

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

Part XVII. Additional Notes on the Hawaiian Alpheids: New Species, Subspecies, and Some Nomenclatorial Changes¹

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IN 1953 the senior author monographed the shrimp of the family Alpheidae (then called Crangonidae) for the Hawaiian archipelago. Since that date two additional papers dealing with Hawaiian alpheids have been published, additional species new to Hawaii have been recorded, and a series of nomenclatorial changes have occurred. In addition, we have recently found three new species and subspecies and we wish to raise a subspecies reported originally from Hawaii to specific rank. All of these changes we wish to publish in a single publication for the convenience of future workers dealing with Hawaiian alpheids. In a second paper, to be published subsequently, Guinther, Grouvhoug, and Banner will give specific data for the alpha-numerical designations used in this paper and additional capture records and ecological notes for the species from Pearl Harbor, Oahu.

Primary type material will be deposited in the Bernice P. Bishop Museum, Honolulu; some of the paratypic series, where possible, will be deposited in the National Museum of Natural History, Washington, D.C.

ADDITIONAL RECORDS AND NOMENCLATORIAL CHANGES, 1953-1973

Additional Records and Notes

In 1959, the senior author described *Alpheus lanceostylus* from Pearl and Hermes Reef and a subspecies, *A. malabaricus* Fabricius *mackayi*,

from Oahu as new (Banner 1959). In the same paper *A. lanceoloti* Coutière was recorded from Oahu and additional taxonomic or ecological notes were supplied on the following species: *A. paragracilis* Coutière, *A. huikau* (see below), *A. ventrosus* Milne Edwards, *A. diadema* Dana, *A. rapax* Fabricius, and *A. platyunguiculatus* Banner.

In 1960 Banner and Banner described a new species, *Metabetaeus lobena*, from a brackish pool in a lava flow from the island of Hawaii.

In 1966a Banner and Banner recorded *Synalpheus streptodactylus* Coutière as a symbiont in sponges from Oahu.

We also wish to record the penetration of two species of *Alpheus* into the brackish water pond system in loose lava flows on the island of Maui that Holthuis (1973) has described. To these pools he has applied the name "anchialine," defined as designating those pools "without surface connection with the sea, containing salt or brackish water which fluctuates with the tide." One species was *Alpheus gracilis* Heller which reached only to pond *f* (see Holthuis 1973, fig. 3). The other, *Alpheus lobidens polynesica* (new subspecies, see below; it should be pointed out that some specimens were too fragmentary for positive identification), was found not only in this pond, but also in ponds *e*, *r*, *s*, and *w*. Dr. John Maciolek reports that in most cases the alpheids were burrowing in the bottom material of the ponds, but some were occasionally seen in the cracks between the basaltic boulders. The salinity of the ponds varied between 7 and 24‰. *Metabetaeus lobena* Banner & Banner is characteristic of the anchialine pool system, especially of those ponds that have cavelike connections; it will be discussed below. *M. lobena* was not found in the same pools as the two species of *Alpheus*. We are indebted to Dr. John Maciolek, Hawaii

¹ Work supported in part by U.S. National Science Foundation grant GB 25020. Manuscript received 7 September 1973.

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Cooperative Fisheries Unit, University of Hawaii, for the specimens and the collection data.

Nomenclatorial Changes

The names, Crangoidae Weber and *Crangon* Weber have been officially changed to Alpheidae Rafinesque and *Alpheus* Fabricius by the International Commission on Zoological Nomenclature in Opinion 334, 1955.

The generic name *Jousseaumea* Weber was found to be preoccupied and changed to *Salmoneus* by Holthuis in 1955.

In the genus *Synalpheus*, we are placing *S. prolificus* Bate in synonymy to *S. charon* Heller and are removing the two subspecific names from *S. streptodactylus*. These changes in status will be discussed in Part II of "The Alpheid Shrimp of Australia" (in press).

In the genus *Alpheus* the following trivial (or specific) names have been changed:

A. paracrinatus bengalensis Coutière is now *A. paracrinatus* Miers (Banner and Banner 1967).

A. tubilli (Banner) is now *A. crockeri* Armstrong (Crosnier and Forest 1966).

A. ventrosus Milne Edwards is now *A. lottini* Guérin (Holthuis 1958, also Banner and Banner 1964).

A. latipes (Banner) is now *A. lottini* (Banner 1958 as *A. ventrosus*).

A. amirantei Coutière was changed to *A. amirantei sizon* (Banner and Banner 1964).

In addition we accept the redefinition of the genus *Metalpheus* Coutière as separated from *Alpheus* by Chace (1972), and the following species are now placed within it:

M. paragracilis (Coutière) previously *A. paragracilis*.

M. rostratipes (Pocock), previously reported as *A. clippertoni* Schmitt (1939), *A. nanus* Banner (1953), *A. huikau* Banner (1959) (see discussion in Banner and Banner 1967 and Crosnier and Forest 1966).

M. hawaiiensis (Edmondson) previously *A. hawaiiensis* (Edmondson 1925). We have re-examined the holotype (the only specimen known) at the Bernice P. Bishop Museum and find that it agrees with the generic characteristics set forth by Chace.

NEW RECORDS AND SPECIES, 1973

Leptalpheus pacificus sp. nov.³

Fig. 1.

Holotype

14-mm nonovigerous female (carapace length 5 mm). Collected in 4.5 m of water in Pearl Harbor, Oahu (bc 11 04104).

Paratype

21-mm ovigerous female (carapace length 6 mm). Dug from low intertidal sand flats of a reef in Kaneohe Bay, Oahu, near 21°27'00" N, 157°47'16" W.

Description

Anterior portion of carapace produced into a smoothly rounded hood covering eyes from dorsal aspect only, without trace of orbital hoods, rostrum, or carinae. Pterygostomial angle rounded, not produced. Without orbito-rostral process.

Antennular peduncles stout. Second article 1.3 times as long as broad and only a little longer than first article, third article 0.6 as long as second. Stylocerite acute distally, reaching slightly past end of first antennular article. Squamous portion of scaphocerite broad and reaching near middle of third antennular article, lateral tooth acute, a little longer than squame. Carpocerite 4.5 times as long as broad in lateral view, and reaching to near end of antennular peduncles. Basicerite with heavy, acute tooth on inferior margin.

Chelipeds asymmetrical with large chela 2.5 times length of small, both chelae carried flexed against a flattened merus. Palm rounded except for flattened area to accommodate merus. Fixed finger bearing three teeth on outer face and tip: proximal tooth broad, thin, very large, and triangular; second tooth, almost at tip, also thin but truncate, almost rectangular with superior surface irregular; tooth at tip a small rectangle. Dactylus without corresponding

³ The appearance of the name *Leptalpheus pacificus* in *Pearl Harbor Biological Survey: Final Report*, ed. Evan C. Evans III (NUCTN 1128, 30 August 1974), page 5.0 1, does not create a *nomen nudum* as this report was issued preliminary to publication and had only limited and controlled distribution; it was not available to the public.

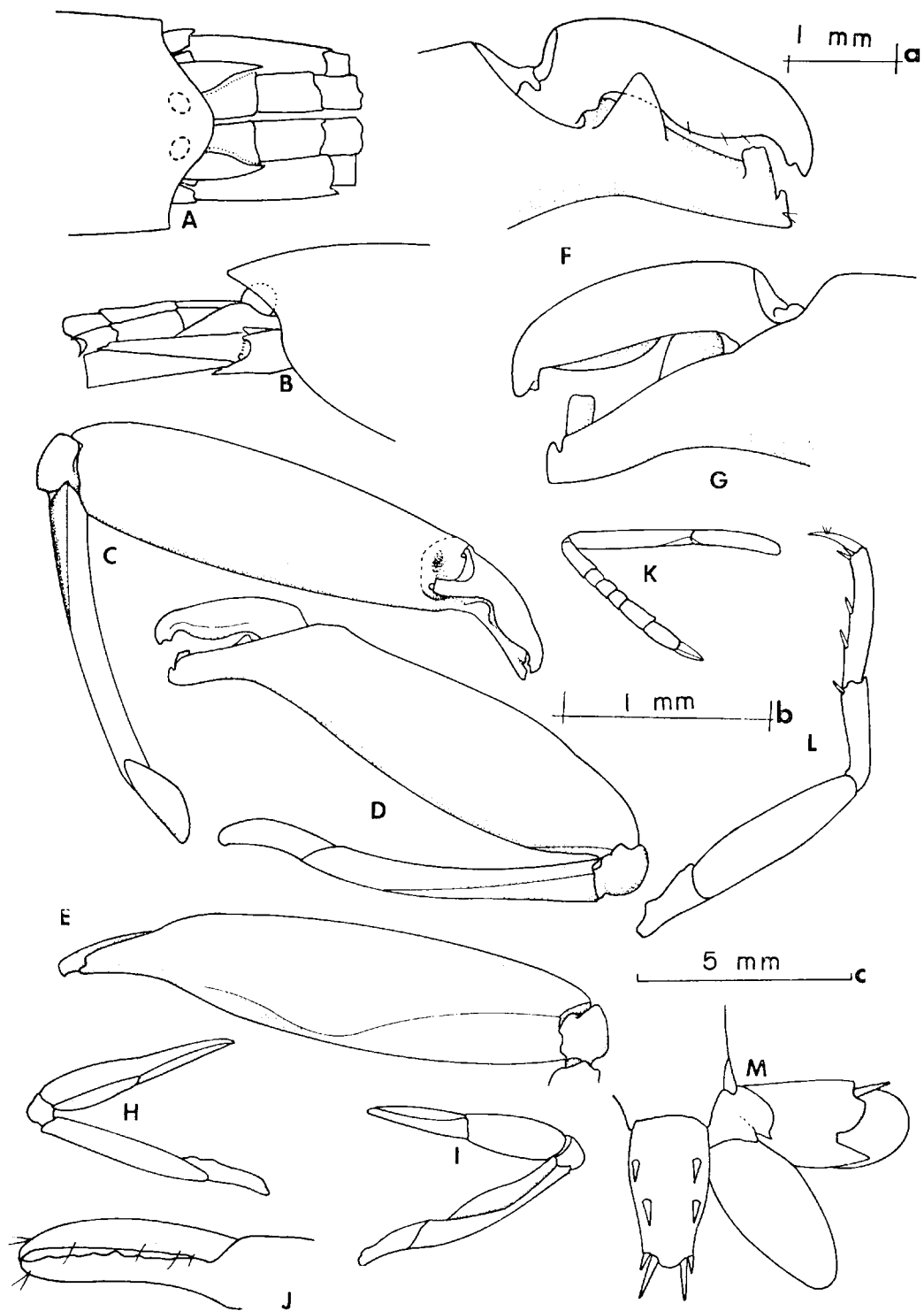


FIG. 1. *Leptalpheus pacificus* sp. nov. Holotype. A, B, anterior region dorsal and lateral view; C, D, E, large cheliped—superior, medial, and inferior aspects; F, G, distal region of chela—enlarged, lateral, and medial face; H, I, small cheliped—superior and inferior aspect; J, distal region of small chela—enlarged, medial face; K, second leg; L, third leg; M, telson and uropods.

SCALES: C, D, E, H, I, K, L, scale a; F, G, J, scale b; A, B, M, scale c.

dentition except at tip which bears two low teeth meeting with tooth of tip of fixed finger; however, in the hiatus between proximal and middle tooth opposite, outer margin of dactylus developed as a low crest. Carpus cup-shaped, less than half as long as fingers. Merus a little shorter than palm, slender, slightly twisted with flattened face to accommodate chela; distal margins not projected, distal section of merus thicker than proximal.

Small cheliped with chela 5.0 times as long as broad. Fingers and palm almost equal in length, face of palm flattened to accommodate merus. Opposing margins of fingers without teeth except for slight jagged surface of fixed finger; both fingers sparsely beset with short setae. Merus flattened, a little shorter than chela, slightly excavate, and twisted to accommodate cheliped.

Carpal articles of second leg with ratio: 10:4:4:4:8, chela as long as last three articles. Merus slightly excavate to accommodate carpal articles when flexed.

Ischium of third leg without spine, almost 0.4 as long as merus. Merus 4.0 times as long as broad, inermous. Carpus 0.5 as long as merus with superodistal margin terminating in rounded tooth, inferodistal margin truncate, bearing one spine. Propodus 0.7 as long as merus bearing two spines on inferior margin and a pair distally. Dactylus 0.4 as long as propodus, simple, slightly curved distally. Fifth leg with heavy distal row of bristles, a second row not as broad, and two minute tufts proximally.

Pleura of sixth abdominal somite articulated.

Telson 3.2 times as long as posterior margin is broad, margins convex anteriorly, straight to slightly concave posteriorly. Tip between terminal spines produced and arcuate. Inner spine of posterolateral pair long and slender, more than one-quarter length of telson, outer pair not half as long as inner. Dorsal surface with two pairs of strong spines. Anal tubercles present but not well developed. Outer uropod bearing proximal to articulation the usual strong lateral spine, and in addition a strong triangular tooth medially.

Discussion

The only other species in this genus is *Leptalphens forceps* Williams (1965: 192). The species

was first known only from the waters of North Carolina where it was found originally in night plankton tows in shallow water; it was subsequently found in burrows of *Upogebia affinis* (Say) by day. A later study in Old Tampa Bay, Florida, revealed that it was not uncommon in the enriched (= polluted) tide flats where it was collected in the ratio of one specimen to about six specimens of *U. affinis*, and that the ovigerous females ranged in carapace length from 3.8–7.1 mm (Saloman 1971: 69). Dawson (1967: 224) reported the specimens from Davis Bayou, Mississippi River, apparently associated with *Callinassa jamaicense louisianensis* Schmitt.

This Pacific species is quite similar to the Atlantic in a number of characteristics including the general form (but not the proportions) and shape of the anterior portion of the carapace, flexure of the large chelipeds, shape of telson and uropods, etc. However, it can be clearly separated by the following characteristics: (1) the proportions of the antennular peduncles, with the second article being only slightly longer than broad instead of between 4 and 5 times as long as broad; the stylocerite reaches past the end of the first antennular article, instead of being half as long; (2) while in both species the scaphocerite reaches to end of second antennular article, in this species it is about twice as long as broad, instead of 3 times; on the large chela the fixed finger bears only two major teeth and lies at an angle of 30°–40° to the axis of the palm, while in the Atlantic species both fingers bear many meshing teeth, and the fixed finger lies at about 60° to the palm; (4) the chelae of the second legs are equal in length to the three distal carpal articles instead of the distal two; and (5) the propodus of the third leg bears two spines on the inferior margin instead of four (this characteristic may not be reliable).

Neither of the specimens found so far were males, but it is likely that this species, like *L. forceps*, will show no marked sexual dimorphism.

The holotype was collected in coarse sand with shell fragments and wood chips in about 4.5 m of water near the mouth of Pearl Harbor. In the same collection was a chela of a callinassid shrimp. The paratype was collected from

clean fine sand intertidally at about the 0.0 tide level on a reef in Kaneohe Bay by digging in an area with many burrows of callianassids. Thus, the association of *L. pacifica* with callianassids is implied but not proven.

Color Notes

Translucent white with pale yellow-green on ends of antennae, antennules, and large chela. Eggs with pigment spots well developed; bright, yellow-green egg mass.

Alpheopsis diabolus Banner

A. diabolus Banner 1956: 325, fig. 3.

New Records

Seven specimens were obtained from a dead coral head in 8 ft of water near the mouth of Honaunau Bay at the City of Refuge, Hawaii. This species is known from the Society Islands (Banner and Banner 1967) to the Mariana Islands (type locality); the record of its previous capture close to Hawaii was from Fanning, Line Islands (Banner 1970).

Metabetaeus lobena Banner & Banner

M. lobena Banner & Banner 1960: 299, fig. 1.

New Records

The only previous record of this species was from a brackish pool in a lava flow near South Point (Ka Lae), Hawaii. Maciolek and Brock (1974) found it in their study of the anchialine water pools of the island of Hawaii from the north Kohala district around South Point and on east coast at Kapoho (Puna District). On Maui Maciolek has collected it from many sites from Ahihi Bay south and east to Wekea and also in the Waianapanapa Caves in the Hana District (Maciolek, personal communication). Holthuis (1973) gives specific pools where it was captured in southwest Maui.

Synalpheus thai Banner & Banner

S. thai Banner & Banner 1966b: 61, fig. 19.

New Records

In a subsequent paper this species is reported from Pearl Harbor. The only previous record is

from the Gulf of Thailand, but we are to report it also from the southern Philippines in a future paper. The Hawaiian specimens agree well with the specimens from Thailand.

Synalpheus bituberculatus de Man

S. bituberculatus de Man 1911: 276, fig. 53.

New Records

In the subsequent paper this species is reported from Pearl Harbor. It should be noted that elsewhere, as in Australia, the species has been reported as a symbiont in sponges, but that its capture records here indicate no such relationship. We discuss its variability in Part II of our Australian monograph (in press). It was previously known from Thailand, Singapore, and Japan in addition to de Man's specimens from Indonesia. We also have some in our collections from the Philippines.

Alpheus lanceoloti Coutière

fig. 2K

A. lanceoloti Coutière 1905: 900, fig. 39. Banner 1959: 143, fig. 8.

Remarks

In a collection of four male specimens, 19-25 mm in length from the reef at 21°27'00" N, 157°47'16" W in Kaneohe Bay, the first four thoracic sterna carried a rounded flap that protruded ventrally and posteriorly along the median line (see fig. 2K). We have also observed similar projections on specimens of *Athanas dorsalis* (Stimpson), *Athanas granti* Coutière, *Alpheus bisuicinus* De Haan from Australia, and on specimens of *Alpheus pacificus* Dana from Nosy-Bé, Madagascar. It has not been reported elsewhere in the literature. We offer no suggestion as to the function of the flap, nor to its possible systematic significance.

Alpheus rapacida de Man

A. rapacida de Man 1911: 394, fig. 91.

New Records

In a subsequent paper this species is reported from Pearl Harbor; we also have specimens from intertidal sandflats and on patch reefs in

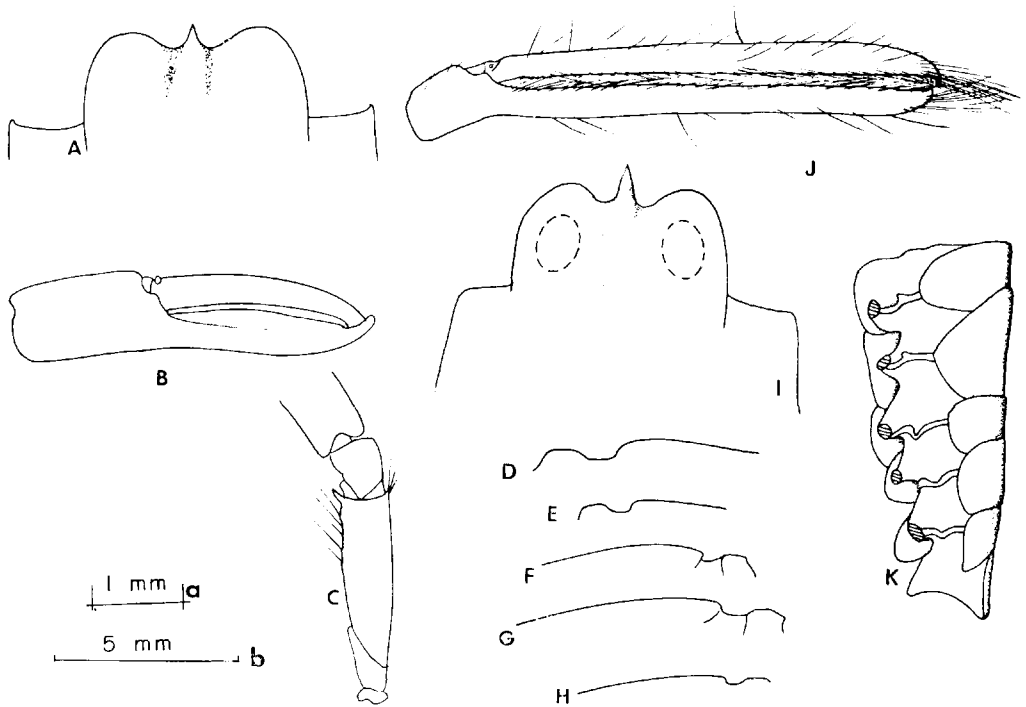


FIG. 2. *Alpheus mackayi* Banner, 35-mm male from Pearl Harbor (BE 11-13501). A, anterior region of carapace; B, small chela, lateral face; C, merus of small chela, medial face; D-H, superior margin of large chela of five specimens. *Alpheus malabaricus* Fabricius, 24-mm male from Thailand. I, anterior region of carapace; J, small chela, lateral face. *Alpheus lanceoloti* Coutière, 25-mm male from Kaneohe Bay, Oahu. K, ventral side of abdomen. SCALES: A, D, E, F, G, H, I, K, scale a; B, C, J, scale b.

Kaneohe Bay. This species, like the related *A. rapax* Fabricius and *A. platyunguiculatus* (Banner), lives in burrows in the sand. Mochring (1972) shows that both *A. rapax* and *A. rapacida* live in a symbiotic association with the goby *Psilogobius mainlandi* Baldwin. Lewinsohn and Holt-huis (1964: 47, fig. 1) have discussed some points of taxonomic importance, and our studies of this species in Hawaii support their observations. This species is also known from South Africa, the Mediterranean, Vietnam, Thailand, Singapore, and Indonesia.

***Alpheus mackayi* nov. comb.**

Fig. 2A-H

A. malabaricus mackayi Banner 1959: 149, fig. 12.

In the senior author's description of the form from Hawaii as a subspecies, he found marked

differences from *A. malabaricus* Fabricius known from India (and Southeast Asia and Africa): in the Hawaiian form the rostrum is a low triangle that scarcely reaches past the anterior region of the orbital hoods, in contrast to *A. malabaricus* in which the rostrum is slender and acute, reaching well past the orbital hoods (Fig. 2I); second, and possibly more important, the fingers of the small chela in the Hawaiian form are only 1.5 times the length of the palm instead of 2.5 times as long or more (see Figs. 2B, J). These differences seemed to be subspecific in nature and he named his subspecies *A. m. mackayi*. However, we now have specimens of this type from Guam and Tular, Madagascar. We are therefore raising it to specific rank. We note that the proximal shoulder of the superior saddle varies from a gradual curve to slightly overhanging the groove (see Figs. 2D-H).

Alpheus lobidens polynésica subsp. nov.

Fig. 3

Alpheus lobidens De Haan 1850: 179.*Alpheus crassimanus* Heller 1865: 107, pl. 10, fig. 2. Banner 1953: 134, fig. 28.*Holotype*

22-mm male from Kaneohe Bay, Oahu, Hawaii, 21°26'23" N, 157°48'29" W. Along outer side of Heeia Fish Pond, under rocks and dead coral heads imbedded in a mixture of coral sand and terrestrial silt at 0.0 to +10 cm tidal level.

Allotype

20-mm female cohabiting with holotype.

Paratypes

34 specimens from 10-24 mm from same location as holotype; 173 specimens from Pearl Harbor (see subsequent paper).

Description

Rostrum acute, reaching past middle of first antennular article. Rostral carina rounded. Orbital hoods slightly inflated, forming moderately rounded orbitorostral grooves.

Second antennular article 2 times as long as broad, 1.6 times longer than visible part of first antennular article. Third antennular article shorter than visible part of first. Stylocerite acute, reaching to end of first antennular article. Outer margin of scaphocerite concave, lateral tooth heavy, reaching well past end of antennular peduncle; squamous portion narrow, shorter than lateral tooth. Carpocerite as long as lateral tooth of scaphocerite. Basicerite with prominent lateral tooth.

Proximal and distal articles of third maxilliped subequal, middle article 0.4 as long as proximal, inferior margin of middle article bearing several fine hairs on inner surface. Outer margin of basal two-thirds of exopodite beset with about 10 long, threadlike hairs; distal portion with usual tuft.

Large chela 2.2 times as long as broad, fingers occupying the distal 0.4. Proximal and distal

shoulders of superior saddle gently rounded. Medial palmar depression a well-marked, narrow triangle with apex reaching half the distance from saddle to proximal end of palm. Lateral palmar depression quadrangular with proximal end gradually merging with surface of palm near the *linea impressa*. Inferior shoulder heavy, making a right angle to inferior margin of palm, with apex rounded. Inferior notch broadly U-shaped, continuing on lateral face of palm as a well-defined, but small, triangular depression with rounded apex, and on medial face as a longer and broader, less well-defined, depression. Merus 2 times as long as broad, inferointernal margin bearing acute tooth distally.

Small chela sexually dimorphic. Mature male chela 3.4 times as long as broad, fingers two-thirds length of palm. Palm slightly constricted proximal to dactylus, but without sculpturing. Palm bearing small subacute tooth medial to dactylar articulation. Dactylus balaeniceps, proximally broadened, with fringe of setae on medial and lateral margins joining on superior surface proximal to somewhat hooked tip. Pollex with short line of setae proximally on outer face, but with long line of setae on medial margin. Female chela not balaeniceps, with tapering hooked dactylus slightly longer than palm, without any fringe of bristles. Both male and female chelae with only sparse scattered setae on medial face. Merus of both chelipeds similarly armed, male about 2.5 times as long as broad, female about 3 times.

Second legs with ratio of carpal articles: 10:8:3:3:4.

Ischium of third leg with spine on inferior surface. Merus 4 times as long as broad, inermis. Carpus 0.5 as long as merus, superodistal margin projected but rounded. Propodus 0.7 as long as merus, with seven spines on inferior margin and two distally. Dactylus simple, slightly curved.

Telson twice as long as posterior margin is broad; anterior pair of dorsal spines placed just anterior to middle; posterolateral spines small, not extending beyond arcuate posterior margin.

Color Notes

Ground color translucent gray-white. Transverse bands of reddish brown to olive-green on

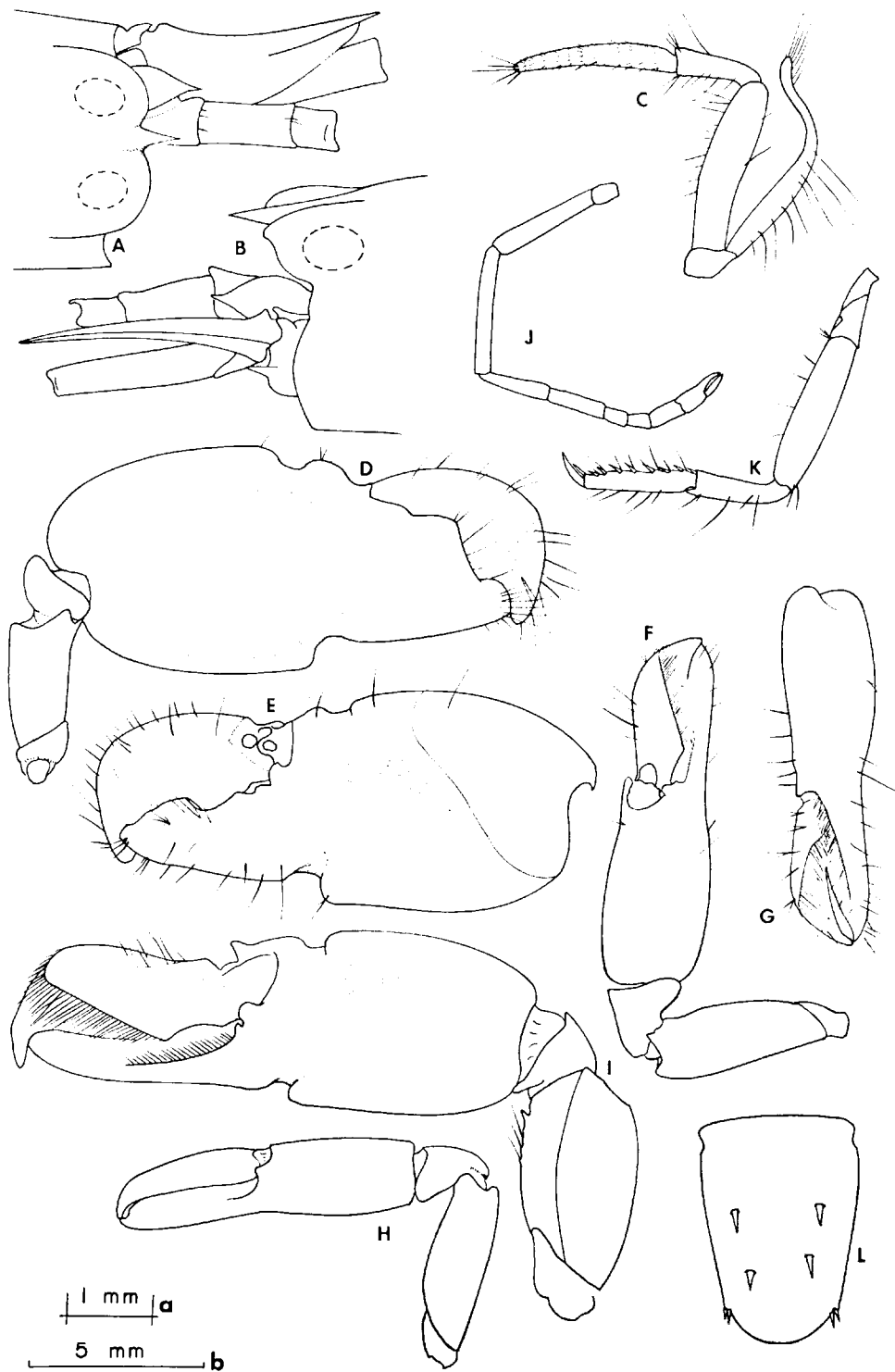


FIG. 3. *Alpheus lobidens polynesiaca* subsp. nov. Holotype. A, B, anterior region, dorsal and lateral view; C, third maxilliped, inner face; D, E, large cheliped, medial and lateral face; F, G, small cheliped, lateral and medial face; H, lateral face of small cheliped of allotype; J, second leg; K, third leg; L, telson.

Alpheus lobidens lobidens De Haan. I, small cheliped, outer face of 40-mm male from Australia.

SCALES: A, B, C, L, scale a; D, E, F, G, H, I, J, K, scale b.

dorsal surface of carapace, and one on each abdominal segment extending across the dorsum to pleura. Caudal fan with similar band on posterior section with color more intense on outer uropod; near sixth abdominal segment a translucent white band. Bands composed of red-brown and yellow-green stellate chromatophores, the overall hue depending upon the expansion of individual units. Sides of carapace with widely dispersed reddish brown chromatophores, more concentrated on anterior margin. Cardiac area dark, blue-green with randomly placed yellow-green spots. Thoracic legs with faint wash of green and red chromatophores. General color of chela orange-brown with inner face and palmar grooves gray-white. Palm darkening distally, basal portion of fingers dark green, tips of fingers gray-white. Eggs dark green.

Variation

The rostrum varies from reaching to a little before the middle of the second antennular to near end and varies from 1.1 to 1.7 times as long as broad at the base. Occasionally there is a tooth on the distal end of the inferointernal margin of the merus of the small chela. The ratio of the length of the first two articles of the second leg varies from 10:6 to 10:8.

Discussion

We wish to do two things in this paper: first reestablish the name *A. lobidens* De Haan for the species usually cited as *A. crassimanus* Heller, and to divide *A. lobidens* into two geographically separated subspecies.

A. lobidens was described by De Haan from Japan in 1850; *A. crassimanus* was described from the Nicobar Islands by Heller in 1865. In most of the literature, when the species was referred to from Japan it was called *A. lobidens*, and in most citations from elsewhere in the Indo-Pacific and Mediterranean it was called *A. crassimanus*. A careful comparison of original and later descriptions of the two species reveals no differences when the normal variation is considered. In 1911: 196 de Man remarked, "It remains uncertain whether the Japanese *A. lobidens* De Haan is identical with *A. crassi-*

manus or not. . . the question. . . must be left to further researches." He suggested that there might be a difference in the proportions of the carpus of the second legs. This slight difference he remarked upon is within the range of normal variation.

Through the courtesy of Dr. Lipke Holthuis of Rijksmuseum van Natuurlijke Historie in Leiden we were able to examine a pair of 25-mm specimens of *A. lobidens* from Japan. Dr. Holthuis remarked that these specimens were from "Ariake Bay, Kyushu, not far from Nagasaki, Kyushu where Von Siebold and Burger lived, who obtained most of the material for *Vanna Japonica*. The type locality is not given by De Haan, but is most likely somewhere near Nagasaki" (personal correspondence). We have compared these specimens to those in our collection from Australia, Thailand, and the Red Sea and can find no reliable differences. The two nominal species, as suspected by de Man, are the same. The name *A. lobidens* is the senior of the two and must be applied.

In our studies of *A. lobidens* we have found two distinct populations. One population is represented in our present study collection by about 180 specimens from Malayo-Thai waters, 500 specimens from Australia, and 200 specimens from the Red Sea. The other population is that which we have reported from previous papers from the central Pacific and the subspecies here described (see especially Banner 1959: 147). The western Pacific and Indian Ocean specimens grow large, with the largest in our present collections reaching 36 mm in length, but those previously reported reaching 45–50 mm. All of the larger males in these collections have heavy sculpturing on the palm of the small chela, as described by previous workers in the area and as shown for an Australian specimen in Fig. 3I. The smallest males, however, lack this sculpturing, having merely a slightly rounded constriction of both margins proximal to the dactylar articulation. While we have some specimens from Thailand as short as 12 mm with a sculptured palm, the transition from a smooth to a sculptured palm usually occurs in the range in length of 16–26 mm. A collection of 20 males ranging in length from 15–20 mm from the Red Sea is typical of the transition size. All of the males were collected

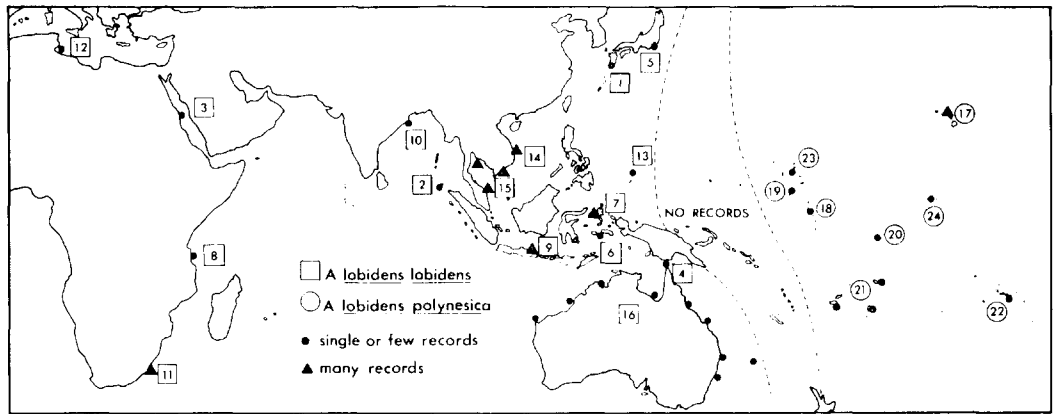


FIG. 4. Known distribution of *Alpheus lobidens lobidens* De Haan and *A. lobidens polynesica* subsp. nov.

Alpheus lobidens lobidens. 1, Japan, De Haan 1850; 2, Nicobar Islands, Heller 1865; 3, Red Sea, Paulson 1875; 4, Cape York, Australia, Spence Bate 1888; 5, Japan, Ortmann 1890; 6, Amboina, Coutière 1898; 7, Ternate, de Man 1902; 8, Zanzibar, Lenz 1905; 9, Indonesia, de Man 1911; 10, Chilka Lake, Kemp 1915; 11, South Africa, Barnard 1950; 12, Tunisian Sea, Forest and Guinot 1956; 13, Yap, Banner 1959; 14, Vietnam, Tiwari 1963; 15 Thailand, Banner and Banner 1966; 16, Australia, Banner and Banner, in press.

Alpheus lobidens polynesica. 17 Hawaii, Banner 1953; 18, Gilbert Islands, Banner 1957; 19, Arno, Banner 1958; 20, Canton Island, Banner and Banner 1964; 21, Fiji, Tonga, Samoa, Banner and Banner 1966; 22, Society Islands, Banner and Banner 1967; 23, Marshall Islands, Banner and Banner 1968; 24, Fanning Island, Banner 1970.

at a single time along a single narrow stretch of beach. Six of these showed only slight grooves, while 14 had the typical rather massive sculpturing. In our present collections from this broad geographic area we have only one large specimen that does not agree. It is a 40-mm male with a balaeniceps dactylus but without palmar sculpturing, collected from Aldabra Island, north of Madagascar, by the International Indian Ocean Expedition. We can offer no explanation for this anomalous condition, but suggest that if the sculpturing is the result of a hormone released at a certain degree of sexual maturity, then this specimen may be retarded in its sexual development. A similar condition was noted for the largest male of *A. euphrosyne* de Man that we collected in Thailand (1966b: 132).

In contrast, the males from the central Pacific never attain the large size of those to the west, and the largest in our Hawaiian collection reached only 28 mm in length (we do not have data on the lengths of the other central Pacific specimens; see Banner and Banner 1962: 238). However, even the largest never develop the sculpturing on the palm of the small chela. We wish to emphasize that there are no characteristics that would be used to separate a mature

male from Hawaii from an immature male without a sculptured chela collected in the western Pacific or Indian Ocean, and that mature males throughout the entire range bear a typical balaeniceps-shaped dactylus.

This appears to be a valid criterion for subspecific separation: a slight difference in gene pools of the two populations permits the western form both to reach greater size and even at intermediate sizes to develop the sculptured condition of the small chela; the central Pacific form cannot attain the greater size and, even at its largest, never has the "mature" form of the small chela. It is as if in the central Pacific the species has a slight degree of neoteny. We therefore have named the form without sculpturing *A. lobidens polynesica* and the form found in Japan and elsewhere *A. lobidens lobidens*. We have shown the known distribution of the two forms in Fig. 4. We do not know the exact dividing line between the two subspecies, for we have no specimens between the Marshall Islands and Yap, or between Fiji and eastern Australia. Moreover, we do not know which subspecies occurs in the Philippines, for in our Philippine collections we have only two males reaching only 20 mm in length, and both lack the sculptured palm. Nobili's report of *A.*

lobidens from the Tuamotus without further description (1907: 356) may well be of *A. l. polynesica*.

Finally, we should remark upon the variation on the distal tooth on the inferoventral margin of the merus of the small chela. This varies from acute to small and round to absent in both sexes in both subspecies and therefore cannot be used as a characteristic for separation; in most, however, it is lacking.

Habitat

See *A. heeia* sp. nov.

Alpheus heeia sp. nov.

Fig. 5

Holotype

15-mm male from Kaneohe Bay, Oahu, Hawaii: 21°26'55" N, 157°47'48" W. 0.0 to +10 cm tidal level.

Allotype

11-mm ovigerous female cohabiting with holotype.

Paratypes

40 other specimens collected with holotype, 20 specimens from adjacent reef. Specimens ranging from 9–16 mm; 40 additional specimens from Pearl Harbor, Oahu, Hawaii (see subsequent paper for collection data).

Description

Rostrum 1.6 times as long as broad with low, slightly rounded carina extending to behind orbits; shallow orbito-orstral grooves.

Visible part of first antennular article and second article subequal, third article a little shorter. Second antennular article 1.6 times as long as broad. Stylocerite reaching to end of first antennular article. Lateral tooth of scaphocerite reaching slightly beyond tip of antennular peduncle and well beyond narrow squamous portion. Carpal article as long as lateral tooth.

Ratio of articles of third maxilliped: 10:4:10.

Second article bearing on inner face a series of spines interspersed with a few fine setae.

Large chela 2.3 times as long as broad. Superior saddle shallow and rounded with both proximal and distal margins gradual and rounded. Depression on outer face quadrangular with proximal margin merging with palmar surface near *linea impressa*. Inferior shoulder heavy, but rounded, making slightly less than a right angle to inferior margin of palm. Inferior notch shallow and flattened, continued on outer surface to a well-demarcated, U-shaped depression and on inner face as a shallow rounded depression, triangular in outline.

Small chela sexually dimorphic. Male chela 3 times as long as broad, fingers slightly shorter than palm, dactylus balaeniceps with fringe of hair extending from both margins over superior surface three-quarters of distance to tip. Both margins of palm with slight constriction near dactylar articulation, but without sculpture; margin above dactylar articulation bearing slight concavity opposite articulation of dactyl. Inner face bearing many long fine setae, outer face glabrous. Carpus cup-shaped bearing on medial superodistal margin a broad rounded projection. Merus 2 times as long as broad, bearing a subacute tooth on its inferodistal margin similar to large chela. Small chela of female not balaeniceps, but with dactylus slightly broadened basally and with fringe of dense setae on middle third of outer margins and with distal portions of inner face of palm and fingers beset with quite dense long setae. Merus similar to male in *A. lobidens polynesica*, more slender in female.

Carpal articles of second leg with a ratio: 10:8:4:3:5.

Ischium of third leg bearing spine. Merus almost 5.0 times as long as broad, incermous. Carpus 0.6 as long as merus, distal margins slightly projected. Propodus 0.7 as long as merus bearing in its inferior margin six prominent spines, two of which are paired with a much shorter spine, and a pair of long spines distally. Dactylus simple, 0.4 as long as propodus.

Telson 2.2 times as long as posterior margin is broad, with lateral margins convex, posterior margins a shallow arc. Dorsal spines placed

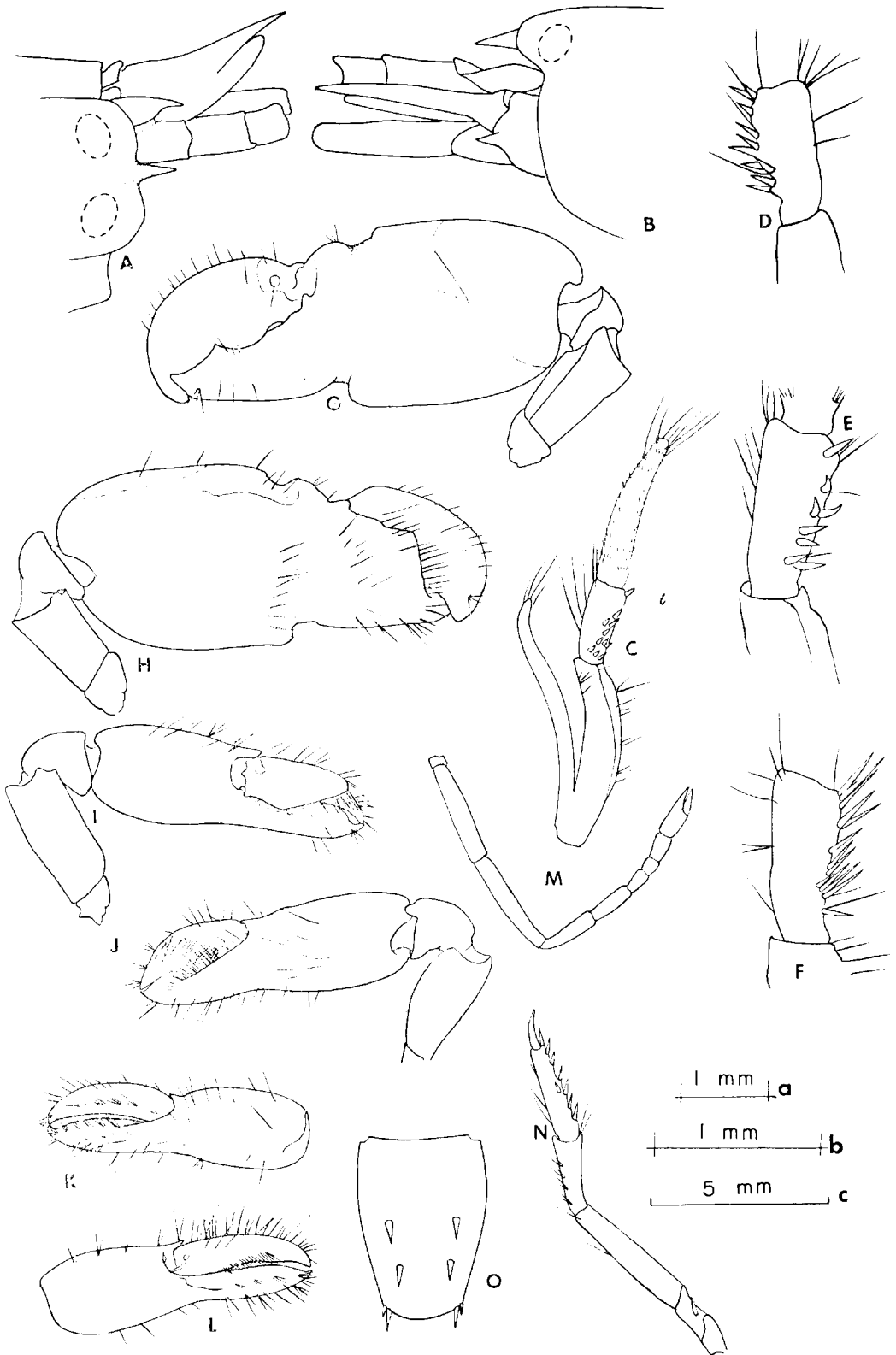


FIG. 5. For legend see facing page.

well in from lateral margins with anterior pair slightly anterior to middle, posterior pair 0.7 of length posterior to telson articulation. Inner pair of posterolateral spines as long as dorsal spines, outer pair about half as long; inner spines extending beyond arc of tip.

Color Notes

The color pattern and hues are similar to *A. l. polynesica* and, like that species, varies from dark olive-green to reddish brown.

Variation

The rostrum in the smaller specimens is shorter and has a more broadly based triangle. The lateral spine of the scaphocerite and carpo-cerite are sometimes equal to antennular peduncles instead of being longer. The spines on the inner side of the second article of the third maxilliped vary from short spines as found in the holotype to longer more slender spines (see Figs. 5C-F); at times they appear truncate, possibly due to breakage. The variation in the first two carpal articles of the second leg is the same as that for *A. l. polynesica*.

Discussion

This species belongs within the Edwardsi group, and is most closely related to *A. l. polynesica*. Not only the criteria that are used to separate *A. lobidens* from its closely related species, but also the criteria used to separate *A. l. polynesica* from *A. l. lobidens*, apply equally well to this species. However four characteristics separate it from *A. l. polynesica* (contrast Figs. 3 and 5). First, the rostrum is slightly shorter (although there is variation in both species); second, the small chela of both male and female bears heavy setae on the inner face, and the female has a short fringe of bristles on the outer face of the dactylus; third, and most important, the middle article of the third maxil-

lipeds has the heavy spines in addition to setae while *A. l. polynesica* has only fine setae; and, fourth, the tip of the telson has a more shallow arc with the inner posterolateral spines extending beyond the tip.

The contrast of habitat preferences between these two species and ecologically related *A. pacificus* Dana in Hawaii is interesting. All three species tunnel into the substrate, but are usually found initiating their burrows under rocks or dead coral heads in the lower intertidal zone; however, *A. l. polynesica* and *A. heeia* were found at 12 m in Pearl Harbor. Intertidally their ranges actually overlap, but *A. pacificus* is usually found in a clean sand substrate on the inner portion of exposed reef flats; *A. heeia* in coral rubble and coarse, but clean, sand; and *A. l. polynesica* in mixtures of sand and silt. Thus, in Kaneohe Bay, only *A. l. polynesica* is found in soft sand-silt along the inner margins of the bay; *A. heeia* alone is found in the rubble on the dead reef flat at the end of the "Sampan Channel" (the type locality) where moderate waves sweep away much of the sand; both *A. l. polynesica* and *A. heeia* may be found on some of the sand flats in the middle of patch and barrier reefs, and *A. pacificus* alone is found under the rocks in the lee of Kapapa Island at the outermost edge of the bay.

The specific name is derived from the old Hawaiian *abupua'a* Heeia, a land division which reached from the top of the mountains to the ocean beyond the reef; the type locality is within this *abupua'a*.

LITERATURE CITED

- BANNER, ALBERT H. 1953. The Crangonidae, or snapping shrimp, of Hawaii. *Pacif. Sci.* 7(1): 3-144, 50 figs.
 ———. 1956. Contributions to the knowledge of the alpheid shrimp of the Pacific Ocean. Part I. Collections from the Mariana Archipelago. *Pacif. Sci.* 10(3): 318-373, 23 figs.

FIG. 5. *Alpheus heeia* sp. nov. Holotype. A, B, anterior region, dorsal and lateral view; C, third maxilliped; D, E, F, enlarged views of second article of third maxilliped of three different specimens; G, H, large cheliped, lateral and medial face; I, J, small cheliped, lateral and medial face; K, L, small chela, medial and lateral face of allotype; M, second leg; N, third leg; O, telson.

SCALES: A, B, C, O, scale a; D, E, F, scale b; G, H, I, J, K, L, M, N, scale c.

- 1958. Contributions to the knowledge of the alpheid shrimp of the Pacific Ocean. Part III. On a small collection from Onotoa, Gilbert Islands. *Pacif. Sci.* 12(2): 157-169, 4 figs.
- 1959. Contributions to the knowledge of the alpheid shrimp of the Pacific Ocean. Part IV. Various small collections from the central Pacific area, including supplementary notes on alpheids from Hawaii. *Pacif. Sci.* 13(2): 130-155, 13 figs. 1 table.
- BANNER, ALBERT H. and DORA M. BANNER. 1960. Contributions to the knowledge of the alpheid shrimp of the Pacific Ocean. Part VII. On *Metabetaeus* Borradaile, with a new species from Hawaii. *Pacif. Sci.* 14(3): 299-303, 2 figs.
- 1962. Contributions to the knowledge of the alpheid shrimp of the Pacific Ocean. Part VIII. Losses of specimens in the fire of the Hawaii Marine Laboratory. *Pacif. Sci.* 16(2): 238-240.
- 1964. Contributions to the knowledge of the alpheid shrimp of the Pacific Ocean. Part IX. Collections from the Phoenix and Line islands. *Pacif. Sci.* 18(1): 83-100, 5 figs.
- 1966a. Contributions to the knowledge of the alpheid shrimp of the Pacific Ocean. Part X. Collections from Fiji, Tonga, and Samoa. *Pacif. Sci.* 20(2): 145-188, 20 figs.
- 1966b. The alpheid shrimp of Thailand. *Siam Soc. Monogr.* 3. iv + 168 pp., 62 figs., 9 tables.
- 1967. Contributions to the knowledge of the alpheid shrimp of the Pacific Ocean. Part XI. Collections from the Cook and Society islands. *Occ. Pap. Bishop Mus.* 23(12): 254-286, 5 figs.
- BANNER, D. M. 1970. Alpheid shrimp from the Line Islands. Pages 160-162 in K. E. Chave, principal investigator. Fanning Island Expedition, January 1970. HIG-70-23. University of Hawaii, Hawaii Institute of Geophysics, Honolulu. iv + 201 pp.
- BANNER, D. M., and A. H. BANNER. In press. The alpheid shrimp of Australia. Part II: The genus *Synalpheus*. *Rec. Aust. Mus.*
- CHACE, FENNER, JR. 1972. The shrimps of the Smithsonian-Bredin Caribbean expeditions with a summary of the West Indian shallow water species (Crustacea: Decapoda: Natantia). *Smithson. Contr. Zool.* 98: 1-179, 61 figs.
- COUTÈRE, H. 1905. Marine Crustacea, XV. Les Alpheidae. Pages 852-921, pls. 70-87, text-figs. 127-139 in J. Stanley Gardiner, ed. *Fauna and geography of the Maldive and Laccadive archipelagoes*. Vol. 2, no. 4. At the University Press, Cambridge.
- CROSNIER, A., and J. FOREST. 1966. Résultats scientifiques des campagnes de la Calypso. Fascicule VII. Masson et Cie, Éditeurs. XXVII...Calypso...Golfe de Guinée...Sao et Annobon (1956)...Îles du Cap Vert (1959). 19. Crustacés, Décapodes: Alpheidae. *Résult. scient. Camp. Calypso* 7(19): 199-314, 33 figs., 4 tables.
- DAWSON, C. E. 1967. Notice of the occurrence of alpheid shrimp *Leptalpheus forceps* Williams in the northern Gulf of Mexico. *Crustaceana* 12(2): 224.
- DE HAAN. 1850. Crustacea. In: De Seibold, P. F. *Fauna Japonica sive Descriptio Animalium, quae in itinere per Japoniam, jussu et auspiciis superiorum...Annis 1823-1830 collegit, notis observationibus et adumbrationibus illustravit*. Pp. i-xvii, 1-233, pls. 1-55, A-Q, 2 tables. Lugduni Batavorum.
- EDMONDSON, C. H. 1925. Crustacea. Pages 3-62, 4 figs., in C. H. Edmondson et al. *Marine zoology of tropical central Pacific*. *Bull. Bishop Mus.* 27. 148 pp.
- HELLER, C. 1865. Crustaceen. In *Reise der österreichischen Fregatte Novara um die Erde in den Jahren 1857, 1858, 1859, unter den Befehlen des Commodore B. von Wüllerstorff-Ubair*. *Zool. Theil* 2(3): 1-280, 25 plates.
- HOLTHUIS, L. B. 1955. The recent genera of the caridean and stenopodidean shrimps (class Crustacea, order Decapoda, supersection Natantia) with keys to their determination. *Zool. Verh., Leiden*, no. 26: 1-157, 105 figs.
- 1958. Crustacea Decapoda from the northern Red Sea (Gulf of Aqaba and Sinai Peninsula). I. Macrura. Contributions to the knowledge of the Red Sea. [State of Israel Ministry of Agriculture Division of Fisheries and Sea Fisheries Research Station.] *Bull. Sea Fish. Res. Stn. Israel*, No. 17, Nos. 8-9.
- 1973. Caridean shrimps found in landlocked saltwater pools at four Indo-West

- Pacific localities (Sinai Peninsula, Funafuti Atoll, Maui and Hawaii Islands), with the description of one new genus and four new species. *Zool. Verh., Leiden* 128: 1-48, 11 textfigs., 7 pls.
- INTERNATIONAL COMMISSION ON ZOOLOGICAL NOMENCLATURE. 1955. Opinion 334, Validation, under plenary powers, of the generic names *Crangon* Fabricius 1798, and *Alpheus* Fabricius 1798 (Class Crustacea), rendered by the International Commission on Zoological Nomenclature [Francis Hemming ed.] 10(1): 1-44.
- LEWINSOHN, C., and L. B. HOLTHUIS. 1964. New records of decapod Crustacea from the Mediterranean coast of Israel and the eastern Mediterranean. *Zool. Meded.* 40(8): 45-63, 5 figs.
- MACIOLEK, JOHN A. and RICHARD E. BROCK. 1974. Aquatic survey of the Kona Coast ponds, Hawaii Island. UNIHI-SEAGRANT-AR-74-04. University of Hawaii Sea Grant Program, Honolulu. v+73 pp., 4 appendices.
- MAN, J. G. DE. 1911. The Decapoda of the Siboga Expedition. Part II. Family Alpheidae. In: *Siboga Expeditie* 39a¹(2): 133-327 [Livre 60]. 1915 Supplement [plates and explanations] 39a¹(2): 23 pls. [Livre 74].
- MOEHRING, J. L. 1972. Communication systems of a goby-shrimp symbiosis. Ph.D. Thesis. University of Hawaii, Honolulu. xiv+373 pp.
- NOBILI, G. 1907. Ricerche sui Crostacei della Polinesia. Decapodi, Stomatopodi, Anisopodi e Isopodi. *Mem. R. Accad. Torino*, II, 57: 353-358.
- SALOMAN, CARL H. 1971. The shrimp *Leptalpheus forceps* in Old Tampa Bay, Florida. *Quart. J. Fla. Acad. Sci.* 34(1): 66-67, 2 figs., 5 tables.
- SCHMITT, W. 1939. Decapod and other Crustacea collected on the Presidential Cruise of 1938. *Smithson. misc. Coll.* 98(6): 1-29, textfigs. 1-2, pl. 1-3.
- WILLIAMS, A. 1965. A new genus and species of snapping shrimp (Decapoda, Alpheidae) from the southeastern United States. *Crustaceana* 9(2): 192-198, 2 figs.

