somewhat inflated, with acute orbital teeth reaching beyond middle of rostrum. Orbito-rostral furrows slight, rounded.

Visible portion of first antennular article more than 0.7 length of second article; second article twice length of third article, and 3 times as long as broad at base. Stylocerite reaching to end of first article. Lateral spine of basicerite nearly reaching to level of tip of rostrum. Squamous portion of scaphocerite narrow and almost 0.9 as long as lateral spine; tip of lateral spine reaching to end of antennular peduncle. Carpocerite reaching slightly past middle of third antennular article.

Large chela slightly over 3 times as long as broad, strongly compressed, with pronounced crests and grooves. [For terminology of crests and grooves, see Fig. 17*e*.] Superior crest strong, terminating distally as strong acute tooth above articulation of dactylus. Transverse groove deep, proximally overhanging, distally rounded. Superior groove only moderately deep. Plaque crest strong, with sharp ridge, proximally merging with superior margin of palm. Palmar groove well defined. Inferior crest with lower margin better defined than upper; ending at dactylar articulation as tooth smaller than that of superior crest. Inferior depression shallow but distinct, shoulder rounded. Dactylus with high crest, over 0.2 length of entire chela, thin, flat on outer face, rounded inner face with several distinct rounded lobes distally, extending over fixed finger. Carpus of usual form. Merus 3 times as long as breadth of outer surface and twice as long as maximum breadth, superior and inferior external margins rounded; inferior internal margin with strong, acute tooth and 3 small spinules; superior margin rounded distally. Ischium with single spine.

Total length of small cheliped 0.7 length of large cheliped, chela about 0.6 length of larger. Chela almost 5 times as long as broad with fingers 0.4 length of entire chela. Palm ovoid, articulation of dactylus with strong teeth on each side. Dactylus narrow, crested. Carpus rather small. Merus 0.7 as long as chela, 1.3 times as long as corresponding article on large chela; slender, about 5.5 times as long as broad; inferior internal margin armed with 4 small spines and small tooth distally. Ischium with single inferior spine.

Carpal articles of second leg with ratio 10 : 5 : 3 : 5.5 : 4.

Ischium of third legs about 0.5 as long as merus, with strong movable spine. Merus 6.5 times as long as broad, unarmed. Carpus 0.6 as long as merus, with acute tooth distally on superior margin. Propodus 0.9 as long as merus, with 10 strong spines along inferior and distal margin; last spine bent distally, with minute serrations on convex portion. Dactylus 0.23 as long as merus, only slightly tapering in proximal 0.7; basal portion demarked from distal 0.25 by slight ridge prolonged inferiorly as small projecting tooth; tip tapering, acute.

DISCUSSION: This particular form is represented in the collections studied by only two semi-intact specimens collected by the "Albatross" in Hawaiian waters. There is a series of additional individuals, from the same and other stations, which are so fragmentary that positive identifications cannot be made.

The other specimen sufficiently intact for positive identification, a male 19 mm. long, varies from the type in the following characteristics: rostrum reaches end of first antennular article; large chela 2.9 times as long as broad; merus of large chela 1.4 times as long as maximum breadth, with 5 spines, plus 2 on ischium; small chela lacking; carpal article with ratio 10 : 5 : 2.5 : 6 : 4; articles of third leg with ratio 2.5 : 10 : 6 : 9 : 1.9; propodus with 14 spines; dactylus with short bristles on superior margin. These differences

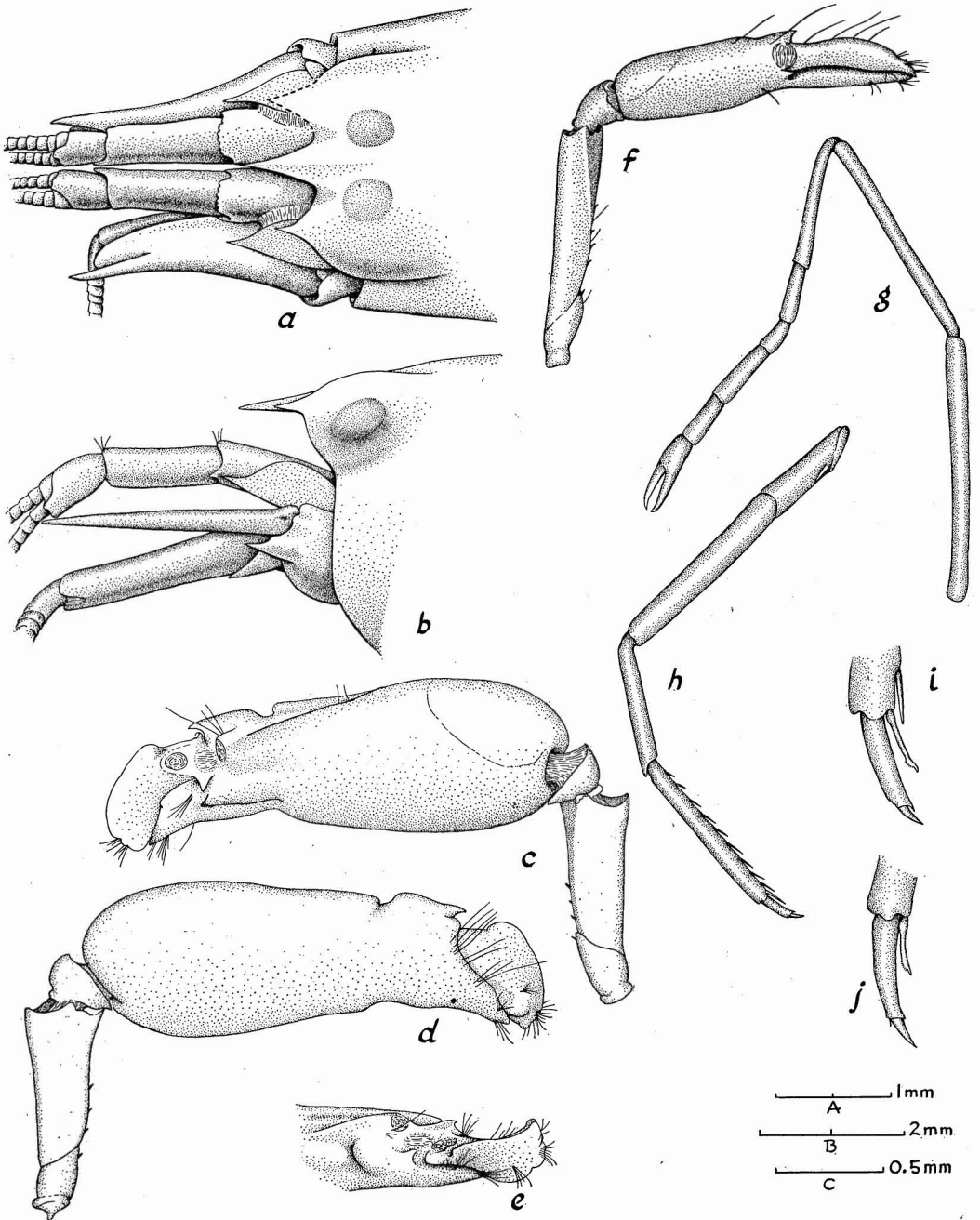


FIG. 16. *Crangon bailstonei* (Coutière) var. *paucispinata* var. nov. *a, b*, Anterior region, dorsal and lateral aspects; *c*, large cheliped, lateral aspect; *d*, large cheliped, medial aspect; *e*, large chela, distal end, dorsal aspect; *f*, small cheliped; *g*, second leg; *h*, third leg; *i, j*, third leg, dactylus. (*a, b*, scale A; *c-h*, scale B; *i, j*, scale C.)

are minor and to be expected in the normal range of variation.

The varietal name refers to the few spines found on the merus of the large cheliped.

RELATIONSHIP: This form and the next four described are apparently closely related to each other, to the species *C. hailstonei* (Coutière), and to its two tentative varieties described by de Man, *C. hailstonei assimulans* and *C. hailstonei laetabilis*. De Man was not sure of the separation of his forms from the parent form described by Coutière, as the differences between them, although distinct, were rather minor. Similarly, these five forms differ from the previously described forms and from each other on minor but distinct points.

It is likely, therefore, that when sufficient intact specimens of these and the previous varieties are available and when the variation in a large population is studied it will be necessary to consolidate this and de Man's varieties, and perhaps the following species as well, into the species described by Coutière. But, on the other hand, it may be necessary to raise this and the previous varieties to specific rank. However, with only a few specimens available, it appears to me that the separation given in this paper is for the present the most wise, as this form is separated from *C. hailstonei* and the other varieties by only more minor characteristics, and the other forms, described as new species, by greater differences in more important characteristics.

Table 2 facilitates the separation of these eight species and varieties. The characteristics given are not all of equal worth for the separation of the species. For example, little if any faith can be placed upon the minor variations found in the relative lengths of the carpal articles, except in *C. brachymerus*, or in the length of the rostrum, except possibly in *C. tuthilli*.

As can be seen from the table, this variety differs from *C. hailstonei hailstonei* and from *C. hailstonei laetabilis* chiefly in the number of spines on the margins of the merus of the large chela, and from *C. hailstonei hailstonei* and

from *C. hailstonei assimulans* in the nature of the dactylus of the third legs. Other differences noted in the table are of more variable characteristics and therefore are of lesser worth.

DISTRIBUTION: One of the positively identified specimens has its collection data given above; the other was collected by the "Albatross" at Station 3868 in Pailolo Channel between Molokai and Maui at 294-684 fathoms (U. S. N. M. 63535). Other specimens, with only one or several appendages attached or with the appendages loose in the bottle so that identification was more uncertain, were collected as follows:

"Albatross" Station 3847 (U. S. N. M. 63528): South coast of Molokai, 23-24 fathoms; 17 specimens, 14 of which are completely lacking thoracic legs.

"Albatross" Station 3872 (U. S. N. M. 63532): Auau Channel between Maui and Lanai, 32-43 fathoms; 1 specimen, lacking large chelae, second legs, and some of posterior legs.

"Albatross" Station 3875 (U. S. N. M. 63527): Auau Channel between Maui and Lanai, 65-34 fathoms; 2 specimens.

"Albatross" Station 4128 (U. S. N. M. 63531): Data as given for type; 3 other fragmentary specimens.

Other specimens from the "Albatross" collection which undoubtedly belong to this complex and were identified by Coutière as *C. hailstonei* (MS.), but which are too badly broken to permit me to even guess as to their identity, were collected as follows:

"Albatross" Station 3809 (U. S. N. M. 63533): South coast of Oahu, 51-125 fathoms; 1 specimen.

"Albatross" Station 3982 (U. S. N. M. 63534): Near Kauai, 40-233 fathoms; 1 specimen.

"Albatross" Station 4055 (U. S. N. M. 63530): Northeast coast of Hawaii, 50-62 fathoms; 1 specimen.



TABLE 2  
CHARACTERISTICS DIFFERENTIATING *Crangon bailstonei* AND SOME RELATED SPECIES AND VARIETIES

CHARACTERISTIC	A <i>C. bailstonei</i> <i>bailstonei</i>	B <i>C. bailstonei</i> <i>assimulans</i>	C <i>C. bailstonei</i> <i>laetabilis</i>	D <i>C. bailstonei</i> <i>paucispinata</i>	E <i>C. brachymerus</i>	F <i>C. albatrossae</i>	G <i>C. tutbilli</i>	H <i>C. oahuensis</i>
Size	Not given	To 19 mm.	To 15 mm.	To 19 mm.	To 18 mm.	To 33 mm.	23 mm.	To 27 mm.
Rostrum								
Length	To end first antennular article	Same as A	"Slightly shorter"	0.7–1.0 of first antennular article	Unknown	0.7 of first antennular article	0.5 of first antennular article	Similar to F
Length/breadth	2	2.5	2(?)	2	Unknown	2	1	1.5
Orbitorostral margin	Straight, transverse	Concave	Similar to A	Similar to B	Unknown	Straight, about 30° to transverse	Similar to F	Similar to F
Antennular peduncle								
Lengths of articles	1 : 1 : 0.5	0.7 : 1 : 0.4	Similar to A	1 : 1 : 0.5	0.9 : 1 : 0.6	0.7 : 1 : 0.5	0.7 : 1 : 0.6	0.7 : 1 : 0.7
Length/breadth, 2nd article	3	3.5	Similar to A	3	3	3	2	1.7–2.0
Length stylocerite	0.7 of first antennular article	Equals antennular article	Similar to B	Similar to B	Almost to end first antennular article	0.8 of first antennular article	Similar to B	Subequal to first antennular article
Antennal peduncle								
Scaphocerite	Equals antennular peduncle	Similar to A	Similar to A	Similar to A	Exceeding antennular peduncle	Similar to E	Similar to A	Similar to E (variable)
Carpocerite	Shorter than scaphocerite	Equals scaphocerite	Similar to B	Similar to A	Similar to B	Slightly longer than scaphocerite	Similar to B	Similar to B (variable)
Large cheliped								
<i>Merus</i>								
Length/breadth	3.0	Not stated	Not stated	3.0	3.0	2.0–2.2	2.7	2.0
Length/maximum breadth	1.6	Not stated	Not stated	1.4–2.0	1.2	1.7	1.6	1.3
Length/palmar height	1.0	Not stated	Not stated	1.0	0.6	0.7–0.8	1.0	0.7

TABLE 2—Continued  
CHARACTERISTICS DIFFERENTIATING *Crangon bailstonei* AND SOME RELATED SPECIES AND VARIETIES

CHARACTERISTIC	A <i>C. bailstonei</i> <i>bailstonei</i>	B <i>C. bailstonei</i> <i>assimulans</i>	C <i>C. bailstonei</i> <i>laetabilis</i>	D <i>C. bailstonei</i> <i>paucispinata</i>	E <i>C. brachymerus</i>	F <i>C. albatrossae</i>	G <i>C. tuthilli</i>	H <i>C. oahuensis</i>
Inferior tooth	Strong	Not stated	Not stated	Moderate to strong	Very strong	Weak to moderate	Strong	Strong
Superior—inferior spines	3—0	0—4—6	4—5—8—9	0—3—5	3—5	0—6—10	0—8	0—9 (variable)
<i>Ischial spines</i> Superior—inferior	0—0	Not stated	2—3	0—1—2	0—0	0—1—3	2—5	0—5
<i>Chela</i> Length/breadth	3.3	2.6—2.9	"Little broader" than A	2.4—3.0	2.7	2.4	2.8	2.5
Superior crest	Interrupted	Interrupted	Interrupted	Interrupted	Interrupted	Interrupted	Continuous	Interrupted
Plaque crest	Sharp	Sharp	Sharp	Sharp	Sharp	Rounded	Low, slightly angular	Rounded
Tip of dactylus	2 lobes on inferior internal face	Similar to A	Similar to A	Similar to A	Similar to A	Expanded and bulbous	Similar to F	Similar to F
Small cheliped Total length/length of large cheliped	0.8	Similar to A	Similar to A	0.7	0.8	Almost equal	Lost	Equal
<i>Merus</i> Length/width	Not given	Not given	Not given	5.5	4.0	2.2—3.0	Lost	2.0
Meral length/chela length	0.6	Similar to A	Similar to A	0.7	0.45	0.7	Lost	0.4
Spines, superior—inferior	0—6	Similar to A (?)	Similar to A (?)	0—3	4—7	0—9—11	Lost	0—13 (variable)
<i>Ischial spines</i> Inferior	1	Similar to A (?)	Similar to A (?)	1	1	0	Lost	7

TABLE 2—Continued  
CHARACTERISTICS DIFFERENTIATING *Crangon bailstonei* AND SOME RELATED SPECIES AND VARIETIES

CHARACTERISTIC	A <i>C. bailstonei</i> <i>bailstonei</i>	B <i>C. bailstonei</i> <i>assimulans</i>	C <i>C. bailstonei</i> <i>laetabilis</i>	D <i>C. bailstonei</i> <i>paucispinata</i>	E <i>C. brachymerus</i>	F <i>C. albatrossae</i>	G <i>C. tutbilli</i>	H <i>C. oahuensis</i>
<i>Chela</i>								
Length/breadth	5.5	Similar to A	Similar to A	5.0	4.0	3–4	Lost	4.4
Finger length/chela length	0.44	"Fingers slightly longer than palm"	Similar to A	0.4	0.5	0.5–0.6	Lost	0.6
Dactylus	Broad, not conspicuously crested	Similar to A	Similar to A	Broad, crested	Broad, high crest	Rounded, heavy	Lost	Very slender and elongate
Second leg Ratio of carpal articles	Not given	10:4–5:3:5:4	10:4–5:3:4:4–5	10:5:2.5–3:5.5–6:4	10:15:6:6:6	10:5–6:3–4:5–6:5–6	10:6:4:4:6	10:7–9:3–4:4–5:5–6
Third leg Ratio of articles	4.6:10:6:9:3	4:10:7:9:2.5	?:10:6:9:2.5	2.5–5:10:6:9:1.9–2.3	5:10:6:7:2.5	3:10:6:8:2.5	4:10:6:8:2.5	3:10:5:7.5:2
Ischial spine	Absent	Present	Not given	Present	Present	Present	Present	Absent
Meral length/breadth	10.5	9.5	6–8	6.5–8	9	5–6	7	3.4–4.0
Distal superior carpal tooth	Absent	Acute	Not given	Acute	Acute	Acute	Acute	Rounded
Carpal spines	Absent	Absent	Absent	Absent	Absent	Absent	Absent	2 (weak)
Propodal spines	6	9	8	10–14	13	11–12	8	6–10
Dactylus	Slender, simple	Single superior tooth	Slight superior and inferior teeth	Similar to C	Similar to C	Superior serrations	Similar to F	Strongly biunguiculate, inermous

The data for *C. bailstonei bailstonei* taken from Coutière (1905: 879–880, figs. 18–18c); for *C. bailstonei assimulans* from de Man (1911: 331–333, pl. 14, figs. 64a–64e); for *C. bailstonei laetabilis* from de Man (1911: 333–334, pl. 14, figs. 64d–64e). Where necessary, the individual characteristics or proportions were derived from the figures. *C. brachymerus*, *C. albatrossae*, *C. tutbilli*, and *C. oahuensis* are all new species described on the following pages.

"Albatross" Station undesignated (U. S. N. M. 84243): Hawaiian Islands; 1 specimen.

*Crangon brachymerus* sp. nov.

Fig. 17 a-j

TYPE SPECIMEN: The type and only known specimen is an 18 mm. male, from "Albatross" Station 3874 (U. S. N. M. 63536) between Maui and Lanai Islands, 21-28 fathoms.

DESCRIPTION: Frontal region of carapace abnormal, distorted and strongly asymmetrical, with right orbital tooth rather poorly developed and left entirely lacking; rostrum displaced and bent sharply ventrad. Second antennular article about 0.1 longer than visible portion of first, 1.7 times length of third, almost 3 times as long as broad. Stylocerite reaching to end of first antennular article.

Lateral spine of basicerite about 0.8 as long as stylocerite. Lateral spine of scaphocerite reaching slightly beyond end of antennular peduncle; spine moderately strong, squamous portion narrow. Carpocerite also reaching slightly beyond end of antennular peduncle, but slightly shorter than scaphocerite.

Large chela similar to *C. hailstonei* var. *pau-cispinata* Banner (p. 51), compressed, 2.7 times as long as high, with fingers about 0.25 as long as entire chela. [For terminology of crests and grooves see Fig. 17e.] Superior crest acute distally, terminating in strong, acute tooth above dactylar articulation, merging proximally with superior edge of chela. Transverse groove deep with proximal margin more or less overhanging, distally rounded. Superior groove deep. Plaque crest pronounced, with sharp ridge, proximally merging with superior margin of palm. Palmar groove shallower and less well defined than superior groove. Inferior crest arising from middle of palm, terminating distally in tooth below dactylar articulation, smaller than superior tooth. Inferior depression marked, shoulder strong but rounded. Dactylus strongly twisted, with high crest, narrow blade; inner surface of dactylus

with 2 large rounded lobes distally that meet cutting surface of immovable finger; distal lobe with several groups of short strong bristles. Carpus small. Merus very short, only 0.6 as long as height of palm, broad, 3.0 times as long as breadth of outer face, 1.2 times as long as maximum breadth at distal end, with 3-4 small spines along superior margin and 5 stronger spines on inferior internal margin. Superior margin of merus distally produced but rounded; inferior internal margin greatly produced distally as broad, flat process terminating as strong tooth. Ischium of usual form, without spines.

Total length of small cheliped 0.8 length of large cheliped, with chela 0.6 as long as large chela and merus 1.3 times as long. Chela 0.25 as broad as long, somewhat compressed, with teeth, crests, and grooves similar to large chela but much more poorly developed. Superior crest developed but rounded; transverse groove very shallow; plaque crest continued as rounded ridge across palm; inferior crest also rounded; superior and inferior crests terminating distally as small but acute teeth at dactylar articulation. Fingers 0.8 length of palm; immovable finger thin and slightly twisted; dactylus with high, blade-like crest continuing almost to end, cutting surface knife-like, whole article twisted into shallow S-shape. Carpus slightly larger than that of large chela. Merus 4 times as long as broad, with superior margin bearing 4 short spines and scarcely projecting, rounded, distal termination; inferior internal margin with 7 small spines and simple terminal tooth. Inferior surface of ischium with single spine.

Carpal articles of second legs with ratio 10 : 14.5 : 5.5 : 6 : 6. Chela 0.8 length of first carpal article.

Third legs in specimen broken. Fourth legs with ischium 0.5 length of merus with strong movable spine. Merus 9 times as long as broad, distally unarmed. Carpus almost 0.6 length of merus; superior margin projecting as short, acute tooth. Propodus 0.7 length of merus, with 13 moderately strong spines on

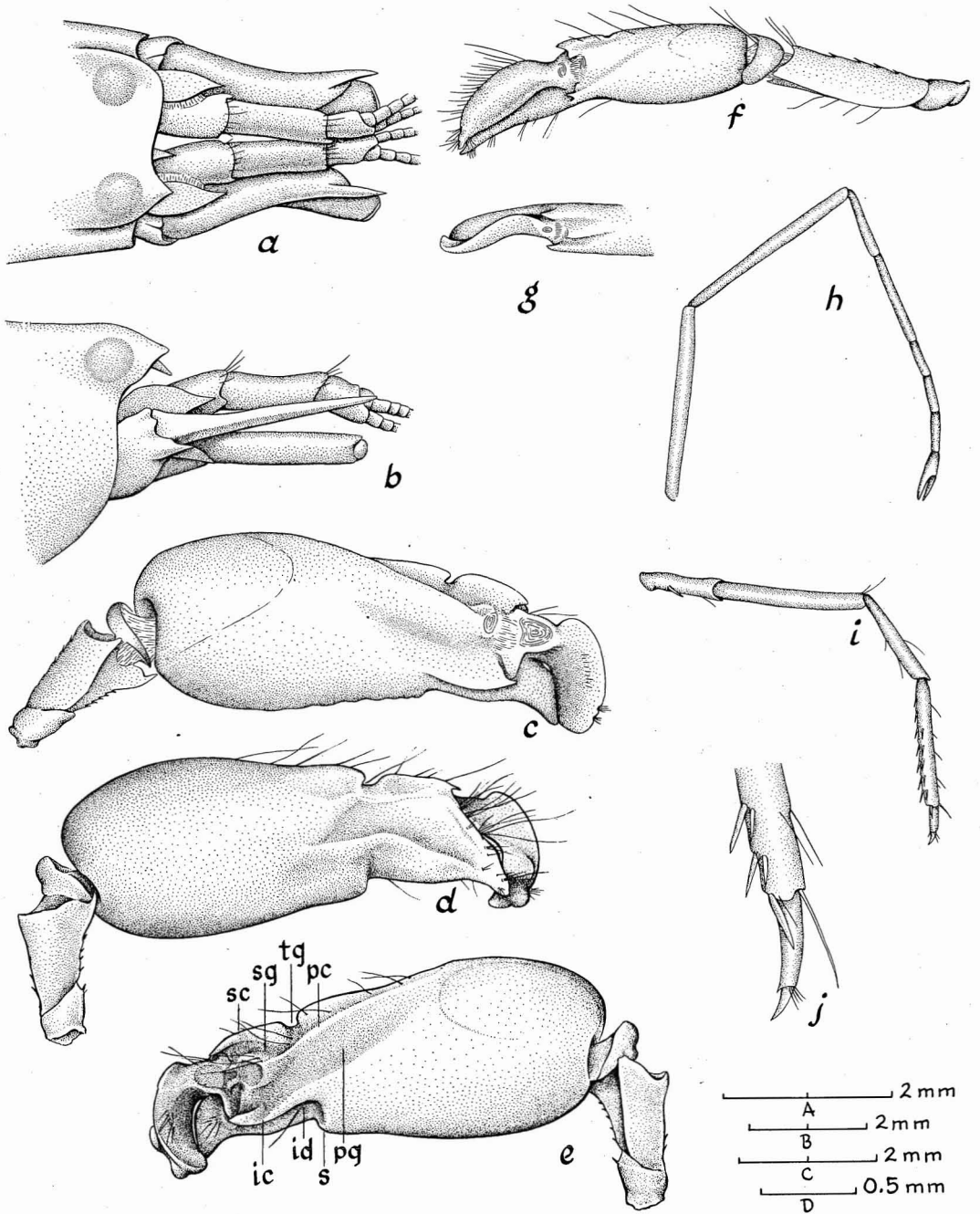


FIG. 17. *Crangon brachymerus* sp. nov. **a**, **b**, Anterior region, dorsal and lateral aspects; **c**, large cheliped, lateral aspect; **d**, **e**, large cheliped from "Albatross" Station 3847, medial and lateral aspects; **f**, small cheliped; **g**, small chela, distal end, superior surface; **h**, second leg; **i**, third leg; **j**, third leg, dactylus. Abbreviations on **e**: IC, inferior crest; ID, inferior depression; PC, plaque crest; PG, palmar groove; S, shoulder; SC, superior crest; SG, superior groove; TG, transverse groove. (**a**, **b**, scale A; **c**, **f**–**i**, scale B; **d**, **e**, scale C; **j**, scale D.)

inferior margin, distal 10 paired. Dactylus 0.25 as long as merus, curved, tapering to acute tip, with very slight accessory tooth about 0.7 distance to tip; small tuft of short thick spines or bristles opposite biunguiculation. Parts of third legs present similar to fourth but larger.

DISCUSSION: A single chela from the "Albatross" Station 3847 (U. S. N. M. 63571), off Laysan Island, 97-199 fathoms, undoubtedly belongs to this species. The chela, shown in Figure 17e, is almost identical to the form described above. The palmar grooves of the outer face are deeper and the inner face has irregular depressed areas, but a closer examination shows that without question these are the result of shrinking during a previous desiccation. The only difference is the armature of the superior margin of the merus where the small spines are so closely pressed against the rounded edge that only two can be discerned. Careful examination did not disclose any more spines; but possibly in a better preserved specimen more would be visible.

The specific name refers to the short, broad merus of the large cheliped.

RELATIONSHIP: The separation of this species from the related species and varieties in the *C. hailstonei* complex is given in Table 2. It is unfortunate that the only specimen of this apparent species available has the frontal region of the carapace distorted and abnormal but other characteristics are sufficient to separate it from the related forms. It may be presumed, however, as none of the seven other species and varieties differ markedly in the nature of the rostrum and the orbital hoods, that in this species too the rostrum is rather elongate and the orbital teeth are well developed, probably quite like the development of *C. hailstonei* var. *paucispinata* Banner (Fig. 16a).

The decisive differences between this species and the variety *C. hailstonei* var. *paucispinata* are three: First, the merus of the large chela is very short and broad, markedly shorter than the palm of the chela is high; second, the merus of the small cheliped is less than

0.5 the length of the chela; third and probably most important, the second article of the carpus of the second leg is 1.5 times as long as the first instead of only 0.5 as long. In my opinion, these three pronounced differences are great enough to separate this form as a distinct species.

*Crangon albatrossae* sp. nov.

Fig. 18 a-m

TYPE SPECIMEN: An ovigerous female 33 mm. long, "Albatross" Station 4031 (U. S. N. M. 63588), Penguin Bank, west of Molokai, in 27 fathoms. Paratypes listed below.

DESCRIPTION: Rostrum 0.7 as long as visible portion of first article of antennular peduncle, somewhat rounded dorsally, twice as long as broad at base; upper surface somewhat depressed toward tip. Orbitorostral grooves broad and shallow. Orbital hoods slightly inflated, with teeth reaching 0.5 length of rostrum. Margin of carapace between base of rostrum and orbital teeth straight but at angle of about 30° to transverse line of body.

Second antennular article 3 times as long as broad, 1.5 times length of visible portion of first article, over twice length of third article. Tip of stylocerite reaching to end of first article.

Lateral spine of basicerite reaching approximately to end of rostrum. Lateral spine of scaphocerite strong, lateral margin somewhat concave; tip reaching slightly beyond end of antennular peduncle; squamous portion narrow, 0.9 length of lateral spine. Carpocerite slightly longer than scaphocerite.

Large chela heavy, 2.4 times as long as broad, compressed, 1.7 times as broad as thick, tapering and distally sculptured. [For terminology of crests and grooves, see Fig. 17e.] Superior crest rounded, terminating distally as subacute tooth above dactylar articulation; merging soon with superior margin of chela proximal to transverse groove. Transverse groove deep and abrupt, proximally overhanging. Superior groove deep. Plaque



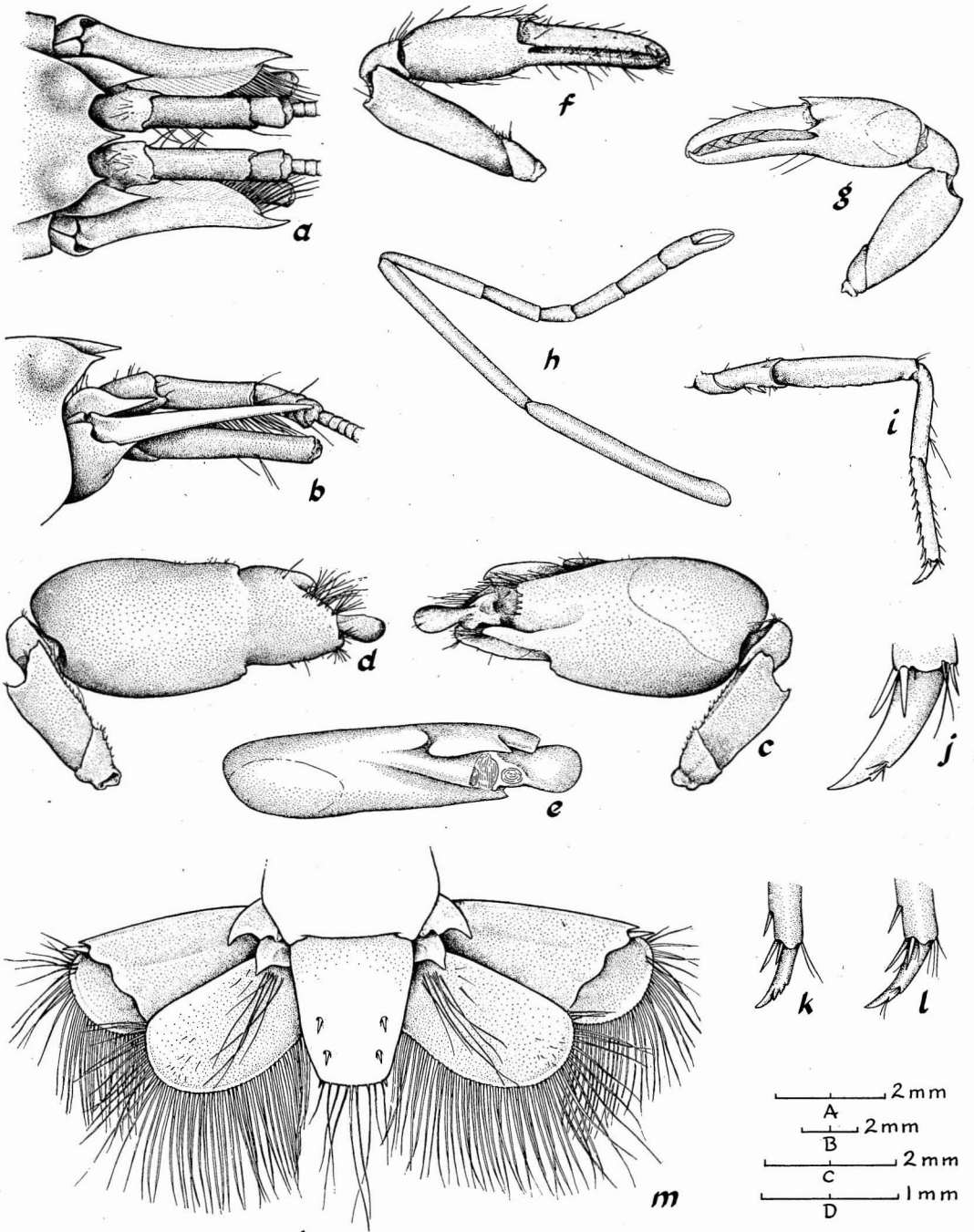


FIG. 18. *Crangon albatrossae* sp. nov. *a, b*, Anterior region, dorsal and lateral aspects (one pair of antennular flagella lost); *c*, large cheliped, lateral aspect; *d*, large cheliped, medial aspect; *e*, large chela, superior face; *f, g*, small chelipeds; *h*, second leg; *i*, third leg; *j, k, l*, third leg, dactylus; *m*, uropods and telson. (*a-d, f, i, j, m*, from type specimen; *e, g, h, k, l*, from specimens collected off southwest Oahu.) (*a, b, m*, scale A; *c-i*, scale B; *k, l*, scale C; *j*, scale D.)

crest strong but rounded, extending to superior margin of chela. Palmar groove short, well defined on lower side. Inferior crest strong but rounded, terminating distally in small, subacute tooth. Inferior depression deep, shoulder abrupt but rounded. Dactylus less than 0.3 length of chela, closing almost across end; with high crest proximally, distally expanded to appear bulbous. Chela with sparse, scattered setae distally, especially near fingers. Merus 2.2 times as long as broad, 1.7 times as long as broad across maximum breadth, 0.8 height of palm; superior distal margin produced but rounded, inferior internal margin with 7 short movable spines and poorly developed distal tooth. Inferior surface of ischium with 4 spines.

Small cheliped almost equal in total length to large cheliped, small chela about 0.75 as long as large chela. Chela 4 times as long as broad in female, 3.5 times as long as broad in male, fingers occupying 0.6 of length. Palm subcylindrical without pronounced sculpturing; articulation of dactylus flanked by acute teeth on each side; plaque crest slight, rounded. Fingers slightly broadened with tips crossing. Carpus with short, broad, rounded tooth on upper distal margin. Merus 3 times as long as broad in female, 2.2 times as long as broad in male, with 9 irregularly placed movable spines and small distal tooth on inferior internal margin.

Second legs lacking in type specimen. On paratypes, carpal articles with ratio 10 : 5-6 : 3-4 : 5-6 : 5-6. Chela about 0.8 length of first carpal article.

Ischium of third legs with strong movable spine. Merus 5 times as long as broad, unarmed. Carpus 0.6 length of merus, with superior margin projecting distad as acute tooth. Propodus almost 0.8 as long as merus, with 11 spines on inferior and distal margins. Dactylus 0.2 as long as merus, about 3 times as long as broad at base, curved, tip simple, superior surface with 2 notches.

Telson short and broad, length only 1.2 times breadth at base, breadth at tip 0.6 that

of base. Lateral margins slightly convex; posterior margin very slightly arcuate. Posterolaterally with only one pair of short spines; larger dorsal spines about 0.55 and 0.8 distance from base.

Maximum size: 33 mm. (type specimen).

DISCUSSION: Only slight variation was noted in seven specimens of this species available. There was the usual and expected variation in the proportions and lengths of appendages: in some the stylocerite was slightly shorter than the first antennular article, and in some it was as long; the length of the lateral spine of the basicerite also varied within narrow limits; the proportions of the large chela itself were quite constant, but the merus of the large cheliped was somewhat more variable in length, breadth, and armature, with the inferior internal tooth more highly developed in some than in the type; the small cheliped appeared to show the slight sexual dimorphism described above; the limits of the observed variation in the carpal articles is given above; the merus of the third legs ranged to almost six times as long as broad in some specimens; the number of spines on the propodus was as high as 11; the dactylus may have one to three superior serrations, and in some cases one of these serrations was developed into a lobe-like extension on the anterior surface; the telson was considerably more narrow and elongate, but still preserving the basic form.

The species is named in honor of the steamer "Albatross" of the United States Fish Commission which collected the type specimens in 1902.

RELATIONSHIP: This species plainly is closely related to *C. hailstonei* and its varieties; therefore it has been included in Table 2. There are a series of minor characteristics that would aid in the separation of this species from the varieties of *C. hailstonei* and *C. brachymerus*, but the most important ones are found in the large chela, in which the crest leading to the plaque is rounded instead of sharp and the dactylus has a bulbous end instead of a

narrow lobe-bearing end, and in the dactylus of the third legs which has marked superior serrations and no trace of inferior teeth.

This species is also related to *C. staphylinus* (Coutière). From the short description and plates of Coutière (1921: 418, pl. 62, fig. 13; note that this later description is exactly the same as the original description [1908: 14] and in addition has figures of the specimen) only small differences appear. The frontal region of the carapace is straighter and the orbital teeth are shorter in *C. staphylinus*; the large chela may be different although with the inadequate description and the drawing of the poorly rotated chela, it is difficult to tell; the small chela is more slender; and, most important, the dactylus of the third leg is longer and without the superior notches which are found in this species.

**DISTRIBUTION:** In addition to the type location given above, the species has been collected as follows:

"Albatross" Station 3873 (U.S.N.M. 63589), in Auau Channel between Maui and Lanai Islands, 32–37 fathoms; a male 23 mm. long.

Off southwest Oahu, 40–350 feet, collected by the "Makua" (specimens in the Bernice P. Bishop Museum); five specimens, male and female, from 20 to 29 mm. long.

*Crangon tutbilli* sp. nov.

Fig. 19 a–g

**TYPE SPECIMEN:** A 23 mm. ovigerous female, collected off southwest Oahu, 40–350 feet deep, by the "Makua." Sole specimen known. Specimen in the Bernice P. Bishop Museum.

**DESCRIPTION:** Rostrum small, reaching only to middle of visible portion of first antennular article, as broad as long, upper surface strongly depressed toward tip. Anterior carapace

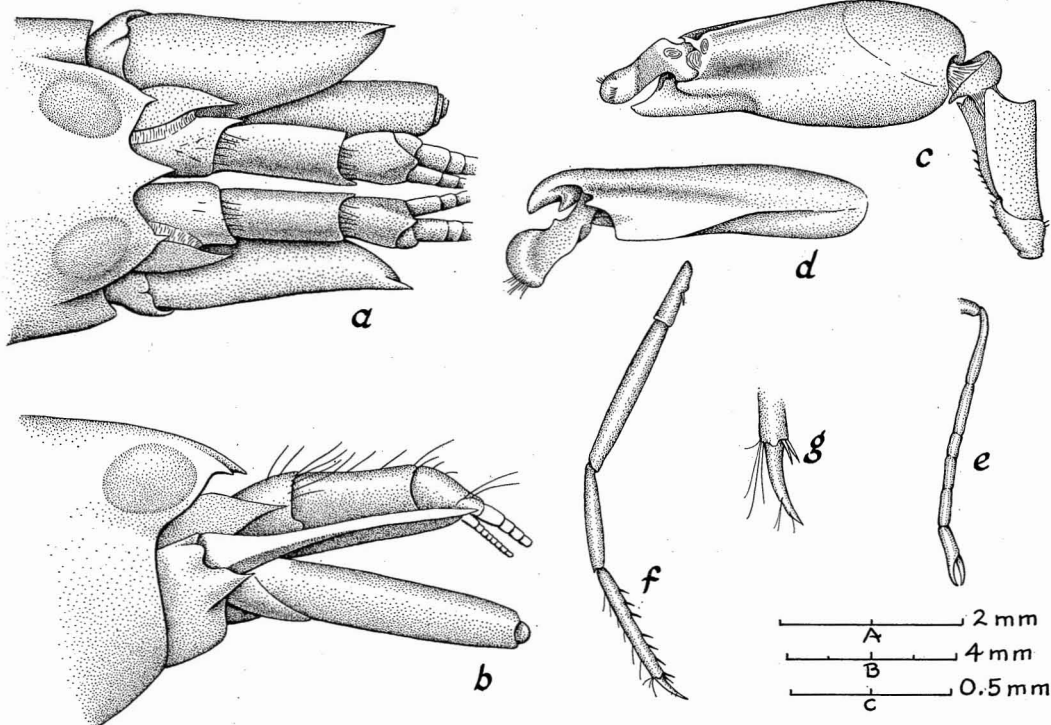


FIG. 19. *Crangon tutbilli* sp. nov. a, b, Anterior region, dorsal and lateral aspects; c, large cheliped, lateral aspect; d, large chela, superior face; e, second leg, distal end; f, third leg; g, third leg, dactylus. (a, b, scale A; c–f, scale B; g, scale C.)

smoothly rounded, without trace of orbito-rostral grooves. Orbital teeth short and narrow, reaching 0.7 length of rostrum.

Second antennular article 1.3 times as long as visible portion of first, 1.5 times as long as third, twice as long as broad. Stylocerite reaching end of first antennular article.

Lateral spine of basicerite strong, longer than rostrum, extending over 0.7 of length of first antennular article. Lateral margin of scaphocerite almost straight, tip of lateral spine reaching end of antennular peduncle; squamous portion only 0.05 shorter than spine. Carpocerite considerably longer than antennular peduncle.

Large chela only moderately heavy, 2.8 times as long as broad, compressed and with distal sculpturing reduced. [For terminology of crests and grooves see Fig. 17e.] Superior crest low, rounded, terminating as relatively small acute tooth above dactylar articulation. Transverse groove lacking. Superior groove shallow and broad. Plaque crest low, rounded, but merging with superior margin of palm. Palmar groove rounded, narrower than superior groove. Inferior ridge slight, rounded, distally ending as rounded protuberance below dactylar articulation. Inferior depression slight, shoulder low, gradual, and rounded. Dactylus similar to that of *C. albatrossae* Banner, with proximal portion narrow and crested, distal portion expanded and bulbous. Carpus of usual form. Merus equal in length to height of palm, 2.7 times as long as breadth of outer face, 1.6 times as long as maximum breadth; superior margin rounded, unarmed; superior distal angle slightly projecting but rounded; inferior internal margin with 8 small spines and large terminal tooth. Ischium with 2 spines on superior margin, 5 on inferior margin.

Small cheliped lost.

Carpal articles of second legs with ratio 10 : 6 : 4 : 4 : 6.

Third legs with ischium 0.4 length of merus, armed with strong spine. Merus 7 times as long as broad, unarmed. Carpus 0.6 as long

as merus, with acute distal projection of superior margin. Propodus 0.8 as long as merus, with 8 inferior and distal spines. Dactylus 0.25 as long as merus, curved, acute, with 2 superior serrations, no trace of inferior teeth.

DISCUSSION: This single specimen came from the same dredge haul that produced the paratypes of *C. albatrossae* Banner and superficially is very similar to them. The basis for separation of the species from the other species of the *C. hailstonei* complex is given in Table 2. Probably the most valid and least variable characteristics that will serve for the identification of this species are the nature of the anterior region of the carapace, the rostrum being much shorter and broader than that of the other species, and the lack of the transverse groove on the large chela.

Unfortunately, with only one specimen available, it cannot be determined whether this specimen represents a heretofore uncollected species or merely an aberrant individual, probably of *C. albatrossae*. Minor genetic mutations could account for the differences between this and the typical *C. albatrossae*. The fact that the specimen was collected with a series of specimens of *C. albatrossae* would incline one toward that belief, but of course in a half-hour dredge haul there is no reason to suppose that all the specimens came from exactly the same habitat. However, the characteristics mentioned above and some of the more minor characteristics, such as the thickness of the second antennular article, appear to be rather constant within a species of this group. For these reasons it was decided to designate this specimen a species.

The species is named in honor of Dr. Leonard D. Tuthill, Department of Zoology and Entomology, University of Hawaii.

*Crangon oahuensis* sp. nov.

Fig. 20 a-m

TYPE SPECIMEN: A male 27 mm. long collected from coral in water about 20 feet deep off Waikiki Reef, Oahu (U.S.N.M. 93455).

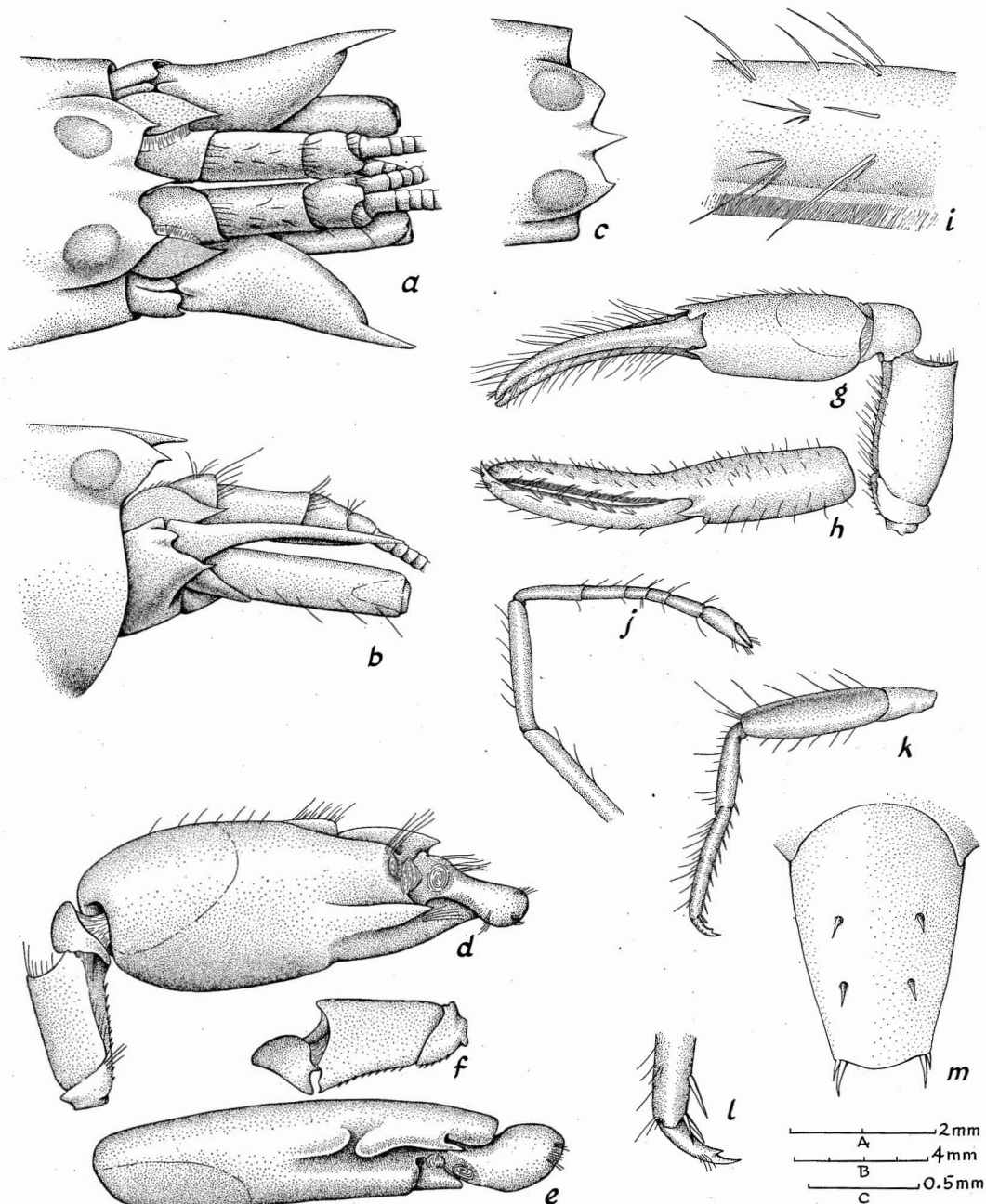


FIG. 20. *Crangon oahuensis* sp. nov. *a, b*, Anterior region, dorsal and lateral aspects; *c*, anterior carapace, dorsal aspect, showing asymmetrical development of orbital hoods; *d*, large cheliped, lateral aspect; *e*, large chela, superior face; *f*, large cheliped, merus, internal face; *g*, small cheliped, lateral aspect; *h*, small chela, superior face; *i*, small chela, section of dactylus showing ridge; *j*, second leg; *k*, third leg; *l*, third leg, dactylus; *m*, telson. (*a-c, m*, scale A; *d-h, j, k*, scale B; *i, l*, scale C.)

DESCRIPTION: Rostrum almost 1.5 times as long as broad, with tip reaching 0.7 of length of first antennular article; rostrum and rostral base slightly rounded dorsally, not carinate. Orbital hoods not inflated. Orbital teeth reaching about 0.7 of length of rostrum. Orbitorostral furrows slight, shallow, and broad; anterior margin between base of rostrum and base of orbital teeth very slightly convex, but at angle of about  $30^\circ$  to transverse line of body.

Second article of antennular peduncle twice as long as broad, 1.4 times length of first article, 1.5 times length of third article. Stylocerite reaching slightly beyond end of first antennular article. Lateral spine of basicerite acute, tip reaching to end of first antennular article. [In the type specimen, the spines are developed asymmetrically, with that of one side as described and that of the other rounded anteriorly, shorter than the rostrum.] Lateral margin of scaphocerite only slightly concave; spine 0.8 longer than squamous portion; squamous portion reaching end of antennular peduncle. Carpocerite equal in length to spine of scaphocerite.

Large chela heavy, 2.5 times as long as high, compressed, 1.6 times as high as thick, distally sculptured. [For terminology of crests and grooves, see Fig. 17e.] Superior crest well developed, terminating distally as strong acute tooth above dactylar articulation, proximally merging with superior margin. Transverse groove deep, abrupt. Superior groove deep and well defined. Plaque crest rounded but heavy, merging proximally with superior margin of palm. Palmar groove with upper margin poorly defined, lower margin abrupt. Inferior crest rounded, strong, terminating as strong, acute tooth below dactylar articulation. Inferior depression shallow; shoulder low, gradual and rounded. Dactylus, occupying distal 0.25 of chela, distorted, hammer-shaped, end bulbous, middle thin, crested, and twisted; outer surface of dactylus with 3 grooves armed with short stiff setae. Chela with numerous short to medium bristles on

distal 0.5 of inner face. Merus twice as long as broad, with superior margin terminated by short obtuse tooth; inferior internal margin with 9 small movable spines and strong subterminal tooth. Ischium with rounded projection on superior margin, inferior margin with 5 spinules similar to those on merus.

Small chela in both sexes of peculiar form, with palm slightly over twice as long as broad, but with dactylus long, slender, and curved, 1.4 times length of palm, when seen in lateral view (as in Fig. 20g) over 11 times as long as broad in middle; fingers curved in both planes, tips cross slightly. Superior side of opposing face of fingers with thin ridge except where tips curve and cross; ridge with close series of fine rugae (Fig. 20i); on interior side of ridge opposing faces with orderly series of short stiff setae. Articulation of dactylus flanked on each side by strong acute teeth. Merus slightly over twice as long as broad, slightly heavier than that of large chela, with similar armature except spinules more numerous and subterminal tooth smaller. Small chela 0.8 as long as large chela.

Carpal articles of second legs with ratio 10 : 9 : 4 : 4 : 6.

Third legs with ischium unarmed. Merus 3.4 times as long as broad, unarmed. Carpus 0.5 length of merus, superior distal angle projecting but rounded; inferior margin with 2 nearly spine-like bristles in type specimen, with distal angle rounded, not projecting. Propodus 0.75 as long as merus, with 10 long slender spines on inferior and inferodistal margins. Dactylus 0.2 as long as merus, curved, with small secondary unguis on inferior margin.

Telson 1.5 times as long as broad, base 1.7 times as broad as tip; lateral margins somewhat convex; distal margin arcuate.

DISCUSSION: The 12 specimens of this species at hand show some variation, especially those of smaller size when compared to the large specimen designated as the type. The general form and appearance was the same in all cases, but in some of the smaller specimens



the articles of the antennular peduncle were shorter and broader (second article ranges to 1.7 times as long as broad); the stylocerite was shorter than the first antennular article; the relative lengths of the antennular peduncle, the scaphocerite, and the carpocerite were not constant; the number of spines on the merus of the large and small chelae varied, but in all cases were numerous; the second carpal article was at times 0.7 or 0.8 the length of the first, with the other articles varying to a similar degree; the merus of the third legs was more slender, up to 4.0 times as long as broad; and finally, the number of spines on the propodus of the third legs usually was less than the 10 spines of the type specimen, often around six or seven.

The most remarkable variation was observed in the orbital teeth of three specimens. Two specimens, one shown in Figure 20c, had the orbital teeth asymmetrically developed, with a tooth of the usual type on one side and the other side terminating in an obtuse non-projecting angle. The third specimen was lacking in the orbital teeth on both sides.

This species has been named after the island from which it was collected.

**RELATIONSHIP:** This species apparently belongs to the group of species designated in this paper as the *C. bailstonei* complex, and for that reason its characteristics have been set forth in Table 2. It can easily be separated from all other members of this complex and from *C. seurati* (Coutière) (which probably also belongs in the complex) by the extraordinary elongation and great thinness of the fingers of the small chela and by the strong biunguiculation of the dactylus of the third legs. Other characteristics which will separate the species from one or several of the group are the size of the rostrum, the heaviness of the antennular peduncle, the rounded condition of the palmar crest and the bulbous dactylus of the large chela, the relatively longer second carpal article of the second legs, the breadth of the merus of the third legs, and the lack of the ischial spine on these legs.

**DISTRIBUTION:** This species is represented by 13 specimens which were collected on Oahu at Hanauma Bay, Kahala, Waikiki, and Nanakuli (all except the Kahala specimen from water 10 to 20 feet deep) and on Hawaii at Halape on the Kau Coast, one specimen from 10 feet, one from 40 feet deep, the last two collected by R. W. Hiatt.

### *Crangon collumiana* (Stimpson)

Fig. 21 a-b

*Alpheus collumianus* Stimpson, Acad. Nat. Sci. Phila., Proc. 12: 30, 1860.

**DESCRIPTION:** Rostrum acute, short, reaching to middle of visible portion of first antennular articles, demarked laterally from orbital hoods by abrupt depressions, with small rostral carina that extends posteriorly between orbital hoods. Orbital hoods rounded with anteriolateral margins produced into acute teeth as long as rostrum. Margin between base of rostrum and orbital teeth convex.

Lateral spine of stylocerite acute, reaching beyond rostrum nearly to end of first antennular article. Second article of antennular peduncle usually 1.8 times length of visible portion of first article, 1.7 times length of third article. Lateral spine of basicerite long, acute, reaching beyond end of first antennular article. Scaphocerite with strong lateral spine that exceeds squamous portion by about 0.25, usually reaching end of antennular peduncle. Tip of carpocerite extending beyond end of scaphocerite.

Large chela 2.3 times as long as broad, laterally compressed and distally sculptured. [For terminology of crests and grooves, see Fig. 17e.] Superior crest heavy, rounded, terminating distally as strong subacute tooth above dactylar articulation; merging with superior margin of palm almost immediately proximal to transverse groove. Transverse groove deep, abrupt, and merging with superior groove. Superior groove deep, broad, but terminating immediately proximad of transverse groove. Plaque crest rounded, heavy, and well defined

but not merging with superior margin of palm. Palmar groove narrow and deep, reaching only about 0.3 length of palm. Inferior crest heavy, rounded, terminating distally as strong, acute tooth below dactylar articulation. Inferior depression moderately developed; shoulder heavy but rounded. Dactylus short, about 0.25 length of entire chela, rotated to close almost distally across end of chela. Chela moderately setose, with numerous groups of setae on inner face, superior and inferior margins, and about edge of fingers. Merus less than twice as long as broad, without spines, with superior and inferior internal margins slightly produced and rounded.

Small chela somewhat heavy. Palm 1.5 times as long as wide, distally with superior crest well developed and ending as projecting tooth which flanks articulation of dactylus. Fingers about equal in length to palm, distally strongly hooked. Carpus with flat tooth on superior distal margin. Merus over twice as long as wide, without spines.

Carpal articles of second legs with ratio 10 : 9 : 4 : 4 : 7.

Ischium of third legs with movable spine. Merus 3.3 times as long as wide, armed with strong but rounded tooth on inferior distal margin. Carpus with superior margin ending distally in acute dentate projection. Propodus with 5-6 sets of strong movable spines along inferior margin. Dactylus biunguiculate, with inferior tooth small and located in distal 0.25 of article.

Largest specimens in collection 20 mm. long. In life body mostly transparent with red and yellow chromatophores, legs with yellow and green chromatophores; superior surface of chelae olive drab.

DISCUSSION: This species does not seem to exhibit the wide range of variation found in some. However, the following variations were noted:

1. The length of the second antennular article varied from 1.5 to 2.0 times the length of the visible portion of the first article; in most specimens about 1.7 or 1.8 times as long.

2. In some specimens the scaphocerite was equal in length or slightly shorter than the antennular peduncle; in others it was slightly longer than the carpoperite. The carpoperite, usually markedly longer than the antennular peduncle, in a few cases was equal to it.

3. In most specimens the small chela was markedly smaller than the large chela, as in the one drawn; in a few of the larger ones it was almost 0.8 the length of the large chela and similar in form to the small chela of *C. deuteropus* (Hilgendorf) (Fig. 22e).

4. The second carpal article of the second legs was usually about 0.9 the length of the first but varied from 0.8 to 1.0 times as long.

5. The merus of the third legs in a few specimens carried one or two weak spines, and the inferior tooth, usually acute with an angle of 60 or 70 degrees, was in some cases obtuse with an angle of more than 100 degrees.

The Hawaiian form of this species differs from Stimpson's original description chiefly in the nature of the third and fourth legs, which he describes as, "Pedes tertii quartique . . . mero lato, inferne spinuloso et apicem unidentato. . . ." In the Hawaiian forms, the few specimens with feeble spinules on the merus would hardly be called spinose. The specimen described by de Man (1911: 334) had one or two small movable spines on the carpus of the third legs which are lacking in the Hawaiian specimens. Finally, in de Man's plates (pl. 14, figs. 65, 65a) the superior ridge of the large chela merges with the surface of the palm without any abrupt groove demarking it as in the Hawaiian form. These two characteristics of de Man's specimen were not remarked upon in the original description. These differences are minor and probably insignificant.

The three specimens listed below, which were collected by the "Albatross," had been examined but not published upon by Cou-tière. The Laysan specimen ("Albatross" Station 3962) was given a manuscript name for a new species. The specimen had recently

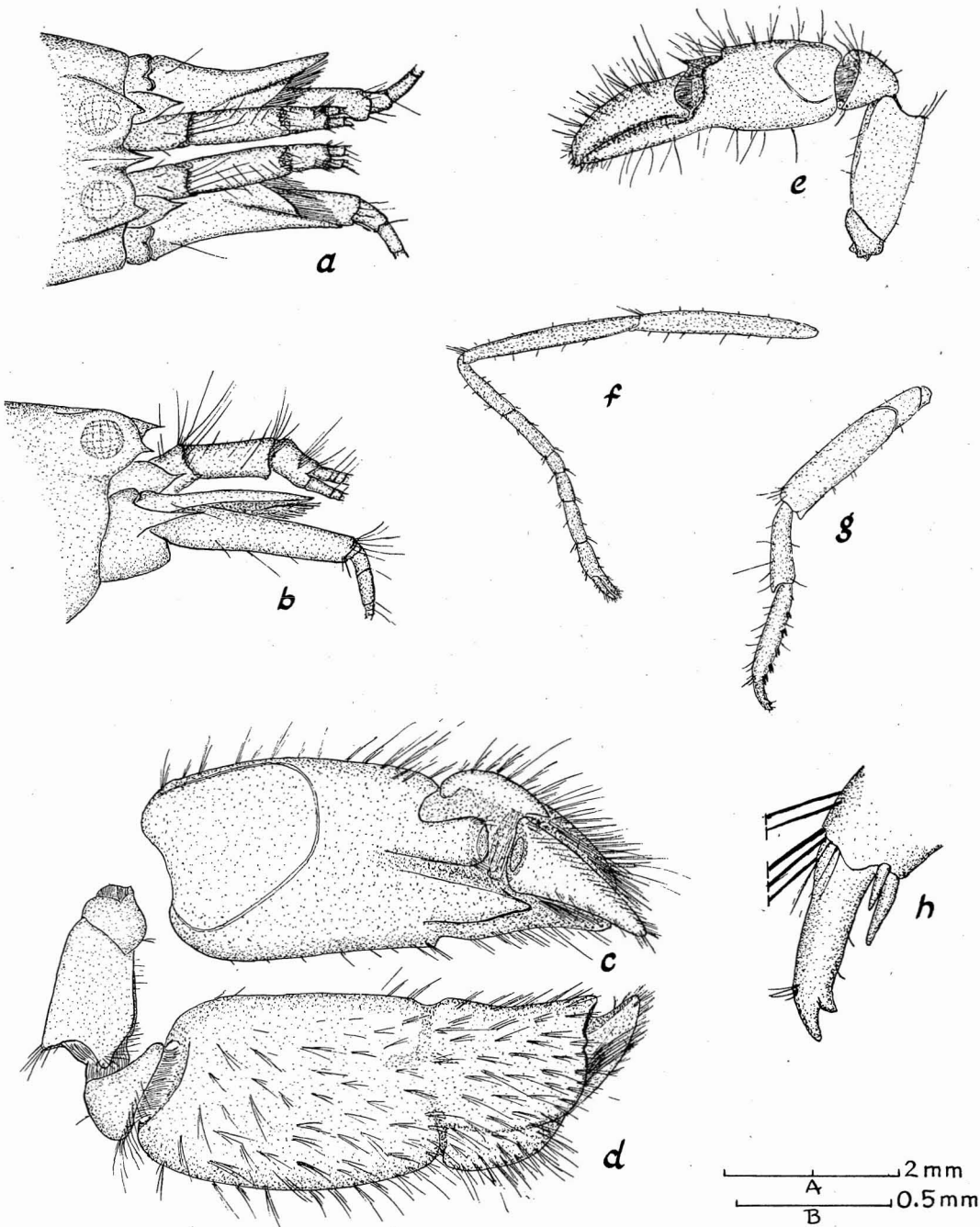


FIG. 21. *Crangon collumiana* (Stimpson). *a, b*, Anterior region, dorsal and lateral aspects; *c*, large chela, lateral aspect; *d*, large chela, medial aspect; *e*, small chela; *f*, second leg; *g*, third leg; *h*, third leg, dactylus. (*a-g*, scale A; *h*, scale B.)

molted, and its chitin was soft and distorted; however, close examination showed only one difference from the specimens described above: there were two spines on the carpus of the third legs (therefore more like the specimen described by de Man). The other two specimens, which Coutière had identified as *C. dentipes* (Guerin)—a species never reported in the Indo-Pacific—showed no characteristics that would distinguish them from *C. columiana* as identified in this paper.

**DISTRIBUTION:** This rather common species has been collected from the reef flats and from waters ranging to 20 feet deep at the following localities around Oahu: Waimanalo, Hanauma Bay, Black Point, Waikiki, Mokuleia, Haleiwa, Kawela Bay. It was dredged from 100–200 feet off Diamond Head and from 180 feet off Kaena Point, where it was found living in sponges. Off Maui it was collected at Makena, Kalama Park, Lahaina, and two localities south of Lahaina. The "Albatross" specimens came from off Laysan, 16 fathoms (Station 3962, U.S.N.M. 63596), off French Frigate Shoal in 14½–16½ fathoms (Station 3968, U.S.N.M. 63509), and off Nihoa, 24–40 fathoms (Station 4163, U.S.N.M. 63510). Edmondson (1925) has reported the species from Pearl and Hermes Reef, Laysan, Lisianski, and Ocean Islands.

Edmondson (1925) has also reported the species from Johnston, Wake, and Palmyra Islands in the central Pacific. The species has been otherwise reported from Djibouti, at the mouth of the Red Sea, through the Indian Ocean and western Pacific to Japan. The type locality is the Bonin Islands.

### ***Crangon deuteropos* (Hilgendorf)**

Fig. 22 a–g

*Alpheus deuteropos* Hilgendorf, K. Akad. Wiss. Berlin, Monats. 1878: 834.

**DESCRIPTION:** Rostrum acute, curved abruptly upward near tip; tip reaching about to middle of visible portion of first antennular article, posteriorly continued as distinct ro-

stral carina; base separated from orbital hoods by depression. Orbital hoods rounded except for acute orbital teeth which equal rostrum in length. Margin between orbital teeth and rostrum straight to slightly arcuate.

Antennular peduncle long and slender, with second article slightly less than 1.5 times as long as visible portion of first, about twice as long as third. Lateral spine of stylocerite from 0.7 as long to as long as first antennular article. Entire antennular peduncle densely hirsute. Lateral spine of scaphocerite strong, 1.25 times as long as narrow squamous portion; outer margin strongly concave. Lateral spine of basicerite strong, extending beyond end of rostrum. Carpocerite hirsute. Scaphocerite usually not reaching end of last antennular article; carpocerite almost always longer than both antennular peduncle and scaphocerite. [The specimen drawn in Figure 22a is abnormal in these relationships.]

Chelae very densely hirsute on inner face and superior portion of outer face; structure obscured by setae. Hirsute surfaces papillose where bundles of setae are attached. Large chela strongly compressed, ovate in shape, about twice as long as high. Fingers approximately 0.2 as long as entire chela. [For terminology of crests and grooves, see Fig. 17e.] Superior crest strong, rounded, distally projecting as long, subacute tooth, proximally ending in transverse groove. Transverse groove deep. Superior groove deep but short. Plaque crest heavy, soon merging with face of palm. Inferior crest heavy, well defined but not extending proximad to shoulder of inferior depression, distally ending in strong, acute tooth. Inferior depression shallow; shoulder slight and rounded. Short immovable finger emarginate at tip to receive dactylus. Dactylus rotated to close laterally and distally across end of chela, compressed and sharply carinate. Carpus relatively large. Merus heavy, without teeth, with superior distal angle subacute.

Small chela large, 0.8 as long as large chela, ovate, densely hirsute on inner face. Fingers

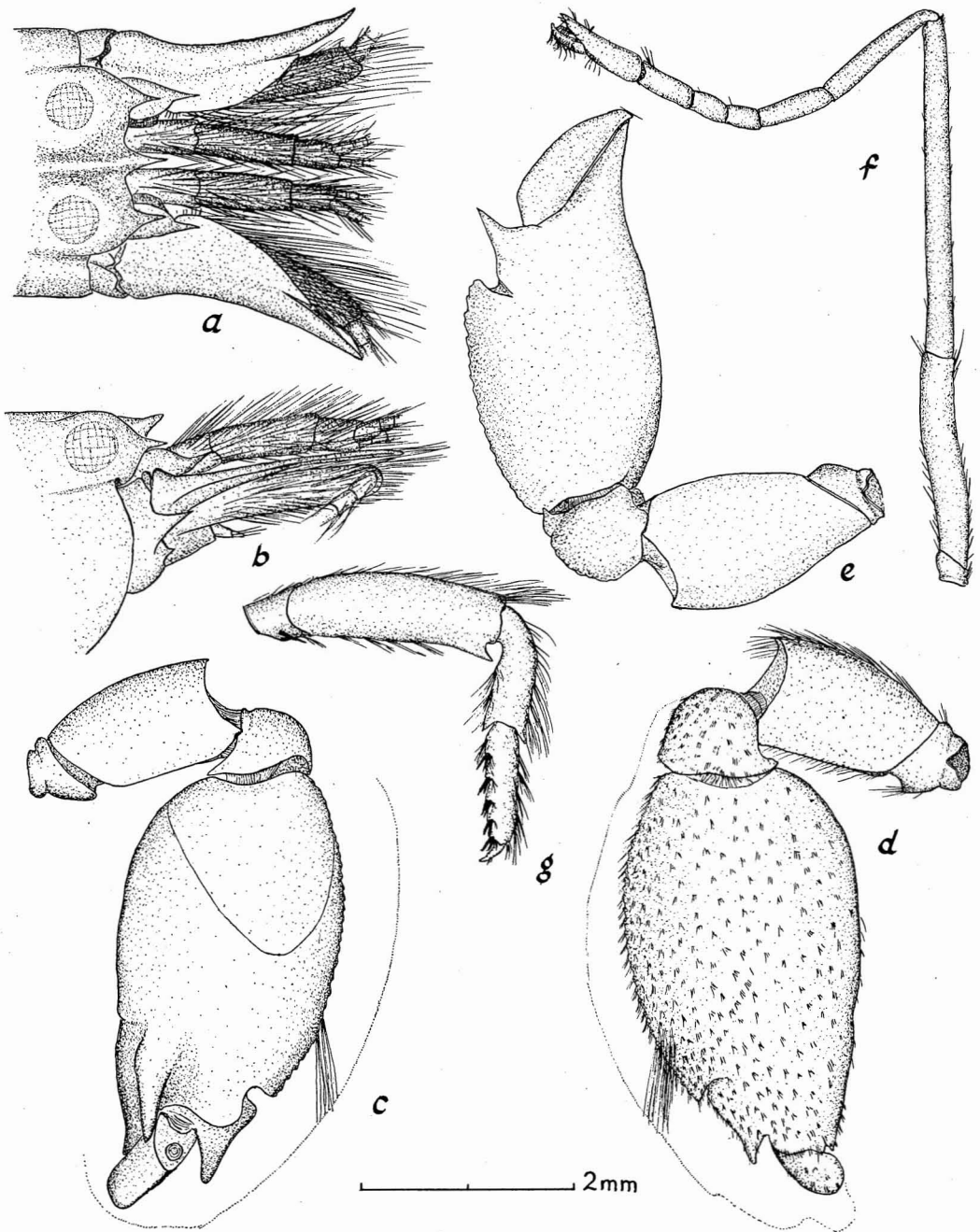


FIG. 22. *Crangon deuteropus* (Hilgendorf). *a*, *b*, Anterior region, dorsal and lateral aspects; *c*, large cheliped, lateral aspect, setae not shown; *d*, large cheliped, medial aspect, only bases of setae shown, length indicated by dotted line; *e*, small cheliped, medial aspect, setae not shown; *f*, second leg; *g*, third leg.

slightly over 0.5 length of palm. Distal portion of superior crest well developed, ending distally in very large, acute, projecting tooth, ending proximally in transverse groove. Other grooves and crests not developed. Fingers laterally compressed, thin at cutting edge. Carpus heavy, with rounded to acute flat tooth superior to point of articulation of propodus. Merus heavy, only twice as long as wide, without teeth.

Second legs only lightly hirsute. Carpal articles with ratio 10 : 5 : 2 : 3 : 4 (in specimen drawn).

Third legs compressed and wide. Ischium with long spine. Merus 3.5 times as long as wide, strong tooth on inferior distal edge, lined by long setae along superior margin. Carpus also lined by setae on both edges; each distal margin projecting as acute tooth. Propodus with superior edge lined by setae, inferior edge with 5 pairs of movable spines and unpaired proximal spine. Dactylus short, simple, acute, strongly curved.

Specimens range to 35 mm. long. In life mostly colorless with scattered small red chromatophores on body and greenish-brown tracing of margins of anterior body regions and appendages; chelae with dark greenish cast.

**DISCUSSION:** The 50 specimens of this species from Oahu were examined in detail and the following variations were noted:

1. The rostrum varied from slightly shorter to slightly longer than the orbital teeth.

2. The frontal margin of the carapace between the rostrum and the orbital teeth varied from almost straight to definitely arcuate.

3. The length of the stylocerite and the relative lengths of the scaphocerite, carpocerite, and antennular peduncle varied as noted in the description. Usually the scaphocerite reached to somewhat past the middle of the third antennular article.

4. The second carpal article of the second legs varied from 0.55 to 0.85 times the length of the first article, usually being about 0.6 to 0.7 its length. The distal articles appeared to

bear a more fixed relationship to the length of the second article than to the length of the first article.

5. The number of spines of the propodus of the third legs varied from five to seven pairs.

The smallest specimens, 8 millimeters long, as well as the largest, 35 millimeters long, were within this range of variation, and no particular variation was correlated with the growth differences.

If one considers that Hilgendorf described the small chela as if it were the large chela—if he did not, his was a most aberrant crangonid—the Hawaiian form of this species does not differ from the original description in any way that is not covered by the observed variation.

**DISTRIBUTION:** The species has been collected, mostly in water from 6 to 20 feet deep, at the following localities about Oahu: Kaneohe Bay, Waimanalo, Hanauma Bay, Waikiki, Nanakuli, Kawela Bay. One specimen was dredged from water 100 feet deep off Waimanalo. Off Maui it was collected at five localities north and south of Lahaina. Edmondson (1925) reported the species from French Frigate Shoal; the Bernice P. Bishop Museum has two unreported specimens from Pearl and Hermes Reef.

Elsewhere the species has been reported in the Pacific only from the Netherlands Indies, but within the Indian Ocean it has been collected at various points, including the Maldivé Archipelago and the east coast of Africa,

### *Crangon paradenitipes* (Coutière)

Figs. 23 a-i, 24 a-b

*Alpheus paradenitipes* Coutière, Fauna and Geog. Mald. and Laccad. 2(4): 880, pl. 74, fig. 17, 1905.

**DESCRIPTION:** Rostrum short, reaching only to near middle of first antennular article, narrow, rather flattened on top, with carina extending only short distance on anterior carapace. Orbital hoods not inflated, anterior



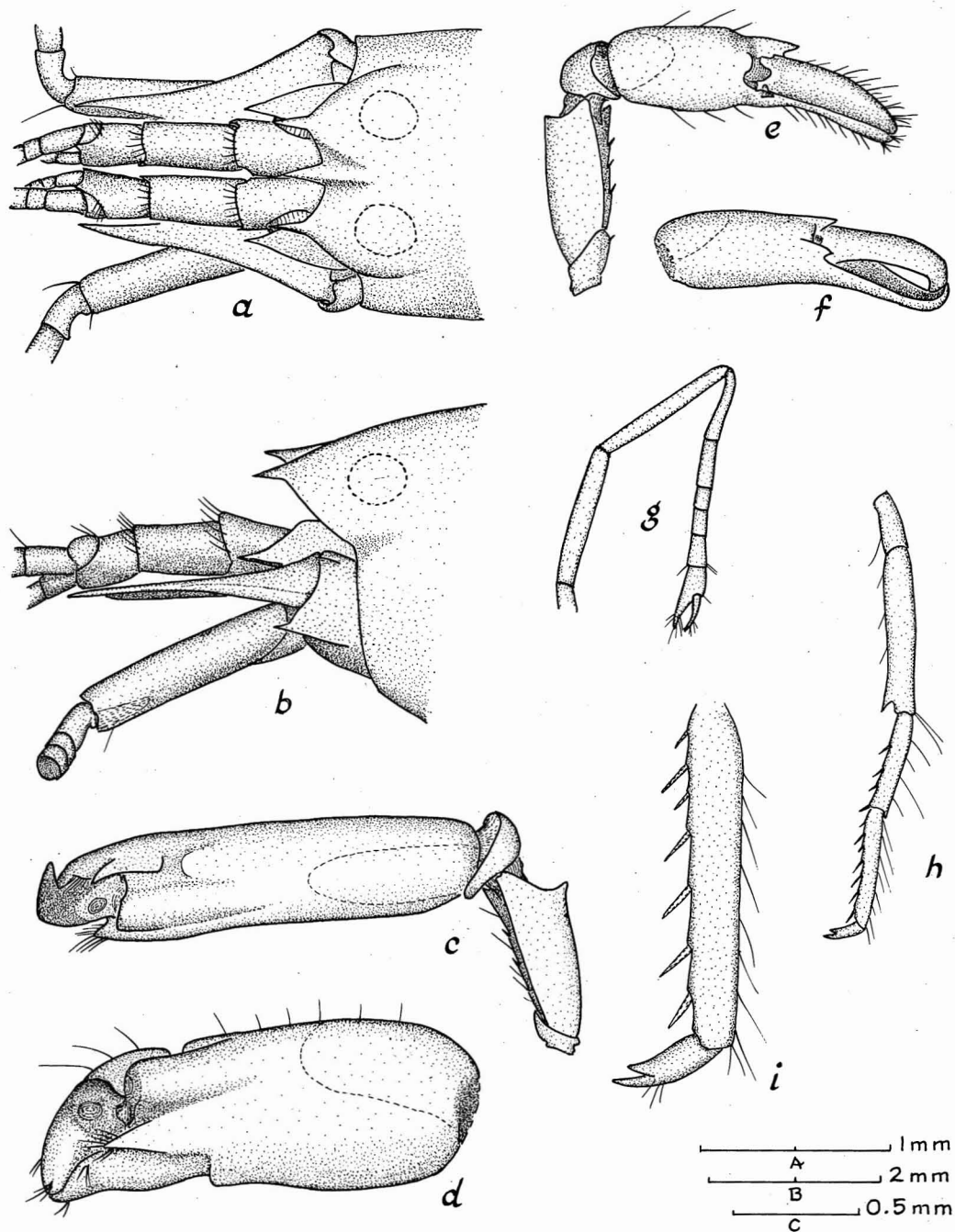


FIG. 23. *Crangon paracentipes* (Coutière). *a, b*, Anterior region, dorsal and lateral aspects; *c*, large cheliped, lateral aspect; *d*, large chela, ventral aspect; *e, f*, small chela, female, lateral and ventral aspects; *g*, second leg; *h*, third leg; *i*, third leg, propodus and dactylus. (*a, b*, scale A; *c-h*, scale B; *i*, scale C.)

margin not continuous curve, with acute orbital teeth that extend beyond tip of rostrum. Anterodorsal surface of carapace somewhat depressed; orbitorostral furrows very broad and shallow, not reaching as far posteriorly as posterior edge of eyes; anterior margin between rostral base and base of orbital spines almost straight, forming angle of about  $30^\circ$  to transverse line of body, base of orbital spines advanced.

Second article of antennular peduncle twice as long as broad, equal in length to visible portion of basal article, 1.3 times as long as distal article. Spine of stylocerite reaching to end of first article. Lateral spine of basicerite poorly developed but reaching to end of rostrum. Scaphocerite equal in length to antennular peduncle, slightly exceeded by carpocerite.

Large chela heavy, 2.5 times as long as broad, compressed, 1.7 times as high as thick, with pronounced sculpturing distally. [For terminology of crests and grooves, see Fig. 17e.] Superior crest high and thin, continuing distally as strong acute tooth lying above dactylar articulation; soon merging with superior margin of palm proximal to transverse groove. Transverse groove broad and deep. Superior groove rather deep. Plaque crest heavy, rounded. Palmar groove deep. Inferior crest flattened with margins rounded, distally projecting as strong, acute tooth below dactylar articulation. Inferior depression extensive and deep; shoulder slightly overhanging but without sharp margins. Dactylus strongly compressed, curved, distorted; only 0.2 length of entire chela because of distortion; chela rotated so finger closes horizontally almost across end of palm. Merus 3 times as long as broad, with superior margin terminated by acute tooth and inferior internal margin with 2 spines and subterminal tooth. Ischium also with small spine.

Small chela of female 3.5 times as long as broad, with fingers 0.5 of length. Articulation of dactylus flanked on each side by strong teeth. Fingers with tips bent at  $90^\circ$  and crossing. Merus with 3 spines and small distal

tooth on inferior internal margin; ischium also with spine. [No male in the collection with the small chela intact, but according to Coutière the male chela has the fingers broadened but not hooked.]

Carpal articles of second legs with ratio 10 : 7 : 3 : 4 : 5.

Merus of third legs almost 6 times as long as broad, armed with strong subterminal tooth. Carpus 0.6 as long as merus, with small acute projection on superior distal margin; inferior margin with 4 movable spines, most distal one on inferior distal angle. Propodus 0.7 as long as merus, with 7 spines on inferior margin but none distally. Dactylus 0.3 as long as propodus, biunguiculate with inferior unguis shorter than superior.

Telson twice as wide at base as at tip, 1.8 times as long as broad at tip; lateral margins slightly convex; posterior margin arcuate.

Largest specimen, a female, 10 mm. long; color in life not noted.

DISCUSSION: The few specimens in the present collection show but little variation; in some the orbital teeth are slightly longer than in the specimen described; in some the lateral spine of the basicerite is better developed; the number of movable spines on the merus of the large chela is as great as five. The expected variation in the number of spines on the carpus and propodus of the third legs was observed. One interesting specimen from the "Albatross" collection had its sole remaining second leg with the carpus divided into six rather than five articles; it appeared as if an extra article was inserted between the normal first and second articles.

Allowing for the variation observed, these specimens agree well with the descriptions and figures of Coutière. I believe that the difference in the merus of the large chela, which was described as bearing on "son bord supéro-interne [*sic*] . . . 7-8 denté . . ." and which was shown as being serrate on the inferior internal margin, probably normally carried movable spinules as do the specimens described above. Otherwise there are no marked differences.

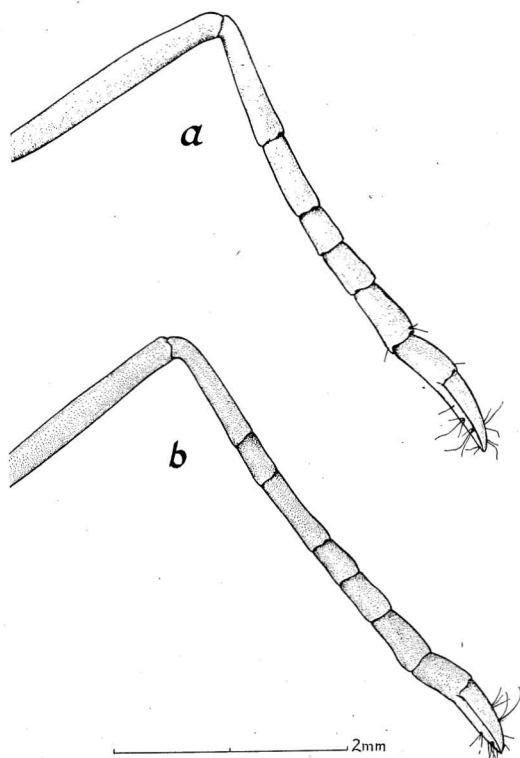


FIG. 24. *Crangon paradentipes* (Coutière). *a*, Normal second leg from specimen from "Albatross" Station 4063; *b*, second leg with a carpus of six articles from specimen from an undesignated "Albatross" Station (U.S.N.M. 63600).

**DISTRIBUTION:** This species is one of the few that have been found in sponges in Hawaii, a common habitat for some species in other parts of the world. However, of the four separate collections of the individuals noted below, only one was noted as coming from a sponge; whether the others did or not is not known.

All records of the species probably are from deep water beyond the reefs; two were from Oahu, off Kaena Point, 180 feet (in sponge), and off Diamond Head, 100–200 feet; one taken by the "Albatross" was from northeast of Hawaii in 61–63 fathoms (Station 4063, U.S.N.M. 63601); the fourth, also taken by the "Albatross," merely states "Hawaiian Islands" (U.S.N.M. 63600).

The species is also known from the Laccadive Archipelago, its type locality, from other

localities in the Indian Ocean, and from the Netherlands Indies.

#### Macrochirus Group

*Crangon gracilis* (Heller) var. *simplex*  
var. nov.

Fig. 25 *a–k*

*Alpheus gracilis* Heller, K. Akad. Wiss., Wien, Sitzungber. 44: 271, Taf. 3, figs. 19–20, 1861.

**TYPE SPECIMEN:** A male 12 mm. long, collected on Waikiki Reef, Oahu (U.S.N.M. 93456).

**DESCRIPTION:** Rostrum acute, rounded dorsally, without carina; tip reaching from slightly past middle of visible portion to end of first antennular article. Rostrum separated from orbital hoods by rounded shallow depression. Orbital hoods rounded, with small acute orbital teeth, well demarked from curvature of hoods; tips reaching almost to end of rostrum.

Antennular peduncles with second article somewhat longer than broad and shorter than visible portion of first or third. Stylocerite large, lateral spine reaching past middle of second antennular article. Lateral spine of basicerite from shorter to longer than rostrum. Scaphocerite with strong lateral spine slightly longer than antennular peduncle and shorter than carpocerite.

Large chela strongly compressed, slightly over 0.5 as thick as high, 2.5 times as long as high, without lobes or grooves. Shallow rounded depression on superior internal face proximal to articulation of dactylus, similar concavity on inferior internal face inferior to point of articulation. Fingers 0.3 length of chela. Chela almost glabrous except for usual bristles near tip of fingers and few scattered setae along superior and inferior margins. Merus without teeth, with 4–6 short spines along inferior internal margin. Small chela with fingers longer than palm, with tooth at point of articulation of dactylus; merus with armature similar to that of large chela.

Carpal articles of second legs with ratio 10 : 6 : 3 : 3 : 6.

Ischium and merus unarmed; merus 4-5 times as long as broad; propodus tapering distally, with proximal end about 1.5 times width of distal; inferior margin with 6-8 long slender spines; dactylus slender, 0.25 length of merus, simple, with slight convexity on inferior margin at point where lower unguis would be expected.

Telson with sides rather straight and with pronounced taper, 1.8 times as wide as long at posterior margin. External spine of uropods almost always brown to black.

Specimens in collection range to 18 mm. in length. In life, body and chelae transversely banded with broad gray bands of red and blue chromatophores; eggs brilliant yellow. Transverse bands red in preserved specimens.

DISCUSSION: This species varies in a number of characteristics. The rostrum, which in most extends only to the middle of the visible portion of the first antennular article, in some specimens reaches to the end of that article and in one specimen extends to one third of the second article. In some specimens there is a faint trace of an obtusely angular dorsal carina on the rostral base. The orbital teeth vary in breadth and length, sometimes being almost as long as the rostrum and sometimes only half as long (contrast Fig. 25a and c); in all cases, however, the teeth arise abruptly from a uniformly curved anterior margin of the orbital hood. There are variations, as would be expected, in the lengths of the styllocerite and of the lateral spine of the basicerite, the latter in a few cases exceeds the length of the rostrum. The small and large chelae vary somewhat in their proportions but their general form and armature remain constant as shown. The second carpal article of the second legs varies from 0.5 to 0.7 the length of the first, with a similar variation in the other articles as well. On the third legs the variation of the breadth of the merus and the number of spines on the propodus is noted above. Variations were also noticed in the propor-

tions of the telson where a series of six specimens gave differences in the ratio of the width of the posterior border to the greatest width of 1.6-2.0, and in the ratio of the width of the posterior border to the length of 2.4-3.0. A most peculiar variation was observed in the external spine of the uropods: in 40 specimens all but 5 have brown to black spines, 2 have spines with faint color, and 3 have colorless spines. This change of color is not the result of the solvent action of the preserving fluid (formaldehyde or alcohol), as some specimens preserved over 14 years still have the spines as dark as the newly preserved ones. Perhaps the variation may be the result of moulting, for several of the specimens with slightly colored or colorless spines have what appears to be softer chitin.

The varietal name refers to the lack of a secondary unguis on the dactylus of the third leg.

RELATIONSHIP: There have been four descriptions published for this species and its varieties. The type specimen first described by Heller was subsequently redescribed by de Man (1911), who corrected some errors found in Heller's description and also extended the original description. Coupled with this redescription, de Man also described a tentative variety, *C. gracilis* var. *luciparensis* which he distinguished from Heller's type specimen chiefly by minor differences in the proportions of the various appendages and by the external spine of the uropods being black instead of brown. It is interesting that the variations noted above are sufficient to bridge these differences. Coutière (1905) described *C. gracilis* var. *alluaudi* from Mahé which was distinguished from the main species by the lack of a secondary unguis, and on all other points. "ces spécimens me paraissent impossibles à distinguer de l'*A. gracilis*." One is at a loss to know whether the specimens were exactly like Heller's erroneous description, therefore different from the type specimen, or exactly like the type specimen.

The Hawaiian form here described is distinguished from the original species and from

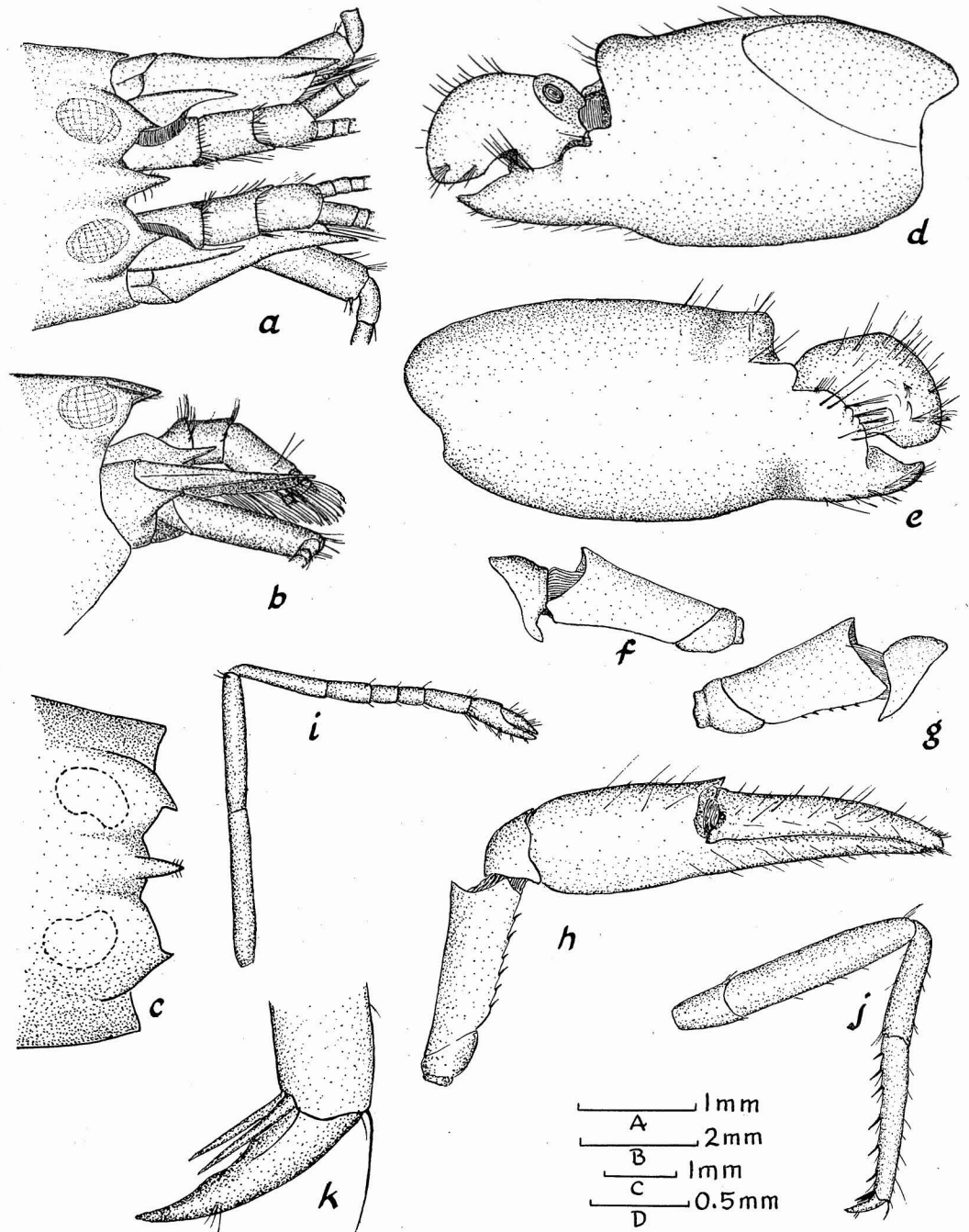


FIG. 25. *Crangon gracilis* (Heller) var. *simplex* var. nov. *a, b*, Anterior region, dorsal and lateral aspects; *c*, anterior carapace, dorsal aspect, showing a more typical development of the orbital teeth; *d, e*, large chela, lateral and medial aspects; *f, g*, large cheliped, merus and carpus, lateral and medial aspects; *h*, small cheliped; *i*, second leg; *j*, third leg; *k*, third leg, dactylus. (*a-c*, scale A; *d-g*, scale B; *h-j*, scale C; *k*, scale D.)

the two varieties by the following characteristics: First, the other forms have a distinct but subacute dorsal carina, while the Hawaiian variety is usually evenly rounded dorsally. Second, the base of the rostrum is separated from the orbital hoods by rather shallow rounded depressions instead of deep narrow grooves as de Man describes them. Third, the inferior internal margin of the merus of the large cheliped is without a small obtuse tooth at its distal extremity in the local specimens. From the original type for the species and from de Man's variety, this variety is distinguished, as is *C. gracilis* var. *alluaudi*, by the lack of the secondary unguis on the dactylus.

Future workers may decide that the lack of the secondary unguis is sufficient to separate this form, together with Coutière's, as a species distinct from that of Heller. Except for the fact that this is not supported by other differences, I would be inclined to make this separation myself. However, as Coutière did not think of this as a specific difference, as there are no supporting differences, and as there is the swelling on the dactyl which may be the remnant of the secondary unguis, I have decided to leave the form within this species. The new variety for the Hawaiian specimens was created to emphasize this difference and the fact that these specimens do not have the deep grooves between the orbital hoods and the rostrum.

*C. gracilis* var. *simplex* is most closely related to *C. edmondsoni* Banner and *C. latipes* Banner of the other local species. The differences between them are set forth in Table 3.

**DISTRIBUTION:** This species has been collected both from the shallow reefs and in waters up to 20 feet deep at the following locations on Oahu: Waimanalo, Hanauma Bay, Black Point, Waikiki, Nanakuli, Mokuleia, Kawela Bay, and Punaluu. On Maui it was collected at Makena, Kalama Park, Lahaina, and four localities north and south of Lahaina. Edmondson (1925) reported it (as *C. gracilis*) from Laysan and Lisianski Islands. No specimens were collected by the "Albatross."

Edmondson (1925) also recorded the species from Johnston Island in the central Pacific. It and its two varieties have been reported from the Netherlands Indies, the Indian Ocean, and the Red Sea.

*Crangon edmondsoni* sp. nov.

Fig. 26 a-p

**TYPE SPECIMEN:** A female 24 mm. long collected at Kawela Bay, Oahu, by C. H. Edmondson (Bernice P. Bishop Mus. 4059).

**DESCRIPTION:** Rostrum narrow, longer than breadth at base; concave sides with 3 or 4 pairs of short bristles; produced as acute tip, reaching to or slightly beyond end of first antennular article, distally depressed; slightly rounded dorsally, without carina. Orbital hoods continuous with curvature of carapace posteriorly, not sharply delimited from surrounding carapace and separated from base of rostrum by only slight shallow depressions. Anterior margin of orbital hoods produced into acute, dorsally flattened teeth, reaching almost to mid-point of rostrum. Margin of orbital hoods between rostral base and apex of hoods straight to concave.

Visible portion of first article of antennule slightly larger than second and 0.25 longer than third. Stylocerite strong, reaching to middle of second antennular article. Entire dorsal surface of antennular peduncle with occasional short setae, with denser groupings of longer setae at points of articulation. Inner flagellum about 7 times as long as peduncle; outer flagellum 4 times as long as peduncle.

Lateral spine of basicerite of antenna acute. tip not reaching to end of first antennular article. Scaphocerite as long as antennular peduncle with lateral spines only slightly longer than squamous portion, squamous portion tapering toward tip. End of carpal cerite reaching slightly beyond scaphocerite. Antennal flagellum longer than body, about twice as long as inner antennular flagellum.

Large chela elongate, tapering, margins rounded, laterally compressed, 3.4 times as



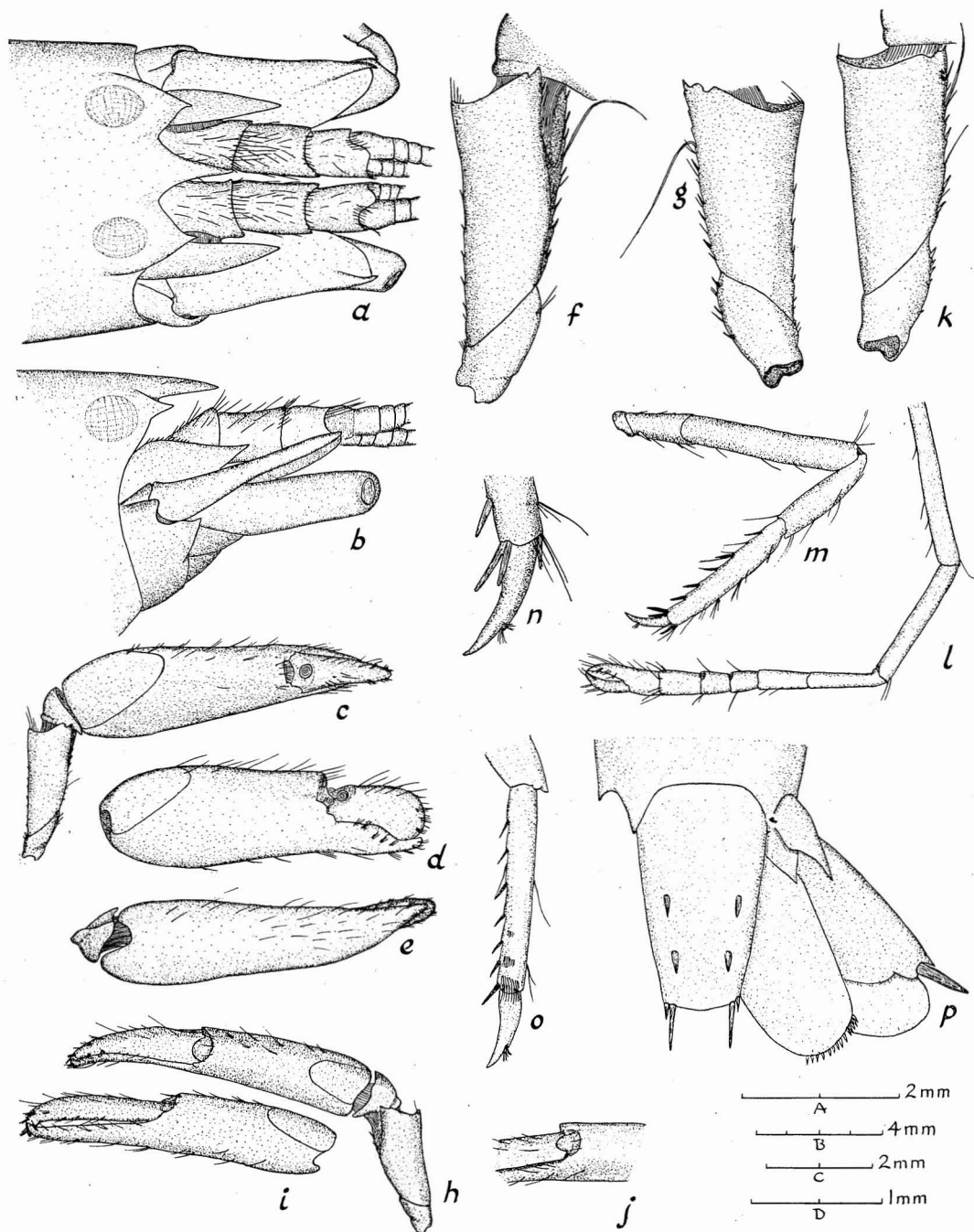


FIG. 26. *Crangon edmondsoni* sp. nov. *a*, *b*, Anterior region, dorsal and lateral aspects; *c*, *d*, *e*, large cheliped, lateral, ventral, and medial aspects; *f*, *g*, large cheliped, merus, lateral and medial aspects; *h*, small cheliped, lateral aspect; *i*, *j*, small chela, ventral and ventrolateral aspects; *k*, small cheliped, merus, medial aspect; *l*, second leg; *m*, third leg; *n*, third leg, dactylus; *o*, fifth leg, propodus and dactylus; *p*, uropod and telson. (*a*, *b*, *f*, *g*, *o*, *p*, scale A; *c*-*e*, *b*-*k*, scale B; *l*, *m*, scale C; *n*, scale D.)

long as high, 5.0 times as long as thick. Margins entire, with slight trace of longitudinal groove proximal to dactylus. Fingers compressed, slightly less than 0.5 as long as palm, slightly depressed from axis of palm, rotated so dactylus opens and closes on lateral plane. Dactylus 1.8 times as long as broad, 2.5 times as long as thick near base, with the upper (or lateral) margin slightly rounded, distal margin strongly rounded. Chela with occasional setae on superior and inner face, with usual grouping of short bristles on opposing faces of fingers. Carpus of usual form. Merus with inferior margins acute, superior margin rounded. Superior margin with 6 feeble spinules on basal 0.7; distal angle with obtuse, projecting tooth. Inferior lateral edge of merus with 13 feeble spinules, slightly larger than those on superior edge, margin produced as acute tooth. Inferior internal margin of merus with 7 movable spinules, with bristles between them. Merus 2.7 times as long as wide distally. Ischium of usual form, with 3 strong movable spines on inferior internal face, and on adjacent margin of merus.

Small chela almost as long as large chela and with same rotation. Chela almost as high as thick, 5.0 times as long as broad, with slight taper toward fingers. Inner margin of palm continued as obtuse projection at point of articulation of dactylus. Fingers almost as long as palm, tapering, definite hook on tip. Merus somewhat similar to that of large chela, but without spines or bristles on superior or inferior external margins; 5 movable spines and several bristles on inferior internal margin. Ischium with 5 smaller movable spines. Lateral face of merus slightly more than twice as long as wide.

Second thoracic legs about 0.7 as long as entire animal. Ischium 1.2 times as long as merus, 0.7 as long as entire carpus. Carpal articles with ratio 10 : 7 : 4 : 4 : 6; fifth article twice as broad as proximal end of first. Chela 1.5 times as long as first carpal article.

Ischium of third legs 0.4 as long as merus, with proximal movable spine. Merus 6 times

as long as broad, with rather straight margins, without distal teeth. Carpus 0.6 as long as merus, with inferior and superior margins projecting distally as small rounded teeth. Propodus 0.7 as long as merus, with 6 movable spines along inferior margin. Dactylus almost 0.3 as long as propodus, curved, simple; superior margin with indentation or tooth 0.7 of distance from base, curve then continuing to tip, with tuft of short setae on each side of dactylus at this break. Entire legs with occasional setae. Fourth legs similar. Propodus of fifth legs with 7 movable spines, and with "brush" feebly developed, of but 6 rows of setae.

Telson 3.0 times as long as width of posterior margin. Sides tapering, with angle of taper greater in distal 0.2. Anterior pair of dorsal spines located in middle of dorsal surface, posterior pair 0.7 of distance toward posterior edge. Posterior margin somewhat convex.

Specimens range to 27 mm. long. Color in life not noted; some of preserved specimens with 7 distinct longitudinal bands reaching from antennular peduncles to end of abdomen; in preservation all bands red. Middle band very narrow; dorsolateral bands quite broad; lateral and ventrolateral bands, latter along margins of abdominal pleura, each about 0.5 width of dorsolateral band. Distal 0.25 of large and small chelae violet in preservative. No specimens with any dark pigmentation on external spine of uropod.

DISCUSSION: Even with the small number of specimens of this species at hand, 19 in all, some interesting variation was noted. As usual, the relative length of the rostrum varied in some specimens. This may be due more to the degree of flexure of the antennular peduncle than to the variation in length of the rostrum. In all cases the inner anterior margin of the orbital hoods were concave. Slight differences were noted in the relationships of the parts of the antennular and antennal peduncles. The most conspicuous differences were in the large chela, where the length of the fin-

gers varied from 0.3 to 0.5 the length of the palm, and the whole chela from less than 3.0 to more than 3.5 times as long as high. Both large and small chelae may be glabrous. In all specimens the chela was without the depressions of the upper and lower margins that were found in *C. gracilis* var. *simplex* Banner. The teeth on the superior margin of the merus, not conspicuous even in large specimens, were scarcely visible in small specimens. The ratio of the first to the second article of the carpus of the second legs varied from 10 : 7 to 10 : 8. The merus of the third leg varied from six to seven times as long as broad.

The species is named in honor of Dr. C. H. Edmondson, Professor Emeritus of Zoology at the University of Hawaii and Curator of Invertebrates at the Bernice P. Bishop Museum.

RELATIONSHIP: This species appears to be very closely related to *C. gracilis* and, therefore, should belong to the Macrochirus Group. According to de Man's key (1911), the characteristics of this species would leave it close to *C. shearmeri* (Alcock and Anderson), but obviously they are not closely related, because *C. shearmeri*, a deep-sea species, has a minute rostrum, and the large chela lacks entirely the piston on the dactylus.

This species shows many characters in common with *C. gracilis* var. *simplex* Banner and *C. latipes* Banner; the three species are distinguished in Table 3.

DISTRIBUTION: Besides the type specimen from Kawela Bay, Oahu, the species has been collected on Oahu from Hanauma Bay at 15 feet, off Kahala at 150 feet, and off Nana-

TABLE 3  
CHARACTERISTICS DIFFERENTIATING *Crangon latipes*, *C. gracilis* var. *simplex*, AND *C. edmondsoni*

<i>C. latipes</i>	<i>C. gracilis</i> var. <i>simplex</i>	<i>C. edmondsoni</i>
Maximum observed size 8.8 mm.	Maximum observed size 18 mm.	Maximum observed size 27 mm.
Orbital teeth 0.3–0.5 length of rostrum; abruptly set off from orbital hoods; rostrum reaching end of first antennular article	Orbital teeth usually 0.7 length of rostrum; abruptly set off from orbital hoods; rostrum not reaching end of first antennular article	Orbital teeth 0.5 length of rostrum; merging with orbital hoods on inner margin; rostrum reaching to or beyond end of first antennular article
Large chela 2.2 times as long as broad; 2.2 times as broad as thick; without depressions on margins	Large chela 2.5 times as long as broad; 2.0 times as broad as thick; with depressions on upper and lower margins	Large chela 3.5 times as long as broad; almost as broad as thick; without depressions on margins
Merus of large cheliped with 2 or less spines on inferior internal margin; none elsewhere	Merus of large cheliped with 4–6 spines on inferior internal margin; none elsewhere	Merus of large cheliped with 7 spines on inferior internal margin; superior and inferior external margins also spinose
Carpal articles of second legs with ratio 10 : 8 : 3 : 3 : 14; second article as broad as long	Carpal articles of second legs with ratio 10 : 6 : 3 : 3 : 6; second article twice as long as broad	Carpal articles of second legs with ratio 10 : 7 : 4 : 4 : 6; second article over twice as long as broad
Third legs	Third legs	Third legs
Ischium with spine	Ischium unarmed	Ischium with spine
Merus 3–3.5 times as long as broad	Merus 4–5 times as long as broad	Merus 6–7 times as long as broad
Propodus with 4–5 spines	Propodus with 6–8 spines	Propodus with 6 spines
Dactylus 2.3 times as long as broad, distally strongly curved and abruptly tapering	Dactylus almost 4 times as long as broad, slightly curved and gradually tapering throughout length	Dactylus 3 times as long as broad, slightly curved and gradually tapering throughout length, with notch on superior margin
External spine of uropod never dark	External spine of uropod usually brown to black	External spine of uropod never dark
Coloration not noted	Body with longitudinal stripes	Body with transverse stripes

kuli at 15–20 feet; two other specimens came from unspecified localities on Oahu, presumably from shallow water. One specimen in Bernice P. Bishop Museum came from Makena, Maui, and one was also collected in 3 feet of water at Kalama Park on that island. R. W. Hiatt collected two specimens at Halape, Kau Coast, Hawaii, from coral heads in the intertidal zone.

*Crangon latipes* sp. nov.

Fig. 27 a–j

*Alpheus* sp. Coutière, Fauna and Geog. Mald. and Laccad. 2: 882, pl. 74, fig. 19, 1905.

TYPE SPECIMEN: A male 8.5 mm. long collected off Waikiki Reef, Oahu, in 20 feet of water (U.S.N.M. 93457).

DESCRIPTION: Anterior carapace produced as well-developed rostrum, tip reaching slightly beyond end of first antennular article; rostrum about 0.3 longer than width at base. Rostral base laterally demarked from orbital hoods by shallow depressions; depressions deeper and more abrupt posteriorly; rostrum and base without definite carina, rounded dorsally. Orbital hoods inflated, anterior margin rounded in both dorsal and lateral aspects. Orbital teeth small, acute, arising abruptly from curvature of orbital hoods; tips reach about 0.3 length of rostrum.

Antennular peduncle in dorsal view with second article about 0.2 longer than visible portion of first article and 0.3 longer than third; second article 1.3 times as long as broad. Acute tip of stylocerite reaching to middle of second antennular article.

Lateral spine of basicerite reaching nearly to end of first antennular article. Scaphocerite with lateral spine strong, lateral margin almost straight, squamous portion well developed; tip reaches well beyond end of antennular peduncle. Carpocerite reaching almost to end of scaphocerite.

Large chela smooth in contour, strongly compressed. Chela 1.8 mm. high, 0.8 mm. thick, 4.0 mm. long to end of dactylus; dactylus occupying distal 1.1 mm. Only indenta-

tions 2 very shallow grooves reaching proximally from articulation of dactylus; grooves very faint, visible only by rotating cheliped. Merus 1.3 mm. long, about twice as long as breadth of inner face; inferior internal margin with 2 movable spines, terminating distally as small, acute tooth; termination of superior margin rounded.

Small chela 1.0 mm. broad, 2.0 mm. long; fingers 0.5 length of chela, hooked distally. Merus similar in size and proportions to that of large chela but with 3 short spines on distal portion of inferior internal margin.

Second legs with ischium 0.7 mm. long; merus 0.9 mm. long, 0.24 mm. broad; articles of carpus with total length of 1.0 mm., with ratio 10 : 8 : 3 : 3 : 14; second secondary article as long as broad; chela 0.6 mm. long, fingers 0.5 of length.

Ischium of third legs 0.4 mm. long, with movable spine; merus 1.36 mm. long, 0.44 mm. broad, inermous; carpus 0.6 mm. long; propodus 1.1 mm. long, with 5 movable spines; dactylus 0.35 mm. long, 0.13 mm. broad in basal half, abruptly tapering to sharply curved acute tip.

Fourth legs similar in structure. Fifth legs generally similar but more slender, propodus with only several distal spines and without well-defined "brush."

Telson 1.4 mm. long, 0.75 mm. broad at base, and 0.36 mm. broad at tip, sides with uniform taper. Outer distal spines 0.07 mm. long, inner spines 0.18 mm. long; anterodorsal spines about 0.5 distance from tip, posterior spines 0.32 mm. from tip.

Three additional specimens: male 6.5 mm. long; 2 females 8.8 and 8.0 mm. long. Color of specimens in life not noted.

DISCUSSION: Two of the paratypes agree quite well with the type specimen. The female from Nanakuli differs chiefly in that the rostrum is asymmetrically bifurcate at the tip and one of the orbital teeth points toward the rostrum. This, obviously, is the result of an accident or of anomalous growth. The female from Lahaina also agrees with the type quite

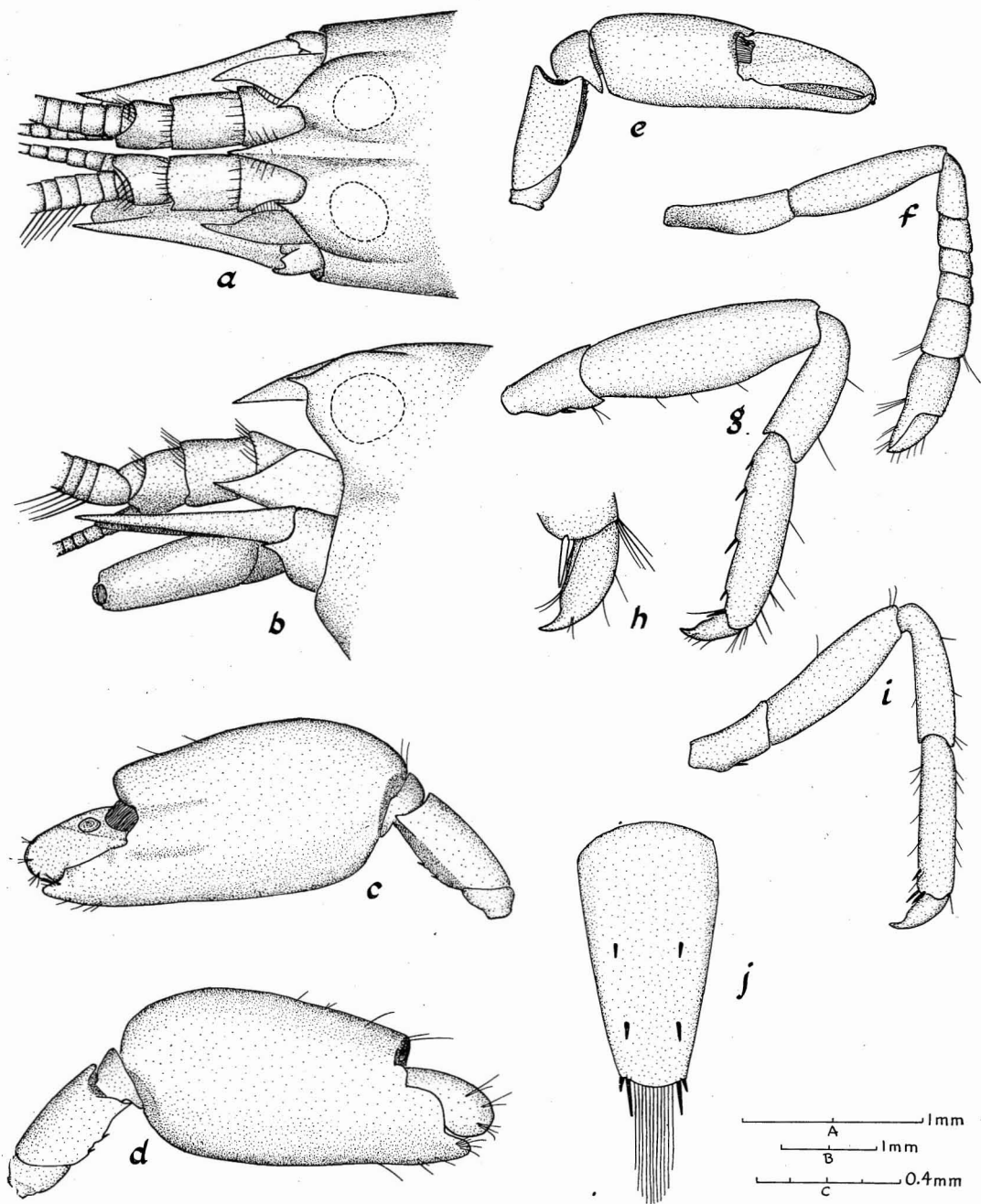


FIG. 27. *Crangon latipes* sp. nov. *a, b*, Anterior region, dorsal and lateral aspects; *c, d*, large cheliped, lateral and medial aspects; *e*, small cheliped, lateral aspect; *f*, second leg; *g*, third leg; *h*, third leg, dactylus; *i*, fifth leg; *j*, telson. (*a, b, f, g, i, j*, scale A; *c-e*, scale B; *h*, scale C.)

well, except that the large chela is somewhat more slender and its merus does not bear the two movable spines found in the type.

However, the second male, from the island of Hawaii, shows a few notable differences. The rostrum, the stylocerite, and the lateral spine of the basicerite are all shorter, with the rostrum and the stylocerite reaching only to near the end of the first third of the second antennular article, and the lateral spine of the basicerite reaching only to the middle of the visible portion of the first article. The orbital teeth are half the length of the rostrum, and the orbital hoods are slightly less inflated. The large chela is 2.7 times as long as broad instead of 2.2, and the fingers occupy slightly over 0.5 of the length of the chela instead of slightly more than 0.25. The ratio of the carpal articles of the second legs is slightly different—10 : 10 : 8 : 6 : 16, with the second article slightly broader than long. The merus of the third legs is 3.5 times as long as broad instead of 3.0 times, and the propodus of the same legs bears four instead of five spines. Other parts of the two specimens showed close similarity.

This male appears to be either within the normal range of variation or to be a closely related variety. It is likely that all the differences may be due to simple growth differences combined with the inherent variation as shown in so many other species; in any case, the differences are not great enough, especially with only one specimen showing them, to warrant the erection of a new species or variety.

**RELATIONSHIP:** This species is closely related to two other Hawaiian species, *C. gracilis* var. *simplex* Banner and *C. edmondsoni* Banner. The more conspicuous differences are given in Table 3.

Of these characteristics, the most readily observed and decisive for rapid separation of this species are the carpus of the second legs and the dactylus of the third to fifth legs. The anterior region of the carapace also affords good characteristics, but it is more variable and therefore less reliable.

According to de Man's key (1911) in the Macrochirus Group, this species keys out to the two species *C. faceta* (de Man) and *C. splendida* (Coutière). It can be separated easily from these two species on the basis of the breadth of the articles of the second and third legs; by the greater breadth of the large chela; and especially by the lack of the longitudinal groove on the palm of the chela (characteristics taken mostly from de Man's key; Coutière's original description, without figures, of *C. splendida* was too brief to be of any value).

This species is apparently identical to *Alpheus* sp. of Coutière (*loc. cit.*) which was left unnamed because his three specimens each lacked the large chela. The form and proportions of the anterior body region and the proportions of the second legs, both shown in the plates, are identical to this species; the unique dactylus of the third legs was neither mentioned nor drawn. If the dactyli are the same, the specimens undoubtedly belong to this species. Incidentally, Coutière believed that the species would belong to the Megacheles Group; the large chela shows its affinities to be with the Macrochirus Group.

**DISTRIBUTION:** This rare species is evidently widespread among the larger Hawaiian Islands at least, for the four specimens are from three islands. The type came from water 20 feet deep off Waikiki Reef, Oahu; an 8.8 mm. female came from 15–20 feet of water off Nanakuli, Oahu; an 8.0 mm. female came from 4 feet of water at Lahaina, Maui; and the aberrant 6.5 mm. male was collected by R. W. Hiatt from a head of *Pocillopora meandrina* Verrill in 5 feet of water at Halape, Kau Coast, Hawaii. Coutière's specimen came from Hule Male Atoll, Indian Ocean.

### *Crangon ventrosa* (Milne-Edwards)

Fig. 28 a-i

*Alpheus ventrosus* Milne-Edwards, Histoire Naturelle des Crustacés, 2: 352, 1837.

*Alpheus laevis* Randall, Acad. Nat. Sci. Phila., Jour. 8(1): 141, 1839.



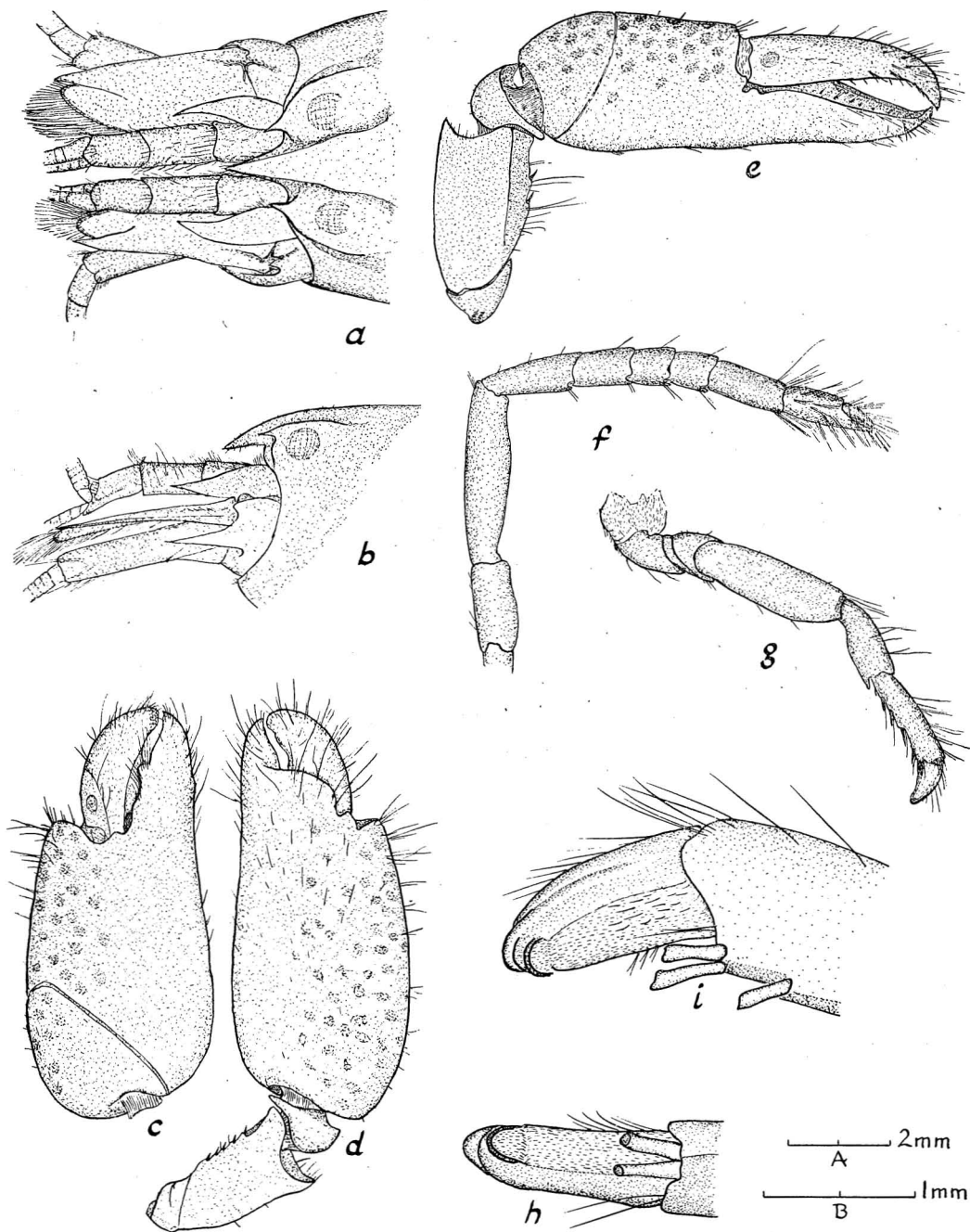


FIG. 28. *Crangon ventrosa* (Milne-Edwards). *a*, *b*, Anterior region, dorsal and lateral aspects; *c*, large chela of female, lateral aspect; *d*, large cheliped of female, medial aspect; *e*, small cheliped, lateral aspect; *f*, second leg; *g*, third leg; *h*, *i*, third leg, dactylus, inferior and posteroinferior surfaces. (In drawings *b* and *i*, the portions shaded with dashed lines are of thin chitin. Appendages drawn from several specimens, so relative size is not indicated.) (*a*–*g*, scale A; *h*, *i*, scale B.)

*Alpheus obesomanus* Boone, Vanderbilt Mar. Mus., Bul. 6: 135, 1935. [Part of distribution records, only.]

DESCRIPTION: Rostrum slender, acute, reaching almost to end of first article of antennular peduncle, straight to depressed at tip; small groups of short bristles along lower margin. Rostral base broad, flattened, not carinate dorsally, separated from carapace by deep and narrow sulci on each side. Orbital hoods rounded laterally, extending anteriorly as acute teeth from inner portion of hood, 0.3–0.5 length of rostrum.

Antennular peduncle slender, with second article variable but usually only slightly longer than visible portion of first or third. Stylocerite well developed, reaching past middle of second antennular article. Lateral spine on basicerite acute, equal to or exceeding length of stylocerite. Scaphocerite long, distally narrow, with lateral spine only slightly longer than squamous portion and reaching slightly beyond antennular peduncle and tip of carapocerite.

Large chela usually less than 2.5 times as long as broad, compressed, with margins rounded, without grooves or crests. Dactylus elongate, not strongly arcuate, 0.5 length of palm, tip usually acute in males, rounded in females. Merus with both superior and inferior internal angles obtuse, although projecting; inferior internal margin with about 5 spines.

Small chela almost as long as larger but more slender, 2.5–3 times as long as broad. Dactylus strongly curved at tip, crossing fixed finger when closed. Inner margin of cutting face of fixed finger with distinct lamellar ridge along entire length, series of short strong bristles along outer edge. Fingers about equal in length to palm. Merus with superior distal angle subacute, often with several movable spines on inferior internal edge.

Carpal articles of second legs totaling 1.7 times length of merus and broad in proportion to width; second article only 1.5 times as

long as broad; articles with ratio 10 : 8 : 6 : 6 : 12.

Ischium of third legs inermous. Merus inermous, over 3 times as long as wide, widest at 0.7 of length then tapering sharply to tip. Carpus with inferior margin continued as small tooth. Propodus with 5 to 7 movable spines, each with broadened and flattened tip. Dactylus heavy, blunt, laterally compressed, with thick longitudinal ridge on anterior face continuing around tip as transparent flange, blunt tip carrying "fingernail" of hard chitin, tip reinforced with another ridge of chitin in form of horse's hoof. Inferior and lower posterior portion of face of dactylus proximal to "nail" of soft and flexible chitin (see Fig. 28*b*, *i*).

Body in general large and strongly compressed. Large females in collection range to 42 mm. in length. Usually orange-red on upper surface, sometimes longitudinally striped with deeper red along dorsal surface of carapace and abdomen; mottled with spots of deeper red along superior and superolateral portions of both large and small chela.

DISCUSSION: The usual variation was noted in this species; much of it has been remarked upon in the description. Additional variation was found in the proportions of the small chela; in the ratio of the lengths of the carpal articles of the second legs, especially in the fifth article which varied from noticeably shorter than the first to somewhat longer; and in the number of spines on the propodus of the third legs. The fingers of the large chela show sexual dimorphism, but a few specimens seemed to intergrade. One specimen in the collection had an orbital tooth on the right but not on the left side.

These specimens agree well with the brief description given by Milne-Edwards. De Man (1911) remarked on the variation manifested by the few specimens of this species in his collection and noted that the second article of the antennular peduncle varied from slightly shorter than the first article to over 1.5 times as long, the rostrum from shorter than to

equal to the first peduncular article, and the scaphocerite from shorter than to as long as the antennular peduncle. De Man also suggests that the two forms of the large chela (one with a rather obtuse dactylus, the other with an acute dactylus) might be a sexually dimorphic trait; in general this was true in the Hawaiian specimens.

DISTRIBUTION: *C. ventrosa*, in Hawaii at least, has always been found in living heads of corals of the genus *Pocillopora*, usually either *P. meandrina* var. *nobilis* Verrill or *P. ligulata* Dana, and occasionally in *P. damicornis* (Linnaeus); in these corals it associates with *Synalpheus charon* (Heller) and crabs of the genus *Trapezia*.

This, although not the most common Hawaiian species, is certainly the most spectacular, both in color and in size, and consequently there have been many records of it throughout the Islands. The first record was under the name of *A. laevis* made by Randall in 1839; it was also reported by Dana (1852), Stimpson (1860), and Bate (1888). In the Islands it probably occurs wherever *Pocillopora* is found; specimens studied have come from the following localities: on Oahu, both in shallow water and in water up to 20 feet or more deep, at Waimanalo, Hanauma Bay, Waikiki, Nana-kuli, and Kawela Bay; on Maui, at Makena and Lahaina. Previously unreported specimens collected by the "Albatross" came from the following locations: Honolulu (further data unrecorded); south of Molokai, 23–24 fathoms; two dredge hauls on Penguin Bank (west of Molokai), 27–29 fathoms; and off Kauai, 18–41 fathoms. "Albatross" Stations: (not recorded), 3847, 4031, 4032, and 4023, respectively; U.S.N.M.: 63633, 63634, 63636 (63637, 63638—lot divided into two vials), and 63635, respectively. Edmondson (1925) has reported the species from French Frigate Shoal and Laysan Island; there are 15 specimens in Bernice P. Bishop Museum from Pearl and Hermes Reef.

*Crangon ventrosa* has been reported throughout the entire tropical Indo-Pacific region,

from the Gulf of Akabah at the western tip of the Red Sea to the Gulf of California in Mexico. Edmondson has reported the species from Johnston, Wake, and Palmyra Islands, and others have reported it from Tahiti.

As *C. obesomanus* (Dana), Boone (1935: 135) reported the following previous distributional records (in part): "Gulf of California (Coutière); Sandwich Islands (Randall); Honolulu (Bate); . . . Sandwich Islands and Fiji Islands (Dana); . . . Gulf of Aykab [sic] and through the Red Sea (de Man). . . ." She mentions none of the records noted above for *C. ventrosa* (1935: 126). Inasmuch as the records here quoted from Boone were made by the authors to which she attributes them not for *C. obesomanus* but for *C. ventrosa* (*A. laevis*), it would appear that these records have been interchanged. However, other records listed by her under *C. obesomanus* are correct.

### *Crangon amirantei* (Coutière)

Fig. 29 a-j

*Alpheus amirantei* Coutière, Soc. Philomath. Paris, Bul. IX, 11(5): 15–16, 1908.

*Alpheus amirantei* Coutière, Linn. Soc. London, Trans. II (Zoology), 14(4): 421, pl. 63, fig. 16, 1931. [Text exactly the same as 1908 reference; plates not previously published.]

DESCRIPTION: Carapace with swollen, almost hemispherical orbital hoods, anterior margin of hoods produced as rounded, subvertical keel slanting mesad ventrally, area between keel and rostrum flat. Frontal margin anterior to orbital hoods almost straight; small notch near base of rostrum. Rostrum small, extending less than 0.5 length of visible portion of first antennular article, with high rostral carina only slightly lower than orbital hoods. Deep depression between rostral base and orbital hoods. Side of carapace between base of antenna and orbital hood depressed.

Visible portion of first antennular article as long as second; third article about 0.75 length of second; second article about 1.5 times as long as broad. Stylocerite very short, reaching

only slightly beyond 0.7 of length of visible portion of first article, and only slightly exceeding broadened portion. Outer flagellum heavy, short, not over 1.5 times length of peduncle.

Basicerite with strong, acute spine. Scaphocerite strong, outer margin curved, spine dominant over reduced squamous portion; tip reaching beyond end of antennular peduncle and carpocerite. Carpocerite as long as antennular peduncle.

Proximal portion of palm of large chela subcylindrical in section, as thick as high, entire chela less than 3 times as long as thick; distally tapering, more flattened. Chela proximal to articulation of dactylus slightly inflated; lateral face proximad of articulation with poorly defined but noticeable longitudinal groove. Dactylus of usual form, about 0.3 length of entire chela. Merus twice as long as broad, superior distal margin rounded, inferior internal margin with strong subterminal tooth, inermous. Large chela sexually dimorphic in size, that of female 0.8 and that of male 1.4 times as long as carapace.

Small chela sexually dimorphic in size and proportions. Appendage of female with fingers 0.4 as long as chela; chela 3 times as long as broad. Carpus elongate, equal in length to fingers. Merus twice as long as broad, 0.8 as long as chela; superior margin irregular; inferior internal margin without tooth. Appendage of male about 0.3 larger proportionately than that of female, with fingers 0.6 length of chela; chela 3 times as long as broad. Carpus 0.5 as long as fingers. Merus similar to that of female, but 0.7 as long as chela and with superior margin regular.

Carpal articles of second legs with ratio 10 : 23 : 5 : 5 : 10.

Third legs with strong movable spine on ischium. Merus 2.6 times as long as broad, with very strong subterminal tooth. Carpus 0.5 as long as merus, with inferior distal margin projecting as acute tooth; article without movable spines. Propodus only slightly longer than carpus, heavy, with about 10 strong

movable spines. Dactylus simple, strong, and slightly curved, about 0.25 as long as merus.

Telson 1.5 times as long as broad at base, anterior breadth 1.7 times breadth at posterior margin. Lateral margins slightly convex anteriorly and slightly concave posteriorly; posterior margin arcuate. Length of larger pair of posterior spines approximately equal to breadth of tip; dorsal spines as long as larger posterior spines, located approximately 0.3 and 0.7 of distance from anterior end of telson; distal border without spinules. Inner uropod with numerous strong spines on distal and distolateral margins.

Largest female 10.0 mm. long; color in life not noted.

DISCUSSION: In the four specimens available, no marked variation was noticed. Unfortunately, a second female did not have a small chela, so it was impossible to determine whether the irregularity of the superior margin of the merus noted above was actually a sexually dimorphic characteristic or merely an individual variation.

This form differs in several respects from the type as described by Coutière. In the first place, in Coutière's specimens the scaphocerite was not longer than the carpocerite, and both were longer than the antennular peduncle instead of as described here. The basicerite is described as, "à peu près inerme," whereas in this form the basicerite has a relatively strong spine. The greatest differences are in the small chelae; the differences in proportions of the finger and the palm between the specimen drawn by Coutière and the one drawn here are merely sexual dimorphism; however, Coutière shows his specimens as carrying a continuous band of setae which are lacking in all Hawaiian specimens, and he states that the merus bears a strong tooth ("épine") which is lacking in the Hawaiian specimens. The second article of the carpus of the second legs is over three times as long as the first, and in the local specimens it is only 2.3 times as long. Finally, the carpus and propodus in Coutière's specimens were slight-

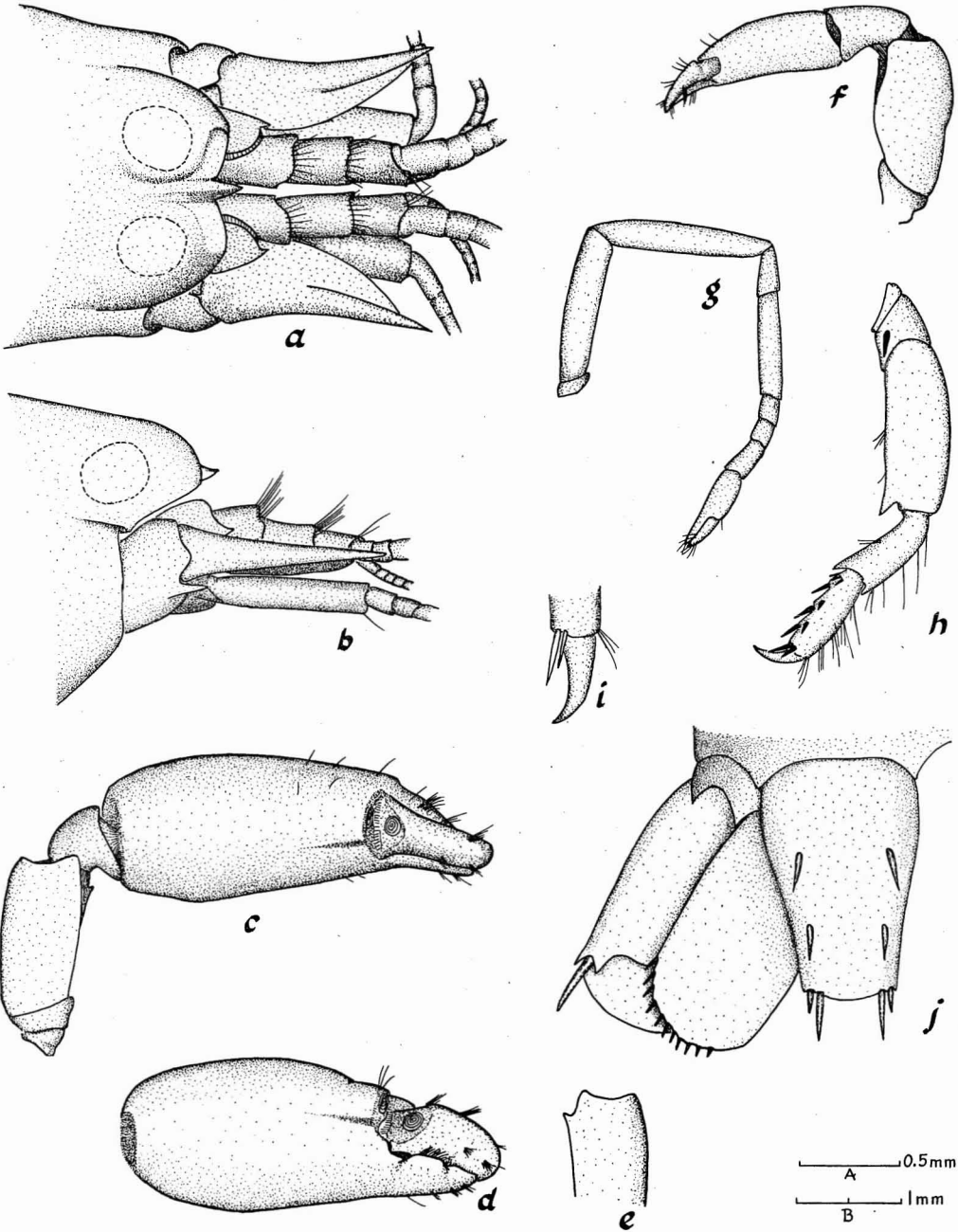


FIG. 29. *Crangon amirantei* (Coutière). *a, b*, Anterior region, dorsal and lateral aspects; *c*, large cheliped, lateral aspect; *d*, large chela, ventrolateral aspect; *e*, large cheliped, merus, medial aspect; *f*, small cheliped, lateral aspect; *g*, second leg; *h*, third leg; *i*, third leg, dactylus; *j*, telson and uropod. (Drawn from a female.) (*a, b, i, j*, scale A; *c-h*, scale B.)

ly longer in relation to the merus than they were in these specimens.

These differences cannot be considered as of major magnitude because in related species (see *C. paragracilis*, *C. brevipes*, and *C. clypeata*) all of these characteristics were found to be quite variable. Possibly the most important difference is the lack of the tooth on the merus of the small cheliped, but, even if this were constant, it would not be sufficient for the erection of a new species.

**DISTRIBUTION:** All five specimens in the collection came from Oahu: two from Hanauma Bay, 20 feet deep, one off Waikiki, 20 feet deep, and two from Nanakuli, 15 feet deep.

Coutière's two specimens, both males, came from Amirante, 25–80 fathoms, in the Indian Ocean.

*Crangon nanus* sp. nov.

Figs. 30 a–n, 31 a–b

*Alpheus* sp.?, *Metapheus*, n. gen., Coutière, Soc. Philomath. Paris, Bul. IX, 9(5): 23–26, 1908.

*Alpheus* sp.?, *Metapheus*, n. gen., Coutière, Linn. Soc. London, Trans. II (Zoology) 17(4): 419–421, pl. 62, fig. 15, 1921. [The same description as above, but with figures.]

**TYPE SPECIMEN:** A female 9.0 mm. long, collected from coral in water about 10 feet deep at Hanauma Bay, Oahu (U.S.N.M. 93458).

**DESCRIPTION:** Rostrum short, acute, barely reaching end of first antennular article, about twice as long as wide at base, without distinct carina, separated from orbital border by shallow rounded concavities. Orbital border projecting forward, rounded tips 0.7 as long as rostrum. Orbital hoods inflated.

Antennular peduncle short and thick, with second article about 0.7 length of visible portion of first and slightly more than 0.7 length of third; second article about 1.3 times as broad as long. Stylocerite with tip of spine

reaching beyond middle of second article. Outer flagellum not bifurcate.

Basicerite of antenna very heavy, reaching beyond end of first article of antennular peduncle, 0.3 thicker than long. Lateral spine of basicerite acute, extending to tip of stylocerite. Scaphocerite with squamous portion broad and rounded, 0.8 as long as lateral spine; tip of lateral spine not reaching end of third article of antennular peduncle. Carpocerite heavy, subconical, almost 0.3 longer than antennular peduncle.

Labrum massive. Incisor process of mandible expanded, covering inferior portion of labrum and bearing numerous strong teeth; mandibular palp also expanded, with strong bristles in addition to teeth similar to those on incisor process. Maxillule and maxilla normal. First maxilliped with endite of basipodite extended and contours rounded; no visible articulations in endopod. Epipodite of second maxilliped enlarged. Third maxilliped as shown in Figure 30c.

Large chela strongly compressed laterally, twice as long as broad. Margins entire except for several small rounded eminences on inferior edge where bristles arise. Outer face with 2 shallow grooves extending 0.25 of length proximally, superior starting at point of articulation of dactylus, inferior near socket for piston of dactylus. Palm almost 4 times as long as fingers. Dactylus laterally disposed, upper margin strongly arcuate and closing across end of chela. Fixed finger very short, with terminal indentation to accommodate dactylus. Chela with scattered setae and bristles distally on inner face and on proximal portion of dactylus. Merus over 0.3 as long as chela, 1.5 times as long as broad, inermous, triangular in section, with inferior margins rounded.

Small chela more than 0.7 length of larger, fingers as long as palm. Palm 1.5 times as long as high. Fingers curved, hooked tips crossing, immovable finger with thin knife-like ridge on inner edge. Distal portions of palmar edges and fingers with scattered groups of short



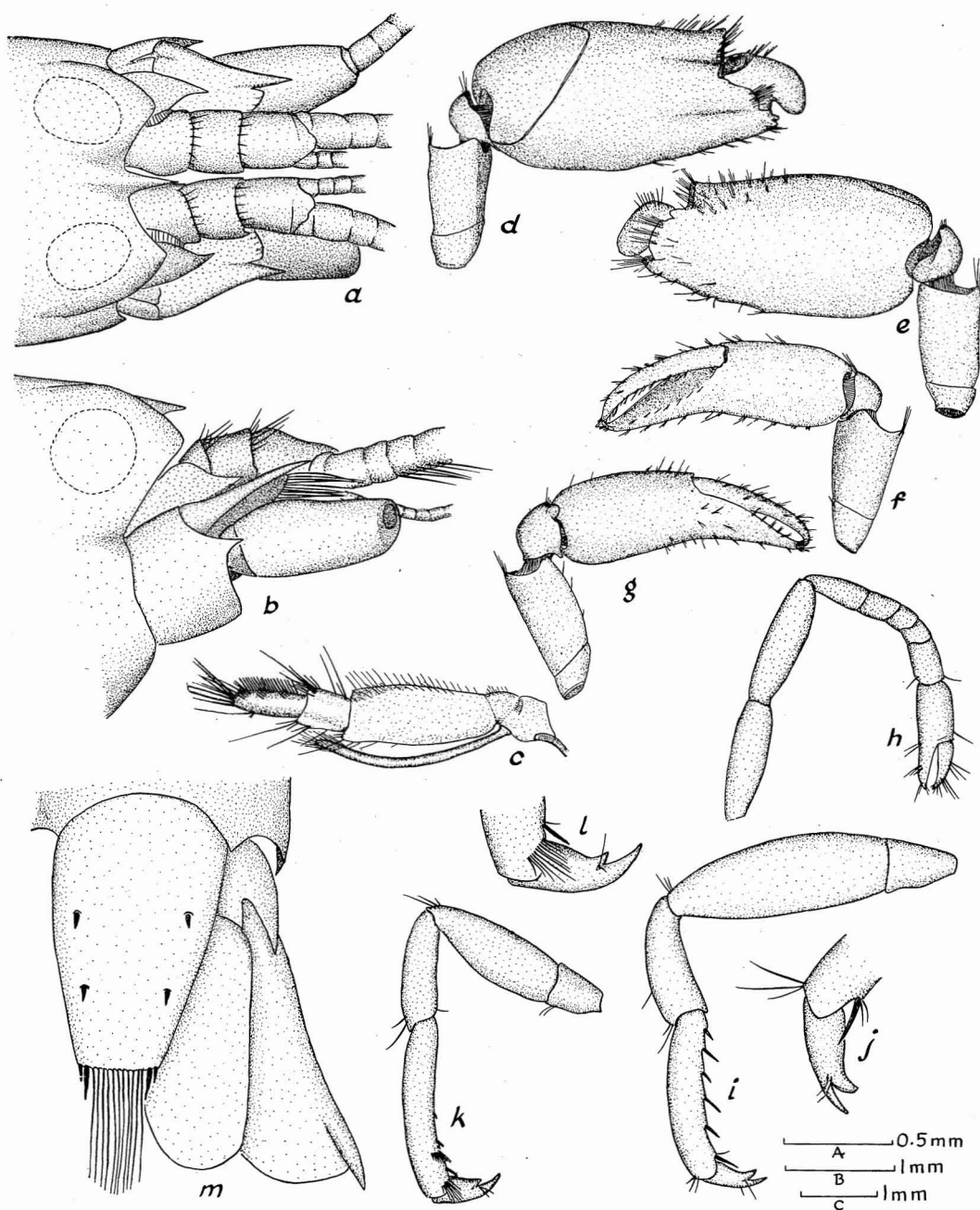


FIG. 30. *Crangon nanus* sp. nov. *a*, *b*, Anterior region, dorsal and lateral aspects; *c*, third maxilliped; *d*, *e*, large cheliped, lateral and medial aspects; *f*, *g*, small cheliped, lateral and medial aspects; *h*, second leg; *i*, third leg; *j*, third leg, dactylus; *k*, fifth leg; *l*, fifth leg, dactylus; *m*, telson and uropods (*c*–*g* from a paratype). (*a*, *b*, *j*, *l*, *m*, scale A; *c*, *h*, *i*, *k*, scale B; *d*–*g*, scale C.)

setae and bristles. Carpus slightly longer than that of large cheliped and with rounded projection on inner distal edge. Merus similar in form and proportions to that of large cheliped.

Ischium of second legs almost as long as merus. Carpal articles together 1.2 times length of merus, with ratio 10 : 6 : 4 : 3 : 8. Fingers of chela as long as palm. Entire appendage shorter than third legs.

Third legs without spines on ischium. Merus tapering, inermous, 3 times as long as wide. Carpus 0.4 as long as merus, without spines but with both margins continued distally to form rounded tooth. Propodus arcuate, 0.7 as long as merus, with 6 movable spines. Dactylus biunguiculate with inferior hook larger in diameter but slightly shorter in length than distal hook. Fourth legs similar but larger. Fifth legs with proximal 3 articles shorter and of slightly different proportions; propodus and dactylus equal to those of third legs; brush of propodus of but 2 rows of bris-

ties; inferior tooth of dactylus feebly developed.

First pleopod of female reduced and without articulations in both rami; endopod lacking *appendix interna*; second and following pleopods with endopods bearing separate broad lobes for *appendix interna*. Second pleopods of male of peculiar form (see Fig. 31a).

Telson 1.7 times as long as broad, tip about 0.5 as broad as base; margins slightly convex; dorsal spinules at 0.4 and 0.7 of distance from anterior articulation.

Branchial formula without mastigobranch on base of seventh thoracic appendage and setobranch on eighth; pleurobranch of third also lacking.

Mature individuals of both sexes ranged from 6 to 10 mm. in length. Color in life not recorded.

DISCUSSION: The 20 specimens of this species show little variation. One peculiar tendency, similar to that observed in *C. paragracilis*, is for the anterior portion of the body to

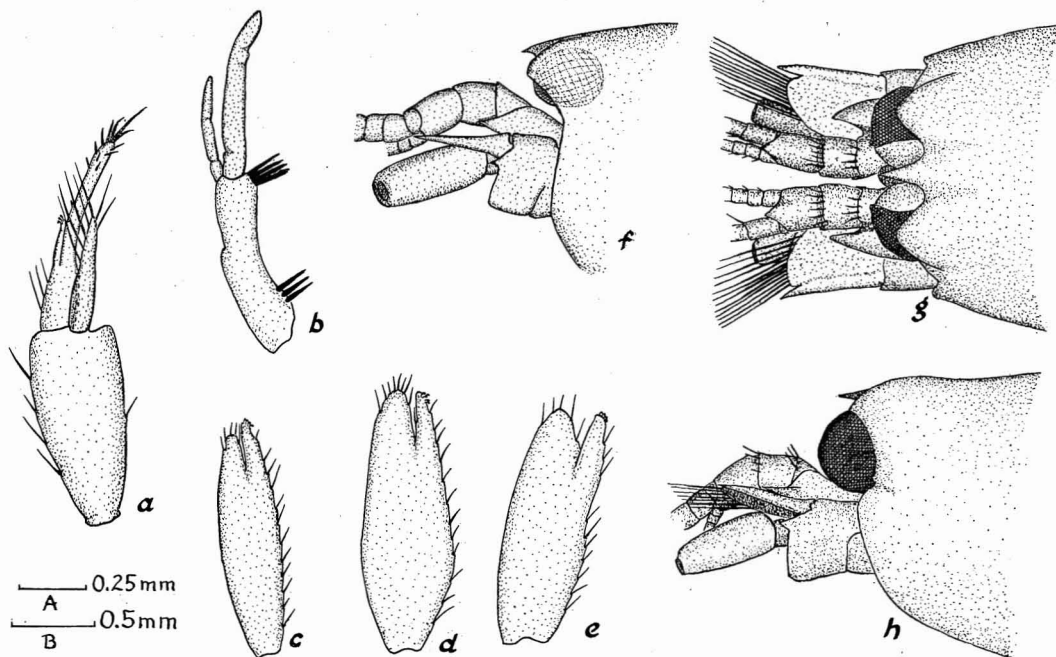


FIG. 31. *Crangon nanus* sp. nov. a, Second pleopod of male; b, first pleopod of female; c, d, e, endopods of second to fourth pleopods of female; f, anterior region of specimen showing slight protrusion of eyes; g, h, anterior region of specimen showing extreme protrusion of eyes. (a-e, scale A; f-h, scale B.)

be displaced, exposing the eyes as is shown in Figure 31*f-h*. Five specimens of this species show this condition to some degree. The possible causes of the condition are discussed under *C. paragracilis*.

Normally occurring variations were slight. In one specimen the orbital hoods are equal to the rostrum in length. Slight differences in the proportions of the carpal articles of the second legs and in the proportions of the articles of the third legs were observed but all articles exhibited a generally consistent if not exact relationship one to another. Finally, the articles of the antennal peduncle between the basicerite and the carpocerite are or are not visible in lateral view, the differences evidently caused by the degree of rotation of the carpocerite.

**RELATIONSHIP:** Because of the close relationship this species bears to *C. paragracilis* (Coutière) it has been placed in the Macrochirus Group. According to de Man's key (1911) this species is a relative of *C. macrochirus* (Richters). However, it does not appear to be closely related when the characteristics of the latter species are considered, for *macrochirus* has deep orbitorostral grooves, the second antennular article is three times the length of the third antennular article, and the fingers of the large chelae are proportionally larger.

Certainly, of all Hawaiian species this species is most closely related to *C. paragracilis* (Coutière) and to the close relative of *C. paragracilis*, *C. hawaiiensis* Edmondson. As *C. hawaiiensis* is distinguished from *C. paragracilis* principally in the form of the large chela, as *C. paragracilis* is better known, and as *C. paragracilis* is probably the parent species to both this species and *C. hawaiiensis*, *C. nanus* is compared chiefly to *C. paragracilis*. In the two species the form of the anterior carapace is almost exactly the same; the compact antennular peduncle and the stylocerite are similar; the long and heavy carpocerite is similar; the peculiar mouthparts are similar; the general shape of both the large and small chela are similar (specific differences are noted below); the re-

lationship of the lengths of the carpal articles of the second legs are roughly the same; even the curvature of the propodus is similar in both species. The branchial formula is similar and evidently different from all other members of this genus.

In fact, there is sufficient similarity between the two species so that they could easily be confused unless they were closely examined. The chief differences lie in the following characteristics: the large cheliped, in which the chela has the inferior margin entire and the merus unarmed in *C. nanus*, but with the chela bearing a shoulder on its inferior margin and the merus with spines on the inferior internal margin and a spine on the superior distal angle in *C. paragracilis*; the pleopods, which are of the usual form in *C. paragracilis* and as shown in Figure 31 in *C. nanus*; the merus of the third leg which is unarmed in *C. nanus* and bears an acute tooth in *C. paragracilis*. Furthermore, in *C. nanus* the scaphocerite is shorter than the antennular peduncle, the merus of the second leg is equal in length to the first four carpal articles, and the inferior unguis of the dactylus of the third leg is normally about 0.75 as long as the distal unguis, whereas in *C. paragracilis* the scaphocerite is longer than the antennular peduncle, the merus of the second leg is equal in length to the first three carpal articles, and the inferior unguis of the third legs is 0.25–0.3 the length of the distal claw. The differences between the two species appear to be constant.

There is one other description in the literature that appears to be of the same or a closely related species, that of "*Alpheus* sp.? *Metalpheus* n. gen.?" of Coutière (*loc. cit.*). There seems to be some confusion about this species, for while Coutière states it shows relationship to *C. paragracilis* and considers it as possibly identical to the unfigured *C. rostratipes* (Pocock, 1890), he also considers it as a representative of a new genus.

*C. nanus* is similar to "*Alpheus* sp." in many important respects: the form of the orbital hoods, anterior carapace, antennules and an-

tennae, mouthparts (with the exceptions noted below); small chela (the large chelae were lacking in Coutière's specimens), second and following legs, including the important dactyli; and the peculiar pleopods of the male and female. Even the tendency toward protuberant eyes, noted above, was found in Coutière's specimens, as in the plate the medial portion of the eyestalks appears beyond the anterior margin of the carapace.

*C. nanus* differs from Coutière's specimen in the rostrum, which is poorly demarked laterally even at the edge of the carapace and which has its tip depressed in lateral view; in the endopod of the third maxilliped, in which the basal article is narrower, the second article broader, and the third article bearing a distal tuft of setae; and in the small chela, which lacks spines on the lower margin of the palm. In *Alpheus* sp. the rostral ridge is still discernible between the orbital hoods, the rostral tip is not depressed, and the palm of the small chela bears five (?) spines on its inferior margin. When the wide range of variation in the closely related *C. paragracilis* is considered, these minor differences certainly do not appear to be of specific worth.

The possibility suggested by Coutière that *C. nanus* is a synonym of *C. rostratipes* (Pocock) can be ruled out. In the first place, Pocock's specimen came from Fernando Noronha in the Atlantic Ocean off Brazil; while this does not exclude the possibility that the two species are identical, it certainly reduces the probability, for almost no species of this genus found off the Atlantic coast of the Americas is also found in the Indo-Pacific area. Anatomically, several characters separate the species in spite of the fact that Pocock published only a short description without plates: *C. rostratipes* is described as having the rostrum "springing from center of a depression," which certainly could not be applied to the Hawaiian form; the articles of the antennular peduncle are described as being equal in length, whereas in *C. nanus* the third article is the longest; the merus of the small chela is

described as having the superior margin produced into a "conspicuous tooth," a description that would not suit the subacute projection of this species; finally, the articles of the carpus of the second legs in *C. rostratipes* have the ratio 10 : 5 : 2 : 3 : 4, instead of 10 : 6 : 4 : 3 : 8.

Returning to the contention of Coutière that his specimen may represent a distinct new genus, he states:

Volume des fouets antennaires et de l'antenne, incomplète protection des yeux, volume du labre, forme très spéciale des mandibules, du 2° maxillipède, du 3° maxillipède, des pinces de la 1° paire (?), brièveté de la 2° paire, réduction du nombre des épipodites, forme très spéciale des pléopodes, tels sont les caractères que l'on pourrait invoquer pour la séparation de l'*A. rostratipes* et des formes affines. Le nouveau genre pourrait recevoir le nom de *Metalpheus* s'il était conservé.

The prime basis for separation, not emphasized in this paragraph, was the supposition of Coutière that the large chela (lost in his specimens) was similar in form to the small chela. This was an erroneous assumption.

Of these characteristics, all save the shortness of the second thoracic legs and the modified pleopods are found in *C. paragracilis* as well as *C. nanus*. The similarity of the two species, as pointed out above, is especially marked in the peculiar mouthparts and branchial formula. This relationship is so close that *C. paragracilis* and *C. nanus* must be included in the same genus. However, as *C. paragracilis* shows definite affinities to other members of the genus *Crangon*, I do not believe that the erection of the proposed genus would be justified.

**DISTRIBUTION:** Most of the specimens of this species came from coral heads in water 10–20 feet deep immediately outside the shallow portions of the reef. The few specimens from near the intertidal zone were collected at the following places: from algal holdfasts at Kawela Bay and on the open coast east of Koko Head, on Oahu; from coral at Kalama Park and at Lahaina, on Maui. The specimens from deeper water came from the following localities: off Mokulua Islands, Hanauma Bay, Waikiki Reef, and Nanakuli, on Oahu;

in the deeper water off Kalama Park, on Maui.

Coutière did not record the locality in the Indian Ocean where his specimens were collected.

***Crangon hawaiiensis* Edmondson**

Fig. 32 *a-h*

*Crangon hawaiiensis* Edmondson, Bernice P. Bishop Mus., Bul. 27: 14, figs. 2a-i, 1925.

DESCRIPTION: Rostrum triangular with narrow acute tip, about 1.5 times as long as broad at base, tip probably reaching to near end of first antennular article. Orbital hoods probably subacute, pointed, and somewhat shorter than rostrum. Orbitorostral grooves shallow.

First antennular article heavy, probably with visible portion slightly longer than second article. Second article about 1.3 times as broad as long, somewhat shorter than third article. Stylocerite reaching to or slightly beyond end of first antennular article. Lateral spine of basicerite longer than stylocerite. Lateral margin of scaphocerite slightly concave; lateral spine 0.2 longer than squamous portion; tip reaching beyond end of antennular peduncle. Carpocerite heavy, reaching about to end of scaphocerite.

Mouthparts similar to *C. paragracilis* and *C. nanus* (see pp. 96 and 90).

Large chela almost 2.5 times as long as broad, strongly compressed but not twisted, fingers occupying distal 0.3. Palmar surfaces smooth, rounded; slight concavity in inferior margin below and proximal to articulation of dactylus; faint groove on outer face of palm, extending short distance proximad from upper margin of dactylar articulation. Merus 1.8 times as long as maximum breadth; inferior external margin rounded and not definite; superior margin terminating in acute tooth. Scattered setae on inner face of chela and on inferior internal margin of merus.

Small chela lost.

Carpal articles of second legs with ratio 10 : 5 : 5 : 5 : 7; second article 1.1 times as broad as long.

Ischium of third legs 0.5 length of merus, unarmed; merus 3.3 times as long as broad, with small acute tooth or smaller obtuse projection; propodus 0.3 as long as merus, almost twice as wide distally as proximally, with neither inferior nor superior margins projecting but terminating at approximately right angles without spines or teeth; propodus 0.9 length of merus, curved, with 6 small spines; dactylus biunguiculate, curved and heavy, less than 0.4 length of merus, 2.2 times as long as broad at base, with distal unguis longer but less broad at base than inferior unguis.

Sole specimen known female 12 mm. long.

DISCUSSION: The type specimen was re-examined and redrawn for this study. Unfor-

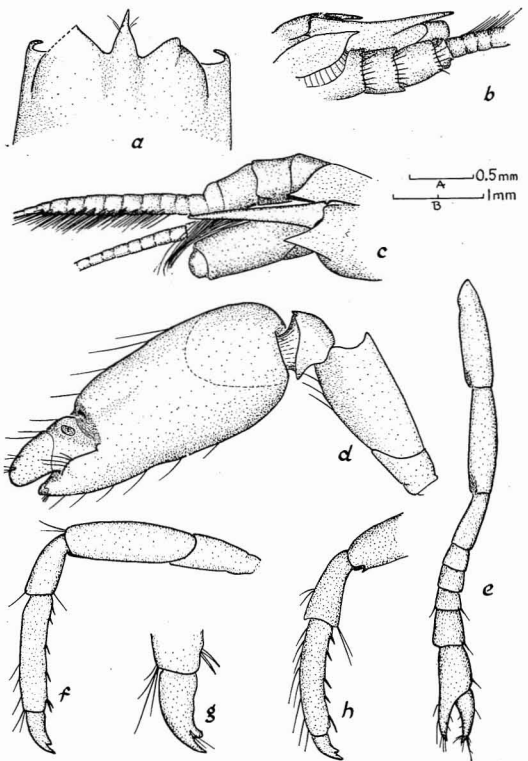


FIG. 32. *Crangon hawaiiensis* Edmondson. *a*, Anterior carapace, dorsal aspect (the right orbital hood is folded; the left is badly crumpled and its restored outline is indicated by the dashed line); *b*, *c*, antennule and antenna, dorsal and lateral aspects; *d*, large cheliped; *e*, second leg; *f*, third leg; *g*, third leg, dactylus; *h*, fifth leg, propodus and dactylus. (*a-c*, *g*, scale A; *d-f*, *h*, scale B.)



unately the type not only lacks the small chela, but the chitin of the anterior thoracic regions is so soft and distorted that the true nature of the orbital hoods could not be ascertained.

Careful comparison of the specimen to the original description and plate of Edmondson showed only two minor differences: first, there was a faint longitudinal groove on the palm of the large chela that was not previously noticed; second, the inconsistency of the specimen as to the armature of the merus of the third legs was not remarked upon. On this last point the omission is probably of no great moment, for in other species it has been observed that occasional specimens may lack a tooth on one or more legs, as this one does, yet the majority of the specimens will have it.

Of the Hawaiian species this stands midway between *C. paragracilis* (Coutière) and *C. nanus* Banner. It is like both species in the form of the rostrum and orbital hoods (probably), in the mouthparts, in the general form of the antennular and antennal bases, in the general form (but not the specific sculpturing) of the large chela, in the general form of the third legs, especially in the curved propodus and the shape of the biunguiculate dactylus. It is like *C. paragracilis* in the length of the scaphocerite and in the tooth on the merus of the third legs, although in this species it is more poorly developed. It is like *C. nanus* in the heavy form of the basicerite although not as heavy, in the breadth of the articles of the carpus of the second legs, and in the lack of the deep sculpturing of the large cheliped.

However, it can be easily distinguished from these two species, as the lower concavity of the chela of *C. hawaiiensis* is slight and gradual, whereas in *C. paragracilis* it is delimited posteriorly by a lobe, and in *C. nanus* the entire depression is lacking; the second article of the carpus of the second legs is broader than long instead of slightly or markedly longer than broad, as it is in the other two species. From *C. paragracilis* it may be distinguished also by the lack of spines on the

inferior internal margin of the merus, by the shorter spine of the stylocerite, and by the ratio of the articles of the carpus of the second legs. It may also be distinguished from *C. nanus* by the shorter stylocerite and the longer scaphocerite.

Schmitt (1939) has described a new subspecies, *C. hawaiiensis clippertoni* from Clipperton Island in the eastern Pacific. It was distinguished from the type by two characteristics: the supposed lack on the type of longitudinal grooves on the palm and by the rostrum which in Schmitt's specimen did not reach beyond the orbital hoods. The first of these differences is already removed, and it is likely that, if this species shows variation similar to that of *C. paragracilis*, the other difference will be within the range of variation for the species. However, until such a time as more specimens are examined, it would be best to leave the subspecies as it now stands.

DISTRIBUTION: The type locality for this species is Lisianski Island, in shallow water.

### *Crangon paragracilis* (Coutière)

Fig. 33 a-b

*Alpheus paragracilis* Coutière, Soc. Ent. de France, Bul. (7): 149-152, 1898a.

*Alpheus paragracilis* Coutière, Fauna and Geog. Mald. and Laccad. 2(4): 883, pl. 76, fig. 22, 1905. [Description same as original; figures added.]

DESCRIPTION: Carapace produced into short acute rostrum almost reaching end of first article of antennular peduncle. Rostrum and carapace rounded dorsally, without carina. Shallow, rounded depression between base of rostrum and orbital hoods. Orbital hoods rounded, without processes.

Stylocerite acute, extending to middle of second article of antennular peduncle. Peduncle proper short and heavy, with second article shorter than visible portion of first or third. Lateral spine of scaphocerite not over 0.2 longer than squamous portion, as long as carapocerite, definitely longer than antennular pe-



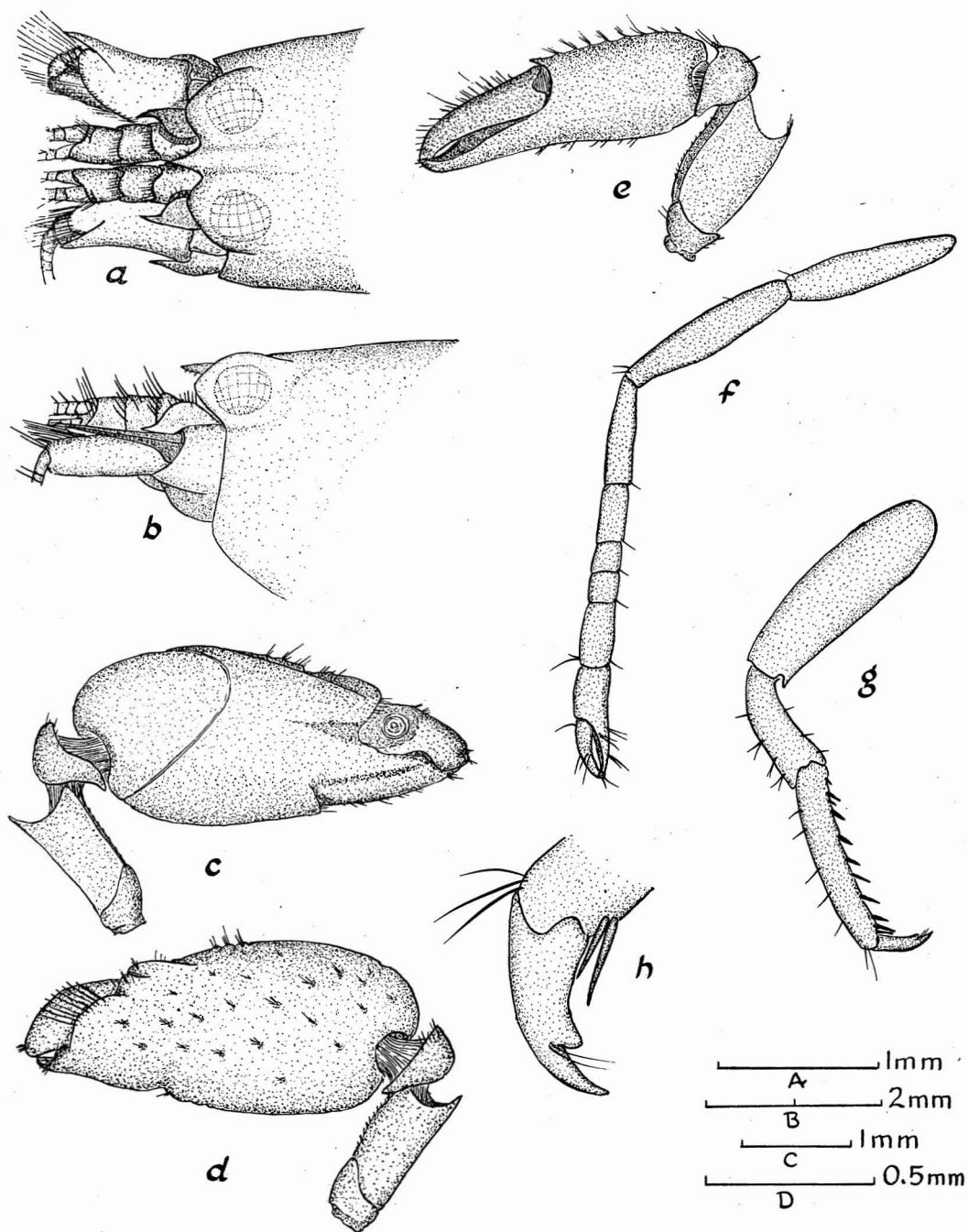


FIG. 33. *Crangon paragracilis* (Coutière). *a, b*, Anterior region, dorsal and lateral aspects; *c, d*, large cheliped, lateral and medial aspects; *e*, small cheliped; *f*, second leg; *g*, third leg; *h*, third leg, dactylus. (*a, b*, scale A; *c-e*, scale B; *f, g*, scale C; *h*, scale D.)

duncle. Outer margin of scaphocerite somewhat concave. Lateral spine of basicerite extending beyond rostral tip.

Large chela compressed, slightly over twice as long as high. Palm with 2 indentations on outer face, longitudinal groove behind articulation of dactylus and vertical shoulder on inferior side slightly proximal to articulation. Distal end of chela rotated almost  $45^\circ$  to proximal end, dactylus opening somewhat laterally. Fingers slightly less than 0.3 length of palm. In addition to usual bristles on immovable finger and dactylus, row of several groups of bristles on inner face near superior margin, occasional bristles on inner face of chela. Merus with superior edge produced as acute tooth, with series of 8–10 very short, conical spines along inferior internal margin.

Small chela about 0.75 as long as large chela, slender; fingers curved, about as long as palm. Propodus with acute tooth at point of articulation of dactylus. Merus similar in form to that of large chela.

Carpal articles of second legs with ratio 10 : 7 : 4 : 5 : 7.

Third legs with merus over 3 times as long as broad, with small acute tooth distally on inferior margin; carpus with distal projections of superior and inferior margins poorly developed, rounded; propodus shorter than merus, strongly arched, with 6–10 strong movable spines along inner edge; dactylus biunguiculate, with both claws strong and acute, distal claw twice as long as and broader at base than inferior.

Branchial formula without mastigobranch on seventh thoracic appendage, without setobranch on eighth appendage, without auxiliary pleurobranch at base of third maxilliped.

Largest specimens reaching 17 mm. in length; body with bright blue and smaller red chromatophores, blue predominating on body, especially on antennular and antennal bases, chelae, and caudal fan; tips of chelae yellow-green; eggs green.

DISCUSSION: This species shows some variations but they are not as marked as they are

in some other members of the genus. Like most species studied, there is some variation in the proportions of the appendages, for example, the first 2 carpal articles of the second legs which vary in ratio from 10 : 5 to 10 : 7. The tooth on the merus of the third legs varies from a strong and acute tooth to a less well-developed tooth with the point approaching an obtuse angle. The squamous portion of the scaphocerite varies from broadly rounded as shown in Figure 33a to narrow as shown by Coutière for the type (1905, fig. 22).

When this variation is considered, there is only one minor difference apparent between these specimens and those described by Coutière, the difference being that the propodus of the third legs in the type bears only four weak spines instead of the 6–10 in the Hawaiian form.

A peculiarity of this and the related species, *C. nanus* Banner, is that these species, seemingly alone among the local crangonids, can have their eyes forced out from under their carapace. In the collection of both species available about 5 per cent of the specimens showed this condition, which is evidently caused by rough handling in collecting, a thing very easily done with specimens so small. Either too much pressure on the thorax or too much pull on the antennules and antennae will displace the anterior portion of the body so the eyes will be exposed partially or completely (see Fig. 31f–h for *C. nanus*). As there is usually no distortion of the body or the appendages accompanying this protrusion, the condition could be confusing to an inexperienced worker.

DISTRIBUTION: This is one of the most common species about the Islands and has been collected from most of the seaward reefs of Oahu. It has been found in heads of coral, in coralline algae, and in the holdfasts of algae. Specific localities on Oahu where it has been collected, from water up to 20 feet deep, include: Kaneohe Bay, Waimanalo, Hanauma Bay, Black Point, Waikiki, Nanakuli, Moku-leia, Kawela Bay. On Maui, at a similar depth

range, it was collected at Makena, Kalama Park, Lahaina, and four localities ranging from 12 miles south of Lahaina to 10 miles north of Lahaina. The only record of the species from deeper water was a collection from 180 feet off Kaena Point, Oahu, where it was living in sponges. Edmondson (1925) has reported it from French Frigate Shoal, Pearl and Hermes Reef, Laysan, Lisianski and Ocean Islands. The "Albatross" took only one group of specimens, those from Laysan Island, evidently from shallow water.

The species has been reported from Johnston and Wake Islands (Edmondson, 1925) and from Tahiti in the central Pacific, and from the Indian Ocean. It was not reported by de Man from the Siboga Expedition material, although the range of the species extends to either side of the area investigated by that expedition.

#### Crinita Group, Crinita Subgroup

#### *Crangon paralcione* (Coutière)

Fig. 34 *a-i*

*Alpheus paralcione* Coutière, Fauna and Geog. Mald. and Laccad. 2: 895, pl. 80-81, figs. 34a-h, 1905.

*Crangon laysani* Edmondson, Bernice P. Bishop Mus., Bul. 27: 17, figs. 3a-j, 1925.

*Crangon bucephalus* (Coutière), Edmondson, Bernice P. Bishop Mus., Bul. 27: 14, 1925 [at least in part].

**DESCRIPTION:** Rostrum not reaching beyond middle of visible portion of first antennular article, broad yet acute, with dorsal carina continuous from tip to behind orbital hoods. Orbital hoods with no trace of teeth, depressed anteriorly as flattened shelf expanding as broad area between base of rostrum and anterior portion of orbital hoods; frontal margin of this area varying from arcuate to S-shaped. Margin of carapace above base of antenna higher than at base of the orbital hoods, forming slight but distinct depression.

Antennular peduncle short, with second article somewhat longer than visible portion

of first, about twice as long as third (note that the elongation of the second article shown in Figure 34*a* is atypical). Stylocerite short and variable with lateral spine not reaching end of first antennular article. Basicerite with acute lateral spine of varying size, usually quite small. Scaphocerite relatively narrow, with strong lateral spine 1.3 times as long as squamous portion; lateral margins concave. Lateral spine of scaphocerite usually longer than antennular peduncle, usually greatly exceeded by carpocerite.

Large chela subcylindrical, tapering, without grooves or lobes; distal portion slightly bent, thus lower surface concave in profile. Fingers about 0.3 length of entire chela. Dactylus laterally disposed, with strongly arcuate margin. Distal portion of inner face of chela sometimes sparsely covered with setae. Carpus of usual form. Merus short, triangular, with superior margin ending distally as rounded to subacute projection, inferior internal margin with acute tooth distally.

Small chela short, approximately 3 times as long as broad. Fingers 0.6 as long as palm, broad, flattened, lined with dense setae in male, narrower and conical in female. Palm somewhat triangular in section. Merus similar to that of large chela.

Carpus of second legs variable, but usually with ratio 10 : 30 : 9 : 9 : 11.

Ischium of third legs with small blunt spine (not shown in Fig. 34*b*). Merus about 3.5 times as long as broad, with strong acute tooth on distal portion of inferior border. Carpus with 1-5 movable spines on inferior border, continued distally as acute tooth; superior margin with numerous long setae. Propodus with varying number, usually about 12, movable spines along inferior margin, most of them in pairs, with many long setae on superior margin. Dactylus short, 0.2 as long as propodus, with small secondary unguis rotated so as to be almost invisible, except when legs are turned slightly. Fifth legs with "brush" well developed.

Pleura of first abdominal segment showing sexual dimorphism, in male ending posteriorly as dentate process that points slightly posteriorly, in female rounded. Following pleura of usual shape.

Telson 1.7 times as long as broad, tip 0.7 as wide as base; sides straight and posterior margin somewhat arcuate; dorsal surface slightly depressed medially. Dorsal spinules large, posterior pair located near middle; posterior margin usually with series of about 10 very feeble spinules. Inner branch of uropod with strong spines on posterolateral margin.

Most specimens were 10 mm. long or less; however, those specimens from Kaneohe Bay, Oahu, listed below reach 17.6 mm. in length. Color in life not observed.

DISCUSSION: This species, as well as the two other members of this subgroup from Hawaii, has been found to vary considerably in characteristics commonly accepted as of taxonomic importance.

The ratio of the lengths of the articles of the antennular peduncle varies considerably, with the second article varying from 1.4 to 2.0 times the length of the visible portion of the first article. The stylocerite varies from markedly shorter than the first antennular article to almost equal in length.

The relative lengths of the antennular peduncle, the scaphocerite, and the carpocerite also vary. In some specimens the scaphocerite is scarcely longer than the antennular peduncle, and in turn is greatly exceeded by the carpocerite; in others the scaphocerite is almost equal to the carpocerite, and both extend far beyond the end of the antennular peduncle; although the carpocerite is always longer than the antennular peduncle, the amount by which it exceeds is variable. The lateral spine of the basicerite also varies in size and in some specimens is so reduced that it is difficult to discern.

The large cheliped is constant in its general form in all specimens but varies somewhat in its proportions; in one specimen the tooth of

the inferior internal margin is reduced and rounded (Fig. 34d).

As noted by Coutière, the small chela is sexually dimorphic, but the breadth of the dactylus of the male is greater in proportion in larger specimens, and in the largest specimens it is broader than that described by Coutière.

In the second legs the second carpal article is usually nearly three times the length of the first, but it varies more or less continuously from 2.2 to 4.0 times as long. The proportions of the other articles also vary but not as much.

The spines on the carpus of the third legs usually are two in number but vary from one to five. The spines along the inferior margin of the propodus vary from 8 to 13. Studies were not made on the size of the secondary unguis of these legs because it was so difficult to rotate the leg to where the full unguis could be seen; however, they, too, appear to vary, being quite reduced in some specimens.

In none of the specimens examined does the sixth abdominal somite bear spines. The telson was not measured over a series of individuals, but examination did not show that it varies greatly in general shape. How variable the spinules on the tip of the telson are could not be determined, as at best they are exceedingly difficult to discern. In some specimens they may have been missing.

This form evidently has been described under two names: as *C. paralcione* (Coutière) from the Maldives and Laccadives in the Indian Ocean and as *C. laysani* Edmondson from the Hawaiian Archipelago. The two species appeared to be separate and valid on the basis of the original descriptions, but when the variation within the form is considered it appears that there are no important differences.

The original descriptions of the two species showed the following characteristics in common: the length of the stylocerite; the shape of the front of the carapace except for the rostrum; the shape of the large and small chelipeds; the shape and armature of the third legs; and the shape of the telson. On the basis of

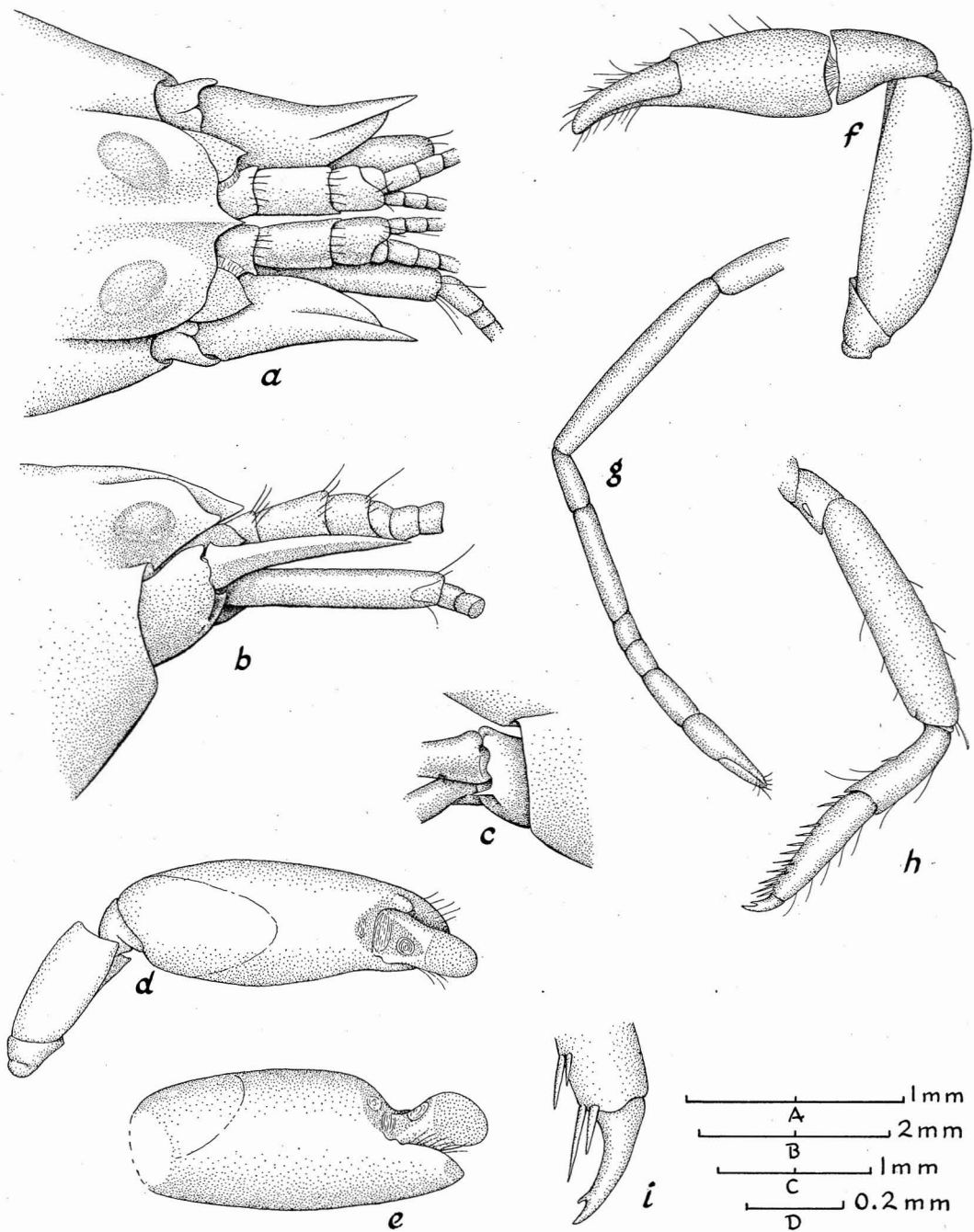


FIG. 34. *Crangon paralcione* (Coutière). *a*, *b*, Anterior region, dorsal and lateral aspects; *c*, basicerite, showing tooth (same specimen); *d*, large cheliped, lateral aspect; *e*, large chela, ventral aspect; *f*, small chela; *g*, second leg; *h*, third leg; *i*, third leg, dactylus. (*a*–*c*, scale A; *d*, *e*, scale B; *f*–*h*, scale C; *i*, scale D.)

other characteristics, it appeared that the two forms might be separated. For example, the relative lengths of the scaphocerite to the antennular peduncle and carapocerite; the relative length of the second article of the second thoracic legs, described by Coutière as 2.43 times the length of the first and by Edmondson as 3.0 times the length of the first; the armature of the carpus of the third legs; and the presence of spinules on the posterior border of the telson. However, all of these characters are found to be variable and the differences between the Indian and the Pacific forms removed by the variation within the Hawaiian population.

There are several differences that seem to remain between this form and the form described by Coutière: first, in the Indian Ocean form, the rostrum is but slightly produced, whereas in this form it usually reaches the end of the first article of the antennular peduncle; however, Coutière has shown in his plates that this varies in his specimens, and similar variation has been seen in the local specimens. Second, the lateral spine of the basicerite is longer in Coutière's specimens than in the local specimens; however, in the latter it is quite variable. Third, the merus of the large chela was shown by Coutière without spines or teeth (although he described it as bearing "une forte épine à son apex inféro-interne"); in the Hawaiian form there is a pronounced and almost always acute tooth. The external spine of the uropod is shown to be bent in Coutière's plates, whereas in this form it is straight. Finally, de Man in his key (1911: 314) puts emphasis on the presence of two teeth on the posterior dorsal margin of the sixth abdominal segment, teeth that are not found in the Hawaiian specimens; however, Coutière reported that, "... 2 prolongments épineux ... pouvant parfois manquer ou être très peu marqués."

Therefore, as all the differences between the Hawaiian forms and the type described by Coutière are either bridged by the variations noted or are both minor and variable so the

differences can be anticipated to be bridged by the study of additional specimens, it is advisable to place the species *C. laysani* as a synonym of *C. paralcynone*.

The specimen from Laysan identified by Edmondson (1925) as *C. bucephalus* (Coutière) was re-examined and found to be a member of this species.

**DISTRIBUTION:** This species appears to be more abundant in deeper water than in shallow water. It has been collected at the following locations in water up to 20 feet deep: at Kaneohe Bay, Hanauma Bay, Kahala Beach, Waikiki Beach, off Nanakuli, on Oahu; at Makena, Lahaina, and 10 miles south of Lahaina, on Maui; at Halape, Kau Coast, Hawaii, from coral at 35–40 feet deep. It was re-

TABLE 4  
DEEP-WATER COLLECTIONS OF *Crangon paralcynone*

LOCATION	DEPTH	U.S.N.M.	
		STATION NUMBER*	CATALOGUE NUMBER
	<i>fathoms</i>		
NE of Hawaii	29-26	4053	63623
	26-50	4054	63619
	24-83	4061	63608
Auau Channel	32-43	3872	63607
	34-65	3875	63617
	28-43	3876	63609, 63612, 63625
Off Puaaloa, Maui	26-27	—	—
N of Maui	45-52	4070	63626
	49-57	4075	63611
S of Molokai	23-24	3847	63618
	44-73	3848	63613
	43-73	3849	63621, 63624
Penguin Bank	27-29	4032	63616
Oahu			
Off Mokulua Island	20	—	—
1 mile S of Kahala	25	—	—
Off Diamond Head	35	—	—
Off Kaena Point	25	—	—
Off SW Oahu	6-60	—	—
Off Kauai	24-43	4024	63610
Off Kaula Rock, SW of Niihau	35	—	—
Off Nihoa	26	4147	63622
	27-29	4158	63614
Off French Frigate Shoal	14-17	3968	63615
	17	3971	63620

\* Station numbers are those of the "Albatross"; collections without station numbers were made by the "Makua" and "Salpa."



ported from shallow water at Laysan as *C. laysani* and *C. bucephalus* by Edmondson (1925). It has been dredged at the locations given in Table 4.

The species has been reported from various locations in the Indian Ocean and from the Netherlands Indies.

(?) *Crangon paralcione* (Coutière)

A single 9 millimeter specimen, collected at Hanauma Bay, Oahu, in 20 feet of water, has been referred to this species with doubts. It agrees with *C. paralcione* in the form of the rostrum and the orbital hoods, the stylocerites, the spine on the basicerite (on one side only; the spine is lacking on the other side), the relative lengths of the scaphocerite, carpocerite, and antennular peduncle; somewhat in the form of the large and small chelipeds; in the relative lengths of the articles of the carpus of the second legs; and somewhat in the form and armature of the third legs. It differs in the following points: the articles of the antennular peduncle are broader; the dactylus of the large chela is relatively shorter; the mesal tooth of the third legs is reduced to a very short rounded protuberance, the spines of the propodus are much longer, almost comb-like in form.

Most of these differences could be individual differences in a variable species, the most notable being the dactylus of the large chela and the armature of the third legs which has the reduced tooth on the merus and the longer propodal spines. It is possible that these too may be individual differences, or they may be constant and adequate criteria to separate this specimen as a species. However, with only one such specimen, and with the parent species showing such marked variation, it is considered advisable to place the specimen in *C. paralcione*, with reservations.

*Crangon brevipes* (Stimpson)

Figs. 35 a-j, 36 a-e, 37

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

NEOTYPE: A female 13.4 mm. long, col-

lected from a head of coral in 10 feet of water off Nanakuli, Oahu. A male paraneotype 9.6 mm. long has also been designated from the same locality (U.S.N.M. 93459).

DESCRIPTION: Anterior portion of carapace with dorsal carina high and thin, ending abruptly at base of rostrum. Rostrum short, triangular, seldom reaching past anterior margin of orbital hoods. Orbital hoods hemispherical, continued forward as short, subacute, subvertical keel that slants mesally toward ventral side; anterior margin of hoods almost vertical when seen in profile, reaching higher than rostral carina. Area between orbital hoods and base of carina flattened, with anterior margin varying from concave to straight. Lateral margins of carapace with indentation between lateral margin of orbital hoods and covering of base of antennular peduncles.

Second article of antennular peduncle from 1.5 to 2.0 times as long as visible portion of first article; third article about as long as first. Stylocerite short, broad, lateral spine reaching only 0.8 length of visible portion of first antennular article. Basicerite unarmed. Scaphocerite narrow, tapering, squamous portion about 1.1–1.2 times as long as lateral spine; lateral margin slightly concave. Scaphocerite usually slightly longer than antennular peduncles and slightly shorter than carpocerite.

Large chela without notches or grooves, subcylindrical, tapering. Dactylus heavy, between 0.25 and 0.3 length of entire chela, strongly arched dorsally. Merus about 1.5 times as long as broad, unarmed, distal end of superior margin rounded. Chela sexually dimorphic in both size and proportions, in female noticeably shorter than carapace, in male longer than carapace, with relatively greater thickness and shorter fingers than in female.

Small chela about 3 times as long as fingers, latter narrow and conical in both sexes; in male fingers about twice as long as broad, in female about 3 times as long as broad. Carpus 0.3 length of chela. Merus 3 times as long as broad but otherwise similar to large chela.

Carpal articles of second legs variable, but ratio usually within following range: 10 : 15-21 : 5-7 : 5-7 : 9-12.

Third legs with spine on ischium. Merus 2.7-3.1 times as long as wide, with strong subapical tooth on inferior margin. Carpus with acute tooth on distal end of inferior margin, without movable spines. Propodus with 10 movable spines along inner margin. Dactylus simple, curved, acute.

Pleura of abdomen rounded in both sexes. Telson broad, flat, slightly tapering distally, point of greatest width 1.3-1.8 times as wide as posterior margin, length 2.7-2.9 times breadth of posterior margin; both pairs of dorsal spines heavy, 0.3 and 0.6 of distance from point of articulation.

In addition to usual setiferous bristles posterior margin of telson with about 10 small spinules, these difficult to discern. Inner branch of uropod also with series of strong movable spinules, about 20, along posterolateral margins.

Specimens reaching 16.0 mm. in length; color in life not observed.

DISCUSSION: Inquiry at the major American museums revealed no records of Stimpson's type specimen, so it is presumed to have been lost. Unfortunately from Stimpson's description it is not possible to determine the exact type locality, for all that he specified was, "islands Hawaienses; inter ramos madreporarum." The neotype meets those specifications.

All the specimens available were examined carefully, but a group of specimens from Waikiki Reef which exhibited the usual range of variation were studied in greater detail. In this group, the variable characteristics were measured as accurately as possible and the results are here summarized.

*Anterior region of the carapace:* The dorsal carina varied from broad and dorsally rounded to narrow and acute; in no specimen did it reach the anterior tip of the rostrum. The variation in thickness of the anterior ridge of the orbital hoods may be seen in the drawings. One of the most variable characteristics was

that of the anterior margin of the carapace between the ridges of the orbital hoods and the rostrum; this varied from a concave margin in which the tip of the short rostrum did not reach the anterior margins of the orbital hoods, to a straight margin with the rostrum reaching beyond the hoods; in some specimens the frontal region was asymmetrical.

*Antennules and antennae:* The observed range in proportions of the articles of antennular peduncle is reported in the description. The relative length of the scaphocerite also varied, but without exception it was no shorter than the antennular peduncle and no longer than the carpocerite. In all specimens the basicerite lacked a lateral spine.

*Chelipeds:* Some of the variation of this sexually dimorphic appendage is indicated in the description. It was also found to differ in the degree of compression, with the breadth almost equaling the height in some specimens while in others the breadth was only about 0.7 of the height. The palm was found to vary from 1.5 to almost 3.0 times the length of the merus. In none of the specimens did the merus have an acute tooth on the end of the inferior internal margin, but although the margin was straight in most cases, a few specimens were found to bear a small obtuse and rounded projection.

The small cheliped was quite uniform except for the slight sexual dimorphism described above.

*Second legs:* The range of variation of the carpal articles has been given; a further discussion of this variation is given below where *C. brevipes* is contrasted to *C. clypeata* (Coutière).

*Third legs:* These appendages were quite constant in armature and proportions, with the ischium always bearing a spine; the merus varying from 2.7 to 3.0 times as long as broad, that of the smaller specimens being more narrow than the larger; the merus always with a strong distal tooth; the propodus always bearing strong spines; the dactylus always simple. However, in the smallest specimens (those

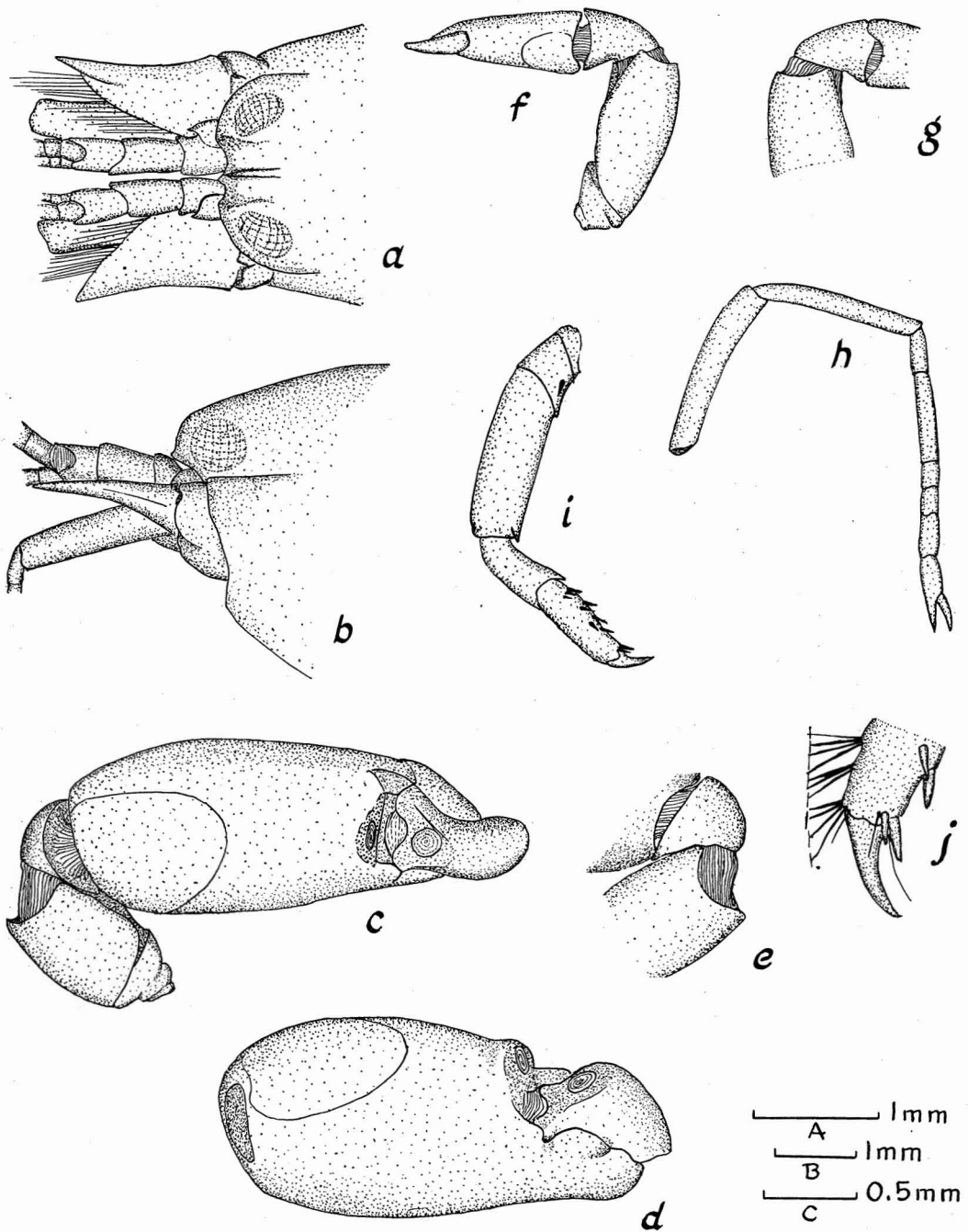


FIG. 35. *Crangon brevipes* (Stimpson). *a*, Anterior region, dorsal aspect (asymmetry of rostrum and scaphocerite found in specimen); *b*, anterior region, lateral aspect; *c*, large cheliped, lateral aspect; *d*, large chela, ventral aspect; *e*, large cheliped, merus and carpus, medial aspect; *f*, small cheliped, lateral aspect; *g*, small cheliped, merus and carpus, medial aspect; *h*, second leg; *i*, third leg; *j*, third leg, dactylus. (*a*, *b*, scale A; *c*-*i*, scale B; *j*, scale C.)

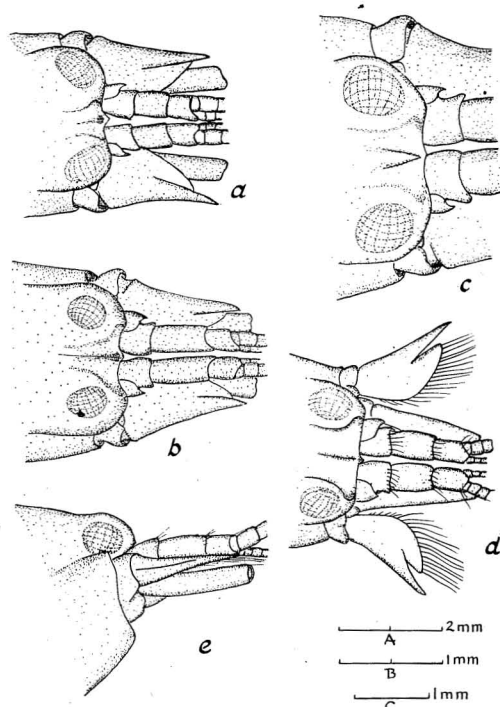


FIG. 36. *Crangon brevipes* (Stimpson). Variation in the frontal region of the carapace, antennules, and antennae; specimens drawn in *a*, *b*, and *c* came from Waikiki Beach, Oahu; the specimen in *d* and *e* came from Mokuleia, Oahu. (*a*, *b*, scale A; *c*, scale B; *d*, *e*, scale C.)

about 5 millimeters long) the propodus bears only 4–5 well-developed spines instead of the usual 8–11 spines.

**Telson:** The measured range of variation of the telson has been given. No attempt was made to determine whether the small spinules on the posterior border of the telson or on the posterolateral margin of the inner uropod varied in number, as it was too difficult to count them accurately. In all specimens that were studied carefully the spinules were present.

These specimens agree perfectly with my interpretation of the short description given, without figures, by Stimpson; the description is adequate to separate this species from all other species known to occur in the Hawaiian Archipelago.

Until this species was thoroughly studied, it was felt that probably it was identical with

*C. clypeata* (Coutière), a species found in the same habitat; if that had been so, *C. clypeata* would have been relegated to synonymy. The two species agree in most characteristics: in the general shape and configuration of the anterior portion of the carapace; the proportions of the antennular peduncle and antennal peduncle; in the large chela; in the third legs; in the telson.

When a large number of specimens was studied, however, the following characteristics were found to be reliable for their separation:

1. *Sexual dimorphism of the small chela of males.* In *C. clypeata* the dactylus of the small chela of males, although somewhat variable, is always noticeably broadened or subspatulate and surrounded by dense setae; in *C. brevipes* it is never subspatulate.

2. *Tooth on basicerite.* This tooth, or spine, is almost always present in *C. clypeata* and is always lacking in *C. brevipes*; however, in a few of the specimens of *C. clypeata* it is very reduced, and sometimes it is entirely lacking.

3. *Tooth on merus of large cheliped.* This tooth is usually large and acute in *C. clypeata* and entirely lacking in *C. brevipes*; however, this characteristic alone is not adequate to separate the species, as sometimes in *C. clypeata* it may be reduced and obtuse or rounded, or even entirely lacking, whereas in *C. brevipes* the margin may bear an obtuse projection.

4. *The relative length of the second article of carpus of the second legs.* In an attempt to find the extent of variation in the relative lengths of the first and second carpal articles, they were measured in 103 specimens of both species; the result of this study is shown in Figure 37. This shows that most of the specimens of *C. clypeata* have the ratio of the second to the first articles of 1.0 and that most of the specimens of *C. brevipes* have the ratio of the same articles between 1.7 and 2.0. However, specimens that on the basis of the other characteristics were definitely *C. clypeata* did reach the maximal ratio of 1.3, and similarly specimens

that were definitely *C. brevipes* did reach the minimal ratio of 1.4. Therefore, it is likely that, if enough specimens were measured, the edges of the normal distributional curve would overlap. Another graph, not reproduced here, was made to ascertain whether the ratio between the articles varied with the size of the specimens; in this the ratio of the lengths of the first two carpal articles was plotted against the length of the carapace. This study showed no correlation whatsoever, with both species having great variation in ratios for all size ranges.

On the basis of these four variable characteristics, satisfactory separations of the two species may be made. If, for example, the ratio of the first two articles of the carpus of the second legs was between 1.3 and 1.5, in cases where it was undecisive, then the specimen could be assigned to its correct species on the basis of the teeth of the merus of the large chela or of the basicerite. In none of the well over 200 specimens examined was any doubt encountered as to the identity of an individual specimen.

The belief that these are indeed separate species is confirmed by the study of paired specimens. Both of these species live in algae-covered tubes on old coral; in each tube there is a single pair of specimens, a male and a somewhat larger female which are evidently mates. During routine collecting, whenever it was possible to get both members of this pair, they were removed and preserved for special study. In the small number of these pairs available, none consisted of mixed species—either both were plainly *C. brevipes* or both were plainly *C. clypeata*.

This endemic species apparently has been derived from the Indo-Pacific *C. clypeata*. As the differences between the species are neither constant nor of great magnitude, as the habitat remains the same, the separation of the two species can be presumed to have been in relatively recent time.

Coutière described a species, *C. parabrevipes* (1898a: 151), which he thought might be iden-

tical with this species. It was plainly a different species as *C. parabrevipes* had grooves and ridges on its chela which are entirely lacking in *C. brevipes*. *C. parabrevipes* (Coutière) was considered a synonym of *C. acuto-femorata* (Dana) by de Man (1911).

**DISTRIBUTION:** The species appears to be moderately plentiful on Oahu, where it was collected both in shallow water of the reef flat and outside the reefs in water to about 20 feet deep at the following locations: off Mokolua Islands, Waimanalo, Hanauma Bay, Waikiki, Nanakuli, Mokuleia, Kawela Bay. It was collected at Halape, Kau Coast, Hawaii, by R. W. Hiatt, in coral at a depth of 30–40 feet. The only record of the species from deep water is two specimens collected in 30 fathoms off Waikiki Beach.

### *Crangon clypeata* (Coutière)

Figs. 37, 38 a–k, 39 a–u

*Alpheus clypeatus* Coutière, Fauna. and Geog. Mald. and Laccad. 2: 897–898, pls. 81–82, figs. 36–36g, 1905.

**DESCRIPTION:** Frontal border, seen from above, truncate and projecting, with margin from slightly concave to slightly convex. Rostrum either small or lacking. Dorsal carina high and definite, sharp or rounded, anteriorly terminated abruptly before reaching edge of frontal area. Area between orbital hoods and

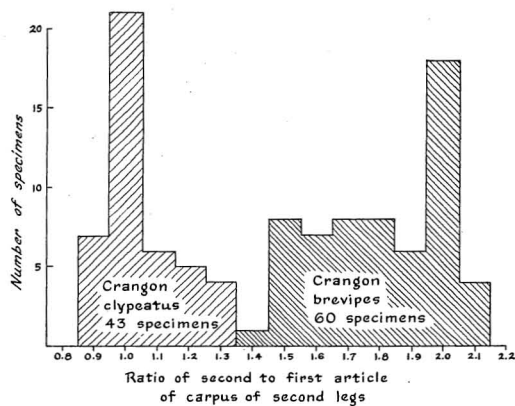


FIG. 37. Comparison of carpal ratio of *Crangon clypeata* (Coutière) and *Crangon brevipes* (Stimpson).

rostrum convex dorsally. Orbital hoods hemispherical. Depression between lateral margins of orbital hoods and portion of carapace above base of antennae.

Antennular peduncle with second article 1–2 times as long as visible portion of first article; third article equal to or somewhat longer than visible portion of first; second article 1.5–2.0 times as long as broad. Short lateral spine of stylocerite reaching nearly 0.7 length of visible portion of first article. Basicerite almost always bearing thin, acute lateral spine. Scaphocerite, antennular peduncles, and carpopocerite subequal in length, all variable, but carpopocerite almost always slightly longer.

Large chela of male subcylindrical, usually slightly compressed, entire and smooth, tapering toward fingers. Entire chela about 4 times length of fingers and about 2.5 times its greatest height. Chela rotated, with dactylus lateral in position. Merus about 1.5 times as long as wide, with superior distal angle not greatly produced; inferior internal margin usually with strong acute tooth distally. Chela relatively shorter and thinner in female than in male.

Small chela of male with dactylus expanded, about twice as long as broad, with dense fringe of short setae on margin; fingers slightly shorter than palm; height of palm slightly over 0.3 length of chela. Merus twice as long as wide, about 0.7 as long as chela, with all distal angles rounded. In female dactylus narrow, 3 times as long as broad, uniformly tapering; palm about 1.5 times as long as fingers; chela slightly over 3 times as long as high; merus thinner than in male.

Ratio of carpal articles of second legs varying thus: 10 : 9–13 : 2.9–4.7 : 2.9–4.7 : 6.3–10.0 (see Fig. 37).

Ischium of third legs armed with short strong movable spine. Merus 3.1–3.5 times as long as wide, with strong tooth distally on inferior margin. Carpus prolonged distally on inferior border as rounded tooth, otherwise unarmed. Propodus broad and flattened, with 9–11 movable spines along inferior margin.

Dactylus simple, curved. Fourth legs similar to third legs except meral tooth less pronounced.

Telson with sides of uniform taper 2.2–2.9 times as long as width of posterior margin, greatest breadth 1.3–2.2 times as wide as posterior margin. Pairs of dorsal spines about 0.4 and 0.7 distance from articulation. Posterior margin between posterolateral spines arcuate, with about 10 small spinules; inner branch of uropod similarly with spinules along distolateral margin.

Mature specimens usually reaching maximum length of 18 mm.; one female, however, 23 mm. long. Color of live specimens variable, body transparent, covered dorsally with red, yellow, and blue chromatophores in reticulated pattern; abdomen with reticulations in transverse bands; legs usually transparent; large chela with more red and blue chromatophores than body; eggs bright green.

DISCUSSION: Like *C. paralcione* and *C. brevipes*, this species shows great variation in many characteristics. Some 10 specimens were studied intensively to determine the range of variation; unfortunately, time did not permit the making of the complete series of measurements for the almost 100 specimens available. The specimens not measured, however, were all examined to determine any marked variation.

The ranges of variation of the frontal region of the carapace, of the antennular and antennal peduncles, of both chelipeds, of the third legs, and of the telson either have been given in the description or are shown in Figures 38 and 39. The range of variation of the second legs is given in the description and shown graphically in Figure 37. A few additional variations are noteworthy: The lateral spine of the basicerite, usually well developed, is sometimes reduced or absent. The large chela, already noted as sexually dimorphic, also varies from almost circular in cross section to distinctly compressed. The merus of the large cheliped almost always carries a well-developed tooth on the inferior internal margin, but in some



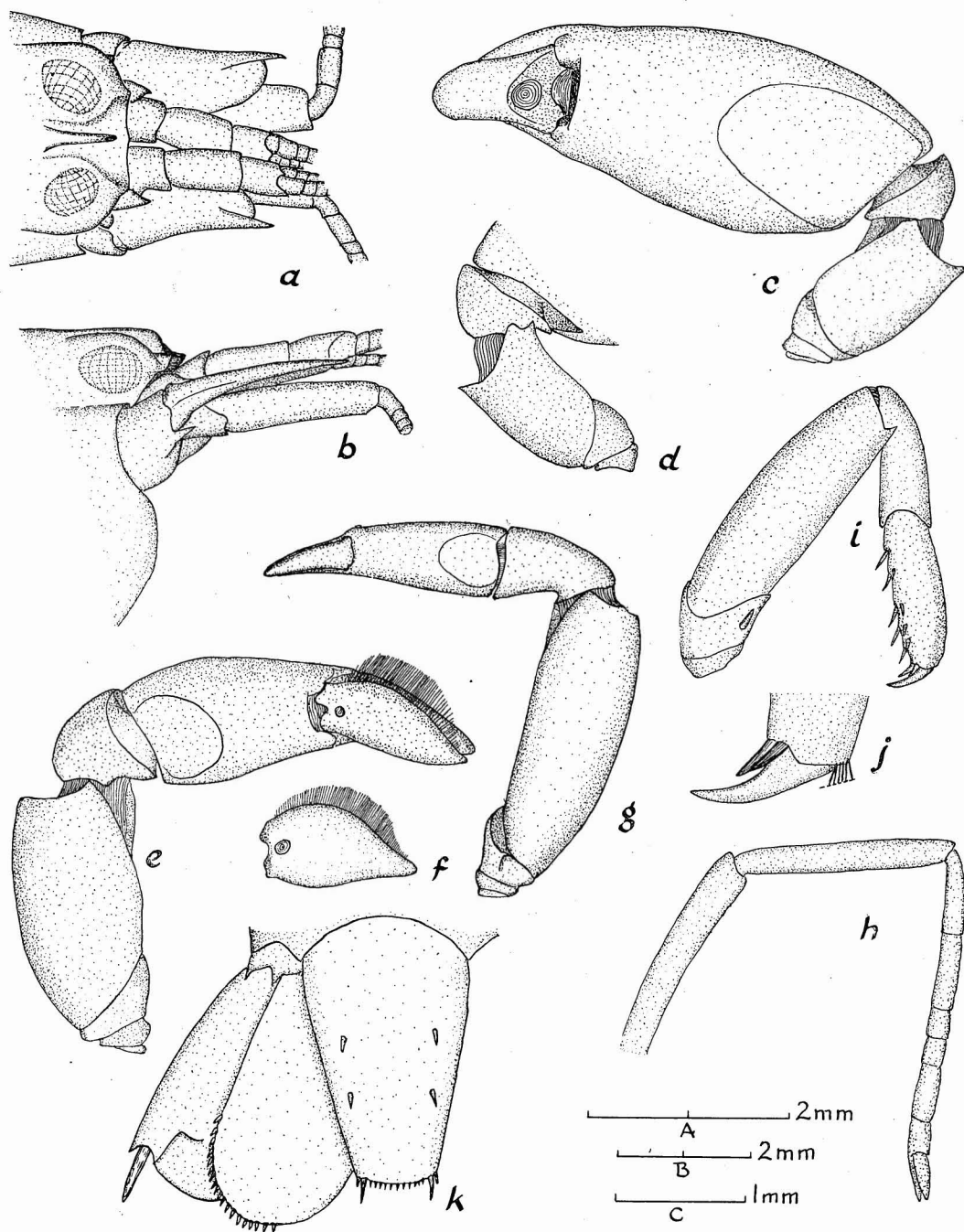


FIG. 38. *Crangon clypeata* (Coutière). *a, b*, Anterior region, dorsal and lateral aspects; *c*, large cheliped, male, lateral aspect; *d*, large cheliped, merus and carpus, medial aspect; *e*, small cheliped, male; *f*, dactylus of *e* showing maximum breadth; *g*, small cheliped, female; *h*, second leg; *i*, third leg; *j*, third leg, dactylus; *k*, telson and uropods. (*a, b, e-i, k*, scale A; *c, d*, scale B; *j*, scale C.)

specimens it is reduced and rounded and in a very few completely absent. On the third legs of very small specimens (less than 5.0 mm. long) there are only 4-5 spines on the propodus instead of the usual 9-11.

The observed range of variation of this species is great, and if a few specimens on the fringes of the normal curve of variation were examined alone they probably would be interpreted as separate but related species. However, in the large number of specimens examined, the gaps between the extremes were closed so the collection presented an almost continuous spectrum of variation from one extreme to the other.

The description of the type specimen of *Coutière* easily falls within the range of variation noted above; there should be no doubts as to the specific identification of this species.

Locally this species can easily be confused with *C. brevipes*; the separation of the two species is discussed in detail on page 106.

**DISTRIBUTION:** This species is usually found in the same habitat as *C. brevipes*; like *C. brevipes*, it is moderately common around Oahu. In the shallow water of the reef surface and on the outer sides of reefs to the depth of about 20 feet it has been collected at the following localities: off Mokulua Islands, Waimanalo, Hanauma Bay, Waikiki, Nanakuli, Mokuleia, on Oahu; at Lahaina and at 10 miles north of Lahaina, on Maui. Edmondson (1925) has reported this species from French Frigate Shoal, Pearl and Hermes Reef, and Ocean Island. One chela, collected by the "Albatross" at Honolulu—without further designation—probably is this species (U.S.N.M. 63633).

Edmondson has also reported the species from Johnston and Wake Islands. Its original description was based on specimens from the Indian Ocean, but it was not collected by the Siboga Expedition.

Crinita Group, Diadema Subgroup

### *Crangon paracrinita* (Miers)

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

As I have seen no specimen of this species, the original description is given.

Rostrum triangular, acute, arising from the frontal margin of the carapace (which is slightly concave on each side of its base), but not prolonged backward as a dorsal carina. Orbital arches entire, arcuated, without spinules; anterior margin of the carapace sinuated on the sides, without spines. Postabdominal segments smooth, entire, with the lateral margins broadly rounded; terminal segment not three times as long as broad at the base, with its distal end subtruncated. Eyes completely concealed beneath the carapace. Antennules with three joints of the peduncle exposed, of which the middle one is slightly the longest, with a small spine-like scale at base, reaching nearly to the end of the basal joint. Basal scale of antennae about reaching to the end of the antennal peduncle, with the outer margin convergent towards it and clothed with long hairs. Anterior legs or chelipeds having the merus and carpus slender; merus with a small tooth or spine at the distal end of its under margin; palm of larger cheliped rather more than twice as long as broad, smooth, without notches or ridges, largest at its rounded basal end, with an impressed curved line on its upper and proximal end; fingers nearly half as long as the palm; the upper with its superior margin arcuated. Smaller cheliped with the carpus rather longer, and chela very slender, fingers hairy. Second legs with the first joint of the carpus longer than the second, the last three joints of nearly equal length, the last a little the longest, the joint preceding these somewhat longer. Ambulatory legs somewhat hairy. Distal ends of the rami of the uropods clothed with long hairs. Color light yellowish (in spirit). Fingers of larger cheliped pinkish. Length 7 lines (nearly 15 millim.).

Only one specimen has been reported from the Hawaiian Archipelago, that by Edmondson (1925) from Laysan Island.

Elsewhere in the Pacific the species has been recorded from Johnston and Palmyra Islands by Edmondson. It has also been reported from Djibouti in the Indian Ocean. The type locality is Senegambia, West Africa.

### *Crangon paracrinita* (Miers) var.

#### *bengalensis* (Coutière)

Fig. 40 a-k

*Alpheus paracrinitus* var. *bengalensis* Coutière, Fauna and Geog. Mald and Laccad. 2: 901, pl. 32, figs. 37-37e, 1905.

**DESCRIPTION:** Rostrum triangular, acute, longer than width at base, tip reaching approximately to middle of visible portion of first antennular article, rounded dorsally, not

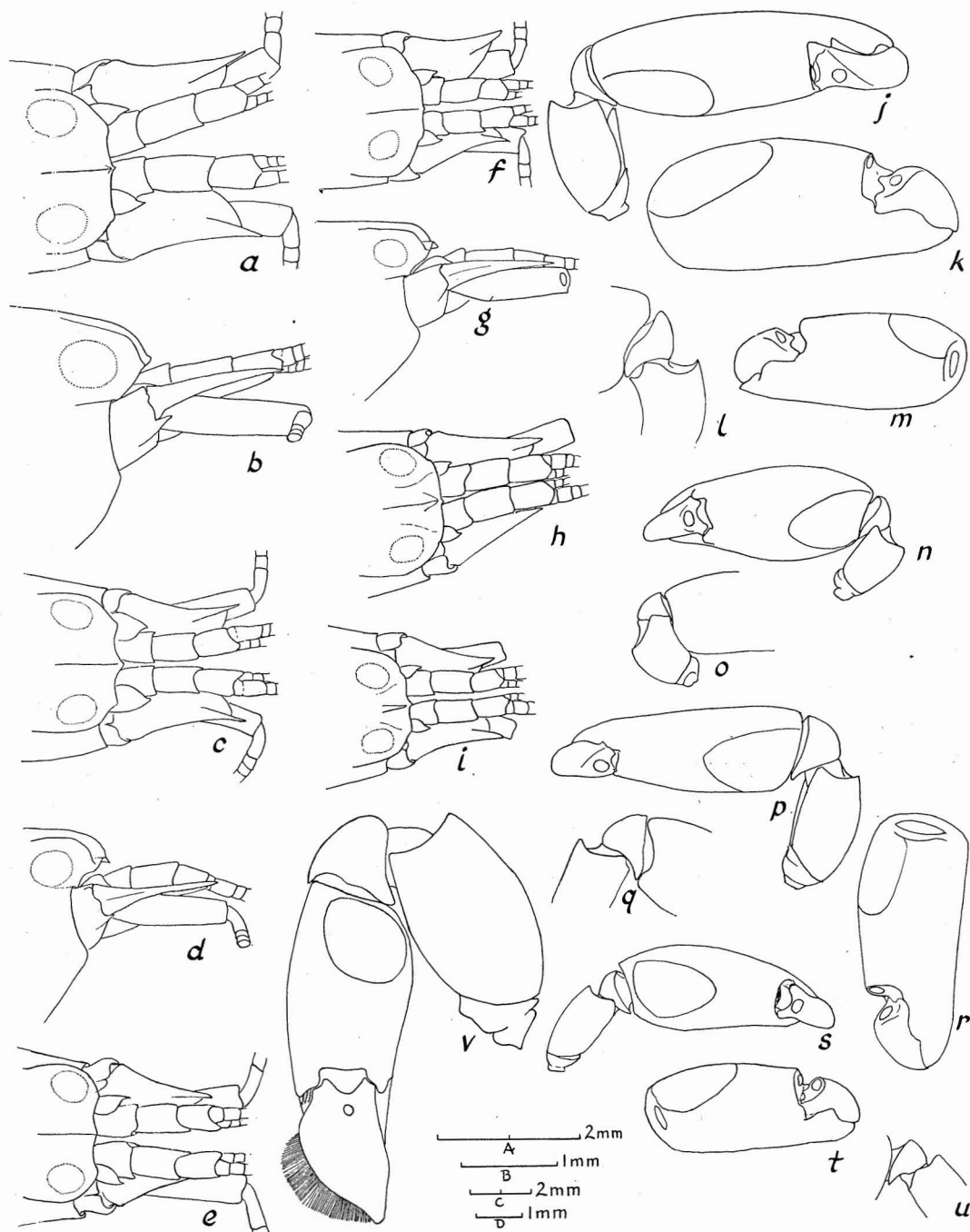


FIG. 39. *Crangon clypeata* (Coutière). Showing variation in front of carapace, antennules, antennae, and chelipeds. (a, b, v, are of one specimen; c, d, j-l, of another; e, m-o, of a third; f, g, p-r, of a fourth; h, s-u, of a fifth.) (a, b, e, i-l, v, scale A; c, d, f, g, scale B; h, scale D; m-u, scale C.)

carinate, separated from anterior orbital hoods by short shallow round-edged depressions. Orbital hoods not conspicuously inflated, rounded anteriorly. Frontal margin between orbital hoods and base of rostrum concave.

Visible portion of first antennular article subequal to second; third article shortest. Tip of stylocerite reaching beyond tip of rostrum, almost to end of first antennular article. Lateral spine of scaphocerite about 1.1 times as long as squamous portion. Basicerite with acute spine. End of carpocerite greatly exceeding both scaphocerite and antennular peduncle; scaphocerite equal to or slightly longer than antennular peduncle.

Large chela compressed, with smooth regular margins and faces except for very slight concavity in upper margin proximal to articulation of dactylus and longer, more gradual concavity in lower margin below articulation of dactylus. Chela 3 times as long as broad, fingers about 0.3 length of chela. Finger 1.5 times as long as greatest height. Merus of large cheliped 2.0 times as long as broad, superior edge distally rounded, inferior external edge rounded in basal portion, inferior internal edge with small acute tooth distally.

Small chela subcylindrical, almost 5 times as long as broad, fingers 0.5 length; shoulders at articulation of dactylus rounded. Carpus elongate, slightly over 0.3 length of chela. Merus 3.4 times as long as broad, similar in form to that of large cheliped but with inferior internal spine either poorly developed or lacking.

Both large and small chelae sexually dimorphic in size, large chela of male 1.3 times length of carapace, equal in female. Small chela with similar range; in addition, dactylus of male broader than that of female and bearing heavy fringe of bristles.

Carpal articles of second legs with ratio 10 : 10 : 5 : 5 : 8.

Ischium of third legs with movable spine. Merus 5 times as long as wide, rounded distally (in specimen drawn only left leg rounded distally, that of right leg with small acute

process distally). Carpus slightly over 0.5 as long as merus with neither distal angle greatly projecting or acute. Propodus about 0.8 as long as merus, with 6-8 spines. Dactylus simple, curved and elongate, 0.3 as long as propodus.

Abdominal pleura of both sexes rounded. Telson 1.7 times as long as broad at base, 1.7 times as broad near base as at tip. Proximal 0.6 of telson broad, only slightly tapered; distal 0.4 abruptly tapered anteriorly, gradually tapered posteriorly. Posterior margin almost straight. Paired dorsal spines 0.3 and 0.6 of length from base.

Length up to 14 mm. Body usually translucent white with definite narrow transverse bands of red on abdomen and somewhat similar bands, poorly defined, on thorax; bands across bases of antenna and antennules more definite; chelae with red mottling; eggs dark yellow in early stages, more greenish in advanced stages.

DISCUSSION: No marked variation in the specimens in the collection was noted, although a detailed study of the ratios of the parts of the appendages was not undertaken. Slight differences were noted, as would be expected, in the proportions of the antennules, antennae, large and small cheliped (especially in the length-width relations of the merus, which varied from 1.8 to 2.7 times as long as broad), in the merus of the third legs, and in the telson. It should be noted that in the 26 specimens of this variety in the collections the second article of the carpus of the second legs varied from 0.85 to 1.3 times as long as the first. The merus of the large cheliped was armed with teeth of varying size on the inferior internal margin, and the corresponding margin of the small cheliped often had a feebly developed tooth. However, in general the specimens were quite similar.

This variety was separated from the parent species by Coutière on the basis of three characteristics: first, the parent species has a small tooth at the articulation of the dactylus of the small cheliped, whereas the variety has none.

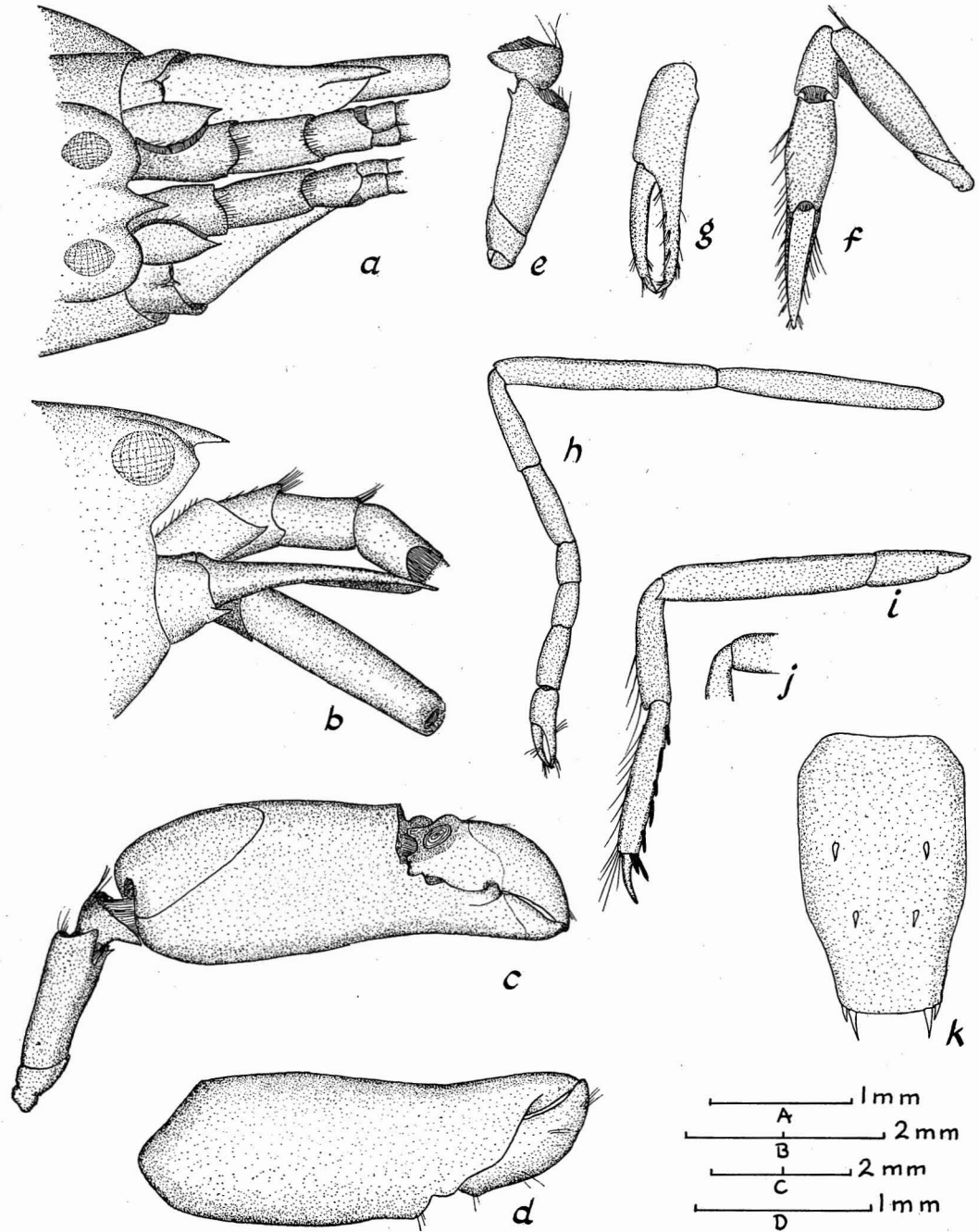


FIG. 40. *Crangon paracrinita* (Miers) var. *bengalensis* (Coutière). *a, b*, Anterior region, dorsal and lateral aspects; *c*, large cheliped, lateral aspect; *d*, large chela, medial aspect; *e*, large cheliped, merus and carpus, medial aspect; *f*, small cheliped, lateral aspect; *g*, small chela, ventral aspect; *h*, second leg; *i*, third leg (meral tooth abnormal); *j*, third leg, meral-carpal articulation normal, from same specimen as *i*; *k*, telson. (*a, b*, scale A; *c-e, b-j*, scale B; *f, g*, scale C; *k*, scale D.)

Second, the tooth on the inferior internal margin of the merus of the large cheliped is reduced, and the one at the corresponding location on the small chela is lacking in the variety, whereas both are present and well developed in the type described by Miers. Finally, the first carpal article of the second legs is almost twice as long as the second in *C. paracrinita* (Coutière: "... rapport de 1.75 à 1.85 . . .," *loc. cit.*), whereas in the variety the two articles are of almost equal length.

The differences between the Hawaiian specimens and those described by Coutière are slight except for the variations noted.

All specimens collected in the windward Hawaiian Islands have been assigned to this variety. It is true that the armature of the merus of the chelipeds has been overlooked in making this separation, but first, the variation of the armature indicates that too much faith should not be placed upon it; second, the Hawaiian forms agree with the variety in the ratio of the articles of the carpus of the second legs—at least, they lie within the expected range of variation—and none had the tooth flanking the articulation of the dactylus of the small chela. If the variation in these two forms is similar to that found in *C. brevipes* (Stimpson)

TABLE 5  
CHARACTERISTICS DIFFERENTIATING THE SPECIES OF THE DIADEMA SUBGROUP

CHARACTERISTIC	<i>C. pugnax</i>	<i>C. diadema</i>	<i>C. pseudopugnax</i>	<i>C. percyi</i>	<i>C. gracilipes</i>	<i>C. paracrinita</i> var. <i>bengalensis</i>
Rostral base	Very narrow triangle without carina; not depressed	Broadly triangular with carina; somewhat depressed	Simple ridge anteriorly, triangular posteriorly; strongly depressed	Slightly broader than in <i>pugnax</i> ; without carina anteriorly; strongly depressed	Similar to <i>pugnax</i>	Rounded, not well marked; slightly depressed
Orbitorostral groove	Narrow, deep	Broad and shallow anteriorly	Broad and deep	Narrow, deep	Narrow, deep	Short, shallow, rounded
Large chela	Transverse groove*	Transverse groove	Transverse groove and depressed areas	Transverse groove	Transverse groove	Without groove
Large cheliped, merus	Strong tooth on superior margin; inferior margin with tooth and series of spines (?)	Similar teeth, lacking meral spines	Similar teeth, with serrations on all margins	Same as <i>C. pseudopugnax</i>	Similar teeth, 2-4 spines on inferior margin	Without superior tooth, inferior tooth weak; no spines
Carpal articles of second legs, ratio of first to second	10 : 25	10 : 10	10 : 11	10 : 10	10 : 10	10 : 10
Third legs, merus	Strong tooth	Strong tooth	Strong tooth	Strong tooth	Without tooth	Without tooth

\*De Man states in his key (1911) "Chela without a transverse groove near the articulation of the dactylus." However, Dana (*loc. cit.*) states "narrow emarginate above, near articulation," and shows in his figure what might be the groove.



and *C. clypeata* (Coutière), the diagnostic characteristic afforded by the ratio of the lengths of carpal articles may prove to be of somewhat questionable worth.

To separate this from the related Hawaiian species, see Table 5.

DISTRIBUTION: On Oahu four specimens were from unrecorded localities, presumably from the shallow water at the reef surfaces; specific localities were Kaneohe Bay, under coral heads on sand flats about a foot deep at low tide, where the species was common; Waimanalo, 6 feet deep; Hanauma Bay, 20 feet deep; Black Point, 2 feet deep; and Wai-kiki, 2 feet deep. On Maui, specimens were collected at Kalama Park, 3 and 8 feet deep; 10 and 12 miles south of Lahaina, both at 6 feet; and at Lahaina, 4 and 6 feet deep. There are no other records of the variety from the Hawaiian Islands.

### *Crangon gracilipes* (Stimpson)

Fig. 41 *a-i*

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

DESCRIPTION: Rostrum narrow, triangular, acute, flattened dorsally, without carina, tip slightly depressed, reaching 0.7 of length of visible portion of first antennular article. Rostrum separated from posterior portion of orbital hoods by deep narrow depressions, more anteriorly by wide flattened areas with abrupt sides against both orbital hoods and rostrum, latter overhanging groove. Orbital hoods inflated, large, with abrupt medial margin, posteriorly merging with carapace, anteriorly with dorsoventral keel. Anterior margin of orbito-rostral area concave. When seen in lateral view, anterior carapace without definite angle along dorsal surface at base of rostrum [as there is in *C. percyi* (Coutière)], and without tubercle at this point.

Antennular peduncle long and slender with second article over twice as long as broad, longer than visible portion of first article, over twice as long as third article. Stylocerite reach-

ing to or slightly beyond end of first antennular article. Scaphocerite long, with strong lateral spine about 1.1 times as long as squamous portion; outer margin somewhat concave; squamous portion somewhat reduced. Strong lateral spine of basicerite reaching tip of rostrum. Scaphocerite slightly longer than antennular peduncle; tip of carpocerite reaching slightly beyond end of second antennular article. Antennal flagellum about 1.5 times body length.

Large chela subcylindrical, 1.3 times as high as broad, 3.7 times as long as high, tapering toward distal end. Palm with deep transverse groove proximal to articulation of dactylus. Palm, at articulation of dactylus, with narrow depression to accommodate high crest of dactylus when flexed. Dactylus 0.3 length of chela, compressed, strongly arcuate, longer than fixed finger. Merus about 2.5 times as long as broad; superior margin somewhat rounded but usually projecting as acute tooth (specimen drawn also with secondary tooth); inferior internal margin acute, with 2-4 spines and acute tooth distally.

Small chela not sexually dimorphic, long and narrow, over 5 times as long as broad, fingers somewhat broadened, 0.7 length of palm. Dactylus with fringe of long setae running longitudinally from near point of articulation over crown of article before apex. Small subacute tooth on propodus above articulation of dactylus. Merus usually with acute teeth distally on inferior internal and superior margins; inferior internal margin usually with one to several spinules.

Carpal articles of second legs with ratio 10 : 10 : 4 : 5 : 6.

Ischium of third legs with small movable spine; merus 8 times as long as broad, inermous; carpus 0.5 as long as merus, with tooth at inferior distal margin poorly developed; propodus almost as long as merus, with 9-11 slender spines; dactylus simple, curved, 0.2 length of merus.

Telson 2.1 times as long as broad at base, tip 0.6 width of base. Lateral margins almost

straight, posterior margin arcuate. Dorsal spines moderately developed, 0.4 and 0.7 of distance from articulation to tip. Length of larger pair of terminal spines less than 0.5 breadth of tip. Tip of telson and distolateral margin of inner uropod with series of small spinules.

Length up to 22 mm. One specimen observed alive; dark, almost black, to unaided vision; color from greatly expanded blue and red chromatophores. Under microscope body mottled, with clear areas over eyes and on branchiostegites over third maxillipeds and elsewhere, and with darker areas like two "eye spots" on sides of abdomen. Antennules and antennae, second to fourth legs, and caudal fan bluish; fifth legs reddish; chelae slightly darker than body with pink cast at dactylar articulations and on tips of fingers.

DISCUSSION: In a few specimens available for comparison no great variation was noted. The rostral length varied, with the tip reaching from 0.7 of the length of the first article of the antennular peduncle to beyond the end of the same article. In some cases the second antennular article was over twice the length of the first. The merus of the large chela varied as noted above; almost always the distal teeth were well developed; the same is true of the small chela. In some of the specimens the second carpal article of the second legs was slightly shorter than the first. The number of spines on the propodus of the third legs varied slightly.

The only possible difference between this and the original description of Stimpson lies in the lateral spine of the basicerite which he specifies to be minute, whereas on all of these specimens it is large and well formed; however, exactly what Stimpson meant by "minute" is not known. The specimens also agree well with the specimens described by de Man (1911) from the southwest Pacific.

To separate this from the related Hawaiian species, see Table 5.

DISTRIBUTION: The few specimens available were collected from Kaneohe Bay, Kaaawa,

and Waikiki, Oahu, and one from Maalaea, Maui; these were all without records as to depth, but presumably they were from shallow water. Edmondson (1925) reported two specimens from Lisianski Island. The species has also been reported from the Hawaiian Islands by Coutière.

*C. gracilipes* occurs from the Red Sea through the Indian Ocean, the East Indies, and Japan, to Samoa, Tahiti, and Hawaii. The type locality is Tahiti.

### *Crangon pugnax* (Dana)

Fig. 42 a-b

*Alpheus pugnax* Dana, U. S. Explor. Exped. 13: 554, pl. 32, figs. 6a-6h, 1852.

*Alpheus pugnax* Dana, Acad. Nat. Sci. Phila., Proc. 6: 27, 1854. [Description without figures.]

As no specimens are available, the original description is given:

Beak [rostrum] acute, narrow triangular, flat above, arising from between the bases of the eyes. Basal spine of outer antennae [of basicerite] small, basal scale [scaphocerite] longer than base [carpocerite]. Base [peduncle] of inner antennae shorter than scale of outer; basal spine [stylocerite] of inner antennae not shorter than the first joint, second joint short. Anterior feet unequal; larger hand long, smooth with rounded margins, narrow emarginate above near articulation, fingers short (about one-third the length of hand), arm having a spine at both inner and outer apex. Feet of second pair long, first joint short, hardly half the second in length. Third and fourth pairs slender, third joint with an acute tooth at lower apex.

At Lahaina, Island of Maui, Hawaiian group.

Length, twelve lines. The beak from its base is very narrow, triangular, with straight sides, and there is no carina prolonged down the back. Second joint of inner antennae hardly longer than first. Larger hand partly pubescent, somewhat fusiform, but little compressed, the finger turned out of plane of the hand; movable finger short, thin above, with arcuate dorsal margin. First joint of carpus of second pair of feet less than half the second; third shorter than fourth; fifth longer than fourth; hand as long as fourth and fifth. The fifth joint of third pair of legs long, very much longer than fourth, about eight set of spinules on its lower side, rather long hairy above.

Dana further states in his key: "Base of rostrum rising between the eyes, deep sulci in carapace either side of rostrum. Orbital mar-

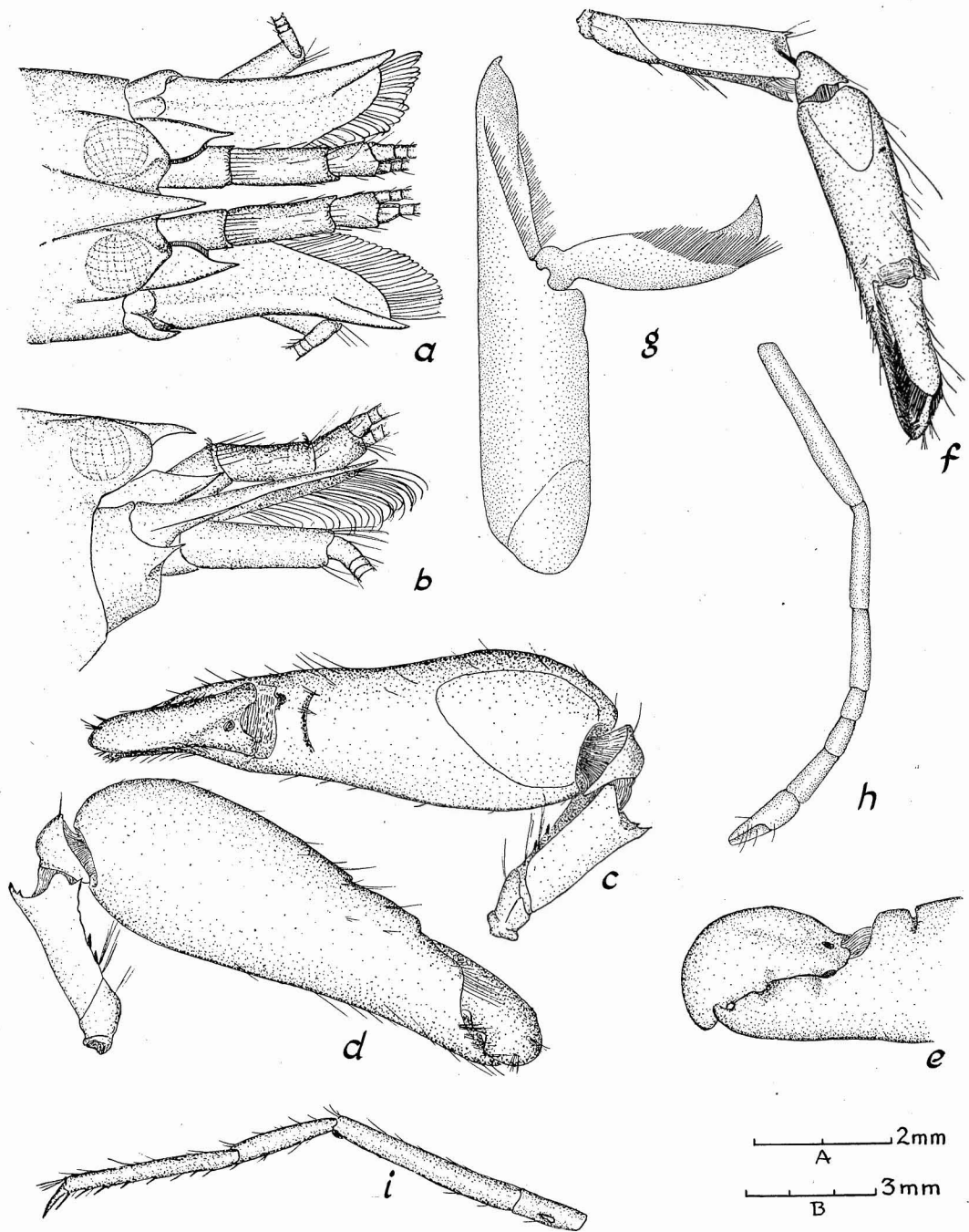


FIG. 41. *Crangon gracilipes* (Stimpson). *a, b*, Anterior region, dorsal and lateral aspects; *c, d*, large cheliped, lateral and medial aspects; *e*, large chela, distal end, ventral aspect; *f*, small cheliped, male, lateral aspect; *g*, small chela, male (different specimen), ventral aspect; *h*, second leg; *i*, third leg. (*a, b, g, h*, scale A; *c-f, i*, scale B.)

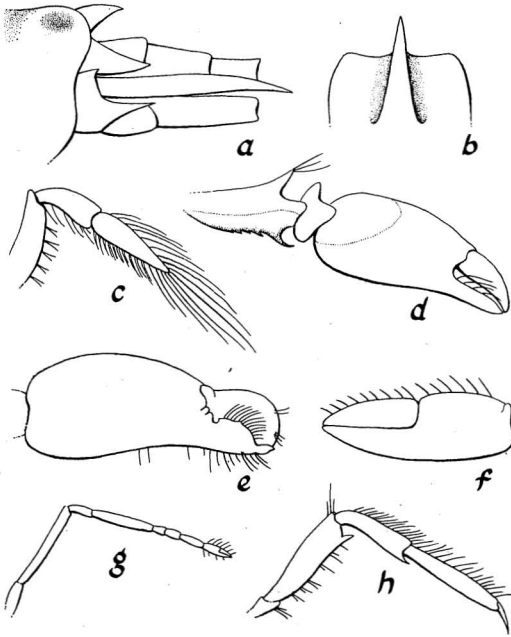


FIG. 42. *Crangon pugnax* (Dana). "a, Front, side view, enlarged; b, upper view; c, part of outer maxilliped; d, e, larger hand, in different positions; f, smaller hand; g, part of leg of second pair; h, part of leg of third pair." (Figures and legend from Dana; figures redrawn from U. S. Exploring Expedition, Folio Atlas to Vol. 13, 1855, plate 35, figures 6a-b.)

gin inermous." [Translated from Latin; Dana, 1854.]

DISCUSSION: As far as I have been able to determine, this species has not been reported since its original description. Moreover, the type specimen has been lost. As no specimens in the collections available agreed with the description on all characteristics, a special field trip was made to the type locality, Lahaina, Maui, to collect neotypes of this species and of *C. diadema* (Dana). Unfortunately, the conditions at Lahaina are not the same as they were 100 years ago when the collections were made by Dana; now the near-by sugar mill is discharging fresh water charged with large quantities of red mud onto the reef area, killing most of the coral and the other life on the reef. It was possible to collect quite a few specimens in spite of the pollution, but none had the characteristics of *C. pugnax*. In a fur-

ther attempt to obtain specimens of the species, the reefs 5, 10, and 30 miles away from Lahaina were visited; none of these reefs duplicated the original conditions of the Lahaina reef, for they were either deeper, or more sandy, or less well developed, etc., and no specimens of *C. pugnax* were obtained.

However, on the basis of the original description and figures alone, it is possible to separate clearly and decisively *C. pugnax* from all other species of Hawaii. Table 5 gives the criteria for its separation from the obviously closely related Hawaiian species of the subgroup *Diadema*.

If this species is not extinct, and there is no good reason to presume it is until far more extensive collections are made about the Hawaiian Islands, it is valid and recognizable.

#### *Crangon diadema* (Dana)

Frontispiece, Fig. 43 a-k

*Alpheus diadema* Dana, U. S. Explor. Exped. 13: 555, pl. 25, figs. 7a-7e, 1852.

*Alpheus diadema* Dana, Acad. Nat. Sci. Phila., Proc. 6: 23, 1854. [Description without figures.]

*Alpheus insignis* Heller, K. Akad. Wiss. Wien, Sitzungber. 44: 269, Taf. 2, figs. 17-18, 1861.

NEOTYPE: A male, 22 mm. long, collected at Lahaina, Maui, from a head of coral (*Porites*) in about 4 feet of water (U. S. N. M. 93460).

DESCRIPTION: Rostrum short, reaching to middle of visible portion of first antennular article; rostral base broad, flattened, extending posteriorly between eyes; margins of rostrum and base anteriorly slightly concave and tapering, almost parallel in middle, posteriorly slightly concave and spreading; margins laterally overhanging orbitorostral groove, with opposing face of groove almost touching rostral portion; carina prominent only in middle section; posteriorly marked by slight protuberance. Orbital hoods high, rounded, exceedingly clear, conspicuously demarked on all sides, anteriorly projecting as slight

rounded vertical keel. Area between orbital hoods and narrow orbitorostral furrow flattened; anterior margin arcuate.

Antennular peduncle with first article slightly shorter than second, correspondingly longer than third; second article almost twice as long as broad. Stylocerite short and broad, lateral spine reaching end of first antennular article. Lateral spine of basicerite well developed, shorter than stylocerite. Carpocerite reaching end of antennular peduncle, exceeded by scaphocerite. Scaphocerite with lateral spine dominant, squamous portion reduced; lateral margins concave.

Large chela subcylindrical, almost as broad as high, about 3 times as long as broad, tapering distally; surface without sculpture except for transverse groove proximad of articulation of dactylus; chela sparsely hirsute on upper and inner surfaces. Dactylus about 0.4 length of chela, strong, with margin arcuate. Merus about twice as long as broad, about 0.25 as long as chela; superior distal margin projecting as acute tooth, inferior internal margin with tooth distally. Large chela of female similar in form but relatively much smaller.

Small chela of male 0.8 as long as carapace, subcylindrical, tapering, 3 times as long as broad, without sculpturing. Fingers slightly over 0.3 length of whole chela, expanded, about twice as long as broad, with dense fringe of setiferous bristles along both sides and over upper distal surface of finger ("balaeniceps-shaped," see Fig. 43f-g). Carpus slightly elongate, 0.25 length of chela. Merus similar to that of large chela but without inferior internal tooth. Small chela of female quite similar in form but much smaller, without balaeniceps-shaped dactylus and with carpus relatively more elongate.

Carpal articles of second legs with ratio 10 : 10 : 3 : 4 : 5.

Third legs with strong spine on ischium. Merus 3.5 times as long as broad, strong, curved, acute tooth subterminally on inferior margin. Carpus 0.5 as long as merus, inferior margin projecting as strong tooth. Propodus

about 0.8 as long as merus, tapering, with about 20 movable spines of varying sizes. Dactylus simple, slightly curved, acute, as long as merus.

Telson almost twice as long as broad, posterior margin 0.75 as broad as anterior section; lateral margins slightly concave. Posterior margin arcuate. Dorsal spines large, located about 0.3 and 0.7 of distance from articulation to tip. Length of larger pair of posterolateral spines 0.3 width of tip; smaller pair less than 0.5 as long as longer pair. Margin between posterolateral spines with 9 somewhat irregularly placed spinules. Distolateral margin of inner uropod with 4 large spines and 9 spinules.

Large females up to 26 mm. long; no males exceeding 22 mm. of neotype. Color in life variable, but usually dark, olive green, reddish brown, etc., with pronounced irregular mottling of lighter color; specimens at times almost transparent.

DISCUSSION: All the specimens at hand were examined, but detailed studies on the variation in proportions of the appendages were not made. However, variation was noted in three parts. First was in the anterior region of the carapace. Small specimens, 8 millimeters long or less, had a markedly different rostrum than the adults. In these specimens the rostrum was narrow and of almost uniform taper, with its tip reaching almost to the end of the first antennular article; the rostral carina was well developed along the complete length; moreover, in these specimens the area between the rostrum and the orbital hoods extended relatively further forward, markedly surpassing the anterior margin of the orbital hoods. In specimens of increasing size, the condition of the rostrum approached that of adults. In mature specimens, variation was noticed especially in the shape of the base of the rostrum between the orbital hoods; in some it was as described above with the margins of the middle portion straight and almost parallel, whereas in others the curve from the edge of the carapace to the posterior limits was uni-



form and gradual. Furthermore, although in most large specimens the tip of the rostrum was depressed as shown in Figure 43*b*, in a few of intermediate size it was found to continue almost "level," and in one it was slightly elevated.

A second field of variation was in the carpal articles of the second legs; some had the ratio given above, but in some the ratio of the first two articles approached 10 : 13. None were noted where the second article was shorter than the first.

The third variation was in the propodus of the third legs. Small specimens had only four, five, or six spines well developed; among the large specimens some had a few more, some had a few less, than the 20 described.

Since the original description of this species from the Hawaiian Islands by Dana, no specimens have been reported. In 1861 Heller described from the Red Sea what was apparently a closely related form, *Alpheus insignis*, and all later workers, evidently because they were not certain of the characteristics of Dana's species, used Heller's name. As *C. insignis* the species was later reported from the Hawaiian Islands. Coutière in 1899 (p. 500) listed *C. insignis* as a synonym of *C. diadema* but in 1909 (p. 899) reviewed the situation and decided, like de Man, to reserve judgment until Dana's type was redescribed. Unfortunately, the type of Dana's species was lost, and it was impossible to determine the exact characteristics of the species.

To resolve this uncertainty, a special trip was made to Lahaina, Maui, the type locality, to collect replacement type specimens for Dana's description. This effort was successful as the reef at Lahaina had a larger proportion of this species than any other locality visited, and the specimens also were larger and more robust. One of them is described above.

This neotype differs in five minor ways from Dana's drawings and description. First, the margins of the base of the rostrum were shown as definitely and uniformly concave throughout their length between the orbital

hoods, instead of straight and parallel as they are in this specimen; however, as noted above, this is a variable character. Second, his profile drawing shows the rostrum as turning up near its apex, instead of being depressed as in this specimen; this, too, is a variable characteristic. Third, the margin between the base of the rostrum and the anterior orbital hoods is shown as concave instead of convex; this may be due to faulty delineation in the drawing. Fourth, the second carpal article of the second legs was described as being much shorter than the first and was shown to have the ratio (approximately) of 10 : 7 instead of 10 : 10 or 10 : 12, as found in all the specimens in the collection. Finally, the propodus was described as bearing "six sets of spinules on inner side," instead of approximately 20 found in the neotype. This last difference could be attributed either to the immaturity of Dana's specimens or to inadequate observation.

Thus, the only significant difference between Dana's description and this neotype is in the ratio of the carpal articles of the second legs. This may be due to a chance variation in the specimens or to faulty observation; but, even if an actual difference, it would not be a sufficient difference to warrant calling the local specimens other than *diadema*.

I can find no significant differences between this species and the form described by Heller. Heller shows the margin between the rostrum and the anterior margin of the orbital hoods to be concave instead of convex (as did Dana) and somewhat more narrow; he describes the propodus of the third legs as bearing seven or eight spines. As these differences, if correct, would be at most of only subspecific value, Heller's species is placed in synonymy.

Table 5 contrasts this with related Hawaiian species.

**DISTRIBUTION:** This species is common in the shallow waters of the Hawaiian Islands. On the reef flats or in water to 20 feet deep it has been collected from the following localities: on Oahu, Kaneohe Bay, Mokolua Island, Waimanalo, the shore near Koko Head,



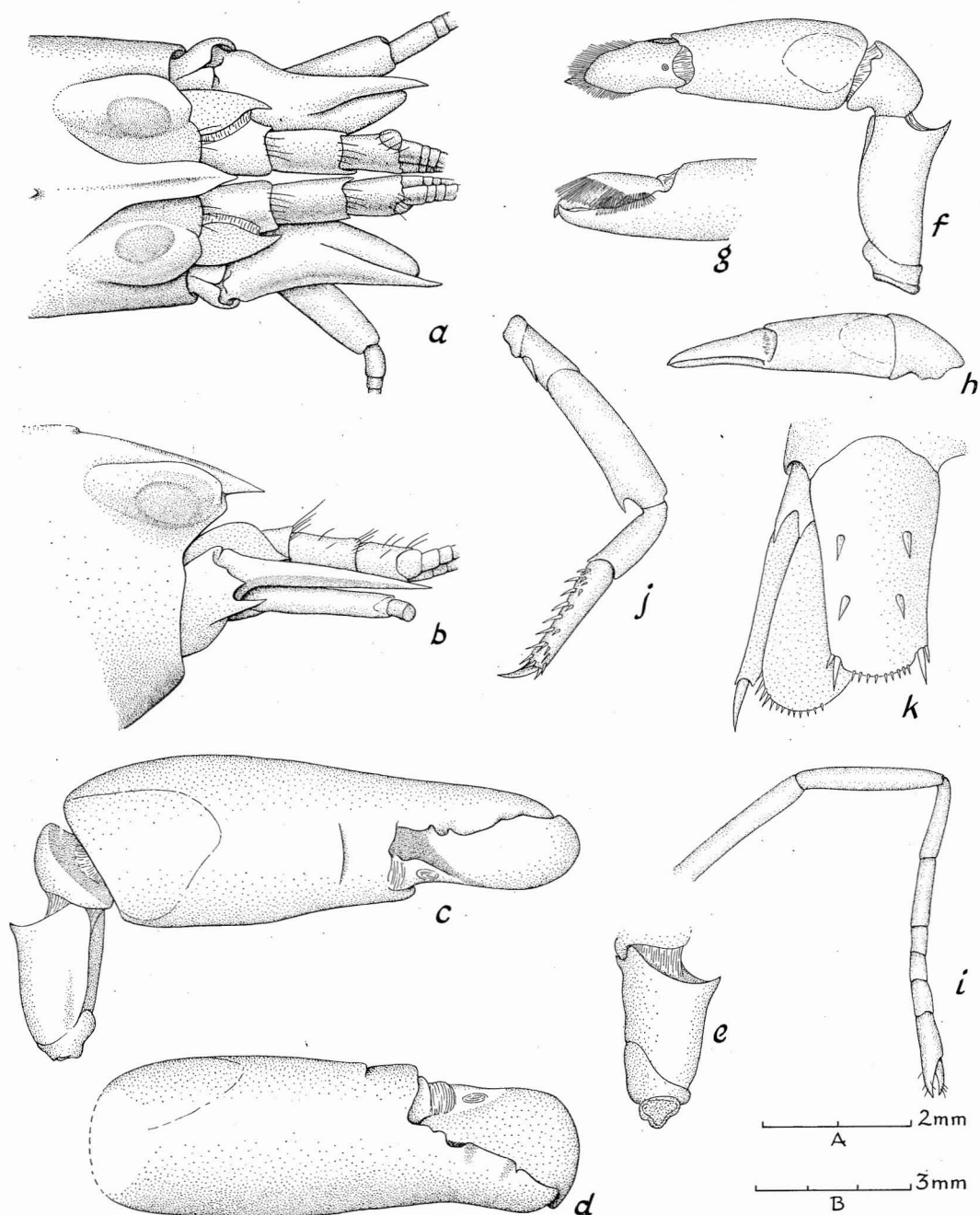


FIG. 43. *Crangon diadema* (Dana). *a, b*, Anterior region, dorsal and lateral aspects; *c*, large cheliped, lateral aspect; *d*, large chela, ventral aspect; *e*, large cheliped, merus, medial aspect; *f*, small cheliped, male, lateral aspect; *g*, small chela, distal end, male, ventral aspect; *h*, small cheliped, female, lateral aspect; *i*, second leg; *j*, third leg; *k*, telson and uropods. (Drawings of neotype.) (*a, b, k*, scale A; *c-j*, scale B.)

Hanauma Bay, Black Point, Waikiki, Nana-kuli, Mokuleia, Kaaawa, and Kawela Bay; on Maui, Makena, Kalama Park, Lahaina, and 12 miles south of Lahaina. The "Albatross" collected five specimens from "Honolulu Reef" (U.S.N.M. 63552, 63553). There is only one dredged specimen, taken between 40 and 350 feet deep off the southwest coast of Oahu. Edmondson (1925) has reported the species (as *C. insignis*) from Laysan and Lisianski Islands and Pearl and Hermes Reef.

As *C. insignis* the species has been reported throughout the tropical Indo-Pacific region from the Red Sea to Samoa; Edmondson (1925) has reported it from Johnston Island in the central Pacific.

*Crangon pseudopugnax* sp. nov.

Fig. 44 a-i

TYPE SPECIMEN: A female 15.6 mm. long, collected at Kalama Park, southeast Maalaea Bay, Maui; it was collected from old coral at a depth of about 8 feet. Five paratypes, one from shallow water at Makena, Maui, one from shallow water at Waikiki, Oahu, and three from about 18 feet of water off Waikiki Reef, Oahu (U.S.N.M. 93513).

DESCRIPTION: Rostrum acute, twice as long as broad at anterior margin of base, tip reaching to end of first antennular article. Rostral carina well-developed crest continuing to middle of orbital hoods, then broadening into dorsally flattened triangular area. Orbital hoods inflated, rounded anteriorly, well demarcated from surrounding carapace, except on posterior margins merging with carapace; orbital hoods very clear. Area between orbital hoods and rostrum flattened; anterior margin arcuate. Anterior portion of carapace depressed, seen in profile, with small medial protuberance or lobe.

Second and third articles of antennular peduncle equal in length but both slightly shorter than visible portion of first article; second article about 1.3 times as long as broad. Stylocerite well developed, tip reaching beyond end of first antennular article.

Lateral spine of basicerite well developed but not reaching end of first antennular article. Scaphocerite with lateral spine dominant and squamous portion reduced; lateral margin strongly concave. Carpocerite as long as antennular peduncle; both exceeded by scaphocerite.

Large chela subcylindrical, 1.3 times as broad as high, 2.7 times as long as broad [note: Figs. 44c and 44d show neither maximal nor minimal diameters]; margins rounded; tapering toward fingers. Palm marked by deep transverse groove proximal to articulation of finger, which spreads and soon disappears on superior face, but on inferior face continues into shallow, poorly defined depressed area extending distally to articulation of dactylus and proximally an equal distance. Adhesive plaque on independent lobe, demarked by palmar depression on inferior side and by deep, short depression on superior side that accommodates ridge of dactylus upon flexure. Dactylus about 0.3 length of entire chela; high, narrow, arcuate, with pronounced ridge along free margin; tip rounded. Fixed finger blunt at tip. Chela with occasional setae and usual tufts on fingers. Merus triangular, sharply angled; superior margin terminating as acute dentate projection, with 5 small indentations proximally from which very small bristles arise; inferior external margin with 7 similar indentations; inferior internal margin with 9 indentations and strong subacute tooth subterminally. Ischium with 3 indentations for bristles.

Small chela cylindrical, 5 times as long as broad, fingers about 0.7 as long as palm. Fingers narrow. Chela with usual setae. Carpus of usual form. Merus about 0.7 as long as chela, triangular, with indentations similar to merus of large chela but fewer; inferior internal margin unarmed.

Carpal articles of second legs with ratio 10 : 11 : 4 : 5 : 7.

Ischium of third legs with movable spine on inferior margin (difficult to see). Merus 5 times as long as broad, with strong, acute

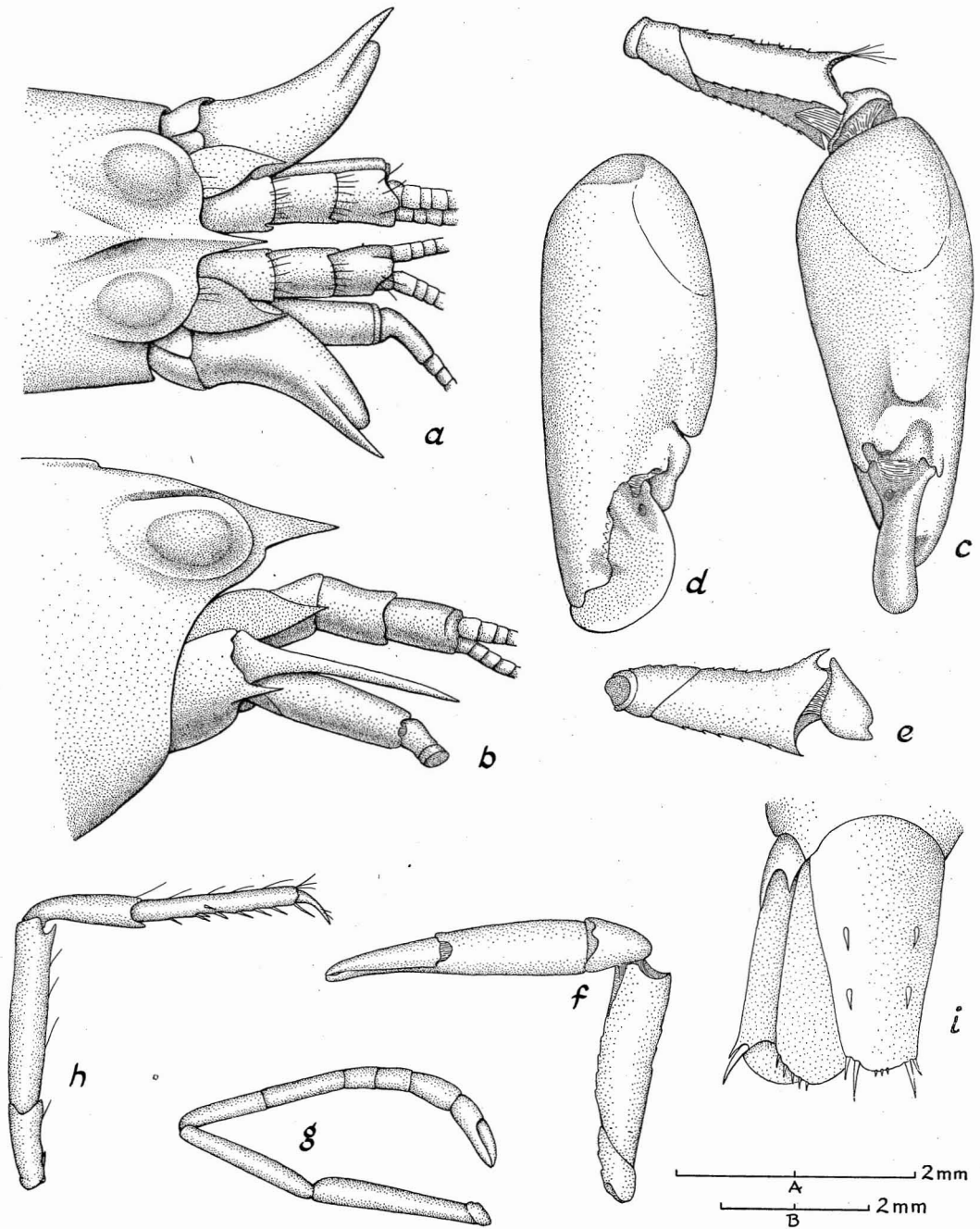


FIG. 44. *Crangon pseudopugnax* sp. nov. *a, b*, Anterior region, dorsal and lateral aspects; *c*, large cheliped, lateral aspect; *d*, large chela, ventral aspect; *e*, large cheliped, merus and carpus, medial aspect; *f*, small cheliped, lateral aspect; *g*, second leg; *h*, third leg; *i*, telson and uropod. (Setae are not shown on the chelipeds or the second legs.) (*a, b, i*, scale A; *c-h*, scale B.)

tooth on distal inferior margin. Carpus 0.5 as long as merus, unarmed except for tooth on inferior distal angle. Propodus 0.8 length of merus, with 10 movable spines in addition to usual setae. Dactylus simple, acute, somewhat curved.

Telson almost twice as long as broad, tip slightly more than 0.5 as broad as base; lateral margins slightly convex anteriorly, slightly concave posteriorly; posterior tip strongly convex. Dorsal spines moderately developed, anterior approximately 0.4 and posterior 0.7 of length of telson from base; medial pair of terminal spines narrow, acute, over 0.5 as long as breadth of tip of telson. Medial margin of tip with 3 irregularly placed, feeble spinules. Inner uropod with 5 spines of graduated size along distolateral margin; spine of outer uropod long, rather slender.

In life, type specimen with broad, red, transverse bands.

DISCUSSION: Only one of the paratypes had all its appendages; all were smaller than the type specimen. In these few specimens not much variation was noted. The most conspicuous difference was in the rostral base between the eyes. Most of the specimens showed a narrow but carinate base that was set off laterally by shallow grooves, while the type lacked these grooves. One specimen had a slight spine on the merus of the small chela, and a specimen half the size of the type did not have the depressed areas on either side of the groove of the large chela. Aside from these differences and slight differences in the proportions of the articles, all the specimens were similar. Unfortunately there were no intact male specimens in the collection, but it is presumed that the small chela of the male is *baeniceps*-shaped as it is in the related species.

RELATIONSHIP: This species plainly belongs to the *Diadema* Subgroup, and shows relationship to *C. diadema* (Dana) in the nature of the orbital hoods and the transverse groove on the palm of the large chela; the rostrum is somewhat like that of *C. gracilipes* (Stimpson) and the general configuration is sufficiently

close to *C. pugnax* (Dana) that I tentatively identified it as that species in the field.

*C. pseudopugnax* can be separated easily from these related species by a combination of characteristics. From *C. diadema* the species may be separated most easily by the nature of the base of the rostrum; from *C. gracilipes* by the presence of a groove on the large chela and by the tooth on the merus of the third legs; from *C. pugnax* by the lengths of the first two articles of the second legs. (See Table 5.)

This species shows a close affinity to another related Hawaiian species, *C. percyi* (Coutière). They can be distinguished by the nature of the rostrum, which in *C. pseudopugnax* bears an acute carina on the anterior portion of the rostral base and does not overhang the orbitorostral groove except at the posterior end, while in *C. percyi* the anterior surface is broad and flat, and the margins overhang the orbitorostral grooves for their entire length; by the large chela, which bears a depression on the lower face in *C. pseudopugnax* that is lacking in *C. percyi*; and by the small cheliped, which lacks teeth at the dactylar articulation and a tooth on the inferior internal margin of the merus in *C. pseudopugnax*, whereas the dactylar articulation is flanked by two teeth and the inferior internal margin of the merus bears a distal tooth in *C. percyi*.

This species is also related to *C. philoctetes* (de Man), but the latter has a series of movable spinules on the merus of the small chela and the merus of the third legs, which are absent in *C. pseudopugnax*. Unfortunately the large chela was absent in de Man's type specimen.

DISTRIBUTION: All specimens known are recorded above.

### *Crangon percyi* (Coutière)

Fig. 45 a-g

*Alpheus percyi* Coutière, Soc. Philomath. Paris, Bul. IX, 9(5): 21, 1908.

*Alpheus percyi* Coutière, Linn. Soc. London, Trans. II (Zool.) 17: 426, pl. 64, figs. 22-

22f, 1921. [Same description as original, but with figures.]

DESCRIPTION: Rostrum acute, reaching to end of first article of antennular peduncle; posteriorly continued as broad base between eyes; lateral margins almost straight, overhanging orbitorostral furrow; base with low, indistinct dorsal carina. Orbitorostral furrows deep and narrow, flattening anteriorly, with anterior margin somewhat sinuate. Orbital hoods hemispherical anteriorly, high and of clear chitin; merging with carapace posteriorly. Anterior region of carapace, seen in profile, depressed; beginning of depressed region with small medial protuberance.

First and second articles of antennular peduncle subequal; third article somewhat shorter. Stylocerite strong, slightly exceeding first article. Lateral spine of basicerite somewhat shorter than stylocerite. Scaphocerite with strong lateral spine, squamous area reduced; lateral margins strongly concave. Basicerite as long as antennular peduncle, both exceeded slightly by scaphocerite.

Large chela rounded, subcylindrical with maximum diameter 1.2 times minimum diameter, chela 2.7 times as long as maximum diameter. Palm with deep transverse groove proximal to dactylus but without other sculpturing. Dactylus about 0.3 length of entire chela, arcuate, high and narrow. Chela with only scattered setae except for tufts about fingers. Merus over twice as long as broad, superior and inferior internal margins with strong acute teeth; all margins with series of small indentations from which fine setae arise.

Small chela subcylindrical with tapering fingers, 2 poorly developed teeth flanking articulation of dactylus; fingers in female conical, in male balaeniceps-shaped, or bearing a dense fringe of setae over broadened dactylus (according to Coutière; no males collected from Hawaii). Merus similar to that of large chela except more slender and superior and inferior-internal teeth more poorly developed.

Carpal articles of second legs with ratio 10 : 10 : 4 : 5 : 6.

Ischium of third legs with moderately strong movable spine. Merus 5 times as long as broad, with strong tooth distally on inferior margin. Carpus 0.5 as long as merus, with usual inferior distal tooth. Propodus almost 0.8 as long as merus, with 11 relatively long spines on inferior and distal margins. Dactylus 0.2 as long as merus, somewhat curved, acute, simple.

Telson of usual form, similar to that of *C. pseudopugnax*, with series of small spinules on posterior margin. Distolateral margin of inner uropod with about 12 small spinules.

Specimens in collection 3 females, one 25 mm., others about 20 mm. long.

DISCUSSION: The other specimens agreed with the one described and illustrated on most characteristics. The points of difference between one or the other of the two undescribed specimens and the one described above were: First, the "break," or angle, the anterior carapace and rostrum made to the dorsal surface of the carapace was less pronounced, and the tubercle was less noticeable. Second, the rostrum was shorter, reaching only 0.7 of the length of the visible portion of the first antennular article. Third, the second antennular article was relatively longer, being 1.3 times the length of the visible portion of the first article. Finally, on the large chela there was a poorly marked shallow depression that ran from the transverse groove toward the articulation of the dactylus. These differences probably are individual variations.

The specimens of this species, which has not previously been reported from the Hawaiian Islands, differ in only a few details from the original description and figures by Coutière. It is uncertain from Coutière's drawings whether the configuration of the base of the rostrum and the orbitorostral furrows are exactly the same in the two forms, but in any case they are very similar. Coutière does not show as much depression of the anterior margin of the carapace as is shown in these specimens, nor does he show the median tubercle. The carpocerite may be somewhat shorter in

Coutière's specimens. It should be noted that on the left side of the described specimen (Fig. 45*b*) the spine of the basicerite was [like that shown by Coutière, but the one on the right was entirely absent. The large and small chelae are similar, but the merus of these appendages in the type may or may not have the series of fine indentations found in the local specimens, for Coutière's plates are not clear at the point. The third legs are similar except that Coutière does not indicate the ischial spine, although he does state that the appendage "est très semblable [to *C. dasycheles* (Cout.)] comme forme . . ." and that *C. dasycheles* has the spine. Finally, on the tip of the telson and on the inner uropod he indicated no spinules; these, however, are very difficult to discern on the local specimens because they are confused with the bases of the setiferous bristles, and it is likely that Coutière merely overlooked them.

In my opinion none of these differences are of sufficient magnitude, constancy, or general reliability to warrant the erection of a new species for the local form.

The characteristics which will distinguish this from closely related local species are given in Table 5.

**DISTRIBUTION:** The three specimens collected locally came from Oahu in 20 feet of water at Hanauma Bay, in 15 feet of water off Nanakuli, and at Halape, Kau Coast, Hawaii, in water 35–40 feet deep (last collected by R. W. Hiatt).

#### Brevirostris Group

#### *Crangon rapax* (Fabricius)

Fig. 46 *a-i*

*Alpheus rapax* Fabricius, Sup. Ent. Syst. p. 405, 1798.

*Alpheus malabaricus* Hilgendorf, K. Akad. Wiss., Berlin, Monats. p. 832, 1878.

*Alpheus brevirostris* de Man, Linn. Soc. London, Jour. 22: 261, 1888.

*Alpheus rapax* de Man, Soc. Zool. France, Mem. 22: 147–155, 1909. [Species rede-

scribed and illustrated; see these and the following pages in this reference for a complete synonymy.]

**DESCRIPTION:** Rostrum small, acute, equilateral, tip reaching to end of first 0.3 of visible portion of first antennular article; rostral carina anteriorly sharp, posteriorly somewhat rounded, extending to end of orbital hoods. Orbital hoods large, inflated, rounded anteriorly, posteriorly merging with the carapace; higher in middle than rostral carina; transparent, hence from side rostral carina visible through hood. Anterior margin of carapace from orbital hoods to rostrum almost straight.

Antennular peduncles elongate and thin, second article 3.5–4.0 times as long as broad, 2.5 times length of first article or of third article. Stylocerite rounded, leaf-like, anterior spine represented by very small tooth reaching about 0.75 of length of visible portion of first antennular article. Antennular articles with few short bristles near points of articulation; stylocerite with fringe of short bristles on margins. Basicerite with distinct but short tooth about same length as rostrum. Scaphocerite with strong lateral spine, squamous portion narrow; lateral margins concave. Scaphocerite slightly longer than carapocerite which reaches to end of antennular peduncle.

Distal articles of third maxillipeds large, of usual form, densely bristled on inner face.

Large chela high, compressed, margins rounded, 2.7 times as long as high, about twice as high as wide. Upper surface with rounded transverse groove extending short distance down each face. Dactylus strong, high, compressed, 0.35 as long as entire chela. Carpus of usual form. Merus 2.6 times as long as broad, with superior distal angle rounded, inferior internal margin with 5 movable spines and acute terminal tooth of moderate size. Dactylus, margins of palm, superior and inferior internal margins of merus with scattered long setae.



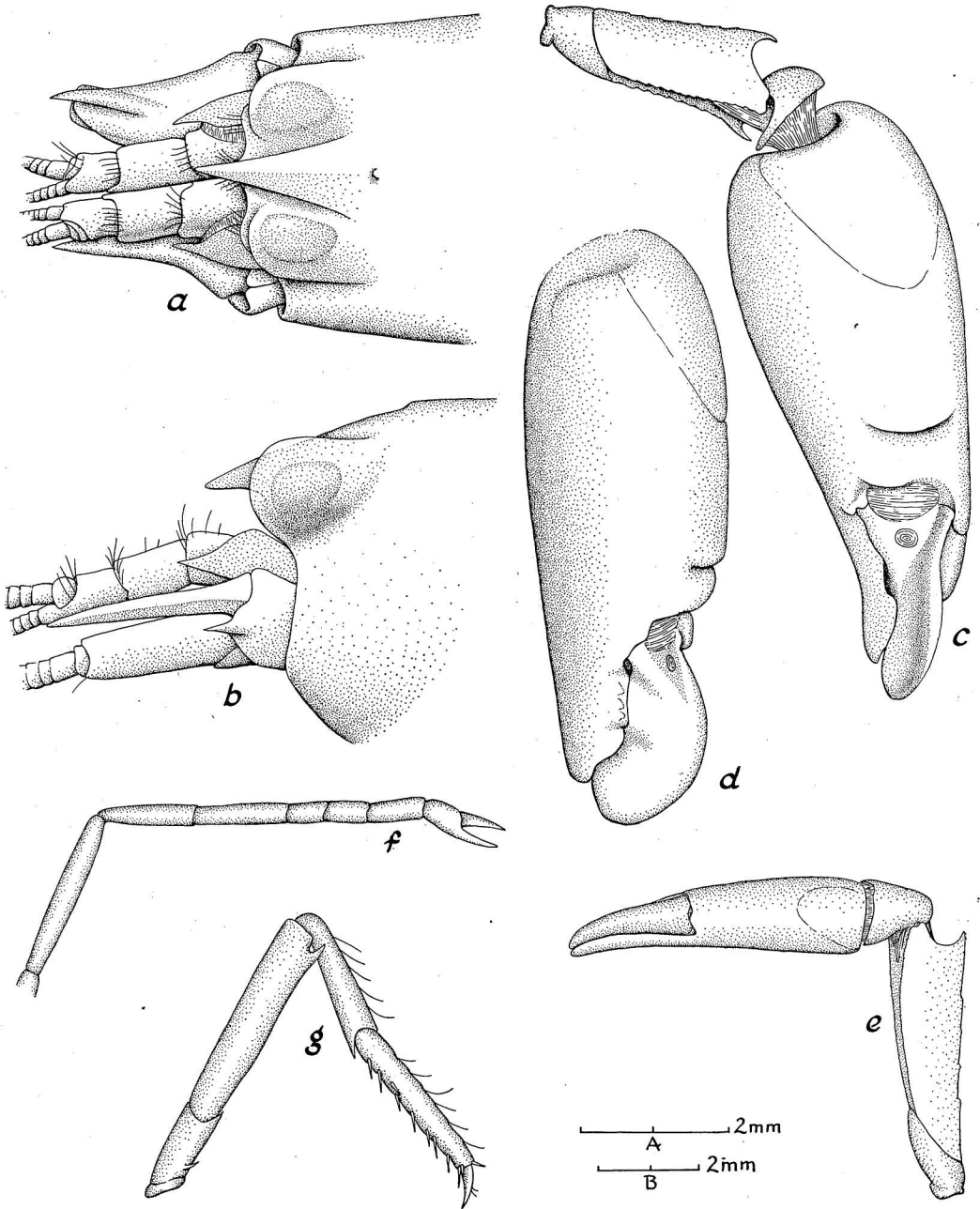


FIG. 45. *Crangon percyi* (Coutière). *a, b*, Anterior region, dorsal and lateral aspects; *c, d*, large cheliped, lateral and ventral aspects; *e*, small cheliped; *f*, second leg; *g*, third leg. (*a, b*, scale A; *c-g*, scale B.)

Small chela of male with palm almost 2.5 times as long as wide, fingers 1.5 times length of palm; margins without grooves. Dactylus broad with opposing faces flattened and fringed with dense setiferous bristles, or balaeniceps-shaped; both dactylus and fixed finger strongly hooked at tip. Carpus somewhat longer than broad. Merus narrower proximally than distally, maximum breadth 1.5 times minimum, article twice as long as broad at maximum breadth; armature like that of large cheliped except tooth on inferior internal margin lacking. Small chela of female reported (de Man, 1909) as similar in form to that of male except lacking rows of setae on dactylus (therefore not of balaeniceps-shape) and slightly smaller in proportions.

Carpal articles of second legs with ratio 10 : 7 : 3 : 3 : 5.

Ischium of third legs with strong spine. Merus 4.4 times as long as broad, with few setae along margins. Propodus slightly less than 0.5 length of merus, superior distal margin with sparse long setae, superior distal angle projecting as tooth. Propodus 0.7 length of merus with 7 spines on inferior and terminal margins, scattered long setae on inferior and superior margins. Dactylus 0.5 length of propodus (or 0.3 length of merus), narrow, almost straight, tip acute, inferior surface flattened, superior surface rounded; rounded surface with 2 short bristles.

Telson similar in form to that described for *C. platyungiculata* (p. 130), 1.8 times as long as wide at point of maximum breadth; tip 0.7 as wide as maximum breadth; posterolateral spines slightly shorter and weaker than those of *C. platyungiculata*. Tip of telson and distal lateral margins of inner uropod with weak spines similar to those of *platyungiculata*.

Sole specimen in collection, male 28 mm. long; specimens reported by de Man (*loc. cit.*) to reach 51 mm. Color in life not noted.

DISCUSSION: *Crangon rapax* (Fabr.) was re-described and illustrated by de Man in 1909. The specimen from Hawaii differs from this

description in a few characteristics. The specimens are similar in general configuration, and the general relationship of the size, shape, and armature of the appendages. Some minor differences were noted in a comparison of this specimen with de Man's description, for example: the rostrum reaches to the end of the first third of the visible portion of the first antennular article in this specimen, and from one half to two thirds of the length in de Man's; the visible portion of the first antennular article is slightly longer and the third article is slightly shorter, when compared to the second article, than those described by de Man; the merus of the large chela is 2.6 times as long as broad in this specimen and bears five spinules, while it is 3.0–3.5 times as long as broad and bears six to seven spinules in the described specimens; the ratio of the carpal articles is 10 : 7 : 3 : 3 : 5 instead of 10 : 8–9 : 3 : 3 : 4; and so on. Two other differences may be of greater importance: the merus of the small cheliped of the male is broader and lacking the small terminal tooth on the inferior internal margin found in the specimens described by de Man; the carpus and propodus of the third leg in this specimen bears only scattered long setae, while de Man describes and depicts his specimens as being densely hirsute on these articles.

When considering these differences it should be remembered that de Man's description is based upon two specimens, a male 51 mm. long and a female 46 mm. long, while the Hawaiian specimen is only 28 mm. long. Therefore, it appears that all these differences are of minor importance and may be growth differences, or differences normally occurring in a population, or, possibly, they may be differences indicative of a geographical subspecies of the parent *C. rapax*. However, in my opinion, the description of this Hawaiian form as a new species or a new subspecies is not indicated on the basis of the present specimen.

This species can be separated from *C. platyungiculata*, the only other Hawaiian species

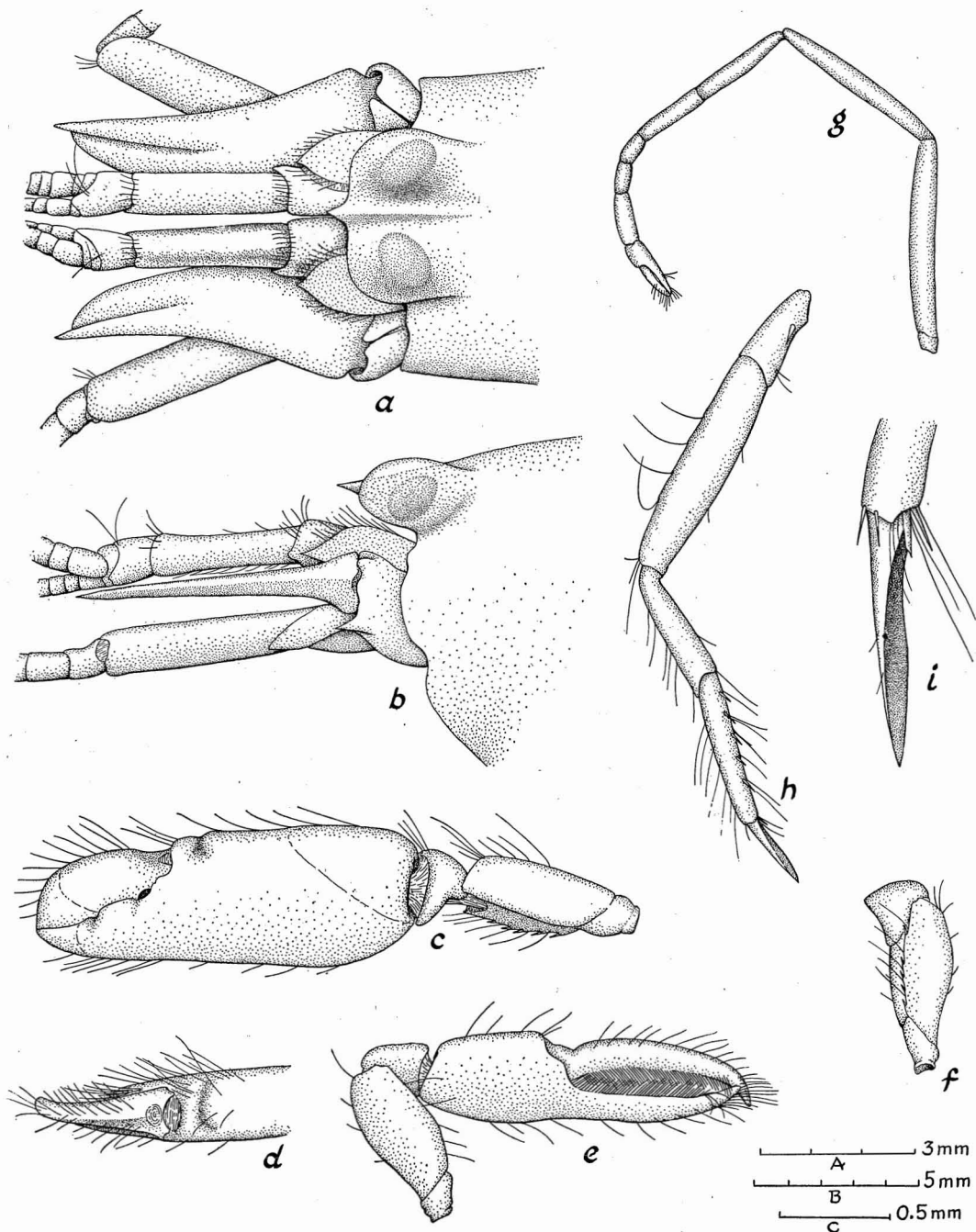


FIG. 46. *Crangon rapax* (Fabricius). *a*, *b*, Anterior region, dorsal and lateral aspects; *c*, large cheliped, lateral aspect; *d*, large chela, dorsal aspect; *e*, small cheliped, lateral aspect; *f*, small cheliped, merus and carpus, medial aspect; *g*, second leg; *h*, third leg; *i*, third leg, dactylus. (*a*, *b*, *g*, *h*, scale A; *c*-*f*, scale B; *i*, scale C.)

of the Brevirostris Group and the only other Hawaiian species with which it could be confused, by the relative lengths of the second carpal articles of the second legs, almost 3.0 times the length of the first article in *C. platyunguiculata* and only 0.7 its length in this species; by the excessive setae on the third legs in *C. platyunguiculata* and by the thicker chela in that species. Other characteristics for the separation of the two species are found in the frontal region of the carapace, the relative lengths of the scaphocerite and the antennular and antennal peduncles, and the small chelae of the males and females.

**DISTRIBUTION:** This specimen was collected on the sand flats of Kaneohe Bay, Oahu, where the water is only a few inches deep at low tide. For the possible habitat of this species, see the discussion under *C. platyunguiculata*.

It has been reported from Zanzibar, Djibouti, and the Mergui Archipelago (Andaman Sea) in the Indian Ocean, from the Netherlands Indies, Japan, and near Queensland in the Pacific, but not previously from the central Pacific region.

*Crangon platyunguiculata* sp. nov.

Fig. 47 a-k

**TYPE SPECIMEN:** A female 25 mm. long, collected at Waialua Bay, Oahu, from old coral in about 6 feet of water. Paratypes, two males, one 20 mm., the other 10 mm. long, from the same location (U. S. N. M. 93461).

**DESCRIPTION:** Rostrum small, triangular, as long as broad at base, tip reaching less than 0.5 length of visible portion of first antennular article. Rostral carina distinct and continuous from tip of rostrum to between orbital hoods, thereafter more rounded and less well defined but continuing to posterior margin of hoods. Orbital hoods large, rounded anteriorly, frontal margin reaching to middle of rostrum; posteriorly merging with convexity of carapace; in lateral view higher than rostral base; transparent, hence outlines of rostral

base visible through hoods in lateral view; much larger than eyes.

Antennal peduncle long, rather slender. Second article 3 times as long as broad, 1.3 times as long as first article, twice as long as third article. Stylocerite large, with lateral spine poorly developed, reaching only slightly beyond curvature of scale; tip reaching almost to end of first antennular article. Lateral spine of basicerite well developed, slightly shorter than stylocerite. Scaphocerite large, with heavy outer spine; lateral margins slightly concave, tip relatively heavy and somewhat incurved; squamous portion narrow. Carpo-cerite reaching beyond end of scaphocerite, which slightly exceeds end of antennular peduncle.

Third maxillipeds of usual form, but inner faces of terminal and subterminal articles very densely clothed with setae and short bristles.

Large chela compressed, 2.3 times as high as thick, 2.3 times as long as high, margins rounded, broadest near middle, slightly tapering proximally, somewhat more distally. Upper margin proximal to dactylus with deep transverse furrow expanding into shallow depressed area on each face. Margin above articulation of dactylus with shallow excavation adjacent to palmar adhesive plaque for accommodation of crest of dactylus when flexed. Dactylus 0.3 length of chela, crested, strongly arcuate, heavy, 2.4 times as long as wide, compressed like chela. Chela with numerous long setae on margins. Carpus of usual form. Merus 2.5 times as long as broad, superior distal margin rounded, inferior internal margin with 2 strong movable spines, one about middle, other more distal, weak but acute subterminal tooth; long setae found only on distal portions of article.

Small chela of female somewhat compressed, 3.5 times as long as broad, fingers between 0.5 and 0.6 of length; surfaces without grooves or depressions; articulation of dactylus flanked by small subacute projection; fingers quite rounded. Entire chela heavily covered with long setae, especially along up-

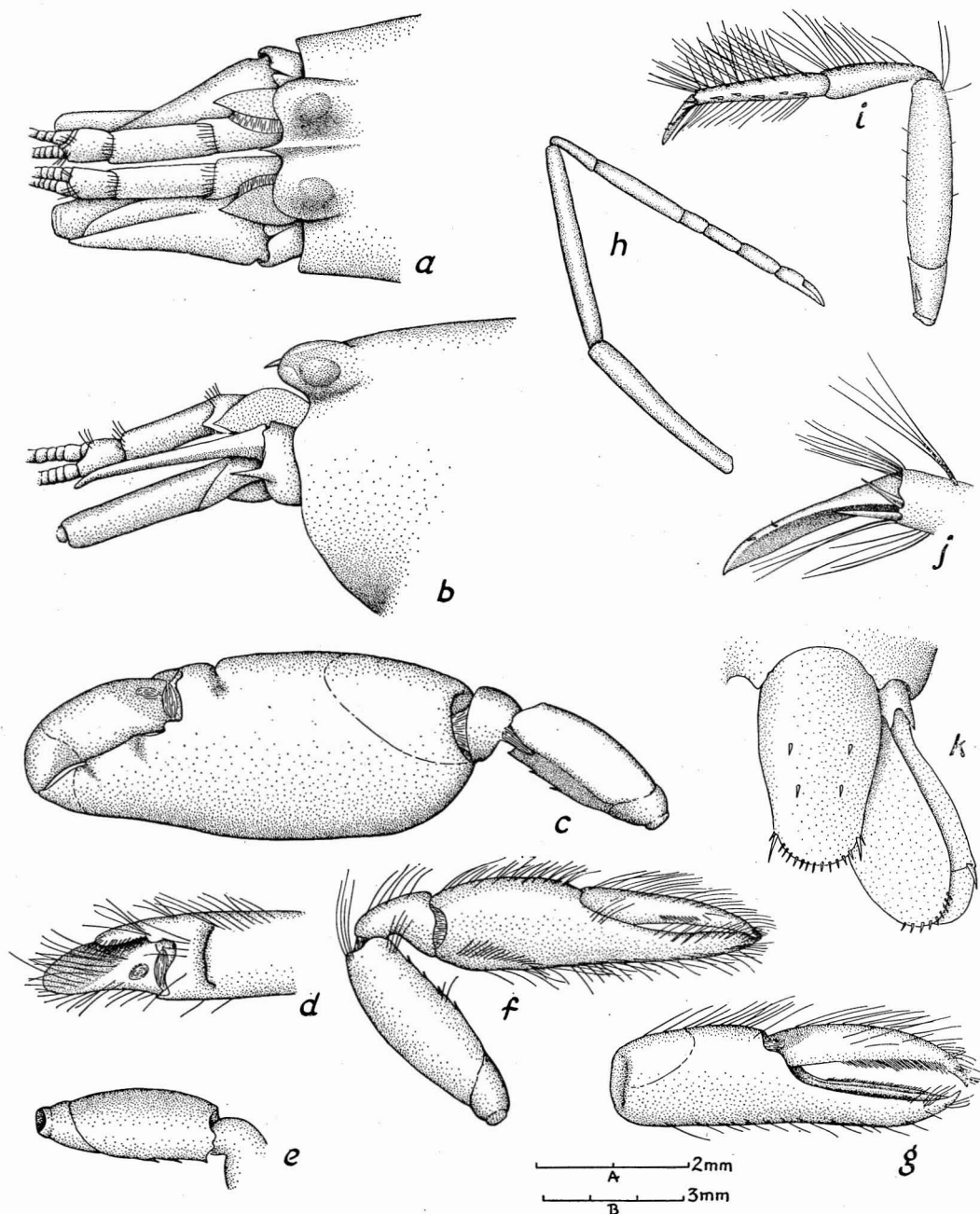


FIG. 47. *Crangon platyunguiculatus* sp. nov. *a, b*, Anterior region, dorsal and lateral aspects; *c*, large cheliped, lateral aspect (setae not shown); *d*, large chela, dorsal aspect; *e*, large cheliped, merus, medial aspect (setae not shown); *f*, small cheliped, medial aspect; *g*, small chela, male, lateral aspect; *h*, second leg; *i*, third leg; *j*, third leg, dactylus; *k*, telson and uropods. (*a, b, j, k*, scale A; *c-i*, scale B.)

per and lower margins and margins of opposing faces of fingers. Carpus 0.25 as long as chela, 1.2 times as long as broad. Merus similar in form to that of large chela but without terminal tooth on inferior internal margin, with 4 small movable spines instead. Small chela of male 3.7 times as long as broad, fingers occupying slightly more than 0.6 length of chela. Dactylus not rounded, but with opposing face flattened, with short dense fringe of stiff setae along margins of face in middle 0.7; fixed finger also flattened, with corresponding fringe of setae in opposition; other setae similar to those of female. Carpus and merus in male similar to those of female.

Carpal articles of second legs with ratio 10 : 23 : 7 : 10 : 11.

Ischium of third legs with strong movable spine. Merus 4.0 times as long as broad, inermous with occasional short setae. Carpus 0.5 as long as merus, distal angles not projecting but rounded; superior margin with series of long setae. Propodus 0.6 as long as merus, tapering toward tip, straight, with 7 movable spines of moderate size, with numerous long setae on both margins, some of setae 0.5 as long as article. Dactylus long, simple, almost 0.3 as long as merus, superior margin rounded, inferior margin broad and flattened, somewhat curved; tip acute; lateral margins with short movable spine and short curved bristle.

Telson with anterolateral margin convex, broadest at about 0.3 of length, posterolateral margin concave and narrowing; 1.8 times as long as broad, tip 0.7 as broad as maximum breadth. Posterior margin strongly arcuate, reaching beyond tip of posterolateral spines. Posterolateral spines about 0.3 as long as breadth of tip; dorsal spines poorly developed, located 0.4 and 0.6 of distance from articulation to tip. Tip of telson and distal lateral margin of inner uropod with weak spinules.

Body translucent white to gray base color, with red and blue chromatophores arranged in poorly defined transverse bands on abdo-

men and in narrow band across eyes; similar poorly defined bands on chelae. In one live specimen blue chromatophores expanded, giving over-all blue-gray appearance; in other, red chromatophores expanded, giving reddish cast.

DISCUSSION: No significant variation was noted in the three specimens.

RELATIONSHIP: This species plainly belongs to the Brevirostris Group and can be separated easily from all other Hawaiian species save *C. rapax* (Fabr.) by the appearance of the anterior margin of the carapace, the compressed chela with a transverse groove, and the dactylus of the third legs.

Within the Brevirostris Group this species and *C. sauensis* (de Man) can be distinguished by the characteristics given in de Man's key (1911: 322-325). From most of the other species in the group these two can be distinguished by the following characters: the presence of a transverse groove on the palm of the large chela; the balaeniceps-shaped dactylus of the small chela of the males; the lack of a tooth on the merus of the third leg. Three more closely related species, *C. djeddensis* (Coutière), *C. djiboutensis* (de Man), and *C. pubescens* (de Man), all have a longer and thinner merus on the third leg; in addition *C. djeddensis* has a transverse groove on the third chela; in *C. djiboutensis* the terminal spine of the scaphocerite is much longer relative to the squamous portion; and in *C. pubescens* the rostral carina is longer.

*C. platyunguiculata* can be separated from *C. sauensis* by the characteristics given in the following tabulation:

<i>C. platyunguiculatus</i>	<i>C. sauensis</i>
Rostrum reaching beyond orbital hoods by 0.5 its length	Rostrum reaching beyond orbital hoods by 0.8 its length
Stylocerite with tip straight	Stylocerite with tip incurved
Scaphocerite shorter than carapocerite	Scaphocerite as long as carapocerite
Large chela with palm 2.0 times as long as fingers	Large chela with palm 1.5 times as long as fingers
Carpal articles of second legs with ratio 10 : 23 : 7 : 10 : 11	Carpal articles of second legs with ratio 10 : 15 : 6 : 6 : 6



Propodus of third legs 1.2 times length of carpus	Propodus of third legs 1.5 times length of carpus
Dactylus of third legs not spiniform, flattened on inferior face	Dactylus of third legs spiniform, not flattened

On almost all other points the two species are similar, so similar in fact that, with only one or two of the differences listed above, the Hawaiian form could be considered at most a variety. However, the great difference in the dactylus of the third leg reinforced with the other more minor differences leaves little doubt but that this species is valid.

The differences between this species and *C. rapax*, its closest relative locally, are discussed under that species.

**DISTRIBUTION:** In addition to the type series listed above, two specimens were collected from Kaneohe Bay, Oahu, where they were found underneath coral heads on shallow sand flats, less than a foot deep at low tide. In many of the areas of silty sand in Kaneohe Bay there are numerous burrows evidently made by this species or by *C. rapax* (Fabr.). Some of these burrows are also inhabited by specimens of a small fish. Unfortunately, I was unable to collect either the crangonids or the fish, as the burrows penetrated through the veneer of sand into the underlying consolidated coral of the reef. It was also impractical to seize the animals in their burrows, to entice them out, or to drive them out. The two that were collected evidently had burrows that led under large loose coral heads lying on the surface of the sand; when the heads were moved the shrimp were caught in a dip net.

#### Edwardsi Group

#### *Crangon leptochirus* (Coutière)

Fig. 48 a-b

*Alpheus leptochirus* Coutière, Fauna and Geog. Mald. and Laccad. 2(4): 914-916, pl. 87, figs. 54-54e, 1906.

**DESCRIPTION:** Rostrum triangular, about 1.5 times as long as broad, tip reaching almost to end of first antennular article. Rostral carina

rounded, extending slightly posterior of eyes. Orbital hoods somewhat inflated, rounded anteriorly, demarked from base of rostrum by shallow rounded grooves. Anterior margin of carapace somewhat emarginate between orbital hoods and rostral base.

Visible portion of first antennular article as long as second article; second article about 1.8 times as long as broad; third article about 0.7 length of second. Tip of spine of stylocerite reaching to end of first article.

Lateral spine of basicerite reaching to tip of rostrum. Scaphocerite strong, lateral margin slightly concave, tip reaching considerably beyond end of antennular peduncle. Carpocerite longer than antennular peduncle, reaching to end of squamous portion of scaphocerite.

Large chela rather slender, 3 times as long as broad, compressed, with grooves and depressions. Transverse groove on superior margin, with distal edge rounded and proximal edge overhanging floor of groove; groove expanding on external face to elongate, narrow, triangular depression with poorly demarked margins; on internal face continuous with similar but less extensive depressed area. On inferior margin, opposite groove on superior margin, notch with abrupt proximal edge and gradual distal edge; on external face notch continues, well-defined, for 0.3 height of face; on internal face notch poorly defined and continuing for only 0.25 of height. Finger of usual form, less than 0.3 length of entire chela. Merus 3 times as long as broad, with superior margin ending in obtuse angle; inferior internal margin with 2 movable spines and distal tooth.

Small chela of female almost 5 times as long as broad, without sculpturing, fingers occupying almost 0.5 length of chela. Articulation of dactylus flanked by small obtuse projection on inner side. Carpus with small tooth projecting over propodus. Merus 4.5 times as long as broad, almost 0.3 longer than merus of large chela, with 3 movable spines and subterminal tooth on inferior internal margin.

Carpal articles of second legs with ratio 10 : 11 : 5 : 6 : 7.

DISCUSSION: Unfortunately all of the three specimens in the collection were dredged from deeper water and only one is reasonably intact, the others having lost most of their appendages in the rough handling in the dredge net. In the Edwardsi Group, the largest of the genus, positive identification cannot be made without reference to the small chela of the male; and, as the small chela of the sole male was lacking in these specimens, they are referred to this species with some doubts.

The specimens compare quite well with the description and plates of Coutière except on the following points:

<i>C. leptochirus</i>	Hawaiian Form
Second antennular article 1.4 times length of visible portion of first	Second antennular article as long as visible portion of first
Scaphocerite exceeding antennular peduncle by 0.1 its length	Scaphocerite exceeding antennular peduncle by 0.2 its length
Large chela with parallel sides; proximal edge of superior groove rounded; depressed areas on upper portions of faces very narrow	Large chela with slight taper; proximal edge of superior groove abrupt, overhanging; depressed areas on faces broader
Meri of large and small chelae each with 4 spines	Meri of large and small chelae with 2-3 spines
Second carpal article of second legs 0.7 length of first	Second carpal article of second legs 1.1 length of first
Third legs without ischial spine, merus 7.5 times as long as broad	Third legs with ischial spine, merus 5.5 times as long as broad

These differences appear to be decisive when listed out in this fashion; however, studies on other species in this group and in other groups of the genus have shown that each of these characteristics are variable at least to the extent here observed. Therefore no dependence can be placed upon any one of the differences listed; possibly in aggregate they are significant, but without the important small chela of the male, and with but a single intact specimen to study, I do not believe that the designation of this form as a distinct species is warranted.

DISTRIBUTION: The three specimens were taken in a dredge haul off Diamond Head,

Oahu, in 100-200 feet of water. Coutière's specimens came from the Indian Ocean.

### *Crangon crassimanus* (Heller)

Fig. 49 a-k

*Alpheus crassimanus* Heller, Reise der . . . Novara. . . Zool. Theil 2(8): 107, pl. 10, fig. 2, 1865.

DESCRIPTION: Rostrum acute, reaching almost to end of first antennular segment, with margins gradually curving out to merge with frontal portion of orbital hoods and carapace, demarked from orbital hoods by broad, shallow depression. Subacute rostral carina arising between anterior portion of orbital hoods. Orbital hood hemispherical, without keels or ridges.

Lateral spine of stylocerite slightly longer than first antennular article. Antennular peduncle slim, with second article equal to or longer than visible portion of first, from 1.5 to 3.0 times as long as third. Lateral spine of basicerite not as long as stylocerite. Scaphocerite with heavy lateral spine; lateral margin concave; squamous portion narrow, with anterior margin not rounded but joining spine at acute angle. Scaphocerite and carapocerite almost equal, slightly longer than antennular peduncle.

Large chela heavy, 2.2 times as long as broad, laterally compressed, 1.7 times as high as thick, with grooves and depressions. Rounded transverse groove on superior margin proximal to articulation of dactylus, continuous with irregular depression with rounded edges on both inner and outer face. Proximal margin of transverse groove, in profile, rounded and sloping back to superior margin of chela. Another groove on inferior margin of chela, directly below superior groove, rounded only distally and demarked by abrupt shoulder proximally, ending abruptly on outer face about 0.2 distance from lower edge, and on inner face gradually diminishing but still visible beyond mid-line. Dactylus 0.3-0.4 length of chela, heavy and

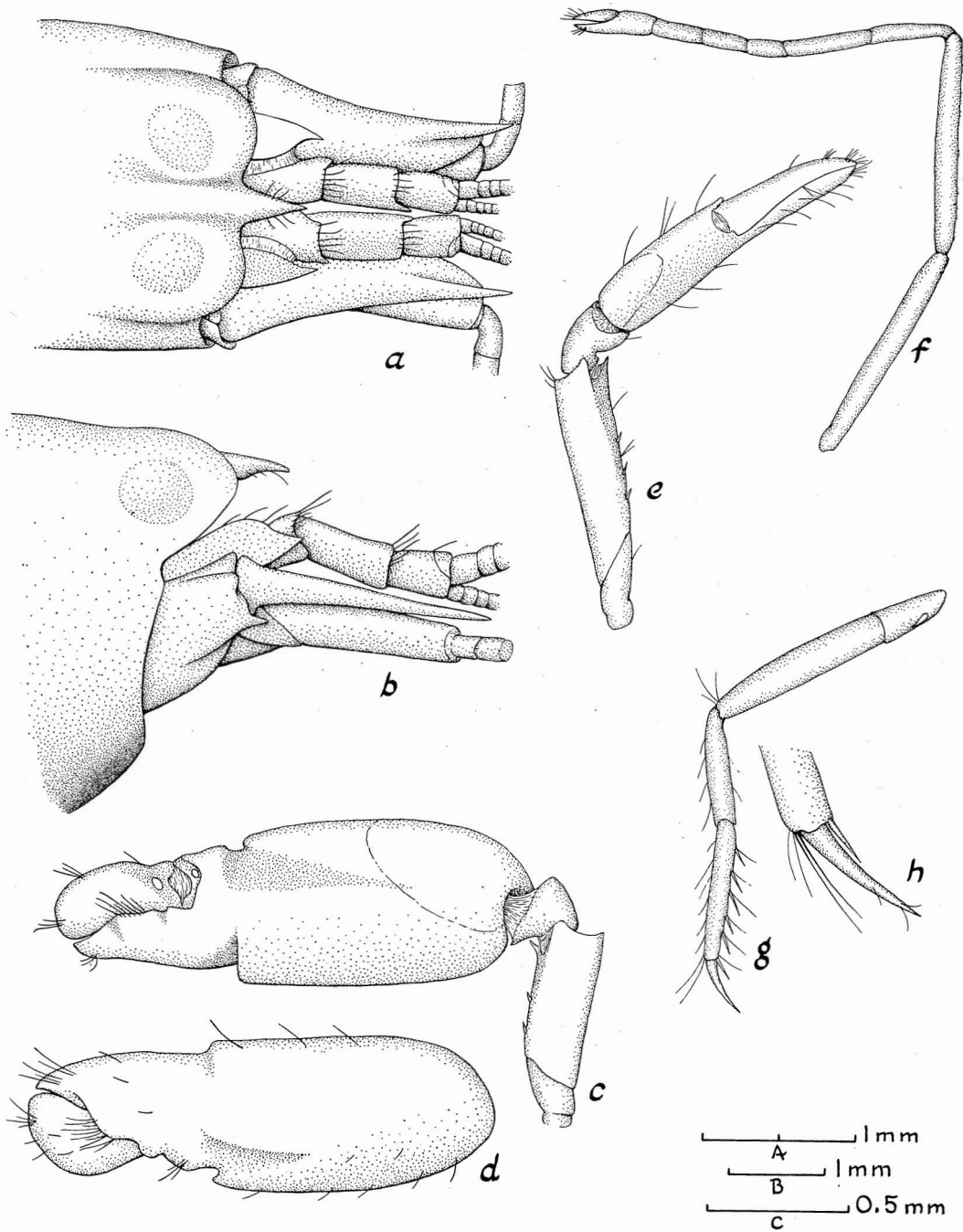


FIG. 48. *Crangon leptochirus* (Coutière). *a, b*, Anterior region, dorsal and lateral aspects; *c*, large cheliped, lateral aspect; *d*, large chela, medial aspect; *e*, small chela, female; *f*, second leg; *g*, third leg; *h*, third leg, dactylus. (*a, b*, scale A; *c-g*, scale B; *h*, scale C.)

curved. Merus twice as long as broad; superior margin unarmed; inferior internal margin with tooth distally.

Small chela of usual form in female, subspatulate in male. In female 3.4 times as long as broad, without sculpture; fingers slender, tapering, about as long as palm; short acute tooth at point of articulation of dactylus usually present, as illustrated, but sometimes reduced or completely absent. In male small chela relatively larger and heavier, 2.9 times as long as broad, without sculpturing except for slight depressed area on upper surface proximal to articulation of dactylus. Dactylus 0.5 total length of chela, broad, flat, 2.7 times as long as broad, with dense fringe of setiferous bristles along margins, crossing top of article proximal to tip; tip compressed and hooked (dactylus *balaeniceps*-shaped). In both sexes carpus projecting over propodus as broad flat tooth, merus without tooth on inferior internal margin, otherwise similar to that of large chela.

Carpal articles of second legs with ratio 10 : 10 : 5 : 5 : 8.

Ischium of third and fourth legs usually with movable spine; merus inermous; distal margin of carpus not produced into acute processes; propodus usually with about 10 movable spines; dactylus simple, slightly curved.

Largest specimen, female from Kaneohe Bay 26 mm. long; color usually transparent with reddish to greenish transverse bands.

**DISCUSSION:** Marked variation was noted in *C. crassimanus*, as in several other Hawaiian species of which numerous specimens were collected. In this species the careful appendage-by-appendage study of size ratios was not made, but the following variations were noted.

*Antennular peduncles:* The second article varies in relative length from as long as the visible portion of the first and 1.5 times as long as the third to twice as long as the first and three times as long as the third.

*Large cheliped:* The amount of sculpturing on this appendage varies markedly as is shown

in Figure 49c, d, e, f. In some specimens, especially the smaller ones, the sculpturing is very much reduced and noticeable only in the area adjacent to the margins; in larger specimens the shallow depression may be quite extensive over both faces, usually with rounded and ill-defined margins but at times with definite limits. The tooth on the inferior internal margin of the merus of the cheliped is usually present although it is not as large as in many other species; however, in some specimens it may be reduced or entirely absent. In no specimen seen was the upper groove other than gradually rounded on both margins.

*Small cheliped:* In some of the larger females the dactylus, although it never approaches the extreme condition found in males, is often proximally broadened, not slender and tapering as in younger females. The tooth on the inner side of the articulation of the dactylus is almost always present, although sometimes reduced; occasionally it is reduced to a rounded shoulder. No specimens were observed with a tooth on the merus like that of the large chela. No males were found without the *balaeniceps*-shaped dactylus.

*Second legs:* The second article of the carpus varies from 0.75 to 1.3 times the length of the first, and the fifth article from 0.5 to 1.0 times the length of the first.

It has been observed that those members of this species collected from Kaneohe Bay and especially those collected on the inner arms of Pearl Harbor, where the water is very warm, quiet, and filled with silt, are larger, averaging about twice the length of, and have a redder color than, specimens collected from coral boulders of the open reefs. No other characters distinctive of the two groups of specimens could be found.

The local specimens agree well with the original description of Heller, differing only in one possible point. Heller states, "*Antennarum spina externa basalis minima*," and, in his plate, does not show a spine at all, while in the Hawaiian specimens it is well formed. The ratio of the articles of the carpus of the

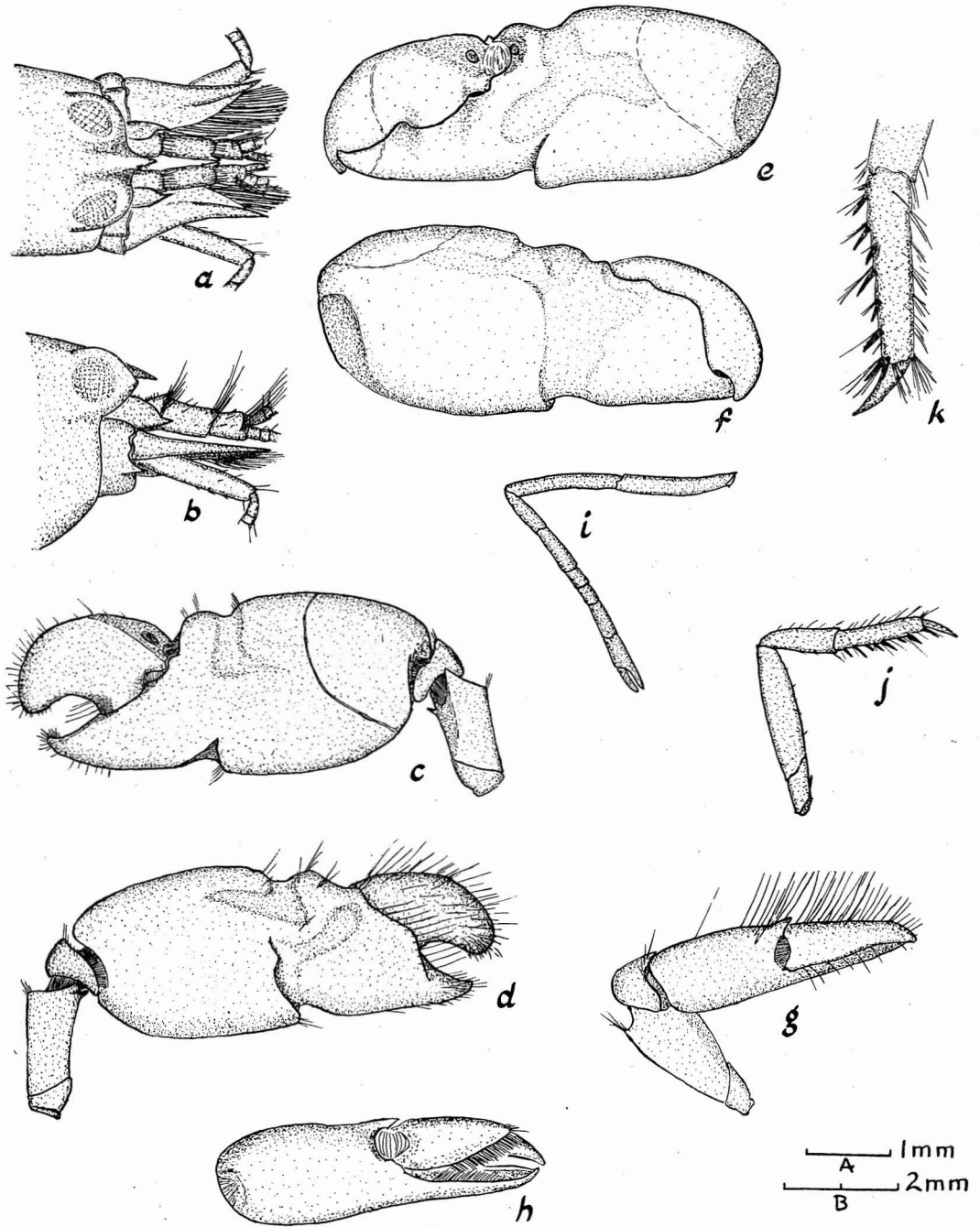


FIG. 49. *Crangon crassimanus* (Heller). a, b, Anterior region, dorsal and lateral aspects; c, d, large cheliped, lateral and medial aspects; e, f, large chela from another specimen, setae not shown, lateral and medial aspects; g, small cheliped, female; h, small chela, male, long setae not shown, lateral aspect; i, second leg; j, third leg; k, third leg, propodus and dactylus. (a, b, k, scale A; c-j, scale B.)

second leg (10 : 6 : 2 : 2 : 4, as taken from the drawings) are almost within the range of variation of the Hawaiian form.

De Man (1911) suggests that possibly *C. crassimanus* is a synonym for *C. lobides* (de Haan), but a study of the literature following the publication of the note reveals that the question has not yet been settled and that *C. crassimanus* is still accepted as a valid species.

One specimen of this species in my collection and two in the collections of the Bernice P. Bishop Museum (No. 5057) bear an unusual parasite attached to the posterior ventral portion of the thorax. It is in the form of a more or less bean-shaped body, whitish in color and about 5 mm. long, which is attached by a short stalk. The specimens from the Bernice P. Bishop Museum were described as new by Nierstrasz and Brandis (1930) as *Faba glabra*, while my specimen was identified as this species by Dr. Edward C. Reinhard. The parasite is of unknown systematic position, but the original authors suggest it may be an epicaridan crustacean. It is interesting to note that, of all the crangonids from Hawaii, the parasite has been found only on this one species and that on that species it is extremely rare.

**DISTRIBUTION:** This species is one of the most common in the shallow inshore waters of the reefs. There is, in Hawaii, no record of its collection from water over 5 or 6 feet deep. On Oahu it has been collected from the following localities: Kaneohe Bay, Koko Head, Black Point, Waikiki, Pearl Harbor, Moku-leia, Haleiwa, Kaaawa, Punaluu; on Maui it was collected at Kalama Park and 12 miles south of Lahaina; on Molokai at Kainalu. Edmondson (1925) reported the species from Laysan and Lisianski Islands. The "Albatross" collected specimens in Pearl Harbor (U.S.N.M. 63559) and Honolulu Reef (U.S.N.M. 63560, 63562).

In the central Pacific the species was reported by Edmondson (1925) from Johnston Island. It ranges through the Indo-Pacific region and has been reported from places as far

distant from Hawaii as Djibouti, at the mouth of the Red Sea, and Cape York, Australia.

### *Crangon pacifica* (Dana)

Fig. 50 a-i

*Alpheus pacificus* Dana, U. S. Explor. Exped. 13 (1): 544, pl. 34, fig. 5, 1852.

*Alpheus pacificus* Dana, Acad. Nat. Sci. Phila., Proc. 6: 21, 1854. [Diagnosis without figures.]

**NEOTYPE:** A male 32 mm. long, collected at Kalama Park, about 18 miles southeast of Lahaina, Maui, from a coral head in about 3 feet of water (U.S.N.M. 93462).

**DESCRIPTION:** Rostrum acute, triangular, almost twice as long as broad at base, reaching nearly to 0.7 of visible portion of antennular peduncle; margins straight, with few short setae. Rostral carina rounded, arising slightly posterior to eyes. Orbital hoods not greatly inflated, rounded anteriorly. Orbitorostral groove moderately shallow with gradually sloping margins; anterior portion of carapace between rostral base and front of orbital hoods concave.

Second article of antennular peduncle about 1.5 times as long as broad, 1.2 times as long as visible portion of first or third articles. Spine of stylocerite reaching slightly past end of first antennular article.

Lateral spine of basicerite reaching almost as far as spine of stylocerite. Scaphocerite with squamous portion well developed, more than 0.9 length of slender lateral spine; lateral margins only slightly curved. Carpocerite slightly longer than scaphocerite; scaphocerite 0.1 longer than antennular peduncle. Antennal flagellum longer than body.

Large chela massive, 2.2 times as long as broad, compressed, twice as broad as thick, with lobes and crests. Superior margin cut by deep transverse groove proximal to dactylus, proximal edge of groove overhanging, distal edge rounded; groove continued on outer face as shallow, poorly defined, depressed area extending downward about 0.3 breadth



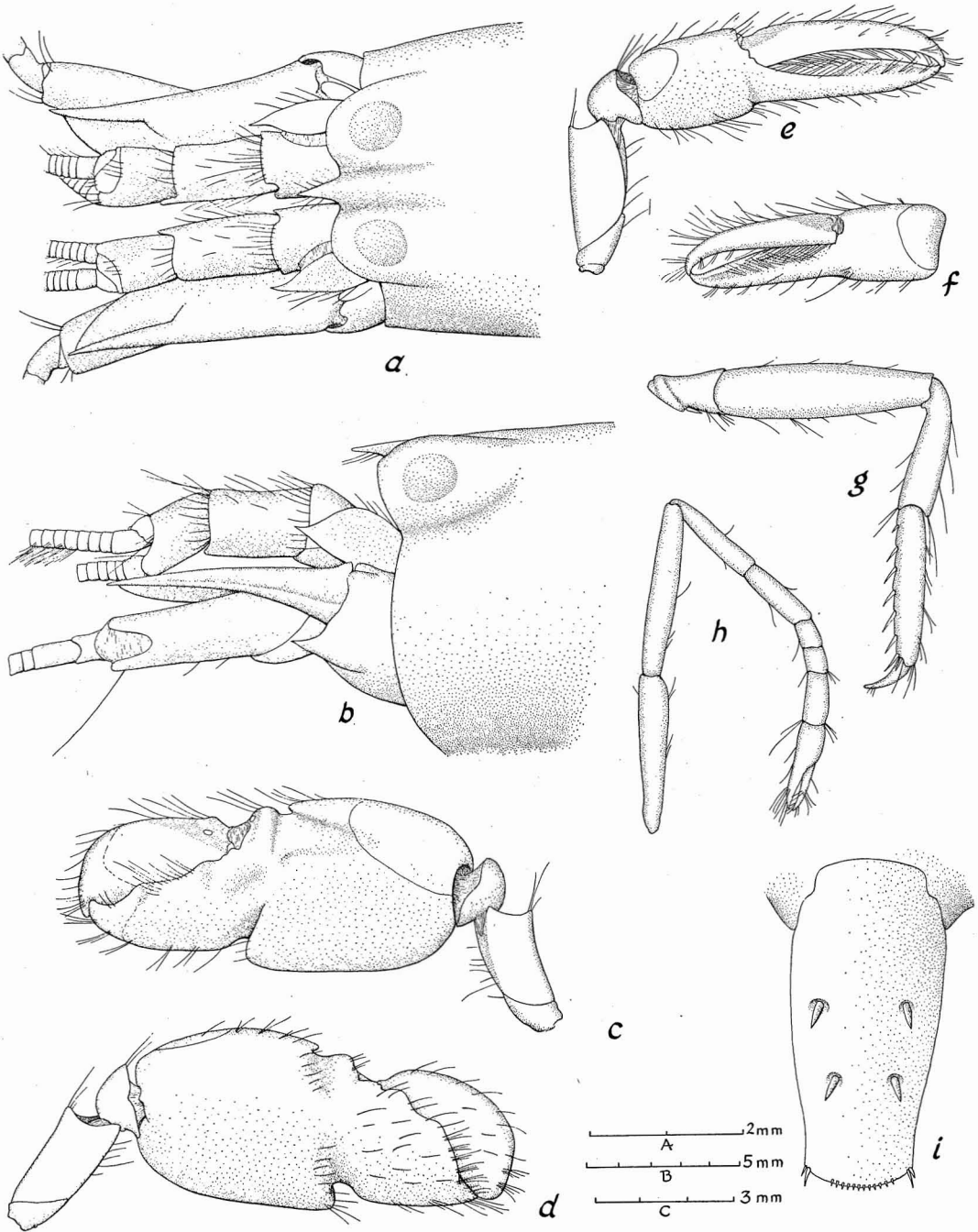


FIG. 50. *Crangon pacifica* (Dana). *a*, *b*, Anterior region, dorsal and lateral aspects; *c*, *d*, large cheliped, lateral and medial aspects; *e*, small cheliped, male, lateral aspect; *f*, small chela, female, lateral aspect; *g*, second leg; *h*, third leg; *i*, telson. (*a*, *b*, *i*, scale A; *c*-*f*, scale B; *g*, *h*, scale C.)

of face and posteriorly beyond middle of palm, continued on inner face as much smaller triangular depressed area immediately below groove. Inferior margin with much deeper notch below upper groove, the proximal edge overhanging, the distal edge abrupt but rounded; notch continues more than 0.3 distance up outer face with proximal edge well defined throughout but distal edge fading; depression on inner face similar to that on outer face but with both edges gradual. Dactylus 0.4 length of chela, heavy, with distal margin strongly curved. Scattered setae on superior margin and inner distal face of chela and on fingers. Merus about 0.25 as long as chela, twice as long as broad, superior distal margin obtuse and lacking inner distal tooth; with occasional setae along margins. Large chela of female similar.

Small chela of male 3.4 times as long as broad, fingers 0.6 of total length. Palm compressed, without grooves, ridges, or depressions except for slight indentation at base of fixed finger. Both fingers curved distally so that points cross; both fingers with dense rows of marginal setae proximally, becoming more scattered distally; oppositional faces of both fingers somewhat flattened. Articulation of dactylus not flanked by tooth. Carpus with tooth extending over base of propodus. Merus similar in form to that of large chela. Small chela of female of same proportions and armature as that of male except perhaps with few less setae proximally on fingers; size relatively less than that of male.

Carpal articles of second legs with ratio 10 : 8 : 3 : 3 : 5.5; second article of carpus 4.4 times as long as broad; chela as long as first carpal article.

Ischium of third legs with strong movable spine; merus 4 times as long as broad, tapering slightly distally, unarmed; carpus about 0.5 as long as merus, neither superior nor inferior distal margin projecting distally as acute tooth; propodus 0.75 as long as merus, with 11 moderately large spines on inferior and distal margins; dactylus acute, curved, simple,

slightly shorter than width of merus. Merus with several short setae; superior margin of carpus and propodus with scattered, long setae. Brush on fifth legs well developed.

Telson tapering only slightly in posterior third, anterior margins convex; 2.2 times as long as broad, maximum breadth 1.4 times breadth of tip. Margin of tip only slightly arcuate. Posterolateral spines feeble, scarcely reaching beyond rounded portion of tip; dorsal spines heavy, 0.4 and 0.6 of distance from articulation to tip. Middle of posterior border and distolateral margin of inner uropod with small, irregularly placed spinules.

Neotype about maximal size observed. Color in life, banded red and transparent, with blue-violet markings on appendages, especially large chela.

DISCUSSION: Although not as much variation was noted in this species as in the closely related *C. crassimanus* (Heller) the following points are noteworthy: The length of the second antennular article was as much as twice the length of the visible portion of the first in some smaller specimens; the sculpturing on the upper parts of both faces of the large chela varied in extent; the number of setae on the opposing faces of the fingers of the small chela also varied from the neotype, some having more, some less; the second article of the carpus of the second legs was almost as long as the first article in some specimens; and the number of spines on the propodus of the third legs varied slightly from the 11 found in the type specimen. In none of the specimens, however, was there a tooth on the merus of the large chela, nor at the articulation of the dactylus of the small chela; in no case was the proximal margin of the superior groove of the large chela other than overhanging the floor of the groove nor was the small chela of the males approaching the condition found in *C. crassimanus* (balaeniceps-shaped).

Dana's original specimen, now lost, was very large,  $1\frac{3}{4}$  inches (or about 45 mm.), and was collected at some undesignated spot in the Hawaiian Islands. The neotype, the larg-

est in the present collection, unfortunately is somewhat smaller (32 mm.), and was collected on Maui near where Dana had collected other Hawaiian types (see under *C. diadema* and *C. pugnax*). It agrees well with Dana's description and plates except in the ratio of the articles of the carpus of the second leg which according to his plate had a ratio of 10 : 5 : 3 : 2.5 : 4, which is 10 : 8 : 3 : 3 : 5.5 in this specimen. While this character was quite variable in the specimens in the present collection, in no case did it approach the extreme given by Dana; however, it is likely that this difference still can be individual variation or possibly a growth difference. A second more slight difference is that Dana's plates do not show the proximal margin of the superior groove of the large chela overhanging the groove; this character, too, is somewhat variable in these specimens, and may well be either an individual or a growth difference.

This species resembles *C. crassimanus* (Heller) very much, and there is no positive way to distinguish between them except by the character of the first thoracic legs. The small chela in the male is subspatulate in *C. crassimanus* and of the usual form in both the male and female in *C. pacifica*. On the large chela the most useful character is the presence of a tooth on the internal distal angle of the merus in *C. crassimanus*, with none in *C. pacifica*; however, this tooth is variable in size and often very much reduced. The proximal edge of the upper depression is rounded in *C. crassimanus* and usually overhangs in *C. pacifica*, but some specimens of both species approach the perpendicular. The superior depression on the internal face usually extends posteriorly past the mid-line of the palm in *C. crassimanus* and scarcely back of the upper edge of the depression in *C. pacifica*.

**DISTRIBUTION:** This species, like *C. crassimanus*, is common in shallow waters. It does not seem to penetrate the inshore portions of the reefs nor the quieter waters of enclosed bays as much as *C. crassimanus* (although it

does penetrate as far into Kaneohe Bay); it also reaches a bit further beyond the tidal zone having been collected from water 15 feet deep at Nanakuli, Oahu. It has been collected from the following localities on Oahu: Kaneohe Bay, Waimanalo, Hanauma Bay, Black Point, Waikiki, Nanakuli, Mokuleia, Kawela Bay, and Kahana Bay; on Maui it has been collected at Makena, Kalama Park, Lahaina, and 12 miles south and 10 miles north of Lahaina. The "Albatross" collected specimens on Honolulu Reef and at Waialua, Oahu (U.S.N.M. 63590 and 63593) and Napili Harbor Reef, Maui (Station No. 3881, U.S.N.M. 63592). Edmondson (1925) has reported the species from Laysan and Ocean Islands.

It is widely spread through the Indo-Pacific region, from the Red Sea and Madagascar to New South Wales and Wake Island.

#### Species of Doubtful Record

##### *Crangon strenua* (Dana)

*Alpheus strenuus* Dana, U. S. Explor. Exped. 13(1): 543, pl. 34, fig. 4, 1852.

Originally described from Tongatabu, Tonga, this species is of wide distribution in the south Indo-Pacific, from the Galapagos on the east to Djibouti at the mouth of the Red Sea on the west. It was reported from an unspecified locality in Hawaii by Stimpson (1861) as *A. avarus* Fabr. (he regarded *A. strenuus* as a synonym for *A. avarus*). However, as the species has not been reported from this archipelago since that time, and as it can be confused most easily with the common *C. crassimanus* (Heller) (the two species can be separated with certainty by the presence of a balaeniceps-shaped small chela in both the male and female in *C. strenua* in contrast to having the condition only in the male in *C. crassimanus*), it is likely that Stimpson made a mistake in identification.

**C. audouini** (Coutière)

*Alpheus audouini* Coutière, Fauna and Geog. Mald. and Laccad. 2: 911-913, pl. 87, fig. 52, 1905.

This species was reported from Hawaii by Coutière in his original description: "L'espèce se trouve dans toute la Mer Rouge, l'Océan Indien, la Malaisie, et de la N<sup>11</sup>e Zélande aux Îles Sandwich." Unless this species is confused with the closely related *C. pacifica* (in which case the name *C. pacifica* would take priority), it has not been reported from the Islands since, nor was it found in the present collections. Therefore it seems likely that Coutière's sweeping distributional list was a little too inclusive.

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