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Callianassidae of the Central Pacific

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INTRODUCTION

Fewer than 200 species of the crustacean family Callianassidae have been recorded, and many of these are imperfectly known as some have been seen but once and others have been described from damaged specimens. The burrowing mode of life of the organisms makes their capture difficult, and the readiness with which their appendages are lost (fig. 1) is partly responsible for the limited knowledge about the group.

With few exceptions, the Callianassidae are marine forms, ranging through warm and cold seas and from shores to depths of over 300 fathoms. Shoal water forms are typical of muddy or sandy flats where they live in burrows at various depths below the surface. Others may find concealment in sponges and porous rocks or under stones.

Few representatives of the family have been reported from the Hawaiian Archipelago. During the *Albatross* Expedition of 1902, *Callianassa articulata* Rathbun (10)¹ was taken near Nihoa at 23 to 33 fathoms, and another, imperfect specimen (unnamed), was taken from a Honolulu reef.

Among the collections of the United States National Museum are a male and a female adult specimen of the genus *Callianassa*, gifts from the Boston Society of Natural History. They are labeled: "Dr. C. F. Winslow, Manai, Sandwich Islands, 4-4, 1860." It is probable that the word "Manai" refers to Maui, as the letters *u* and *n* often are confused in the written name of the island, and the additional letter *a* may be an error. These specimens, which apparently represent a new species, are described in this report.

Within a limited radius in the Pacific to the south and west of Hawaii, a few additional species of the group have been recorded. A widely dispersed species, *Callianidea typha* H. Milne-Edwards, is

¹ The numbers in parentheses refer to Literature Cited, page 61.

known from the Marianas Islands, Rotuma, Funafuti, and Samoa; *Callianidea planocula* Melin was described from the Bonin Islands; *Callianassa armata* A. Milne-Edwards is reported from Fiji; *Upogebia carinicauda* (Stimpson) from Samoa; and *Callianassa bocourti* A. Milne-Edwards is reported as probably from the Union Islands.



FIGURE 1.—*Callianassa (Cheramus) variabilis*, two pairs of legs missing.

Most of the small collection of Callianassidae in Bernice P. Bishop Museum, which forms the basis of this report, was taken from the shallow reefs of Oahu. Although the Hawaiian species apparently are few in number, certain localized habitats seem favorable for the production of some of them. A muddy gravel bed on the shore of Hanauma Bay, Oahu, has supplied at least three species, and by far the greater number of representatives of the family in the museum are from that locality. Shallow burrows in the sandy bottom of the bay are occupied by another species, which is known from no other place. The reefs of Kahala, Waikiki, and Kawaihoa, Oahu, have supplied other species, one of which is widely dispersed about the shores of the island. Young specimens of several species were procured by breaking open porous coral blocks, in the crevices of which the shrimps are sometimes concealed.

The present paper also considers Bishop Museum specimens of the genus *Callianidea* from Tahiti, Guam, and Wake Islands. The specimens from Tahiti and Guam without doubt represent *Callianidea typa* H. Milne-Edwards, a species widely distributed in the Pacific Ocean. A badly damaged specimen from Wake Island probably differs from previously described forms. Also included in the report is the description of an imperfect specimen of the genus *Upogebia*. Although the exact locality from which this specimen was taken is uncertain, there is reason to assume that it was collected in Hawaiian waters.

Knowledge of the early phases of members of this family is limited. In 1937 Gurney (2) reported that but three larval forms of the genus *Callianassa* had been definitely identified and that but two had been hatched from eggs. In 1938 Lebour (3) added another to the list by hatching larvae of *Callianassa affinis* Holmes. During local studies, here recorded, I have been able to hatch larvae of a new species from Hawaii, *Callianassa parva* (p. 45).

The classification of the Callianassidae presented by Borradaile (1) and followed by de Man (5) has not met with universal satisfaction. Gurney (2) believes the characters upon which the subdivisions of the family are usually based to be of secondary importance and feels that a proper basis would include the mouthparts, the arrangement of the gills, and the characteristics of larvae. It is obvious, however, that most students of this group have actually seen but few species and that, until someone can examine the minute structural features of a large number of representatives, the more superficial characters will probably be utilized by the systematist.

In the following report I have accepted, for the most part, the taxonomic arrangement of Borradaile and de Man. Keys of species have been constructed to include local forms.

TAXONOMY

KEY TO SUBFAMILIES OF CALLIANASSIDAE

- A. No *linea thalassinica*² present. Second to fifth pleopods all alike..... **Callianideinae.**
- A. *Linea thalassinica* present.
- B. Rostrum large; first pair of thoracic legs subequal; no appendix interna³ present **Upogebiinae.**
- B. Rostrum small; first pair of thoracic legs unequal; an appendix interna on third to fifth pleopods..... **Callianassinae.**

² A longitudinal furrow separating the lower from the upper portion of the carapace, on either side.

³ A small process articulating with the endopodite of the third to fifth pleopods.

SUBFAMILY CALLIANIDEINAE

Genus *Callianidea* H. Milne-Edwards

Second to fifth pleopods of both sexes fringed by soft, branched, membranous filaments.

KEY TO SPECIES OF CALLIANIDEA TREATED IN THIS PAPER

- A. Telson quadrangular; filaments fringing pleopods short, branched two or three times.....*Callianidea typa* H. Milne-Edwards.
- A. Telson oval in form; filaments fringing pleopods long, branched four or five times.....*Callianidea* sp.

Callianidea typa H. Milne-Edwards, *Hist. Nat. Crustacés* 2: 320, pl. 25, figs. 8-14, 1837; de Man, *Siboga-Exped. Monogr.* 39a⁹: 30-35, pl. 1, figs. 3-3f, and synonymy, 1928. (See figure 2, *a-k*.)

Specimen (from Tahiti), a male 44 mm. in length; carapace 10 mm. long; abdomen, including telson 34 mm. long; length of abdominal segments 1-6, inclusive, 4, 6, 5, 5, 5, and 5 mm., respectively; telson 4 mm. in length.

Anterior border of carapace bearing three short, sharp teeth, the medial (rostral) one slightly sharper and more advanced than lateral ones but concealing little of the eye stalks. Eye stalks nearly as broad as long, distal border slightly convex; cornea small, round, situated on upper surface of eye stalk toward lateral border distal of middle. Terminal segment of antennular peduncle longer than the penultimate one; terminal segment of antennal peduncle about 0.33 length of penultimate one; antennal peduncle overreaching that of antennule by more than the length of the terminal segment of former (fig. 2, *a, b*).

Segments of endopodite of third maxilliped narrow, unarmed, the ischium being the longer (fig. 2, *c*). Palm of first leg on left side (large cheliped) slightly longer than merus; carpus very short, fingers stout; a few short spines on lower border of ischium, and serrations on lower border of propodus; numerous teeth on cutting edges of fingers (fig. 2, *d*).

First leg on right side (small cheliped) slender, unarmed; carpus longer than palm; fingers shorter than palm, immobile one with a large tooth near middle of cutting edge and a few smaller ones distally (fig. 2, *e*). Carpus of second leg almost as long as propodus; fingers longer than palm, the dactylus exceeding the immobile one in length, and both bearing fine teeth on cutting edges (fig. 2, *f*). Third leg with carpus and propodus subequal in length, unarmed except for a sharp spine at antero-ventral border of propodus (fig. 2, *h*).

First pleopod of male consisting of two segments, the terminal one expanded (fig. 2, *j*). First pleopod of female composed of two segments, the terminal one flat, sickle-shaped (fig. 2, *i*). Pleopods 2-5, inclusive, in both sexes, fringed by soft, membranous processes, branched 2 or 3 times, usually dichotomously (fig. 2, *g*).

Telson quadrangular in form, longer than broad, the lateral sides converging somewhat toward the almost straight posterior border. Uropods a little longer than telson, the outer branch slightly broader than the inner one. The anterior and distal borders of the outer branch are fringed, in part, by a row of short spinules, in addition to long hairs (fig. 2, *k*).

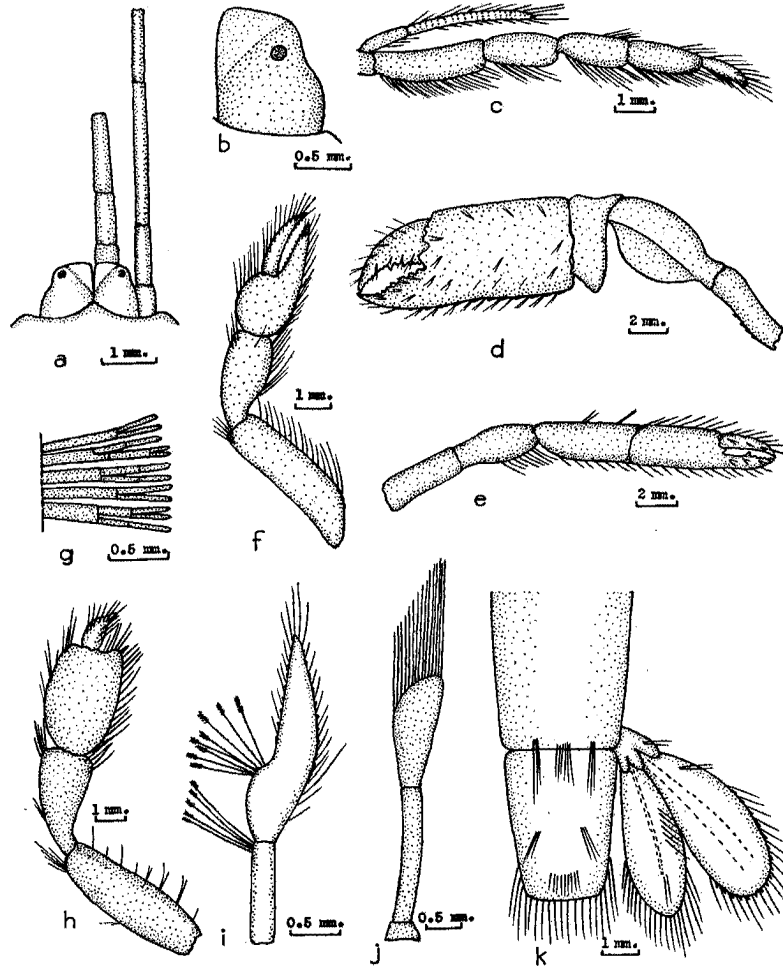


FIGURE 2.—Structural parts of *Callianidea typha*: a, front border of carapace, eye stalks and peduncles of antenna and antennule; b, eye stalk; c, third maxilliped; d, large cheliped; e, small cheliped; f, second leg; g, filaments fringing pleopods; h, third leg; i, first pleopod, female; j, first pleopod, male; k, telson and uropod.

There are two specimens of the genus *Callianidea* in Bishop Museum, examples of the species *Callianidea typha* H. Milne-Edwards (7). One is from Tahiti, the other from Guam. The structural features represented in figure 2 are drawn from the specimen from Tahiti, with the exception of *e* and *i* which are from the Guam specimen. The Tahitian specimen of *C. typha* (4591)⁴ bears the label: "Tahiti, Papeete, Nordhoff, July 1929." The specimen from Guam (4592) was collected in 1923 by Hans G. Hornbostel.

C. typha, which ranges widely through the Indian and Pacific Oceans eastward from the Red Sea differs, according to de Man (5), from *C. laevicauda* Gill of the West Indies in that the pleopod filaments of the latter are cylindrical, composed of three joints, and not branched as in *C. typha*. Schmitt (11), however, finds in a Pacific subspecies, *C. laevicauda occidentalis*, two-jointed pleopod filaments and other minor differences from the typical Atlantic form. Schmitt is of the opinion that Lockington (4) may have based his report of *C. typha* from the Gulf of California on examples of this Pacific subspecies.

C. typha apparently differs from *C. planocula* Melin (6), described from the Bonin Islands, especially in the form of the telson and the pleopod filaments.

Callianidea species (fig. 3, a-g).

Specimen a female, probably 40 to 45 mm. in length. Anterior portion of carapace and eye stalks destroyed. Third segment of peduncle of antenna as long as combined length of first and second, and 1.5 times longer than terminal segment. Antennal peduncle overreaching that of antennule by more than length of terminal segment of former (fig. 3, a).

Third maxilliped (fig. 3, b), small cheliped (fig. 3, c), and third leg (fig. 3, e) slender and resembling the corresponding appendages of *C. typha*. Small cheliped unarmed, a few small teeth on cutting edge of immobile finger. Propodus of third leg bearing a strong spine on the antero-ventral border. Large cheliped absent.

First pleopod composed of two segments, the terminal one sickle-shaped (fig. 3, d). Pleopods 2-5, inclusive, fringed by soft filaments, longer and more frequently branched than in *C. typha* (fig. 3, f).

Telson longer than broad, the lateral borders convex, and rounded posteriorly. Short curved lines close to the posterior border, from which issue tufts of long bristles, give the appearance of scallops. Uropods longer than telson, elongate-oval in form, the outer branch the broader and fringed on distal border by short spinules in addition to long hairs (fig. 3, g).

Collected from Wake Island (1819) in shoal water on the reef by members of the *Tanager* Expedition in 1923.

⁴ Catalog numbers refer to Bishop Museum specimens, unless otherwise stated.

Although its condition precludes a complete description, enough structural parts of the Wake Island specimen are intact to make certain that it is distinct from the widely dispersed species *C. typha* H. Milne-Edwards. While it is distinct from *C. typha* in the form of the telson and pleopod filaments, it seems to be closely related to and may be identical with *C. planocula* Melin (6), described from the Bonin Islands. The two forms compare favorably with respect to the small chelipeds, the pleopod filaments and the telson.

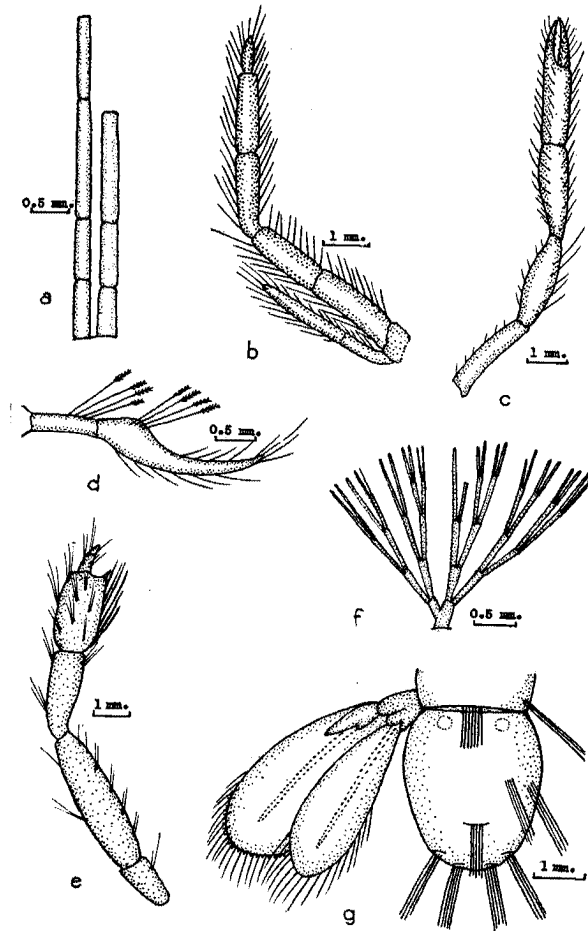


FIGURE 3.—Parts of damaged specimen of *Callianidea* species: a, peduncle of antenna and antennule, left side; b, third maxilliped; c, small cheliped; d, first pleopod, female; e, third leg; f, filaments fringing pleopods, 2-5; g, telson and uropod.

SUBFAMILY UPOGEBIINAE

Genus **Upogebia** Leach

Rostrum short but stout; first pair of legs subchelate; eye stalks cylindrical.

Subgenus **Upogebia** Leach

Dactylus of first legs much longer than immobile finger; one or more spines on the antero-lateral border of the carapace opposite the base of the eye stalk.

Upogebia (Upogebia) species (fig. 4, *a-j*).

Specimen a male, 64.5 mm. in length from tip of rostrum to extremity of telson. Length of carapace 21.5 mm.; length of abdominal segments, 1-6, inclusive, 6, 6, 5.5, 5, 6.5, and 7 mm., respectively; length of telson 7 mm.

Carapace in front of cervical groove flattened above, with declivitous sides; rostrum as long as broad at base, extending considerably beyond extremity of eye stalks; depth of rostrum about 0.5 its length, upper surface flattened and traversed by a median longitudinal groove, lower border entire. Margins of upper surface of rostrum each bearing 5 conical tubercles diminishing in size posteriorly; upper surface and upper portion of sides of rostrum densely hirsute.

Lateral teeth of front border of carapace about 0.25 length of rostrum, the upper extremity of each bearing a large, conical tubercle. Opposite insertion of eye stalk on front margin of declivitous wall of carapace is a strong tooth with a smaller one below it. Lateral borders of upper surface of carapace, in front of cervical groove, each bearing a row of conical tubercles, diminishing in size from front backward, 14 on left side, 11 on right side. Anterior tubercle on each side forms lateral border of notch at base of rostrum. Last two or three tubercles on either side are but slightly elevated and lack brown tips of anterior ones. Median of each lateral row of tubercles is a longitudinal depression extending from notch at base of rostrum posteriorly, being more pronounced toward front. Median of this depression on either side is another row of conical tubercles, about 10 in number, diminishing in size and sharpness toward posterior end.

Posterior of base of rostrum, on either side of midline of carapace is an irregular row of four blunt tubercles and between posterior pair of these is a slight elevation of carapace in the midline; this tubercle marks posterior extremity of a groove extending backward from tip of rostrum. Postero-lateral areas of upper surface of carapace anterior to cervical groove marked by slight elevations from which tufts of hairs proceed. Upper surface of carapace in front of cervical groove densely hirsute except in median area of posterior half, which is free from hairs. Behind cervical groove, carapace is smooth and devoid of hairs except for a fringe on posterior border (fig. 4, *a, b*).

Body of mandible quadrangular in outline, convex on outer (lower) surface; cutting edge diagonal bearing a series of small teeth distally and two or three larger ones proximally; palp two-jointed, curving about anterior extremity of mandible (fig. 4, *c*).

Basal segment of antennular peduncle broad posteriorly, narrow distally, a crest on dorsal surface; second segment short; terminal segment 3 times length of second; upper, thicker filament of antennule 5.5 mm. in length, lower filament 6 mm. (fig. 4, *d*). Basal segment of antennal peduncle thick, as long as the following one, a short, lobe-like process articulated at distal extremity of dorsal border; terminal segment of peduncle shorter and narrower than penultimate one (fig. 4, *e*).

Segments of third maxilliped narrow, the ischium the longer; appendage unarmed but densely hirsute on lower border; exopodite reaching beyond middle of merus (fig. 4, f).

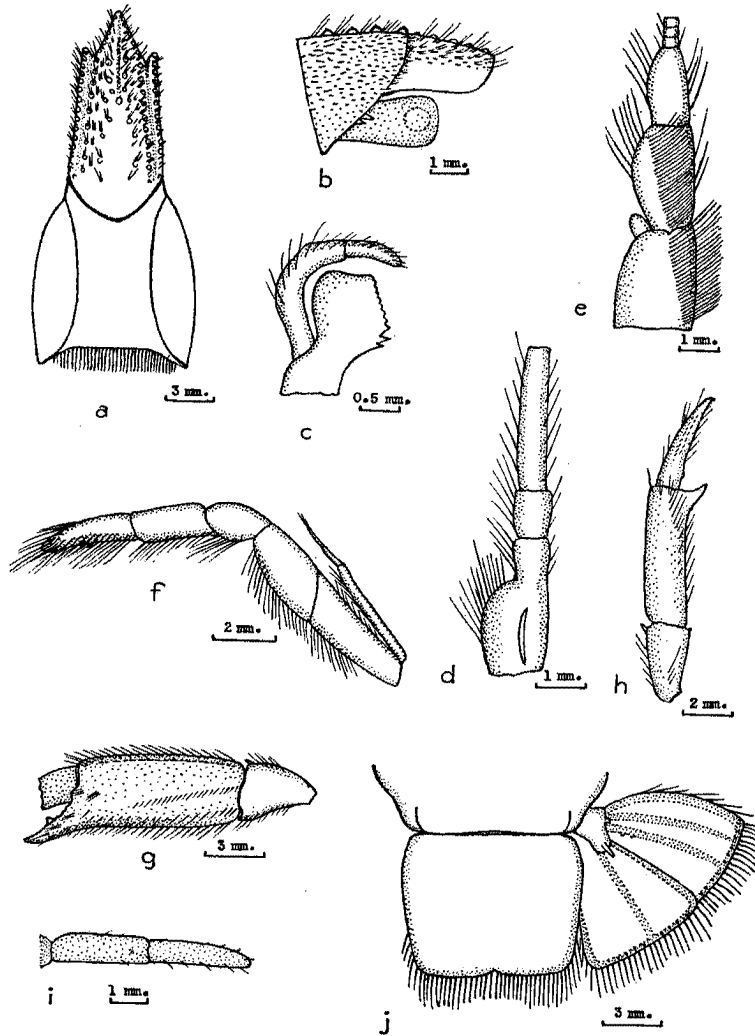


FIGURE 4.—Structural features of *Upogebia* (*Upogebia*) species: a, carapace, from above; b, lateral view of front border of carapace, rostrum and eye stalk; c, mandible; d, antennular peduncle; e, antennal peduncle; f, outer maxilliped; g, first leg, left side, carpus and propodus, dactylus broken near base; h, first leg, right side, carpus, propodus, and dactylus; i, first pleopod, male; j, telson and uropod.

First legs subchelate, unequal, that of right side more slender than left one. First leg on right side with propodus a little more than 2 times its breadth, subcylindrical; length of carpus more than 0.5 that of palm and equalling that of dactylus. A sharp, hooked tooth near distal end of upper border of carpus, and a smaller one at lower front border. Upper border of dactylus with faint, irregular, transverse striae; length of immobile finger about 0.25 that of dactylus, its prehensile border unarmed (fig. 4, *h*).

First leg on left side with propodus broader and less cylindrical than corresponding segment of first leg on right side; carpus, in length, about 0.5 that of palm with a sharp tooth at both upper and lower distal borders, and another just above middle of front border of inner face of segment. Dactylus broken near base; immobile finger with a strong tooth near middle of prehensile border (fig. 4, *g*).

First pleopod a thin, narrow, two-segmented appendage, sparsely haired (fig. 4, *i*). Telson quadrangular in form, slightly shorter than greatest breadth which is a little behind the articulation with sixth abdominal segment; posterior margin nearly straight, notched in middle. Uropods broad, a little longer than telson, margins thickened; outer branch reinforced by two, inner by one rib; basal segment bearing two lobe-like processes, equal in length; two small tubercles near basal end of inner rib of outer branch; margins of both branches fringed with hair (fig. 4, *j*).

The described specimen (4679) was probably collected somewhere about Oahu. This damaged specimen bears the label: "W. A. Bryan, 1916." Although the label is not the original one it may be assumed that the specimen was collected locally. Because of its fragmented condition it is included here without specific designation.

In characteristics of carapace, telson and uropods this species bears a close resemblance to *Upogebia* (*Upogebia*) *pugettensis* (Dana); but, from an analysis of that species by Stevens (12), the Hawaiian form differs from it in having unequal and less spinous chelipeds, and two spines instead of one on the front margin of the carapace below the lateral teeth.

SUBFAMILY CALLIANASSINAE

Genus *Callianassa* Leach

Rostrum small, if present; first pair of legs unequal, chelate; eye stalks flattened.

KEY TO SUBGENERA OF CALLIANASSA (AFTER BORRADAILE)

- A. Propodite of the third leg without a lobe on the hinder edge...*Calliactites*.
- A. Propodite of the third leg with a lobe on the hinder edge.
 - B. Telson long.
 - C. Third maxilliped narrow.....*Cheramus*.
 - C. Third maxilliped very broad.....*Trypaea*.⁵
 - B. Telson short and broad.....*Callichirus*.

⁵ No example of the subgenus has been recognized among the material at hand.

Subgenus *Calliactites* Borradaile***Callianassa (Calliactites) parva***, new species (fig. 5, *a-j*).

Type specimen an ovigerous female 16 mm. long from tip of rostrum to extremity of telson; length of carapace 5 mm. Front margin of carapace bearing three short, sharp teeth, median (rostral) one slightly advanced beyond lateral ones. Rounded antero-ventral borders of carapace separated from lateral teeth by deep notches. Eye stalks large, inner borders contiguous for more than 0.5 their length; outer borders convex, distal extremities obtusely pointed, entire; cornea small, near outer distal border of stalk. Eye stalk overreaching proximal border of second segment of antennular peduncle.

Third antennular segment slightly more than four times length of second segment. Peduncle of antenna slightly exceeding in length that of antennule, second and third segments subequal (fig. 5, *c*).

Dactylus, propodus and carpus of third maxilliped slender, each longer than broad; merus broader than long; ischium triangular, broad in front and bluntly rounded posteriorly (fig. 5, *b*).

First legs (chelipeds) subequal in length; propodus of right leg longer and broader than that of left appendage; carpus of left leg longer and merus shorter but each broader than corresponding segments of right leg. Chelipeds unarmed except for three small spines on lower border of ischium of right leg. Small teeth on cutting edges of fingers of both chelipeds (fig. 5, *a, d*).

Third leg slender, propodus without a lobe on posterior border but bearing a strong spine near antero-ventral border (fig. 5, *h*). Lower front border of propodus of fourth leg bearing a strong spinous process which carries a double row of teeth on its upper distal half (fig. 5, *f*).

Sixth segment of abdomen a little longer than telson, lateral borders slightly concave. Telson as long as greatest breadth, becoming narrower behind, truncate on posterior border. Uropods slightly longer than telson, outer branch rounded distally, inner one narrower, distal border bluntly rounded; basal segment of uropods bilobed, smooth (fig. 5, *i*).

First pleopod of female of two segments, distal one joined at an angle with curved proximal one. Both segments bear long bristles, some of which are feathered (fig. 5, *e*). First pleopod of male in a specimen 8 mm. long consists of two slender segments of nearly equal length (fig. 5, *g*).

Larva of this species, shortly after hatching, characterized by a slender rostral spine twice as long as large oval eye stalks. A short sixth abdominal segment is followed by a fan-shaped telson which is fringed distally by 10 bristles (fig. 5, *j*).

Type specimen, number 4599. Type locality, Hanauma Bay, Oahu.

This species, the smallest yet observed in Hawaii, has been taken from burrows in the sandy bottom of Hanauma Bay under very shallow water. It is probably closely allied to *Callianassa (Calliactites)* sp. described by de Man (5) from Palos Bay, Celebes, but not named by him because the one specimen lacked the first pair of legs. In characters of third maxilliped, third leg, sixth segment of the abdomen, the telson and uropods, de Man's specimen compares favorably with the Hawaiian species. The specimen from Celebes, taken from a depth

of 36 meters, was but 5.64 mm. in length and was considered by de Man to be immature. None of the Hawaiian specimens taken is larger than the type, the males being smaller than the females.

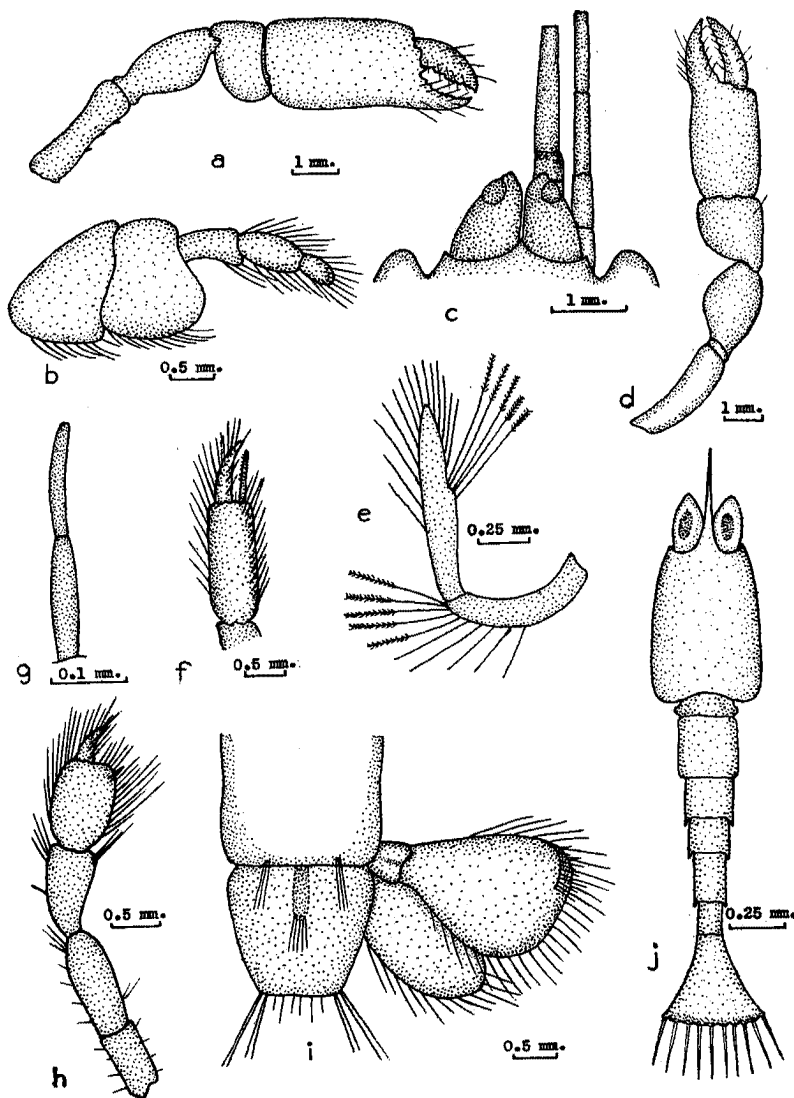


FIGURE 5.—Structural features of *Callianassa (Calliactites) parva*: a, large cheliped; b, third maxilliped; c, front border of carapace, eye stalks and peduncles of antennule and antenna; d, small cheliped; e, first pleopod (female); f, distal portion of fourth leg; g, first pleopod (male); h, third leg; i, telson and uropod; j, larval form, dorsal view.

Subgenus **Cheramus** Bate

Callianassa (Cheramus) variabilis, new species (figs. 1; 6, *a-i*; 7, *a-j*, *l, p*).

Type specimen a male, 72 mm. long from tip of rostrum to extremity of telson. Length of carapace 18 mm., of abdomen, including telson, 54 mm. Length of segments of abdomen, 1-6, inclusive, 9, 9, 7, 5, 8 and 9 mm., respectively.

Anterior border of carapace bearing three low, rounded teeth, the median one extending beyond the lateral ones but concealing little of eye stalks. Border of carapace between median and lateral teeth slightly concave. Eye stalks reaching to distal extremity of first segment of antennular peduncle; tips narrowly rounded, each with a minute spinule; cornea large, faceted, touching outer border of eye stalk and about equal distance from base and tip of appendage (fig. 6, *a*).

Third segment of antennular peduncle slightly longer than the second. Terminal and penultimate segments of antennal peduncle subequal, terminal one extending about 0.5 its length beyond extremity of antennular peduncle. Length of antennal filament, 26 mm., of lower antennular filament, 11 mm., of upper, 10 mm. (fig. 6, *a*).

Mandible strongly convex on outer (lower) surface; cutting edge with six strong teeth; inner (upper) surface marked by a prominent, diagonal crest, free edge of which is toothed; palp curved, with three segments (fig. 6, *b*). Segments of endopodite of second maxilliped narrow, terminal one with a row of strong, curved setae at free end; exopodite curved, blade-like (fig. 6, *c*).

Propodus of third maxilliped with a distinct lobe at the antero-ventral border; inner surface of ischium bearing a curved row of spinules which are crowded together in the anterior half of the row (fig. 6, *d*).

First leg on left side (large cheliped) armed with short teeth on ventral borders of ischium, merus, carpus and proximal half of propodus. Cutting edge of dactylus bearing a large blunt tooth proximal of middle and an anterior, rounded one separated from first by a deep notch (fig. 6, *e*). First leg on right side (small cheliped) unarmed (fig. 6, *f*). Carpus of large cheliped shorter than palm; carpus of small cheliped, in type specimen, also shorter than palm. Propodus of third leg with a lobe on posterior border; lower border slightly concave (fig. 6, *g*).

First pleopod of type specimen composed of two segments, terminal one ending in two rounded lobes with a shallow depression between them (fig. 6, *h*). First pleopod of a female of the species composed of three segments, basal one curved, and all bearing numerous long hairs some of which are feathered near tips (fig. 7, *p*).

Telson a little broader than long, posterior border rounded and slightly concave in middle. Uropods broad, thickened portion of outer branch extending almost to distal border; length of uropods little more than that of telson; no spinule on proximal end of posterior rib of outer branch (fig. 6, *i*).

Type specimen, number 4593. Type locality, Hanauma Bay, Oahu, in a gravel bed of the intertidal zone.

This largest and most numerous representative of the family observed about Oahu is a species closely allied to *C. jousseaumei* Nobili (9), described from the Red Sea, and to *C. indica* de Man (5), from the coast of Kangean.

After examining more than 200 Hawaiian specimens, however, I have concluded that the local form differs from both of the above species sufficiently to justify a separate specific designation. De Man's species, *C. indica*, was founded upon one specimen that lacked the

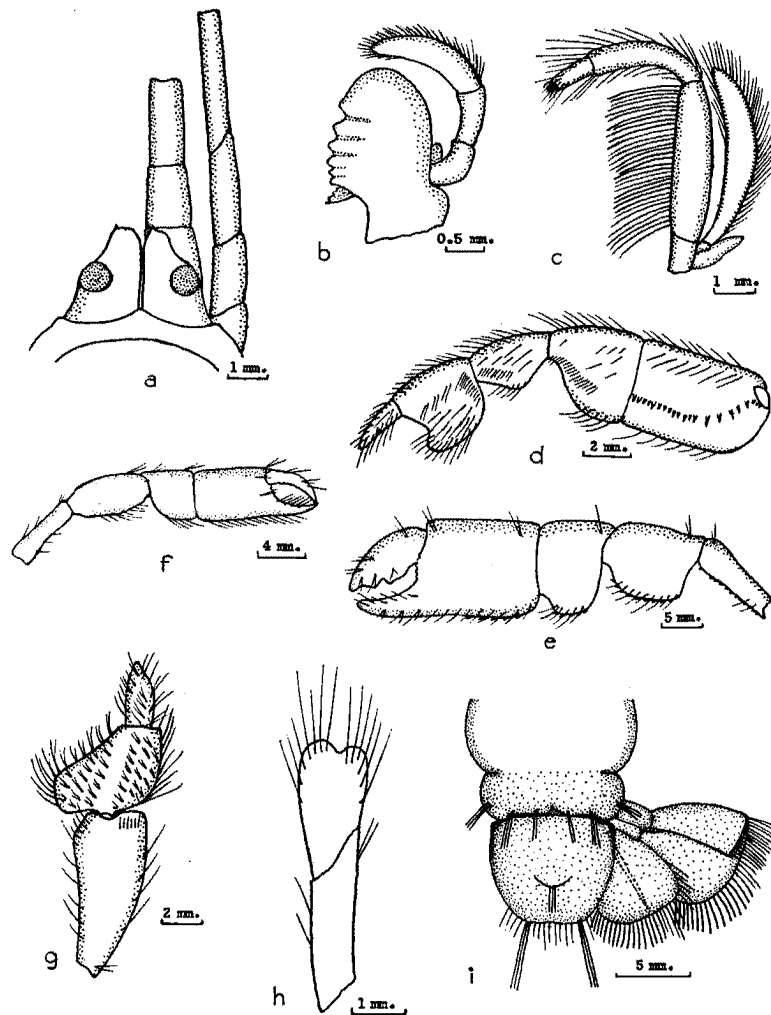


FIGURE 6.—Parts of *Callinassa (Cheramus) variabilis*: a, front border of carapace, eye stalks and peduncles of antennule and antenna; b, mandible; c, second maxilliped; d, third maxilliped; e, large cheliped; f, small cheliped; g, third leg; h, first pleopod, male; i, telson and uropod.

large chela and, although more specimens of Nobili's species are known, the literature does not mention possible variations which may exist among them. Structural features selected by de Man to distinguish *C. indica* from *C. jousseaumei* are found in the Hawaiian form to have wide ranges of variation, which suggests that if sufficient material had been available de Man might have found the species from the Red Sea and Kangean to be identical.

De Man (5) believed *Callianassa indica* to be identical with *C. jousseaumei* except in two structural features which he considered specific. One of these is the first pleopod of the male which in *C. indica* terminates in two rounded lobes with a shallow depression between them (fig. 7, *k*) whereas in *C. jousseaumei* the outer of the two lobes is hooked over the inner one (fig. 7, *n*). According to de Man, the merus and ischium of the third maxilliped in *C. indica* are broader in proportion to their length than in *C. jousseaumei*. In the Hawaiian species both of these structural features, as well as others, are exceedingly variable. Male specimens may be observed in which the first pleopods are very similar to those of *C. indica* (fig. 6, *h*), whereas others approach those of *C. jousseaumei* (fig. 7, *l*), with still others presenting intergradations of form (fig. 7, *f-j*). As indicated by de Man (5) the first pleopods of males of *C. mucronata* Strahl and *C. moluccensis* de Man show the hooked form of the terminal segment (fig. 7, *m, o*), but in characteristics of the rostral border, eye stalks and some other structures these species are distinct from the Hawaiian form.

That the proportion of length to breadth of the merus and ischium of the third maxilliped is also quite variable is indicated by examination of a large number of Hawaiian specimens. Based on 11 specimens, ranging in length from 62 to 80 mm., the average proportion of length to breadth for the merus is 3.09:4.04, and for the ischium is 5.33:3.54. According to de Man (5, p. 165), in *C. indica* (specimen 90 mm. long) the length and breadth of the merus of the third maxilliped are in proportion as 3:4, and those of the ischium as 5:4. For *C. jousseaumei* these proportions are given as 3:3.5 and 5:3.18, respectively. The maxillipeds of these two species, therefore, are somewhat broader in *C. indica*, although the number of specimens measured by de Man were few. With respect to these proportions the Hawaiian species seems to correspond closely to *C. indica* regarding the merus, but more closely to *C. jousseaumei* regarding the ischium.

The terminal borders of the eye stalks in *C. indica* and *C. jousseaumei* are broadly rounded and bear a few minute spinules. In the Hawaiian species the terminal borders of the eye stalks range from narrow to broad lobes and are with or without spinules. In some specimens one eye stalk may bear spinules but not the other (fig. 7, a-e).

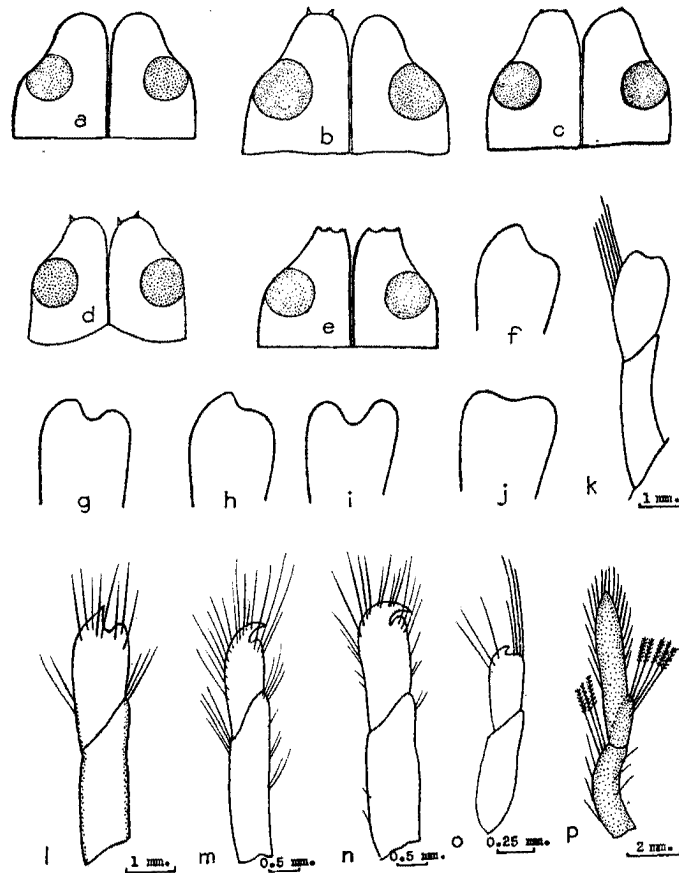


FIGURE 7.—Variations in eye stalks of *Callianassa (Cheramus) variabilis*, and first pleopods (male) of the same species, compared with corresponding appendages of other forms: a-e, eye stalks of *C. (C.) variabilis*; f-j, l, variations in first pleopods (male) of *C. (C.) variabilis*; k, first pleopod (male) of *C. indica* (after de Man); m, first pleopod (male) of *C. moluccensis* (after de Man); n, first pleopod (male) of *C. jousseaumei* (after de Man); o, first pleopod (male) of *C. mucronata* (after de Man); p, first pleopod (female) of *C. (C.) variabilis*. (All enlarged.)

A very constant structural difference between the Hawaiian form and both *C. indica* and *C. jousseaumei* is observed in the propodus of the third maxilliped. In the Hawaiian species, a distinct lobe is produced on the anteroventral border of the segment, whereas in *C. indica* and *C. jousseaumei* this border of the propodus is rounded without evidence of a lobe.

In young individuals, the teeth of the anterior border of the carapace are sharper and relatively longer than in adult specimens. The cornea is larger in proportion to the size of the eye stalk in young than in old specimens.

Although very small individuals may be taken during all months of the year, few ovigerous females of this species have been observed. A collection of more than 50 specimens taken April 14 included one female bearing eggs and 28 young individuals, each less than 30 mm. in length. Ovigerous females have also been taken during May and December.

A favorable habitat of the species about Oahu is the intertidal zone of Hanauma Bay where specimens are concealed in burrows under a few inches of gravel, sand, and malodorous mud kept moist at low tide by stagnant sea water diluted by seepage of fresh water from the shore. Some specimens have been collected from Kahana Bay, windward Oahu, and from the reefs of Kahala and Waikiki. The largest specimen in the collection is a female 85 mm. long.

Repeated laboratory experiments indicate that adult specimens succumb in about two hours when submerged in fresh water, but may become adjusted to a solution of equal parts of sea water and fresh water and exist in this mixture for an indefinite period.

Subgenus *Callichirus* Stimpson

KEY TO SPECIES OF *CALLICHRUS* TREATED IN THIS PAPER

- A. Inner uropod narrow, lanceolate; eye stalk sharp pointed distally.....
.....*Callianassa (Callichirus) lanceolata*, new species.
- A. Inner uropod pointed but not narrow or lanceolate; eye stalk not sharp pointed distally.
 - B. Cornea large, terminal.
 - C. Third maxilliped with a tooth on front border of merus but without a lobe on antero-ventral border of propodus.....
.....*C. (C.) articulata* Rathbun.
 - C. Third maxilliped without a tooth on front border of merus but with a lobe on antero-ventral border of propodus.....
.....*C. (C.) oahuensis*, new species.
 - B. Cornea not large, subterminal.....*C. (C.) winslowi*, new species.

Callianassa (Callichirus) lanceolata, new species (fig. 8, *a-i*).

Type specimen a female 38 mm. long, from tip of rostrum to posterior extremity of telson. Length of carapace 9 mm.; length of abdomen, including telson, 29 mm.; length of telson, 2.5 mm.; length of abdominal segments, 1-6, inclusive, 5, 5, 4, 3, 4 and 5.5 mm., respectively.

Front border of carapace tridentate; rostral spine curving upward, reaching almost to distal extremity of eye stalks; lateral spines of front border short and sharp, not articulated. Border of carapace between median and lateral spines deeply concave (fig. 8, *a, c*).

Eye stalk as long as first segment of antennular peduncle, tip thin and pointed; cornea large, oval, touching outer border of eye stalk and about two times closer to tip than to base of appendage (fig. 8, *a-c*). Antennal peduncle exceeding in length that of antennule by about 0.5 the length of terminal segment of former (fig. 8, *c*). Third maxilliped narrow, each segment longer than broad (fig. 8, *d*).

First leg on left side (large cheliped) armed on lower borders of ischium and merus by a few teeth graduated in length; teeth of ischium becoming longer distally, those of merus longer proximally, all directed forward; fingers stout, as long as palm, a low tooth on cutting edge of each (fig. 8, *e*).

First leg on right side (small cheliped) unarmed except for a few teeth on lower border of ischium; fingers slender, cylindrical, longer than palm; a minute tooth about middle of cutting edge of immobile finger (fig. 8, *f*).

Propodus of third leg with a prominent lobe on posterior border; upper border strongly convex, lower border concave (fig. 8, *g*). First pleopod a curved, flattened appendage of two segments, each bearing numerous long hairs, some of which are feathered (fig. 8, *h*).

Telson broader than long, posterior border a little narrower than base and slightly produced in middle. Uropods exceeding telson in length, outer branch longer, its inner border concave; anterior thickened portion extending for more than 0.5 length of branch. A sharp spine on basal rib of outer branch of uropod close to its inner border. Inner branch of uropod narrow, lanceolate, tapering to an acute distal extremity (fig. 8, *i*).

Type specimen in Bishop Museum (4590). Type locality, Ha-nauma Bay, Oahu, in shallow water on the reef. Two female specimens from Pearl and Hermes Reef, apparently identical with this species, are also in Bishop Museum. The largest of these is 32 mm. in length.

The species which I have designated by the specific term *lanceolata*, by reason of the narrow, pointed inner branch of the uropod, bears slight resemblance to *Callianassa coutierei* Nobili (9) from northwestern Indian Ocean localities. In both species the rostral spine is curved upward, but the armature of the lower border of the ischium of the large cheliped in *C. coutierei* consists of about 12 sharp spines directed at right angles to the long axis of the segment, whereas the merus bears short, blunt crenulations on its lower border.

In the Hawaiian species, the eye stalks are one half longer than their breadth at the base. In *C. coutierei* they are twice as long as broad. The anterior thickened portion of the outer branch of the uropod in the Hawaiian form considerably exceeds one half the length of the appendage, whereas in *C. coutierei* the thickened portion just reaches to the middle of the branch.

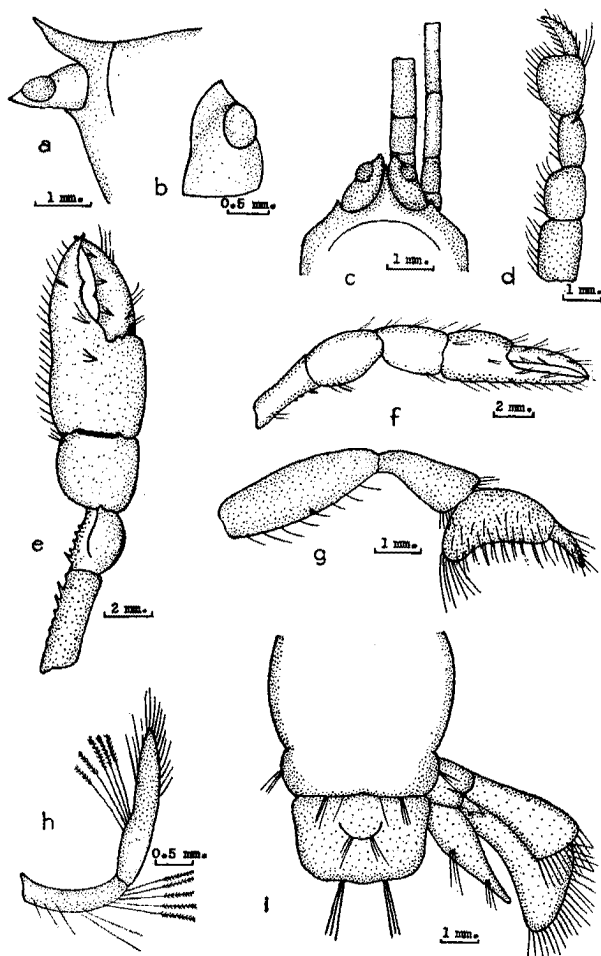


FIGURE 8.—Parts of *Callinassa (Callichirus) lanceolata*: a, front portion of carapace, and eye stalk, lateral view; b, eye stalk, from above; c, front border of carapace, eye stalks and peduncles of antennule and antenna, from above; d, third maxilliped; e, large cheliped; f, small cheliped; g, second leg; h, first pleopod, female; i, telson and uropod.

***Callianassa (Callichirus) articulata* Rathbun (fig. 9, *a-j*).**

Callianassa articulata Rathbun, U. S. Fish Comm., Bull. 23(3): 892, 1906.

In a female specimen from Kahala, Oahu, 24 mm. in length, the carapace is 6.5 mm. long; abdomen, including telson, 17.5 mm. long. Anterior border of carapace bears three sharp spines, median (rostral) one reaching almost to distal extremity of eye stalks; lateral spines short, articulated at base. Eye stalk short, thick, the cornea large, round, faceted, covering more than 0.5 of peduncle (fig. 9, *a, b*).

Antennal peduncle extending beyond that of antennule by about 0.5 the length of terminal segment of former. Upper distal border of antepenultimate segment of antennal peduncle bears a small spine (fig. 9, *a*).

Mandible strongly convex on ventral (outer) surface, three teeth on cutting edge slightly produced; a diagonal crest, serrate on its free margin, marks dorsal (inner) surface. Palp is three-segmented (fig. 9, *c*).

Ischium of third maxilliped (specimen from Kawaihoa, Oahu) as broad as long, a row of 11 spinules on inner surface; merus nearly twice as broad as long, a small tooth near middle of anterior border; propodus rounded on antero-ventral border, without a lobe (fig. 9, *d*).

Large cheliped with palm a little longer than high; carpus 0.5 as long as palm; fingers stout, shorter than palm; a few sharp spines on lower border of ischium and merus (fig. 9, *e*). Small cheliped unarmed except for a row of small spines on lower border of ischium; palm less than twice length of carpus and a little longer than fingers (fig. 9, *f*).

Propodus of third leg broadly rounded postero-ventrally, the ventral border sinuose (fig. 9, *g*). First pleopod of female composed of three segments, the basal one curved (fig. 9, *h*). First pleopod of male consisting of two narrow segments of about equal length (fig. 9, *i*).

Telson shorter than broad, posterior border concave and slightly uneven. Uropods broad, much longer than telson, the inner branch obtusely rounded distally; outer branch nearly straight on the anterior and posterior borders, the thickened portion extending almost the entire length of the appendage and covering about 0.5 its surface. There is a small tooth near the basal end of the rib of the outer branch (fig. 9, *j*).

The type specimen is in the United States National Museum. Eleven specimens (4668-4678) from the reefs of Oahu are in Bishop Museum.

Rathbun's type specimen is an ovigerous female 22.6 mm. long. The largest among 11 specimens from Oahu is a female 33 mm. long and the smallest is a male 18 mm. in length.

A small species collected at numerous localities about Oahu, all in shoal water, is apparently identical with *C. articulata* described by Rathbun (10) from material dredged by the *Albatross* near Nihoa (Moku Manu) at 23 to 33 fathoms.

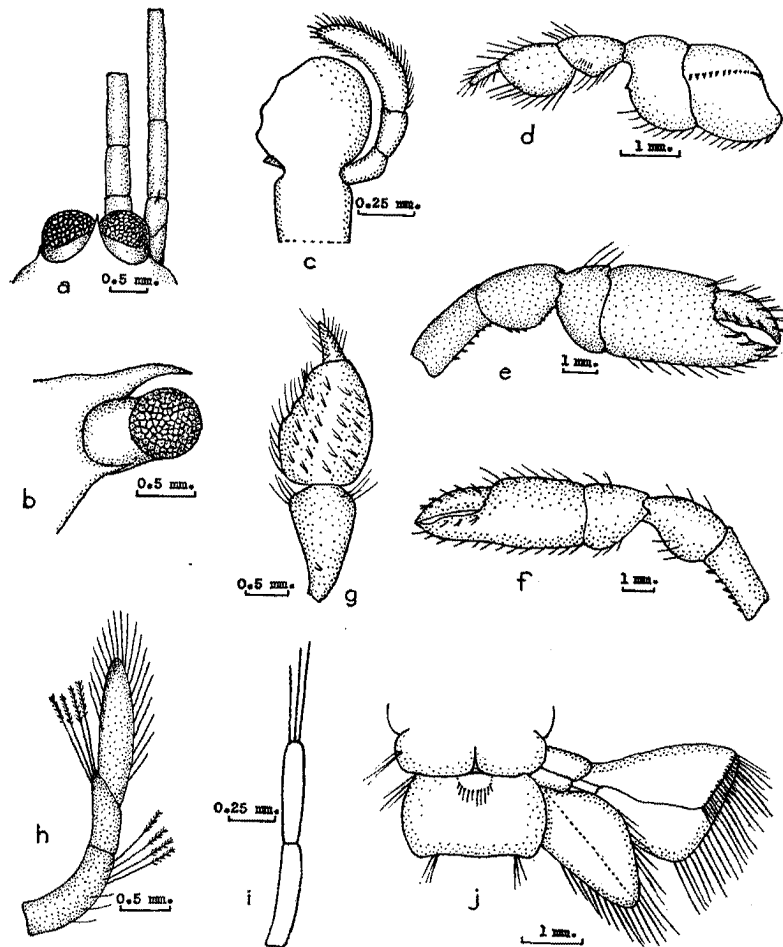


FIGURE 9.—Structural features of *Callianassa (Callichirus) articulata* (parts of specimens from various localities about Oahu): a, front border of carapace, eye stalks and peduncles of antennule and antenna (Kahala); b, lateral view of front border of carapace and eye stalk (Kahala); c, mandible; d, third maxilliped (Kawaialoa); e, large cheliped (Waikiki); f, small cheliped (Waikiki); g, third leg (Kahala); h, first pleopod, female (Kahala); i, first pleopod, male (Hanauma Bay); j, telson and uropod (Kahala).

Although considerable variation is shown among specimens examined, distinguishing features including the large corneae, the articulated lateral spines of the front border of the carapace and the short telson are common to all. Structural parts (fig. 9, *a-j*) are from a number of specimens taken about Oahu.

The species has been taken on the reefs of Hanauma Bay, Kahala, Waikiki and Kawaihoa, Oahu, and apparently is more widely dispersed about the island than any other known species. It has always been taken about Oahu from porous coral blocks and does not seem to conceal itself through burrowing habits as fully as do some of the larger forms. Ovigerous females have been collected about Oahu during the months of January, June, August, and December.

***Callianassa (Callichirus) oahuensis*, new species (fig. 10, *a-h*).**

Type specimen a female 48 mm. long from tip of rostrum to posterior extremity of telson. Length of carapace 12 mm., of abdomen, including telson, 36 mm. Length of abdominal segments, 1-6, inclusive, 6, 8, 4, 4.5, 5, and 6 mm., respectively. Telson, 2.5 mm. long.

Anterior border of carapace bearing three sharp spines, median (rostral) one stout, directed upward at an angle, reaching almost to tip of eye stalks. Lateral spines more slender, reaching nearly to posterior border of corneae, articulated at base (fig. 10, *a, b*).

Eye stalks stout, length nearly twice width at base, not quite reaching distal extremity of first segment of antennular peduncle; cornea large, round, faceted, covering most of end of stalk and about 0.5 of peduncle. A small tip of eye stalk visible medial of anterior border of cornea (fig. 10, *a, b*).

Third segment of antennular peduncle slightly longer than second. Antennular peduncle exceeding in length that of antennule by about 0.75 length of terminal segment of former. Length of antennal flagellum 24 mm.; of lower antennular flagellum 7 mm., of upper antennular flagellum 6 mm. (fig. 10, *a*).

Ischium, merus, and propodus of third maxilliped broad; a row of spinules on inner surface of ischium, above middle; merus as broad as long; propodus broader than long, with a slight lobe at antero-ventral border (fig. 10, *c*).

Large cheliped on left side in type specimen; ischium armed below with a row of spinules, directed forward and increasing in length distally; merus bearing a few short spinules on lower border; carpus shorter than broad; palm longer than broad; fingers stout, shorter than palm; dactylus with a low triangular tooth proximal of middle of cutting edge; posterior half of cutting edge of immobile finger slightly produced into a low blunt tooth. Upper and lower borders of palm and carpus crested (fig. 10, *d*).

First leg on right side (small cheliped) as long as that on left side but more slender. Lower border of ischium bearing a row of spinules directed forward and increasing in length distally; three short spinules on lower border of merus; carpus shorter than palm, which is slightly broader distally; fingers slender, longer than palm; cutting edge of dactylus almost smooth, that of immobile finger bearing one low, sharp tooth (fig. 10, *e*).

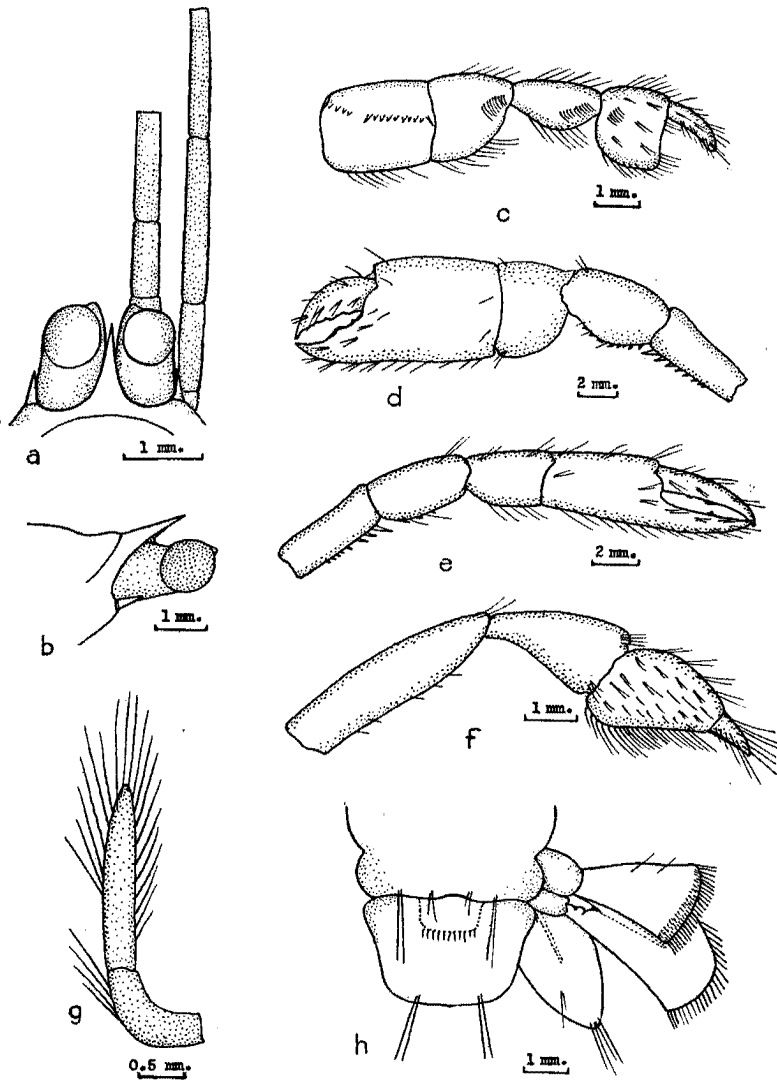


FIGURE 10.—Parts of *Callianassa (Callichirus) oahuensis*: a, front border of carapace, eye stalks and peduncles of antennule and antenna; b, lateral view of front border of carapace and eye stalk; c, third maxilliped; d, large cheliped; e, small cheliped; f, third leg; g, first pleopod, female; h, telson and uropod.

Carpus and propodus of third leg subequal in length; a small, rounded lobe on posterior border of propodus, lower border slightly concave, upper border strongly convex (fig. 10, *f*). First pleopod (female) a slender, two-segmented appendage, proximal segment strongly curved (fig. 10, *g*).

Telson much shorter than broad at base; posterior border narrower than base, slightly produced in middle. Uropods broad and much longer than telson; inner border of outer branch concave, thickened portion extending for more than 0.5 length of appendage and covering about 0.5 its surface. Inner branch of uropod broad in middle, convex borders converging to a narrow distal extremity. Rib of outer branch of uropod bearing two spines near its base, one at a lower level than the other (fig. 10, *h*).

Type specimen, number 4594. Type locality, Hanauma Bay, Oahu, in shallow water.

This species, represented by four specimens in Bishop Museum, three from Hanauma Bay and one from Waikiki reef, falls in the trispinous group of the subgenus *Callichirus* in which the cornea is terminal, occupying a considerable portion of the eye stalk, and the propodus of the third leg is not trilobate.

With respect to the front border of the carapace, the eye stalks and armature of the chelipeds, this species approaches *C. (Callichirus) longiventris* A. Milne-Edwards (8), described from Martinique, but the form of the third leg and the telson separates it from that species.

It also somewhat resembles *C. (Callichirus) placida* de Man (5) in the armature of the chelipeds and in the form of the telson, but the outer branch of the uropod differs in the two species. In *C. placida* the rostrum is slightly curved downward.

The species agrees with *C. articulata* Rathbun (10) in that the lateral spines of the anterior border of the carapace are articulated but in other features including eye stalks, outer maxillipeds, telson, and uropods the two are quite distinct.

Two damaged specimens of the species in the collections of Bishop Museum are much larger than the type specimen, one 75 mm. and the other 94 mm. in length.

Observations on a living specimen indicate that the species is conspicuously marked, especially as to carapace and anterior appendages, red being the prevailing color. In a specimen 75 mm. long the dorsal surface of the carapace was marked by four patches of red color two on either side of the midline, the larger anterior pair oval in form, the posterior pair quadrangular. The small cheliped was bright red with three longitudinal blotches of white on the outer face of palm; fingers red, tipped with white; eye stalk red, cornea black; antennae

and antennules red. Carpus, merus and ischium of small cheliped, red, each segment bordered by white. Second legs with broad transverse bands of red on propodus and carpus. Carpus of third leg with a triangular patch of red on the dorsal surface.

Callianassa (Callichirus) winslowi, new species⁶ (fig. 11, *a-g*).

Type specimen a male 71.5 mm. in length from tip of rostrum to posterior extremity of telson. Length of carapace 17 mm., including rostral spine. Length of abdominal segments 1-6, inclusive, 9, 12, 7, 5, 6.5, and 11 mm., respectively. Length of telson 4 mm., width at base 6 mm.

Front border of carapace bearing three sharp spines, medial (rostral) one broad at base, slightly bent upward, not reaching distal extremity of eye stalks. Lateral spines much shorter than median one, slightly curved medially, not articulated (fig. 11, *a*).

Eye stalks stout with broadly rounded distal borders, not reaching to extremity of first segment of antennular peduncle. Cornea small, round, situated on upper surface toward outer margin, nearer distal than proximal border (fig. 11, *a*).

Antennular peduncle stout, third segment longer than second; antennal peduncle, on right side, extending beyond antennular peduncle by 0.5 the length of terminal segment (fig. 11, *a*). Antennal peduncle on left side (in this specimen) is considerably longer than that on right side.

Third maxilliped broad; ischium with a row of spinules on inner surface; merus, carpus, and propodus subequal in length; propodus as broad as long, antero-ventral border rounded, without a lobe (fig. 11, *b*).

First leg on right side (large cheliped) stout; ischium armed below with two sharp spines near distal end; merus bearing three spines below, longer one proximally; two short teeth are carried on lower border of carpus and the same border of propodus is slightly irregular but not toothed (fig. 11, *d*). Carpus and ischium equal in length; merus a little longer than carpus but shorter than palm; fingers stout, dactylus almost as long as palm, its cutting edge marked by minute irregularities; immobile finger bearing a small tooth near middle (fig. 11, *d*).

First leg on left side (small cheliped) about as long but smaller than that of right side; ischium, merus, carpus and palm of almost equal length; lower borders of ischium and merus each bearing a small spine, distally on ischium, proximally on merus; fingers stout, slightly shorter than palm, a low tooth on cutting edge of dactylus (fig. 11, *c*).

Third leg characterized by a narrow propodus, more than twice as long as broad, postero-ventral border rounded (fig. 11, *e*). Telson shorter than broad at base, lateral margins converging toward posterior border which is slightly produced in middle. Uropods much longer than telson, outer branch broad with median and distal borders arcuate; thickened portion extending a little more than 0.5 length of appendage, its distal margin expanded. Inner branch of uropod broad in middle, tapering to an acute posterior extremity; a blunt tubercle is carried on basal rib of outer branch of uropod (fig. 11, *g*).

First pleopod of male a broad, flat, two-segmented appendage, terminal element rounded distally, one lateral border produced into a strong spinous process. In specimen observed appendage is devoid of hairs (fig. 11, *f*).

⁶ Published by permission of the Secretary of the Smithsonian Institution.

Type specimen (United States National Museum 63255). Type locality, probably the island of Maui. There is also a female cotype in the United States National Museum.

The species bears some resemblance to *C. (Callichirus) oahuensis*, but certain structural features clearly differentiate the two forms.

Through the courtesy of Waldo L. Schmitt, Curator, Division of Marine Invertebrates of the National Museum, I had the opportunity of examining the specimens, and the description presents their essential features.

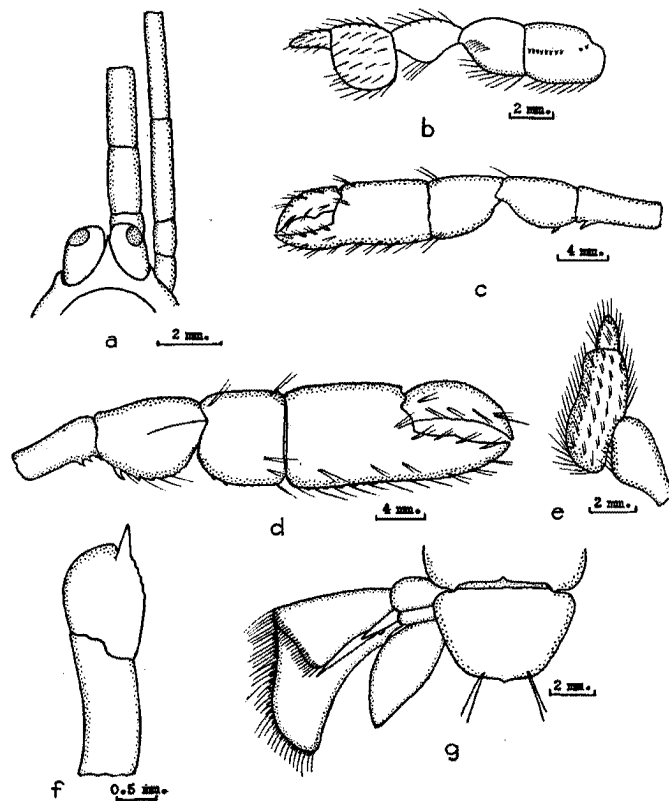


FIGURE 11.—Structural parts of *Callianassa (Callichirus) winslowi*: a, front border of carapace, eye stalks and peduncles of antennule and antenna; b, third maxilliped; c, small cheliped; d, large cheliped; e, third leg; f, first pleopod, male; g, telson and uropod.

From *C. oahuensis* (p. 56) this species differs in that the lateral spines of the front border of the carapace are relatively shorter and not articulated. The two species also differ in the form of the ocular peduncles and the propodus of the third maxilliped; in the armature of the lower borders of both chelipeds; in the shape of the propodus of the third leg and in the form of the outer branch of the uropod. The upturned rostrum relates the species to *C. coutierei* Nobili (9), but in the spines of the lower borders of both the large and small chelipeds it differs from that form.

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