

**The Snapping Shrimp Genus  
*Alpheus* from the Eastern Pacific  
(Decapoda: Caridea: Alpheidae)**

WON KIM  
and  
LAWRENCE G. ABELE

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## ABSTRACT

Kim, Won, and Lawrence G. Abele. The Snapping Shrimp Genus *Alpheus* from the Eastern Pacific (Decapoda: Caridea: Alpheidae). *Smithsonian Contributions to Zoology*, number 454, 119 pages, 45 figures, 2 tables, 1988.—A revision of the genus *Alpheus* revealed 53 nominal species reported from the eastern Pacific. Of these, 23 species are considered valid and an additional 21 new species are described, resulting in 44 eastern Pacific species. A key to all 44 species is provided. Forty-four species are described and 41 are illustrated. The species occur in a variety of habitats including coral (18 species), rocky intertidal (29 species), mangroves (3 species), and sand-mud (21 species). Most species occur in several habitats while a few (e.g., *Alpheus lottini*) are found only in a single habitat. Seventy-seven percent of the species are endemic to the eastern Pacific while 11% also occur on both coasts of the Atlantic. Five percent are shared with the Indo-West Pacific and 2% each with the western Atlantic, eastern Atlantic and Indo-West Pacific and all other tropical regions. Within the eastern Pacific, species of *Alpheus* occur as far north as Horseshoe Cave, Sonora County, California, and as far south as Puerto Montt, Chile. Twenty species occur in the Galapagos Islands of which only one is apparently endemic. The greatest number of species (33) is found in the subregion between about 12°N and 2°N (Costa Rica, Panama, Colombia) with the number decreasing north and south of this subregion.

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# The Snapping Shrimp Genus *Alpheus* from the Eastern Pacific (Decapoda: Caridea: Alpheidae)

*Won Kim and Lawrence G. Abele*

## Introduction

The snapping shrimp genus *Alpheus* is a diverse taxon that contains more than 250 species worldwide. Species are found in four major habitats: (1) on living and dead corals; this is the environment containing the largest number of species; (2) in tide pools and in small pockets of water in the sand or sand-mud intertidal; (3) in burrows in sand and muddy substrate or occasionally under rocks; and (4) as symbionts with some invertebrates, especially anemones, echinoids and annelids, and fishes (Banner and Banner, 1966; Abele and Felgenhauer, 1982).

Prior systematic work on this genus has resulted in monographic publications on the fauna of the eastern Atlantic (Crosnier and Forest, 1966), western Atlantic (Chace, 1972), and Indian Ocean and central Pacific faunas (Banner, 1953; Banner and Banner, 1966, 1982). In spite of these and other systematic studies on *Alpheus*, the status of many species is uncertain and many names have been synonymized by different authors. This situation may be the result of difficulties in identifying members of *Alpheus* owing to their small size, ambiguous morphological characters, and fragility of specimens.

Coutière (1899; indexed by Chace and Forest, 1970) divided *Alpheus* into 5 nominal "groups" and further divided one of these into three "subgroups" in 1905. Even though these groups have no true systematic status, several authors have followed this classification as a means of dealing with the large number of species. Thus A. Banner and D. Banner (1966) and D. Banner and A. Banner (1982) used 7 groups, and Crosnier and Forest (1966) used 5 groups for classifying the species of *Alpheus*.

The eastern Pacific *Alpheus* fauna has been known very

poorly until now. About 150 years ago, H. Milne Edwards (1837) described one species in the genus *Alpheus* from the coast of Chile (*Alpheus spinifrons*) and this may be the first note of any species of *Alpheus* from the eastern Pacific. After H. Milne Edwards, several authors reported species of *Alpheus* from scattered localities in the eastern Pacific. The main works were: Lockington (1878) from both coasts of North America, Kingsley (1878a) from the west coast of Central America including Panama, Holmes (1900) from California, Rathbun (1910) from the Peruvian coast, Hult (1939) and Sivertsen (1933) from the Galapagos Islands, Chace (1937) from Baja California, Schmitt (1939) from the Clipperton Islands and the Galapagos Islands, Holthuis (1952) from Chile, Chace (1962) from the Clipperton Islands, Abele (1975) from the Malpelo Islands (Colombia), Hendrickx et al. (1983) from the west coast of Mexico, and Wicksten (1983) from the Gulf of California. Recently, Wicksten and Méndez (1981) described *A. inca* from Chile, and Wicksten (1983) described *A. mazatlanicus* from the Laguna Caimanero, Sinaloa, Mexico. At present, 53 nominal species have been reported in *Alpheus* Fabricius or *Crangon* Weber, from the eastern Pacific. Of these, 23 species may be valid, even though several are uncertain (Table 1).

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TABLE 1.—A list of 53 species (arranged alphabetically) from the eastern Pacific under the name of *Alpheus* Fabricius or *Crangon* Weber and their current status. (Entries with pages cited are the species that are not described in the text; entries without pages cited are for the species that are described in the text or of which there is no further citation in other literature from the eastern Pacific.)

Nominal species	Current status	References
<i>A. aequalis</i> Kingsley, 1878a.—Holmes, 1900:189 [part, as <i>A. (Betaeus) aequalis</i> ]	<i>Betaeus harfordi</i> (Kingsley, 1878a)	Hart, 1964
<i>A. affinis</i> Kingsley, 1878a.—Lockington, 1878:476	<i>A. normanni</i> Kingsley, 1878b	Kingsley, 1878b
<i>A. arenensis</i> (Chace, 1937)	<i>A. websteri</i> Kingsley, 1880	Wicksten, 1983
<i>A. armillatus</i> .—Wicksten, 1983:50.—Hendrickx et al., 1983:75 [not <i>A. armillatus</i> H. Milne Edwards, 1837]	?another species	present study
<i>A. barbara</i> Lockington, 1878	valid	Word and Charwat, 1976
<i>A. bellimanus</i> Lockington, 1877b	valid	Wicksten, 1983
<i>A. bispinosus</i> Street, 1871.—Kingsley, 1878a:199	?another species	present study
<i>A. biunguiculatus</i> Stimpson, 1860.—Kingsley, 1899:716	<i>Synalpheus biunguiculatus</i> (Stimpson, 1860)	Coutière, 1899
<i>A. bouvieri</i> A. Milne Edwards, 1878	valid	Christoffersen, 1979
<i>A. californiensis</i> Holmes, 1900	valid	Word and Charwat, 1976; present study
<i>A. candei</i> .—Kingsley, 1883:124; 1899:717 [not <i>A. candei</i> Guérin-Méneville, 1855]	<i>A. clamator</i> Lockington, 1877a	Holmes, 1900
<i>A. chilensis</i> Coutière in Lenz, 1902	valid	Holthuis, 1952
<i>A. clamator</i> Lockington, 1877a	valid	Lockington, 1878
<i>A. clippertoni</i> (Schmitt, 1939).—Chace, 1962:609	<i>Metalpheus rostratipes</i> (Pocock, 1890)	Chace, 1972; Crosnier and Forest, 1966
<i>A. cristulifrons</i> Rathbun, 1900b	valid	Wicksten, 1983
<i>A. cylindricus</i> Kingsley, 1878a	valid	Wicksten, 1983
<i>A. dentipes</i> .—Miers, 1881a:74 [labeling of collection site severely doubted].—Rathbun, 1904:108.—Schmitt, 1921:74 (as <i>Crangon</i> ) [not <i>A. dentipes</i> Guérin-Méneville, 1832]	<i>A. clamator</i> Lockington, 1877a	Holthuis, 1952
<i>A. equidactylus</i> Lockington, 1877a; 1878:472.—Kingsley, 1878a:199; 1899:716.—Rathbun, 1904:108.—Holmes, 1900:187.—Schmitt, 1921:76 (as <i>Crangon</i> )	<i>Alpheopsis equidactylus</i> (Lockington, 1877a)	Word and Charwat, 1976
<i>A. fasciatus</i> Lockington, 1878	valid	present study
<i>A. floridanus</i> Kingsley, 1878a	valid	Wicksten, 1983
<i>A. formosus</i> .—Christoffersen, 1979:314 (part) [not <i>A. formosus</i> Gibbes, 1850]	<i>A. panamensis</i> Kingsley, 1878a	present study
<i>A. grahami</i> Abele, 1975	valid	Wicksten, 1983
<i>A. harfordi</i> Kingsley, 1878a; 1899:717	<i>Betaeus harfordi</i> (Kingsley, 1878a)	Hart, 1964
<i>A. heterochaelis</i> .—Lockington, 1878:475.—Kingsley, 1878a:194; 1899:717.—Rathbun, 1910:606 (as <i>Crangon</i> ).—Boone, 1931:182 [not <i>A. heterochaelis</i> Say, 1818].	?another species	present study

have been. We also wish to thank Bruce E. Felgenhauer and Joel W. Martin for invaluable suggestions and kind help in various ways. This work was supported in part by the National Science Foundation (BSR-8215400, 8508430).

### Materials and Methods

Most of the material examined during this study is in the USNM collections of the Smithsonian Institution's National Museum of Natural History. All available locality data for each of the species is given in the "Material Examined" section for that species. Much of the material was collected by organized expeditions and for this material the appendix includes the

station number, its locality and other information, and a list of species collected at that station. Some of the specimen labels contain a substation as well as a station number but for most of these we have no information other than that of the station. When it is available, the substation data are given under the station number. When no information is available for the substation we list all species under the station number with the substation in parentheses following the specific name. Figure 1 shows the main collecting station localities.

Measurements are one of the descriptive methods used to make comparisons among segments of an appendage and it is difficult to measure these accurately. Therefore in this study, measurements are expressed as ratios. Carapace length is given

TABLE 1.—Continued.

Nominal species	Current status	References
<i>A. inca</i> Wicksten and Méndez, 1981	valid	Wicksten and Méndez, 1981
<i>A. laevigatus</i> Nicolet, 1849.—Rathbun, 1910:610	<i>Betaeus emarginatus</i> (H. Milne Edwards, 1837)	Holthuis, 1952
<i>A. laeviusculus</i> Lockington, 1878	<i>Synalpheus lockingtoni</i> Coutière, 1909	Coutière, 1909
<i>A. leviusculus</i> .—Sivertsen, 1933:2.—Hult, 1939:3 (as <i>Crangon</i> ).—Wicksten, 1983:50.—Hendrickx et al., 1983:74 [not <i>A. leviusculus</i> Dana, 1852]	?another species	present study
<i>A. longidactylus</i> Kingsley, 1878a; 1899:717.—Holmes, 1900:190 [as <i>A. (Betaeus) aequalis</i> ]	<i>Betaeus longidactylus</i> Lockington, 1877b	Hart, 1964
<i>A. lottini</i> Guérin-Méneville, 1829	valid	Wicksten, 1983
<i>A. macrochirus</i> Richters, 1880	<i>A. sulcatus</i> Kingsley, 1878a	D. Banner and A. Banner, 1982
<i>A. maindroni</i> .—Rathbun, 1910:606 (as <i>Crangon</i> ) [not <i>A. maindroni</i> Coutière, 1898]	<i>A. chilensis</i> Coutière in Lenz, 1902	Holthuis, 1952
<i>A. mazatlanicus</i> Wicksten, 1983	valid	Wicksten, 1983
<i>A. malleator</i> Dana, 1852	valid	Wicksten, 1983
<i>A. minus</i> Say, 1818.—Kingsley, 1878a:190; 1899:716	<i>Synalpheus minus</i> (Say, 1818)	Coutière, 1909
<i>A. normanni</i> Kingsley, 1878b	valid	Wicksten, 1983
<i>A. pacificus</i> Dana, 1852	valid	Chace, 1962
<i>A. panamensis</i> Kingsley, 1878a	valid	present study
<i>A. paracrinitus</i> Miers, 1881b	valid	Wicksten, 1983
<i>A. parvimanus</i> Kingsley, 1878a.—Lockington, 1878:477	uncertain	Kingsley, 1878a
<i>A. pugilator</i> A. Milne Edwards, 1878	<i>A. malleator</i> Dana, 1852	Crosnier and Forest, 1966
<i>A. saxidomus</i> Holthuis, 1980a	<i>Thunor saxidomus</i> (Holthuis, 1980a)	D. Banner and A. Banner, 1982
<i>A. scabrodigitus</i> Miers, 1881a	<i>Betaeus scabrodigitus</i> (Miers, 1881a)	Rathbun, 1910
<i>A. schmitti</i> .—Wicksten, 1983:49.—Hendrickx et al., 1983:75 [not <i>A. schmitti</i> Chace, 1972]	? <i>A. umbo</i> , new species	present study
<i>A. simus</i> Guérin-Méneville, 1856.—Sharp, 1893:114	<i>Thunor simus</i> (Guérin-Méneville, 1856)	Holthuis, 1980a; D. Banner and A. Banner, 1982
<i>A. spinicaudus</i> Lockington, 1878	valid	present study
<i>A. spinifrons</i> H. Milne Edwards, 1837	<i>Synalpheus spinifrons</i> (H. Milne Edwards, 1837)	Rathbun, 1910
<i>A. strenuus</i> .—Schmitt, 1939:26 (as <i>Crangon</i> ).—Hult, 1939:3 (as <i>Crangon</i> ) [not <i>A. strenuus</i> Dana, 1852]	?another species	present study
<i>A. strenuus v. galapagensis</i> Sivertsen, 1933	valid	D. Banner and A. Banner, 1982
<i>A. sulcatus</i> Kingsley, 1878a	valid	Wicksten, 1983
<i>A. tenuimanus</i> Lockington, 1878	? <i>Synalpheus tenuimanus</i> (Lockington, 1878)	Coutière, 1899
<i>A. transverso-dactylus</i> Kingsley, 1878a	<i>A. clamator</i> Lockington, 1877a	Holmes, 1900
<i>A. websteri</i> Kingsley, 1880	valid	Wicksten, 1983

in millimeters rounded off to the nearest tenth. The abbreviation "cl" refers to carapace length from the tip of rostrum to the posterior dorsal margin. Drawings were made with the aid of a Wild M-5 camera lucida.

There has been no consistency of terms in descriptions of species by previous authors. Therefore some terms are newly used in this study for convenience and consistency in the description of species and these are shown in Figures 2 and 3.

#### *Alpheus* Fabricius, 1798

*Crangon* Weber, 1795:94.—Banner, 1953:46. [Type-species (by monotypy): *Astacus Malabaricus* Fabricius, 1775:415; gender feminine; name suppressed by plenary action of the International Commission on Zoological

Nomenclature, Opinion 334 (1955).]

*Alpheus* Fabricius, 1798:380, 404.—Coutière, 1899:336.—De Man, 1911:299.—Holthuis, 1955:89.—A. Banner and D. Banner, 1966:74.—Crosnier and Forest, 1966:217.—Chace, 1972:57.—Miya, 1974:104.—D. Banner and A. Banner, 1982:18. [Type-species (selected by Latreille, 1810:422): *Alpheus avarus* Fabricius, 1798:404; gender masculine.]  
*Cryptopthalmus* Rafinesque, 1814:23. [Type-species (by monotypy): *Cryptopthalmus ruber* Rafinesque, 1814:23 (= *Cancer glaber* Olivi, 1792:51); gender masculine.]  
*Autonomaea* Risso, 1816:166. [Type-species (by monotypy): *Autonomaea Olivii* Risso, 1816:166 (= *Cancer glaber* Olivi, 1792:51); gender feminine.]  
*Asphalius* P. Roux, 1831:22. [Type-species (by monotypy): *Palaemon brevis* Olivier, 1811:664; gender masculine.]  
*Dienezia* Westwood in Hailstone, 1835:552. [Type-species (by monotypy): *Hippolyte? rubra* Hailstone, 1835:272 (= *Hippolyte macrocheles* Hailstone, 1835:395); gender feminine.]

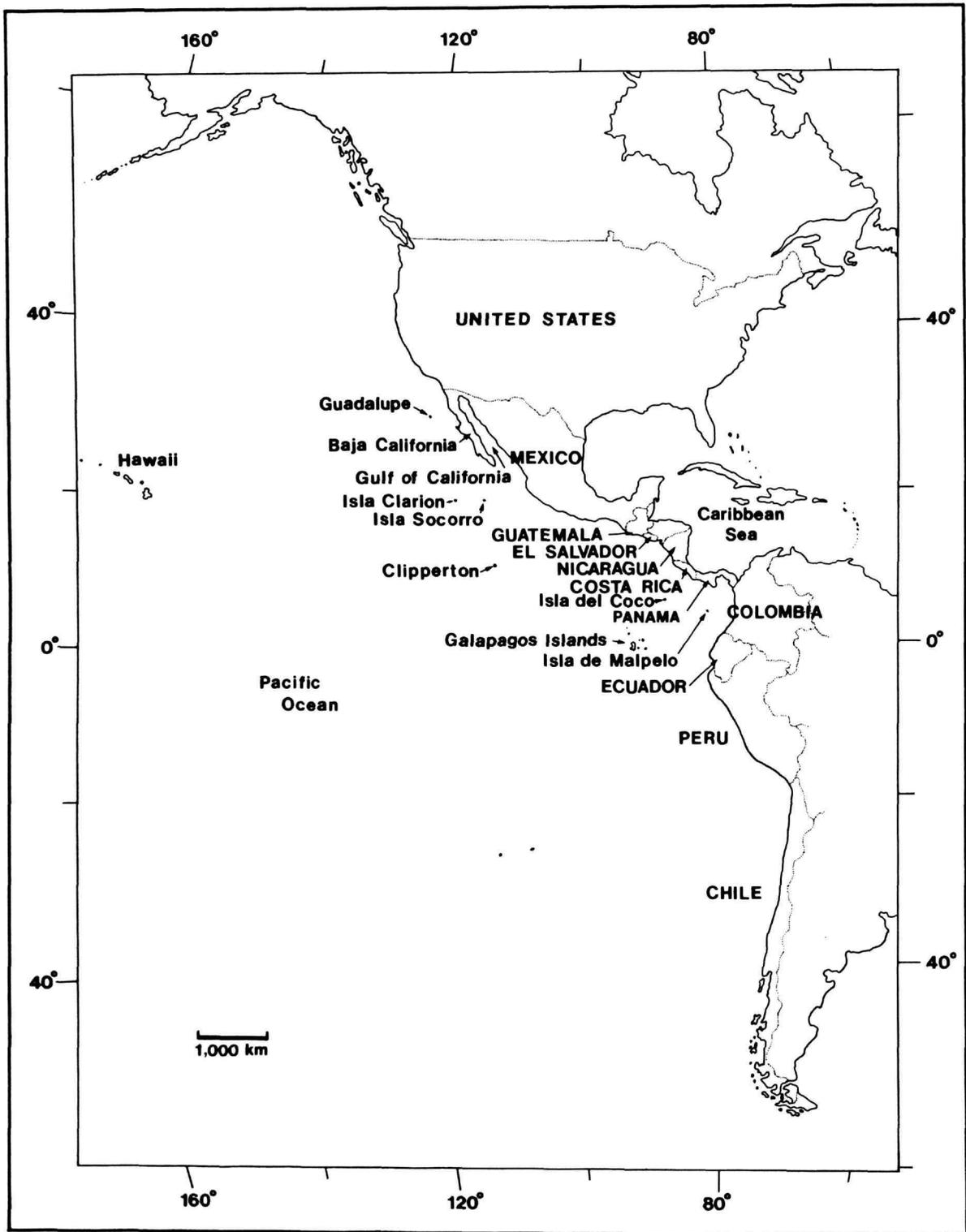


FIGURE 1.—Primary localities from which specimens of the present study were collected.

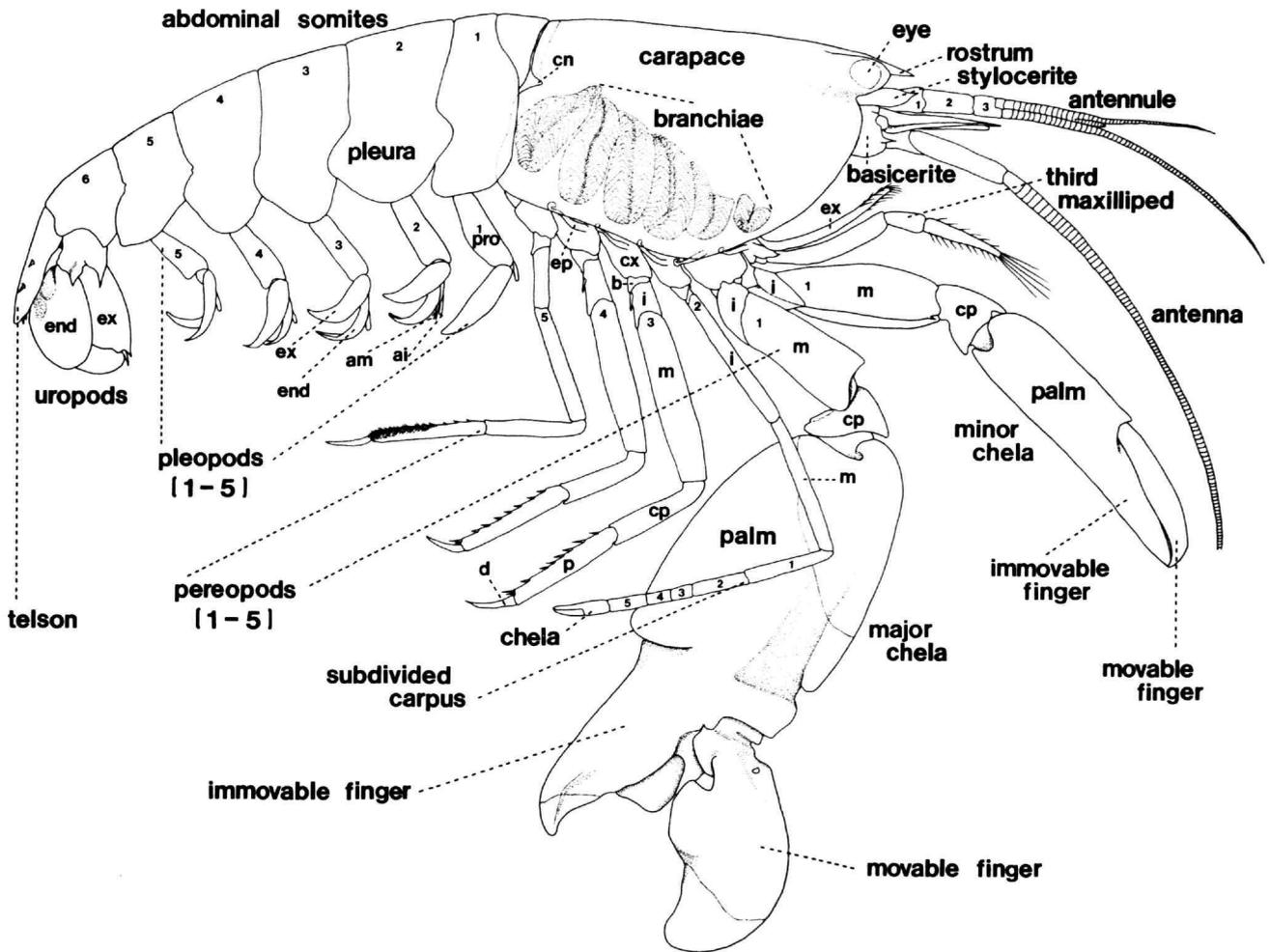


FIGURE 2.—Diagrammatic *Alpheus* showing the terms used in this study: ai, appendix interna; am, appendix masculina; b, basis; cn, cardiac notch; cp, carpus; cx, coxa; d, dactylus; end, endopod; ep, epipod; ex, exopod; i, ischium; m, merus; p, propodus; pro, protopodite.

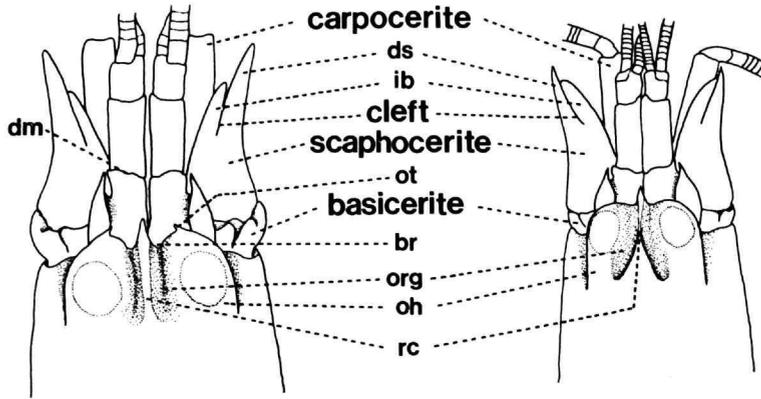
- Phleusa* Nardo, 1847:6. [Type-species (by monotypy): *Phleusa cynea* Nardo, 1847:6 (= *Cancer glaber* Olivi, 1792:51); gender feminine.]  
*Halopsyche* De Saussure, 1857:100. [Type-species (by monotypy): *Halopsyche lutaria* De Saussure, 1857:100 (= *Alpheus heterochaelis* Say, 1818:243); gender feminine.]  
*Alpheoides* Paulson, 1875:105. [Type-species (selected by Holthuis, 1955:91): *Alpheus insignis* Heller, 1861:26; gender masculine.]  
*Paralpheus* Bate, 1888:567. [Type-species (by monotypy): *Palaemon diversimanus* Olivier, 1811:663; gender masculine.]

**DIAGNOSIS** (Figures 2-4).—Carapace continues anteriorly to form ocular hood, which completely encloses eye in dorsal view. Ocular hood frequently projecting as rounded to acute tooth and usually demarked interorbitally from rostral base by shallow or marked depression (orbitrostral groove). Carapace always with cardiac notch on posterior lateral margin and with pterygostomial margin rounded, sometimes produced ante-

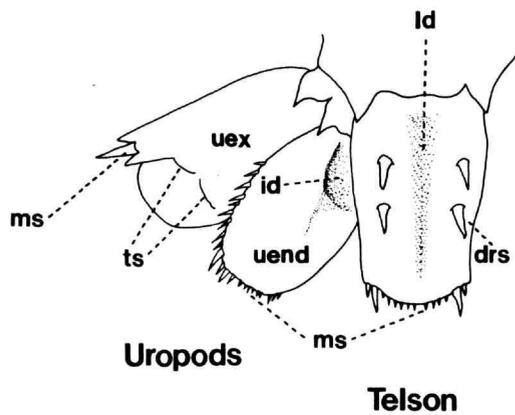
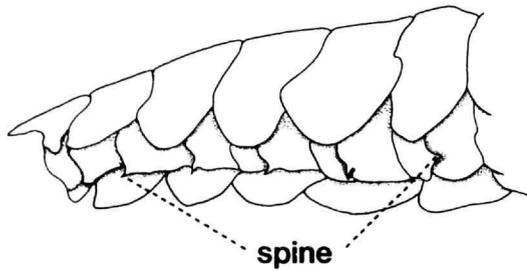
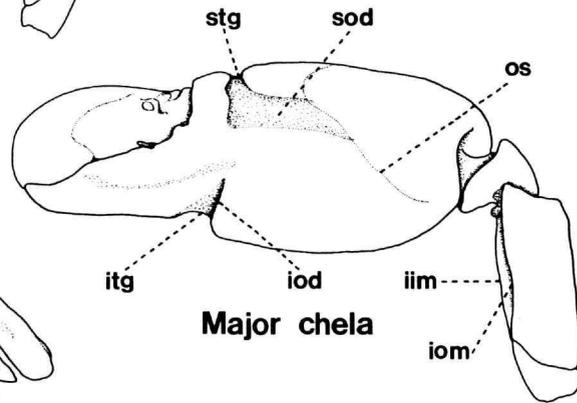
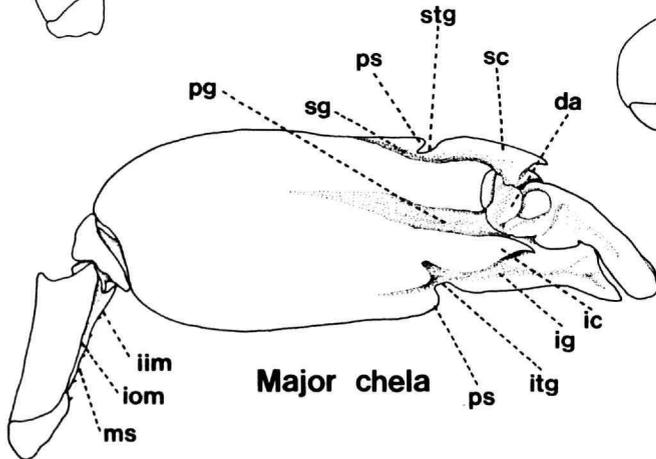
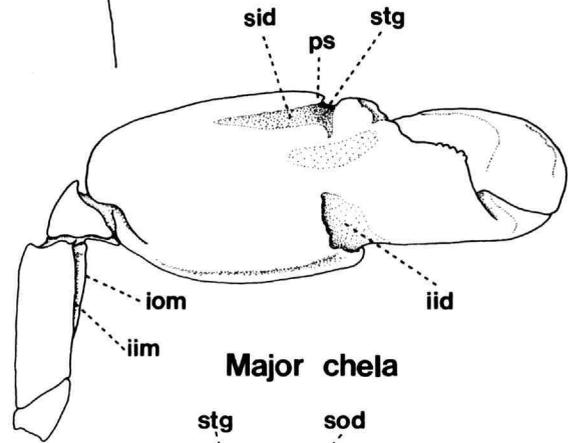
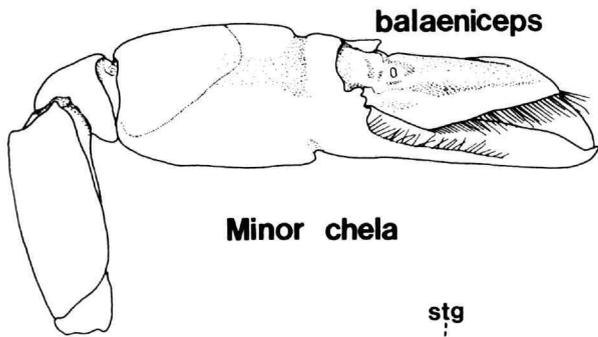
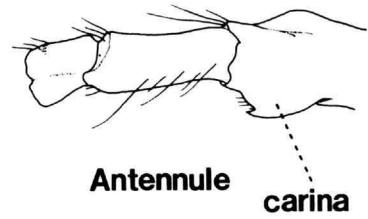
riorly below or behind basicerite. Rostrum usually present and continuing posteriorly as carina. Orbitrostral process almost always present.

Antennules usually short; first antennular segment usually with variously shaped carina extending from ventral inner margin and with stylocerite sometimes reduced. Inner blade of scaphocerite at times reduced; basicerite usually bearing lateral spine; carpo-cerite usually reaching to or beyond distal end of scaphocerite.

Mouth parts as figured (Figure 4). Mandible with incisor process rather broad and bearing several teeth on distal margin; molar process bearing some ridges provided with beds of soft hairs; palp consisting of two distinct segments. First maxilla with upper endite broad, bearing setae on distal margin; endopod or palp bilobed, inner lobe bearing single strong seta.



Anterior region



Second maxilla with upper endite bilobed, provided with setae; lower endite small; endopod or palp narrow and simple; scaphognathite large. First maxilliped with endites separated by distinct notch and bearing row of setae on submarginal and marginal regions; exopod with exopodal (caridean) lobe narrow but distinct; epipod with lateral margin broadly concave. Second maxilliped with ultimate segment of endopod narrow, attached as strip to penultimate segment; epipod fairly large. Third maxilliped with ultimate segment usually bearing long setae on distal margin and bearing tufts of dense setae on inner surface; penultimate and antepenultimate segments usually bearing scattered setae but sometimes bearing movable spines; exopod well developed; epipod slender, same shape of epipods on first through fourth pereopods. Branchial formula usually with five pleurobranchs (two on body wall just beyond precoxa of first pereopod, two beyond precoxa of third pereopod, one beyond precoxa of fourth pereopod), one arthrobranch (near distal end of precoxa of third maxilliped), seven epipods (on coxa of first maxilliped through fourth pereopod) and at times supplementary arthrobranch on third maxilliped (near proximal end of precoxa).

Chelae of first pereopods always asymmetrical in form and usually in size; never carried folded against meri. Major chela variable in form, from smooth and subcylindrical to compressed and twisted with sculpturing of palm at times deep and strong. Movable finger with "plunger," piston-like process on opposite surface fitting into cavity on immovable finger, usually well developed, but at times reduced to slight confluent ridge; always with palmar and digital adhesive plaques. Major first pereopod always with short, hemispherical carpus, with merus triangular in section. Minor chela usually of simple form with conical fingers, but at times showing marked sexual dimorphism with movable finger expanded and carrying dense setae on crests (balaeniceps) in male.

Carpus of second pereopod always with five segments of variable proportions.

Third and following pereopods robust, at times with meri triangular in section; armature and proportions of various segments variable; dactyli usually simple and conical, in some species with additional teeth, in others subspatulate. Fifth pereopod with "brush" on propodus distally.

Abdomen usually without lateral compression, with pleura in females usually broader than those of males, at times with

acute projections on margins. Pleuron of sixth abdominal somite not articulated. Appendix interna present on each endopod, second through fifth pleopods. Endopod of second pleopod of male carrying appendix masculina provided with simple setae. Abdominal sternites bearing spine at midline of each sternite in some species. Telson with posterolateral angles not projecting or acute, bearing pair of movable spines at each side; posterior margin arcuate and slightly projecting, neither indented nor projecting as tooth, bearing seta-like spines in some species; dorsal surface with two pairs of spines. Anal tubercles almost always well developed. Uropodal exopod almost always with transverse suture; uropodal endopod at times bearing short heavy spines on distal margin.

REMARKS.—The genus *Alpheus* was divided into five groups, "Megacheles," "Macrochirus," "Crinitus," "Brevirostris," and "Edwardsii," by Coutière (1899), and later (1905) he divided the "Crinitus group" into three subgroups, "Obesomanus," "Crinitus," and "Insignis." A. Banner and D. Banner (1966) raised these subgroups to the group rank. Banner (1953) used "Diadema" as a group name instead of "Insignis" by considering *A. insignis* to be synonymous with *A. diadema*, Crosnier and Forest (1966) used "Macrocheles" instead of "Megacheles" because *A. megacheles*, Coutière, 1899, was considered as a junior synonym of *A. pontederiae*, which belongs to the "Edwardsii" group, and D. Banner and A. Banner (1982) used "Sulcatus" instead of "Macrochirus" by considering *A. macrochirus* to be synonymous with *A. sulcatus*.

The above synonymy and diagnosis of this genus are based on Holthuis (1955) and D. Banner and A. Banner (1982), respectively. The following diagnosis for each group is based on D. Banner and A. Banner (1982). The species found from the eastern Pacific are listed under the group to which the species probably belong. However, critical information is lacking for two of the species (*A. fasciatus* and *A. exilis*), and we therefore cannot assign them to one of the seven groups. We describe species in the text according to the sequence of the following groups, rather than by alphabetical order (for the sequence of the species, see "Contents").

#### SEVEN SPECIES GROUPS

The *macrocheles* group (= "Megacheles" group): Always with ocular teeth. Palm of major chela moderately compressed, somewhat twisted, with three heavy longitudinal ridges and grooves (except in *A. grahami*), at times interrupted, terminating distally in (1) heavy spine on superior crest, (2) adhesive plaque, (3) usually heavy spine on inferior crest; movable finger frequently high and thin, often with bulbous tip. Movable finger of minor chela never balaeniceps, often laminate. Third pereopod with or without meral tooth; dactylus usually with additional tooth on margin. Composition: *A. bellimanus*, *A. rectus*, *A. hoonsooi*, *A. barbara*, *A. clamator*, *A. inca*, *A. grahami*.

FIGURE 3.—Appendages of *Alpheus* showing the terms used in this study: br, base of rostrum; da, dactylar articulation; dm, distal margin; drs, dorsal spine; ds, distal spine; ib, inner blade; ic, inferior crest; id, inner depression; ig, inferior groove; iid, inferior inner depression; iim, inferior inner margin; iod, inferior outer depression; iom, inferior outer margin; itg, inferior transverse groove; ld, longitudinal depression; ms, movable spine; oh, ocular hood; org, orbitorostral groove; os, oblique suture; ot, ocular tooth; pg, palmar groove; ps, proximal shoulder; rc, rostral carina; sc, superior crest; sg, superior groove; sid, superior inner depression; sod, superior outer depression; stg, superior transverse groove; ts, transverse suture; uend, uropodal endopod; uex, uropodal exopod. [The terms were used for descriptive purpose only, not for morphological homologies.]

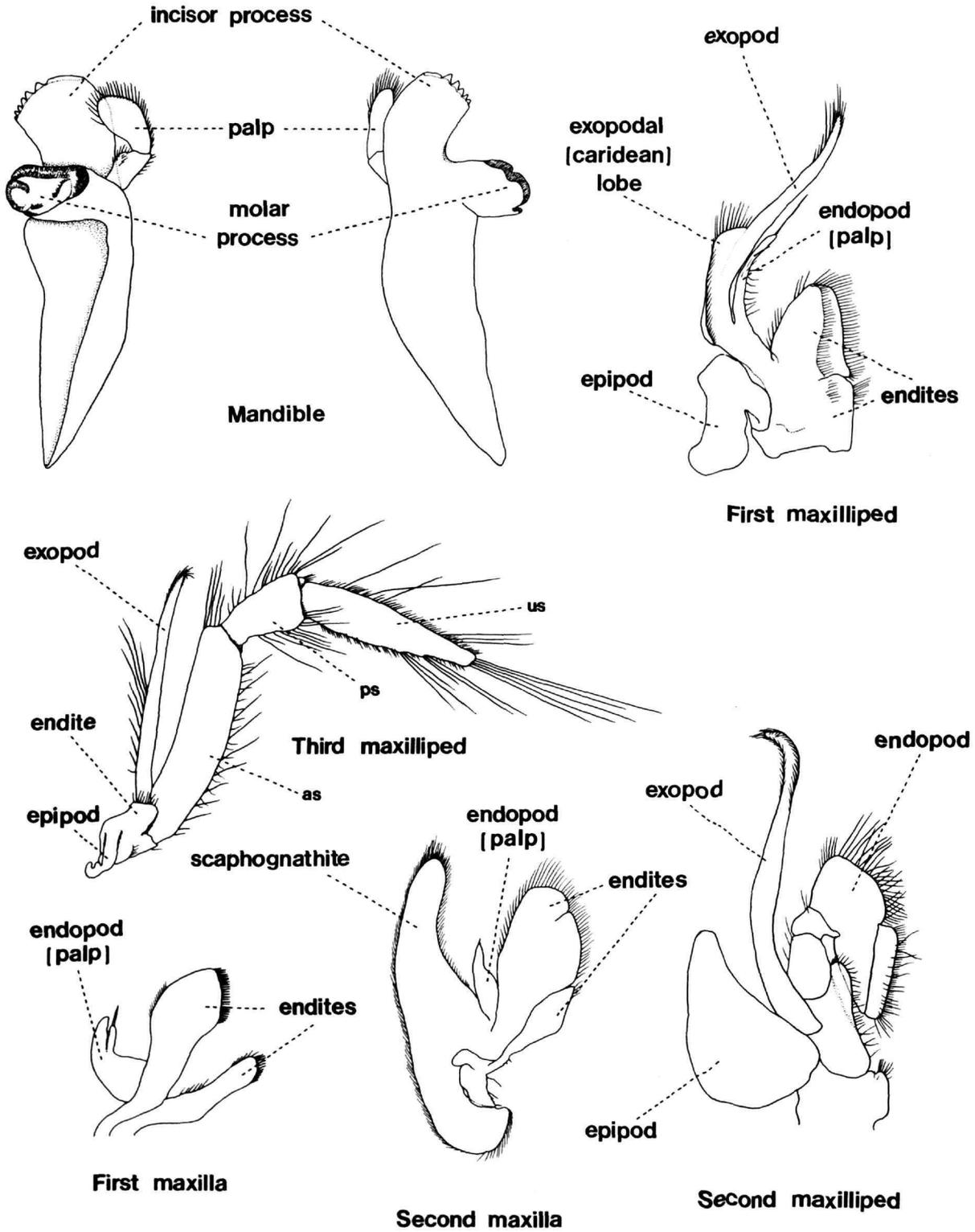


FIGURE 4.—Mouth parts of *Alpheus*: as, artempenultimate segment; ps, penultimate segment; us, ultimate segment.

The *sulcatus* group (= "Macrochirus" group): Ocular teeth usually present; often with rostral carina flattened and demarked from orbitorostral grooves. Major chela usually moderately compressed with light to heavy longitudinal grooves, usually without transverse grooves. Movable finger of minor chela balaeniceps or not. Third pereopod with or without meral tooth; dactylus simple or with additional tooth on margin. Movable spine of uropodal exopod often black. Composition: *A. websteri*, *A. malleator*, *A. lottini*, *A. normanni*, *A. panamensis*, *A. felgenhauri*, *A. sulcatus*.

The *obesomanus* group: Rostrum reduced, at times lacking. Stylocerite and scaphocerite often reduced. Major chela usually rounded proximally, tapering distally with moderate longitudinal grooves and ridges; movable finger hammer-shaped, closing over distal end of immovable finger. Immobile finger of minor chela never balaeniceps. Second pair of pereopods often extremely long and asymmetrical in length. Merus of third pereopod usually armed. Composition: *A. cristulifrons*.

The *crinitus* group: Ocular teeth absent; rostrum often reduced, at times absent. Major chela cylindrical, without grooves or ridges (in *A. cylindricus*, with lateral grooves and ridge). Movable finger of minor chela often balaeniceps in male. Third pereopod with merus usually armed, dactylus simple or biunguiculate. Composition(?): *A. cylindricus*.

The *diadema* group (= "Insignis" group): Ocular teeth

usually lacking. Major chela rounded to oval in section, usually with transverse groove proximal to fingers and lacking marked longitudinal grooves. Movable finger of minor chela often balaeniceps (never in species from the eastern Pacific). Third pereopod with or without tooth on merus; dactylus almost always simple. Composition: *A. paracrinitus*, *A. rostratus*.

The *brevirostris* group: Ocular teeth absent; ocular hoods often prominent. Major chela always strongly compressed, more or less quadrangular in section; often with faces demarked by noticeable angle; with or without transverse groove proximal to fingers. Movable finger of minor chela often balaeniceps in male. Third pereopod with merus usually unarmed, dactylus always simple, at times flattened and subspatulate. Composition: *A. floridanus*, *A. aequus*.

The *edwardsii* group: Ocular teeth always absent in species from the eastern Pacific. Major chela markedly compressed, with transverse groove on superior and inferior margins proximal to fingers; grooves usually extending onto both faces as depressed areas. Movable finger of minor chela often balaeniceps in male. Third pereopod with merus usually unarmed; dactylus usually simple, at times subspatulate. Composition: *A. bouvieri*, *A. chilensis*, *A. hebes*, *A. longinquus*, *A. lacertosus*, *A. californiensis*, *A. canalis*, *A. hyeyoungae*, *A. scopulus*, *A. tenuis*, *A. villus*, *A. umbo*, *A. mazatlanicus*, *A. latus*, *A. hamus*, *A. firmus*, *A. distinctus*, *A. martini*, *A. pacificus*, *A. galapagensis*, *A. spinicaudus*, *A. antepaenultimus*.

### Key to Eastern Pacific Species of *Alpheus*

1. Endite of basis of third maxilliped elongated rectangular in shape bearing dense, long stiff setae on distal margin (ocular hood bearing tooth arising from anterior margin; antennules very slender, second segment very elongate, about 4 times as long as broad and 2.7 times as long as third segment) . . . 44. *A. exilis*, new species
- Endite of basis of third maxilliped various in shape, not bearing dense, long stiff setae on distal margin, if any, sparse short setae . . . . . 2
2. Ocular hood always with tooth; palm of major chela slightly compressed, somewhat twisted usually with 3 heavy longitudinal ridges and grooves (indistinct in *A. grahami*) and always bearing spine flanking dactylar articulation on both inner and outer faces . . . . . 3
- Ocular hood with tooth or not; palm of major chela variable in shape, never bearing spine flanking dactylar articulation on both inner and outer faces, if spine present, only on inner face or outer face, not both . . . . . 9
3. Basicerite without spine . . . . . 4. *A. barbara*
- Basicerite with spine . . . . . 4
4. Merus of third pereopod with tooth on inferior distal margin . . . . . 5
- Merus of third pereopod without tooth on inferior distal margin . . . . . 6
5. Orbitorostral groove shallow; merus of major first pereopod bearing movable spines on inferior inner margin and tooth at distal end; movable finger of minor chela laminate in male . . . . . 3. *A. hoonsooi*, new species
- Orbitorostral groove deep; merus of major pereopod smooth on inferior inner margin and no tooth at distal end; movable finger of minor chela not laminate . . . . . 5. *A. clamator*

6. Palm of major chela without transverse groove on superior margin and without deep, distinct superior and inferior grooves on outer face; stylocerite clearly overreaching distal margin of first antennular segment . . . . . 7. *A. grahami*  
 Palm of major chela with deep transverse groove on superior margin and with deep, distinct superior and inferior grooves on outer face; stylocerite not overreaching distal margin of first antennular segment . . . . . 7
7. Rostrum short, falling far short of middle of visible part of first antennular segment; movable finger of minor chela compressed laterally, but not laminate in male; merus and ischium of major first pereopod without movable spines on inferior inner margins . . . . . 6. *A. inca*  
 Rostrum long, reaching to or far overreaching middle of visible part of first antennular segment; movable finger of minor chela laminate in male; merus and ischium of major first pereopod with movable spines on inferior inner margins . . . . . 8
8. Inferior margin distal to inferior transverse groove of major chela sinuous because of deep transverse groove; movable finger of major chela shallowly arched along proximal  $\frac{2}{3}$  of superior margin and then regularly arched distally, tip stout, often bulbous; appendix masculina subequal to or slightly overreaching distal end of appendix interna . . . . . 1. *A. bellimanus*  
 Inferior margin distal to inferior transverse groove of major chela almost straight because of shallow transverse groove; movable finger of major chela regularly arched throughout superior margin, tip slightly compressed, bluntly rounded; appendix masculina clearly overreaching distal end of appendix interna . . . . . 2. *A. rectus*, new species
9. Ocular hood with distinct tooth . . . . . 10  
 Ocular hood without distinct tooth . . . . . 14
10. Stylocerite clearly overreaching distal margin of first antennular segment; merus of minor first pereopod with distinct spine at distal end of inferior inner margin; ischium of third pereopod with movable spine . . . . . 11  
 Stylocerite not clearly overreaching distal margin of first antennular segment; merus of minor first pereopod without distinct spine at distal end of inferior inner margin; ischium of third pereopod without movable spine . . . . . 13
11. Inferior margins of penultimate and antepenultimate segments of third maxilliped with movable spines; palm of major chela without distinct spine flanking dactylar articulation on inner face; dactylus of third pereopod blunt (body compressed laterally) . . . . . 10. *A. lottini*  
 Inferior margins of penultimate and antepenultimate segments of third maxilliped without movable spines; palm of major chela with distinct spine flanking dactylar articulation on inner face; dactylus of third pereopod conical . . . . . 12
12. Rostrum extending posteriorly as flattened dorsal surface with lateral margin overhanging orbitorostral groove and bearing short setae; ocular hood with tooth arising from surface of hood, not from margin . . . . . 12. *A. panamensis*  
 Rostrum extending posteriorly as narrowly rounded carina with no setae on rostrum or rostral carina; ocular hood with tooth arising from anterior margin of hood . . . . . 13. *A. felgenhaueri*, new species
13. Scaphocerite with prominent, lobate projection near proximal end of lateral margin; rostral carina flattend dorsally; palm of major chela tuberculate on upper half of outer face . . . . . 9. *A. malleator*  
 Scaphocerite without prominent, lobate projection near proximal end of lateral margin; rostral carina rounded dorsally; palm of major chela smooth, not tuberculate . . . . . 8. *A. websteri*
14. Major chela compressed, or rounded to oval in section; palm of major chela without transverse grooves on both superior and inferior margins, if groove present, only on superior or inferior margin, not both . . . . . 15

- Major chela markedly compressed; palm of major chela always with transverse grooves on both superior and inferior margins, extending into both inner and outer faces as distinct depressions . . . . . 23
15. Palm of major chela with superior transverse groove or notch . . . . . 16  
 Palm of major chela without superior transverse groove or notch . . . . . 17
16. Major chela not markedly compressed; basicerite with spine; palm of major chela with distinct longitudinal depression extending from superior transverse groove on each of inner and outer faces; movable finger of minor chela balaeniceps in male . . . . . 11. *A. normanni*  
 Major chela markedly compressed; basicerite without spine; palm of major chela without longitudinal depression extending from superior transverse groove; movable finger of minor chela not balaeniceps in male . . . . . 20. *A. aequus*, new species
17. Palm of major chela with distinct longitudinal groove on outer face . . . . . 18  
 Palm of major chela without distinct longitudinal groove on outer face . . . . . 19
18. Orbitrostral groove absent; penultimate and antepenultimate segments of third maxilliped with movable spines on inferior margins; major chela cylindrical, with spine flanking dactylar articulation on outer face . . . . . 16. *A. cylindricus*  
 Orbitrostral groove very deep; penultimate and antepenultimate segments of third maxilliped without movable spines on inferior margins; major chela slightly compressed, without spine flanking dactylar articulation on outer face . . . . . 14. *A. sulcatus*
19. Major chela markedly compressed; propodus of third pereopod without spines on inferior margin . . . . . 19. *A. floridanus*  
 Major chela rounded to oval in section; propodus of third pereopod with spines on inferior margin . . . . . 20
20. Stylocerite clearly overreaching distal margin of first antennular segment (major chela nearly cylindrical; merus of first pereopod unarmed) . . . . . 21. *A. fasciatus*  
 Stylocerite falling short of, or reaching to distal margin of first antennular segment . . . . . 21
21. Orbitrostral groove very deep and wide; basicerite without spine; first carpal segment of second pereopod shorter than second segment; merus of third pereopod with tooth at distal end of inferior margin . . . . . 15. *A. cristulifrons*  
 Orbitrostral groove very shallow; basicerite with spine; first carpal segment of second pereopod longer than second segment; merus of third pereopod without tooth at distal end of inferior margin . . . . . 22
22. Rostrum falling short of middle of visible part of first antennular segment, bearing short setae on lateral margins; distal spine of scaphocerite reaching to, or slightly beyond distal end of antennular peduncle; antepenultimate segment of third maxilliped with distal end of superior margin produced anteriorly . . . . . 17. *A. paracrinitus*  
 Rostrum overreaching middle of visible part of first antennular segment, without short setae on lateral margins; distal spine of scaphocerite overreaching distal end of antennular peduncle; antepenultimate segment of third maxilliped with distal end of superior margin not produced anteriorly . . . . . 18. *A. rostratus*, new species
23. Inner palmar face of major chela with superior depression transversely elongate, U-shaped, not extending posteriorly as elongate depression . . . . . 24  
 Inner palmar face of major chela with superior depression extending posteriorly . 27
24. Merus of major first pereopod with spine at distal end of inferior inner margin; appendix masculina very short, not reaching to distal end of appendix interna . . . . . 23. *A. chilensis*  
 Merus of major first pereopod without spine at distal end of inferior inner margin; appendix masculina reaching to or slightly overreaching distal end of appendix interna . . . . . 25

25. Rostral carina very shallow and broad, regularly widening posteriorly; third pereopod with movable spine on ischium . . . . . 24. *A. hebes*, new species  
 Rostral carina very shallow and linear; third pereopod without movable spine on ischium . . . . . 26
26. Movable finger of minor chela balaeniceps in male . . . . . 22. *A. bouvieri*  
 Movable finger of minor chela not balaeniceps in male . . . . .  
 . . . . . 25. *A. longinquus*, new species
27. Merus of major first pereopod with spine at distal end of inferior inner margin . 28  
 Merus of major first pereopod without spine at distal end of inferior inner margin . 34
28. Movable finger of minor chela balaeniceps in male . . . . . 29  
 Movable finger of minor chela not balaeniceps in male . . . . . 30
29. Telson with slight longitudinal depression at middle of dorsal surface; rostral carina narrowly triangular posteriorly with lateral margin not overhanging orbitorostral groove; penultimate segment of third maxilliped short, about 1.2 times as long as broad at distal end . . . . . 26. *A. lacertosus*, new species  
 Telson with no longitudinal depression at middle of dorsal surface; rostral carina more regularly triangular posteriorly with lateral margin slightly overhanging orbitorostral groove; penultimate segment of third maxilliped about 1.5 times as long as broad at distal end . . . . . 27. *A. californiensis*
30. Rostral carina narrowly rounded dorsally, not abruptly broadened posterior to eyes; orbitorostral groove not clearly delimited posteriorly . . . . . 31  
 Rostral carina abruptly broadened posterior to eyes; orbitorostral groove clearly delimited posteriorly . . . . . 32
31. Anterior margin between base of rostrum and middle of ocular hood almost straight; distal spine of scaphocerite clearly overreaching distal end of antennular peduncle (telson with distinct longitudinal median depression on dorsal surface) . . . . .  
 . . . . . 28. *A. canalis*, new species  
 Anterior margin between base of rostrum and middle of ocular hood sinuous, slightly concave near base of rostrum; distal spine of scaphocerite reaching to distal end of antennular peduncle . . . . . 41. *A. galapagensis*, new rank
32. Palm of minor chela with transverse notch on inferior margin; abdominal sternites with spine at midline of at least each of first four sternites . . . . .  
 . . . . . 29. *A. hyeyoungae*, new species  
 Palm of minor chela with no transverse notch on inferior margin; abdominal sternites with no spines at midlines . . . . . 33
33. Merus of major first pereopod armed with several movable spines on inferior inner margin in addition to strong spine at distal end . . . 30. *A. scopulus*, new species  
 Merus of major first pereopod armed with sharp spine at distal end of inferior inner margin, but no movable spines on inferior inner margin . 31. *A. tenuis*, new species
34. Second carpal segment of second pereopod at least 1.5 times as long as first segment . . . . . 35  
 Second carpal segment of second pereopod shorter than or at most slightly longer than first segment . . . . . 36
35. Merus of third pereopod without tooth at distal end of inferior margin . . . . .  
 . . . . . 42. *A. spinicaudus*  
 Merus of third pereopod with tooth at distal end of inferior margin . . . . .  
 . . . . . 33. *A. umbo*, new species
36. Third pereopod without movable spine on ischium (movable finger of minor chela balaeniceps in male; merus of major first pereopod without spine at distal end of inferior inner margin) . . . . . 32. *A. villus*, new species  
 Third pereopod with movable spine on ischium . . . . . 37
37. Dactylus of third pereopod subspatulate . . . . . 38  
 Dactylus of third pereopod conical, not subspatulate . . . . . 41
38. Minor chela with fingers clearly longer than palm; first carpal segment of second pereopod very slightly shorter than, or slightly longer than second segment;

- propodus of third pereopod with delicate movable spines on inferior margin . . . 39  
 Minor chela with fingers subequal to palm; first carpal segment of second pereopod  
 clearly longer than second segment; propodus of third pereopod with distinct  
 movable spines on inferior margin . . . . . 40
39. Merus of major first pereopod bearing movable spines on inferior inner margin . .  
 . . . . . 43. *A. antepaenultimus*, new species  
 Merus of major first pereopod without movable spines on inferior inner margin . .  
 . . . . . 34. *A. mazatlanicus*
40. Distal spine of scaphocerite clearly overreaching distal end of antennular peduncle;  
 protopodite of pleopod without teeth on lateral margin . 35. *A. latus*, new species  
 Distal spine of scaphocerite falling far short of distal end of antennular peduncle;  
 protopodite of pleopod with teeth on lateral margin . . 36. *A. hamus*, new species
41. Movable finger of minor chela balaeniceps in male; proximal shoulder of superior  
 transverse groove of palm of major chela not overhanging groove . . . . . 42  
 Movable finger of minor chela not balaeniceps in male; proximal shoulder of superior  
 transverse groove of palm of major chela overhanging groove . . . . . 43
42. Palm of minor chela with no distinct sculpturing as found on palm of major chela  
 in male . . . . . 37. *A. firmus*, new species  
 Palm of minor chela with distinct sculpturing as found on palm of major chela in  
 male . . . . . 38. *A. distinctus*, new species
43. Rostral carina flattend dorsally, abruptly broadened posteriorly from anterior end of  
 eyes as elongated triangular shape; abdominal sternite without spine at midline . .  
 . . . . . 39. *A. martini*, new species  
 Rostral carina broadly rounded dorsally, not abruptly broadened posteriorly;  
 abdominal sternite with spine at midline . . . . . 40. *A. pacificus*

**1. *Alpheus bellimanus* Lockington, 1877**

FIGURE 5

*Alpheus bellimanus* Lockington, 1877b:34; 1878:470.—Kingsley, 1878a:199;  
 1878c:59; 1883:111; 1899:716.—Bate, 1888:54.—Sharp, 1893:112.—  
 Coutière, 1899:28.—Holmes, 1900:184, pl. 2: fig. 41.—Rathbun, 1904:108.—  
 Word and Charwat, 1976:42.—Luke, 1977:4.—Brusca, 1980:252.—  
 Wicksten, 1983:41; 1984:189.  
*Crangon bellimanus*.—Schmitt, 1921:75, fig. 51.—Chace, 1937:118.

MATERIAL EXAMINED.—Mexico: Puerto Refugio, Angel de  
 la Guardia, Baja California (sta 704-37: 1 ♀); off San  
 Francisquito Bay, Baja California (sta 529-36: 1 ♂, 1 spec, sta  
 533-36: 2 ♀, sta 534-36: 1 ♂); San Gabriel Bay, Espiritu Santo  
 Island, Baja California (sta 633-37: 1 ♂, 1 ♀, 1 ovig); Agua  
 Verde Bay, Baja California (sta 521-36: 1 ♂, sta 662-37: 2 ♂,  
 sta 663-37: 1 ovig); South of Isla Partida, Baja California (sta  
 561-36: 1 ♂); Angeles Bay, Baja California (sta 702-37: 2 ♂,  
 1 ♀); San Lorenzo Channel, Espiritu Santo Island, Baja  
 California (sta 607-36: 1 ♀, 1 ovig); San Francisco Island, Baja  
 California (sta 647-37: 2 ♂); Ensenada de los Muertos, Baja  
 California (sta 628-37: 1 juv); South of San Marees Island,  
 Baja California (sta 582-36: 1 ♂); Isabel Island (sta 277-34: 1  
 spec); Sulphur Bay, Clarion Island (sta 134-34: 1 spec); Isabel  
 Island, Sinaloa (sta 747-37: 1 ♀).

Panama: Bahia Honda (sta 113-33: 1 juv); Secas Isle (sta  
 448-35: 1 ♀, sta 450-35: 6 ♂, 2 ♀, 3 ovig, sta 457-35: 2 ♂, sta

458-35: 1 juv). Perlas Islands (*Pocillopora* coral): 2 ovig,  
 12–13 Jun 1973, coll. by W. Patton, and G. Glamm.

Colombia: Octavia Bay (sta 432-35: 1 juv); Gorgona Island  
 (sta 409-35: 2 ♀).

Galapagos Islands: Charles Island (sta 57-33: 1 ♂, 3 juv, sta  
 166-34: 1 ♂, 1 ♀, sta 196-34: 1 juv); Post Office Bay, Charles  
 Island (sta 167-34: 1 ♂, 1 ovig, 2 juv, 2 spec, sta 193-34: 1  
 juv); Sullivan Bay, James Island (sta 177-34: 1 ♂, 1 juv, sta  
 795-38: 1 ♀); Barrington Island (sta 46-33: 1 juv, 1 spec, sta  
 47-33: 1 juv, sta 811-38: 1 ♀, sta 811a-38: 1 ♂, 1 ♀); Academy  
 Bay, Indefatigable Island (sta 169-34: 1 ♂); Conway Bay,  
 Indefatigable Island (sta 82-33: 1 ♂); Cartago Bay, Albemarle  
 Island (sta 73-33: 1 ♂).

MEASUREMENTS.—Males, cl 4.0–14.1 mm; females, cl  
 3.5–8.5 mm; ovigerous females, cl 4.5–7.9 mm.

DESCRIPTION.—Rostrum (Figure 5a,b) long, narrowly trian-  
 gular, not clearly carinate posteriorly and far overreaching  
 middle of visible part of first antennular segment; tip slightly  
 directing upward.

Ocular hood produced anteriorly, separated from rostrum  
 by almost indistinct dorsal depression near base of rostrum and  
 armed with sharp tooth directing slightly inward and down-  
 ward. Ocular tooth reaching to distal 0.3 of rostrum. Anterior  
 inner margin of ocular hood slanting anteriorly from base of  
 rostrum to ocular tooth.

Antennules slender. First antennular segment with deep,  
 triangular carina extending from ventral inner margin; ventral

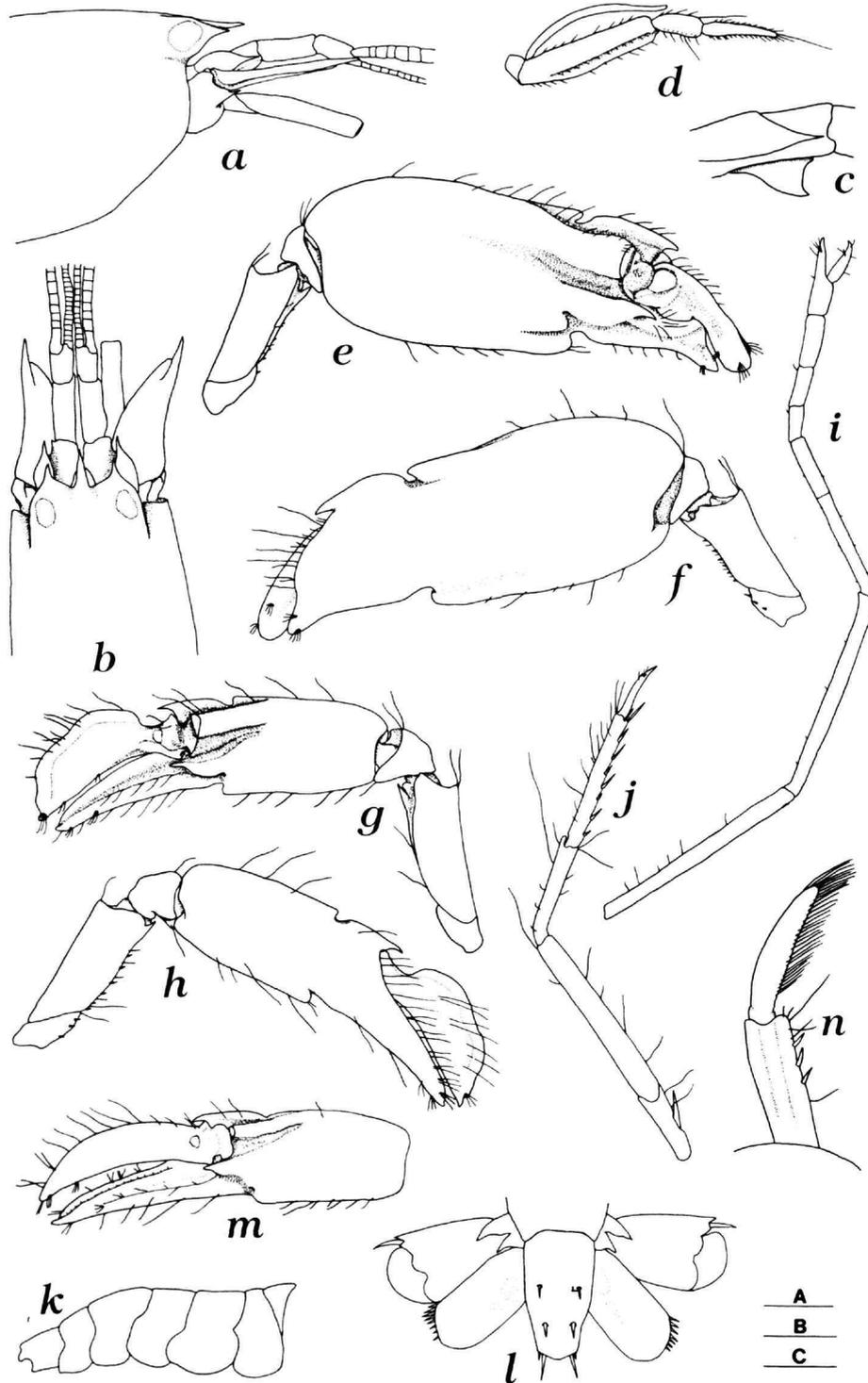


FIGURE 5.—*Alpheus bellimanus*, male, cl 5.2 mm, from sta 450-35: *a*, anterior region, lateral view; *b*, same, dorsal view; *c*, carina below right first antennular segment; *d*, right third maxilliped; *e*, major first pereopod, outer face; *f*, same, inner face; *g*, minor first pereopod, outer face; *h*, same, inner face; *i*, left second pereopod; *j*, right third pereopod; *k*, abdomen; *l*, telson and uropods; *m*, chela of minor first pereopod, outer face (ovigerous female, cl 6.5 mm, from sta 450-35); *n*, right second pleopod (female, cl 4.6 mm, from sta 795-38). (Scale A = 2 mm; *k*; scale B = 1 mm: *a*, *b*, *d*-*j*, *l*, *m*; scale C = 0.5 mm: *c*, *n*.)

part of carina ending in very minute spine directing forward (Figure 5c). Second segment slender, about 2.5 times as long as broad, 1.3 times as long as visible part of first segment and 1.5 times as long as third segment. Stylocerite narrowing to long sharp point, almost reaching to distal margin of first segment.

Scaphocerite slightly more than 3 times as long as broad. Lateral margin concave at middle. Distal spine slightly directing inward, overreaching distal end of antennular peduncle and almost reaching to distal end of carapocerite. Inner blade narrow distally, reaching to middle of distal spine. Cleft between inner blade and distal spine moderate, arising from distal 0.3 of scaphocerite.

Carpocerite overreaching distal end of antennular peduncle by  $\frac{1}{4}$  length of third antennular segment. Basicerite with sharp lateral spine; spine broad at base.

Third maxilliped (Figure 5d) slender, reaching to, or slightly overreaching distal end of carapocerite. Ultimate segment tapering distally with sparse setae on distal margin, about 1.5 times as long as penultimate. Penultimate segment rather elongate, about 2.5 times as long as broad near distal end. Exopod fairly overreaching distal end of antepenultimate segment. Precoxa with one arthrobranch near distal end but with no supplementary arthrobranch.

Major first pereopod (Figure 5e,f) overreaching distal end of carapocerite by most part of chela. Major chela slightly tapering distally, about 2.9 times as long as broad, with fingers occupying distal 0.3. Movable finger opening and closing in obliquely horizontal plane, shallowly arched along proximal  $\frac{2}{3}$  of superior margin and then regularly arched distally, tip broad, bulbous and overreaching tip of immovable finger. Immovable finger with tip slightly deflexed downward and outward. Palm with superior and inferior transverse grooves. Superior transverse groove deep, connecting to very slight, short round depression on inner palmar face and connecting to long longitudinal groove (superior groove), groove spreading from proximal  $\frac{1}{3}$  of superior margin of palm and leading to dactylar articulation on outer palmar face; proximal shoulder well produced distally. Superior crest distal to transverse groove terminating distally in strong tooth flanking dactylar articulation; tip directing downward. Ridge to palmar plaque on outer palmar face demarked on inferior side by distinct longitudinal groove (palmar groove), groove reaching proximally to midlength of palm. Inferior crest rounded on surface and terminating in acute tooth flanking dactylar articulation. Inferior transverse groove deep, broad, connecting to very shallow longitudinal depression proximal to groove and connecting to deep, broad longitudinal depression (inferior groove) distal to groove on outer palmar face and spreading to short depression proximal to groove on inner palmar face; proximal shoulder slightly produced distally; inferior margin distal to groove fairly sinuous. Merus about 2.5 times as long as broad; inferior inner margin bearing 6 to 10 small movable spines and strong, acute immovable spine at distal end; superior margin projected as blunt tooth distally. Ischium bearing 3 to

4 small movable spines on inferior inner margin.

Minor chela of first pereopods (Figure 5g,h) about 3.6 times as long as broad, with fingers occupying distal 0.45 in male. Palmar sculpturing same as that of major chela, but less distinct. Movable finger working at horizontal direction, laterally compressed and forming lamellar expansion; inferior margin concave proximally. Immovable finger slightly deflexed downward and with superior margin broadened proximally. Movable finger and superior margin of immovable finger bearing long scattered setae on inner faces. Merus about 2.9 times as long as broad with inferior inner margin bearing 6 to 7 movable spines and strong, acute immovable spine at distal end. Ischium bearing 2 to 3 movable spines on inferior inner margin.

Second pereopod (Figure 5i) very slender, overreaching distal end of carapocerite beyond distal part of merus. Fingers of chela about 1.3 times as long as palm. First segment of carpus about 1.9 times as long as second; second segment 1.8 times as long as third; third segment slightly shorter than fourth; fifth segment slightly shorter than second and 1.6 times as long as third.

Third pereopod (Figure 5j) rather slender. Dactylus conical, slightly deflexed downward with very small tooth on distal  $\frac{1}{5}$  of superior margin. Propodus about 2.5 times as long as dactylus and 1.4 times as long as carpus, with 7 movable spines and 2 or 3 irregular adjacent movable spines on inferior margin and pair at distal end; distalmost spine long, reaching to middle of dactylus. Carpus with superior distal margin produced as tooth-like process. Merus very slender, slightly less than 8 times as long as broad and 1.8 times as long as carpus. Ischium with rather strong movable spine.

Fourth pereopod almost same as third pereopod. Ischium with rather strong movable spine.

Ischium of fifth pereopod with movable spine.

Pleura (Figure 5k) of first four abdominal somites broadly rounded in both sexes. Pleuron of fifth somite subrectangular on posterior ventral margin. Abdominal sternite with no spine at midline. Appendix masculina reaching to or slightly overreaching distal end of appendix interna.

Telson (Figure 5l) slender, about 1.7 times as long as broad at anterior end, bearing two pairs of dorsal spines and with no distinct longitudinal median depression on dorsal surface. Lateral margin slightly produced at middle. Posterior margin shallowly triangular, armed with pair of spines on each lateral end, inner spine very strong, more than 3 times as long as outer one.

Uropodal endopod bearing conspicuous small spines on distal margin, laterally more strong and with inner depression at anterior half almost invisible. Uropodal exopod bearing slender movable spine flanked laterally by acute immovable tooth and internally by acutely triangular immovable tooth; movable spine reaching to distal margin of uropodal exopod; transverse suture forming two convex lobes.

VARIATIONS.—This species shows several variations. The movable finger of minor chela is typically laminate in males.

In females (Figure 5*m*), the shape of movable finger varies from the very slightly laminated form to the fully laminated form like a typical movable finger of male. This variation has no consistent trends in relation to size because the fully laminated movable finger is observed even in very small specimens. The other prominent variation is observed in the protopodite of pleopod (Figure 5*n*). Some specimens have the spine-like, stout short setae (color, brown in preserved specimens) on lateral margins of the protopodites of pleopods. This variation also has no consistent trends in relation to sex and size. *A. bellimanus* has a spine on the ischium of the fifth pereopod, and shows that the carpopercite and scaphocerite slightly overreach the distal end of antennular peduncle. But one specimen has no spine on the ischium of the fifth pereopod and one specimen shows that the carpopercite and scaphocerite do not overreach the distal end of antennular peduncle.

**HABITAT.**—Lowest intertidal zone to 300 m, usually dredged on sand rocks, soft mud, fine gravel or among corallines.

**COLOR IN LIFE.**—Mostly olive green, orange at tip of tail fan; tips of chelae and branchial regions orange; white mark on palm of major chela (Wicksten, 1983:42).

**TYPE-LOCALITY.**—San Diego, California.

**DISTRIBUTION.**—Monterey, California south along outer coast of Baja California, southern Gulf of California, Islas Socorro and Clarion; western Mexico; Panama. Chile (Coutière, 1899:29). Now reported from Colombia and Galapagos Islands.

## 2. *Alpheus rectus*, new species

FIGURE 6

**MATERIAL EXAMINED.**—Holotype: Male, cl 7.9 mm, Bahia Honda, Panama (outside of Bay) (sta 862-38).

Paratypes: 1 ♂, 2 ♀ (sta 862-38).

Mexico: South of Isla Partida, Baja California (sta 561-36: 1 ♂, 1 ♀, 2 ovig).

**MEASUREMENTS.**—Males, cl 7.5–8.5 mm; females, cl 6.2–7.6 mm; ovigerous females, cl 7.8–8.3 mm.

**DESCRIPTION.**—Rostrum (Figure 6*a-c*) sharply triangular, overreaching middle of visible part of first antennular segment and extending posteriorly a very short distance as dorsally rounded carina.

Ocular hood slightly inflated dorsally, separated from rostral carina by almost indistinct depression near base of rostrum and armed with sharp tooth directing forward. Ocular tooth reaching to distal  $\frac{1}{4}$  of rostrum. Anterior inner margin of ocular hood slightly concave, slanting anteriorly from base of rostrum to ocular tooth.

Carapace with pterygostomian margin very slightly produced anteriorly below base of basicerite.

First antennular segment bearing very deep, triangular carina extending from ventral inner margin; ventral tip ending in very small acute tooth directing slightly upward (Figure 6*d*). Second segment about 2.4 times as long as broad, 1.3 times as long

as visible part of first segment and 1.4 times as long as third segment. Stylocerite narrowing to long sharp point, falling very slightly short of distal margin of first segment.

Scaphocerite rather narrow, about 4.2 times as long as broad. Lateral margin concave at middle. Distal spine overreaching distal end of antennular peduncle by  $\frac{2}{5}$  length of third antennular segment and reaching to, or slightly overreaching distal end of carpopercite. Inner blade narrow distally, falling far short of tip of distal spine, almost reaching to distal end of antennular peduncle. Cleft between inner blade and distal spine shallow, arising from less than distal  $\frac{1}{4}$  of scaphocerite.

Carpocerite overreaching distal end of antennular peduncle by  $\frac{2}{5}$  length of third antennular segment. Basicerite with sharp, triangular lateral spine; spine very broad at base, not reaching to tip of stylocerite.

Third maxilliped (Figure 6*e*) slightly falling short of distal end of carpopercite. Ultimate segment about 1.7 times as long as penultimate and 4.9 times as long as broad near proximal end, tapering distally and bearing sparse long setae on distal margin; tufts of setae on inner face rather sparse. Penultimate segment about 2.5 times as long as broad near distal end, bearing sparse long setae on inferior and superior distal margins. Exopod fairly overreaching distal end of antepenultimate segment. Precoxa with one arthrobranch near distal end but with no small supplementary arthrobranch.

Major first pereopod (Figure 6*f,g*) overreaching distal end of carpopercite by most part of chela. Major chela (Figure 6*h*) about 2.8 times as long as broad, bearing scattered long setae on superior margin of inner face of immovable finger and on superior and inferior margins of inner face of palm. Fingers occupying less than distal 0.3 of chela. Movable finger (Figure 6*h*) opening and closing in obliquely horizontal plane, regularly arched in profile, compressed at sides and bluntly rounded at tip. Immobile finger with tip slightly directing upward and outward. Palm with superior and inferior transverse grooves. Superior transverse groove narrow, connecting to long longitudinal groove (superior groove), groove spreading from proximal superior margin of palm and leading to dactylar articulation on outer palmar face; shoulder proximal to transverse groove produced distally. Superior crest distal to transverse groove terminating distally in strong tooth at dactylar articulation, tip directing downward. Ridge to palmar plaque on outer palmar face well demarked on inferior side by deep, distinct longitudinal groove (palmar groove); groove reaching proximally past to midlength of palm. Inferior crest rounded on surface and terminating in acute tooth flanking dactylar articulation. Inferior transverse groove shallow, connecting to short, shallow depression proximal to groove on inner palmar face and connecting to deep, broad longitudinal depression (inferior groove) on outer palmar face; shoulder proximal to groove well produced distally; inferior margin distal to transverse groove straight to tip of immovable finger. Merus about 2.4 times as long as broad with inferior inner margin bearing 6 to 7 small movable spines and strong acute immovable spine at distal end. Ischium bearing 2 to 3 movable

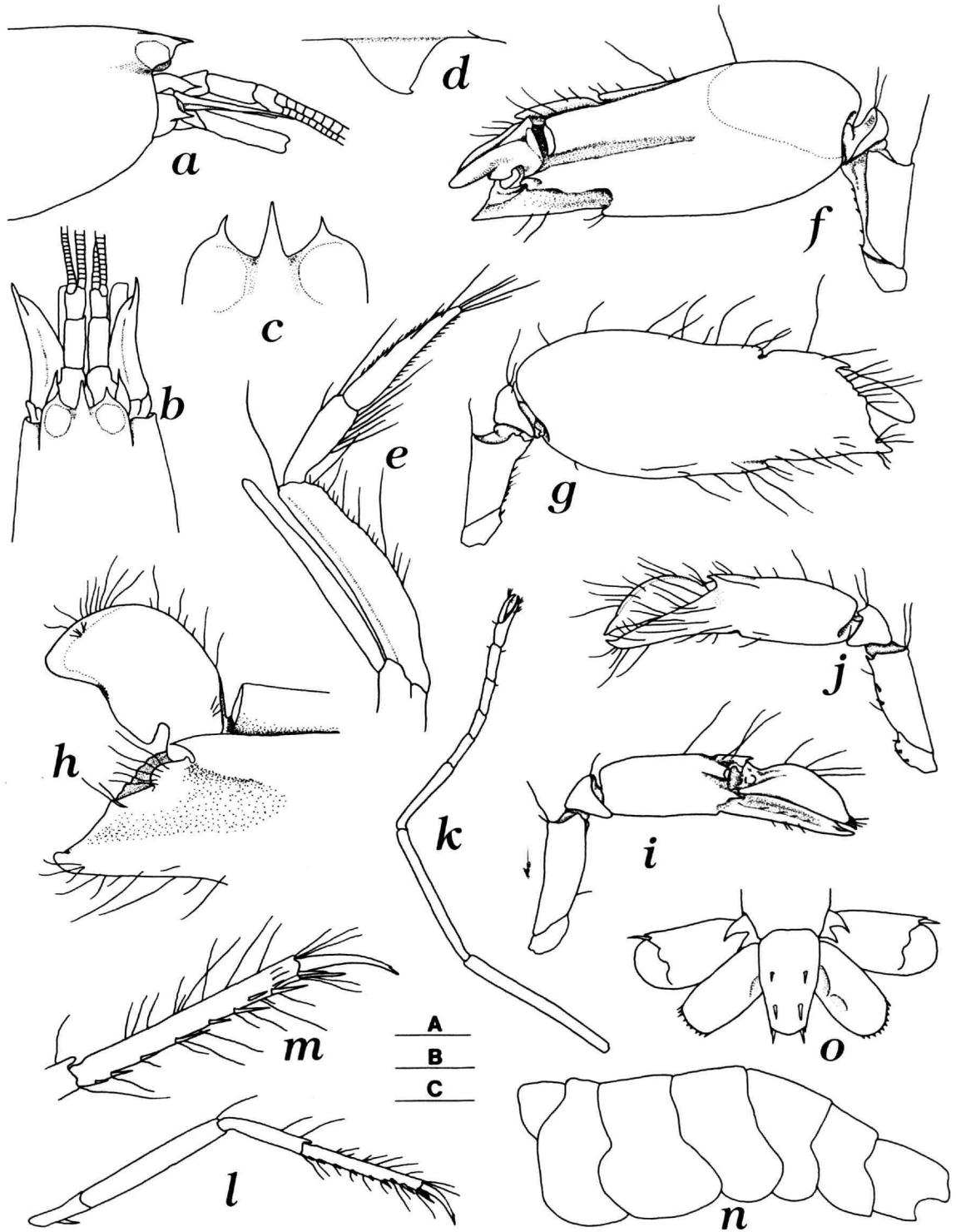


FIGURE 6.—*Alpheus rectus*, new species, holotype male, cl 7.9 mm, from sta 862-38: a, anterior region, lateral view; b, same, dorsal view; c, anterior dorsal margin of carapace; d, carina below right first antennular segment (paratype male, cl 7.5 mm, from sta 862-38); e, right third maxilliped; f, major first pereopod, outer face; g, same, inner face (f, g, paratype male, cl 7.5 mm, from sta 862-38); h, anterior region of major chela, outer face; i, minor first pereopod, outer face; j, same, inner face; k, right second pereopod; l, right third pereopod; m, same, dactylus and propodus; n, abdomen; o, telson and uropods. (Scale A = 2 mm: a, b, f, g, i-l, n, o; scale B = 1 mm: c, e, h, m; scale C = 0.5 mm: d.)

spines on inferior inner margin.

Minor chela of first pereopods (Figure 6*i,j*) about 2.4 times as long as broad, fingers occupying about distal  $\frac{1}{2}$ ; tips of fingers very well crossing when closed, especially in female. Palmar sculpturing same as that of major chela, but superior shoulder not overhanging transverse groove. Movable finger working at horizontal direction, laterally compressed, forming lamellar expansion, about 3 times as long as broad; inferior margin slightly sinuous. Immobile finger slightly directing downward, with superior margin broadened proximally. Fingers bearing long scattered setae on inner faces. Merus about 2.7 times as long as broad, bearing 4 to 5 movable spines on inferior inner margin and small acute spine at distal end. Ischium bearing 2 to 3 movable spines on inferior inner margin.

Second pereopod (Figure 6*k*) very slender, reaching distal end of carapocerite beyond distal part of merus. Fingers of chela about 1.5 times as long as palm. First segment of carpus about 2.2 times as long as second; second segment 1.4 times as long as third; fifth segment slightly shorter than second, slightly longer than fourth; fourth segment 1.2 times as long as third.

Third pereopod (Figure 6*l,m*) very slender. Dactylus narrow, slightly deflexed downward, bearing very small tooth on distal  $\frac{1}{5}$  of superior margin. Propodus about 2.7 times as long as dactylus, 1.5 times as long as carpus, bearing 7 movable spines and 2 irregular adjacent movable spines on inferior margin and pair at distal end; distalmost spine long, reaching to middle of dactylus. Carpus with tooth-like process on superior distal margin. Merus very slender, about 1.8 times as long as carpus and slightly less than 8 times as long as broad. Ischium bearing rather strong movable spine.

Fourth pereopod almost same as third pereopod. Ischium bearing movable spine.

Ischium of fifth pereopod bearing small movable spine.

Pleura (Figure 6*n*) of first four abdominal somites broadly rounded in both sexes; pleuron of fifth somite elongate on posterior ventral margin. Abdominal sternite with no spine at midline. Appendix masculina about 1.5 times as long as appendix interna.

Telson (Figure 6*o*) about 2.0 times as long as broad at anterior end, armed with two pairs of rather stout dorsal spines and with no longitudinal median depression on dorsal surface. Lateral margin slightly produced at middle. Posterior margin shallow, triangular in shape, armed with pair of spines on each lateral end; inner spine very strong, almost 2.5 times as long as outer one.

Uropodal endopod bearing conspicuous small spines on distal margin, laterally more strong and with inner depression at anterior half very slight. Uropodal exopod bearing slender movable spine flanked laterally by acute immovable tooth and internally by blunt lobe; movable spine not overreaching distal margin of uropodal exopod; transverse suture forming two convex lobes, outer one more convex.

VARIATIONS.—The shape of lamellar expansion of movable finger of minor chela varies between sexes and among individuals. The female shows very narrow expansion, but the

male shows the moderately broad to extremely broad expansion.

HABITAT.—55 to 73 m; dredged on coral, sand and mud.

DISTRIBUTION.—South of Isla Partida, Baja California; Bahia Honda, Panama.

REMARKS.—The present species is very close to *A. bellimanus* in most characters. The movable finger of major chela of the present species is weaker than that of *A. bellimanus* because the tip is roundly blunt in the present species while the tip is rather bulbous in *A. bellimanus*. The palm of major chela of the present species is more narrow than that of *A. bellimanus* and the inferior transverse groove of palm in the present species is shallow and lying on the same level of the inferior margin, which is almost straight, of immovable finger, but in *A. bellimanus*, the inferior transverse groove is very deep and the inferior margin of immovable finger is sinuous. In the present species, the longitudinal groove below the inferior crest on outer palmar face does not extend posteriorly beyond the inferior transverse groove, but in *A. bellimanus*, the longitudinal groove extends posteriorly as a short groove beyond the inferior transverse groove. The appendix masculina in the present species is about 1.5 times as long as the appendix interna, while in *A. bellimanus* the appendix masculina is almost subequal to or slightly overreaches the appendix interna. The other minor character in the present species is that the tips of fingers of minor chela in female overlap when fingers are closed.

ETYMOLOGY.—The specific name is from the Latin *rectus* (straight), referring to the almost straight inferior margin of the immovable finger of major chela. This feature can be helpful for distinguishing this species from the most similar species *A. bellimanus*.

### 3. *Alpheus hoonsooi*, new species

FIGURE 7

MATERIAL EXAMINED.—Holotype: Male, cl 8.0 mm, Academy Bay, Indefatigable Island, Galapagos Islands (sta 169-34).

Paratypes: 12 ♂, 3 ♀, 2 ovig (sta 169-34).

Colombia: Gorgona Island (sta 224-34: 1 ♂, 1 ovig).

Galapagos Islands: James Bay, James Island (sta 183-34: 1 ♂, 1 ♀, 1 ovig, 6 spec); Sullivan Bay, James Island (sta 336-35: 1 ♀, sta 177-34: 1 ovig); Tagus Cove, Albemarle Island (sta 147-34: 1 ♂, sta 149-34: 1 ♂, 3 ovig, sta 155-34: 1 ♂, 3 ovig, 1 spec, sta 157-34: 1 ♂, 1 ♀, 1 ovig, 1 spec); Post Office Bay, Charles Island (sta 167-34: 3 ♂, 2 ♀, 1 ovig, 1 juv, sta 193-34: 1 juv).

MEASUREMENTS.—Males, cl 3.9–8.0 mm; females, cl 4.2–7.8 mm; ovigerous females, cl 4.8–9.8 mm.

DESCRIPTION.—Rostrum (Figure 7*a,b*) sharply triangular, reaching to middle of visible part of first antennular segment and bearing several short setae along margins. Rostrum extending posteriorly a short distance as shallow rounded

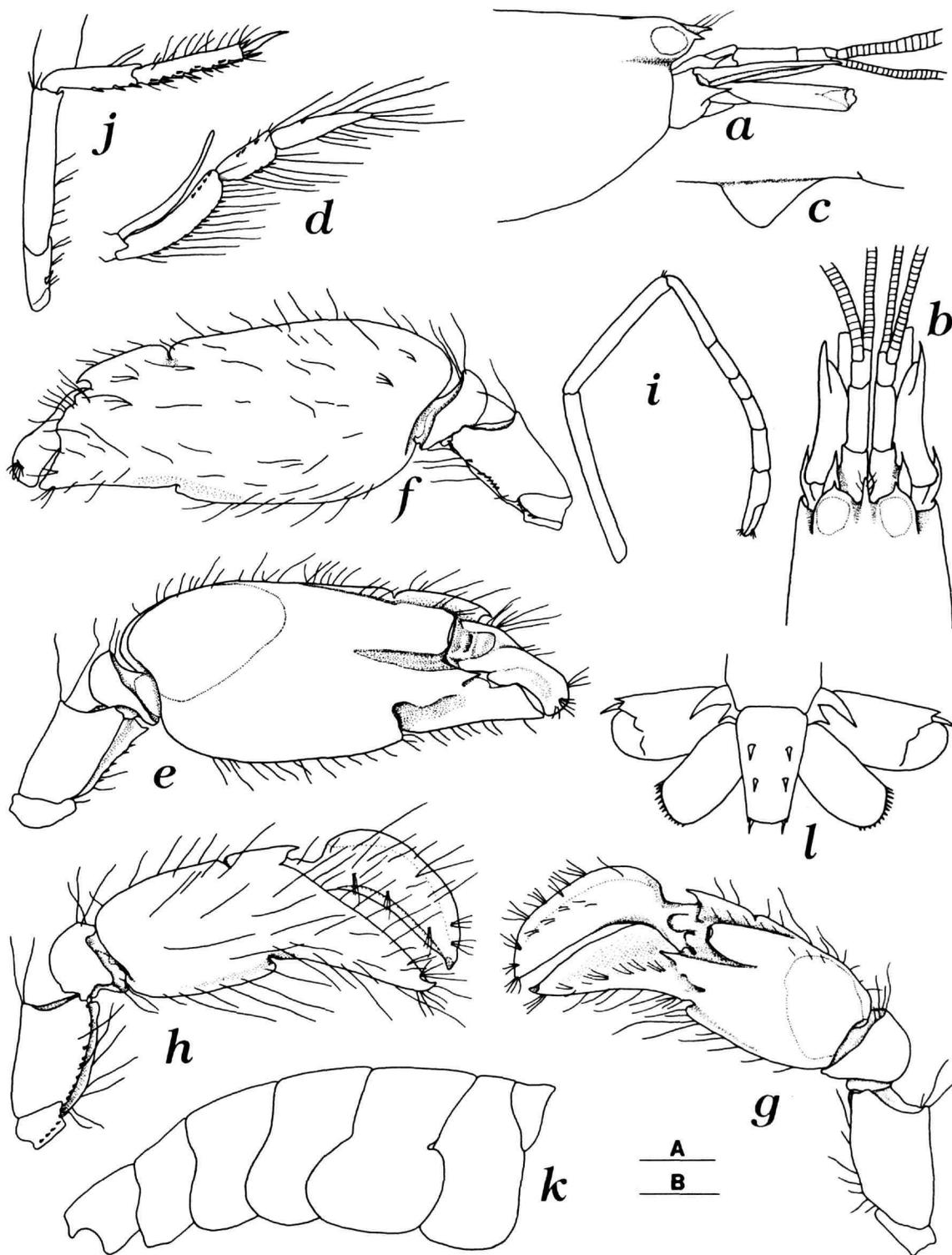


FIGURE 7.—*Alpheus hoonsooi*, new species, holotype male, cl 8.0 mm, from sta 169-34: *a*, anterior region, lateral view; *b*, same, dorsal view; *c*, carina below right first antennular segment; *d*, right third maxilliped; *e*, major first pereopod, outer face; *f*, same, inner face; *g*, minor first pereopod, outer face; *h*, same, inner face; *i*, right second pereopod; *j*, right third pereopod; *k*, abdomen; *l*, telson and uropods. (Scale A = 2 mm: *a*, *b*, *d*-*l*; scale B = 0.5 mm: *c*.)

carina.

Ocular hood moderately produced dorsally, separated from rostral carina by shallow, but distinct depression anteriorly and armed with sharp tooth. Ocular tooth directing downward, reaching to distal  $\frac{1}{5}$  of rostrum. Anterior inner margin of ocular hood slanting anteriorly from base of rostrum to ocular tooth, very concave near base of rostrum.

Antennules rather slender. First antennular segment bearing very deep, triangular carina extending from ventral inner margin; ventral part blunt (Figure 7c). Second segment about 2.8 times as long as broad, 1.4 times as long as visible part of first segment and 1.7 times as long as third segment. Stylocerite narrowing to long sharp point, not reaching to distal margin of first segment.

Scaphocerite rather narrow with lateral margin concave at proximal  $\frac{1}{3}$ . Distal spine directing slightly inward, overreaching distal end of antennular peduncle but falling short of distal end of carpoperite. Inner blade narrow distally, falling far short of tip of distal spine. Cleft between inner blade and distal spine arising from slightly less than distal 0.4 of scaphocerite.

Carpocerite overreaching distal end of antennular peduncle by  $\frac{2}{3}$  length of third antennular segment. Basicerite with sharp, long triangular lateral spine; spine very broad at base, overreaching tip of rostrum and almost reaching to tip of stylocerite.

Third maxilliped (Figure 7d) reaching to distal end of carpoperite. Ultimate segment about 1.5 times as long as penultimate and 3.8 times as long as broad near proximal end, tapering distally, bearing scattered long setae on superior and inferior margins as well as on distal margin; tufts of setae on inner face rather sparse. Penultimate segment about 2 times as long as broad near distal end, bearing seta-like movable spines on superior and inferior margins (less distinct on superior margin) and bearing long dense setae on inferior margin. Antepenultimate segment bearing seta-like movable spines as well as long, dense setae on inferior margin. Exopod reaching to middle of penultimate segment. Precoxa with one arthrobranch near distal end but with no supplementary arthrobranch.

Major first pereopod (Figure 7e,f) reaching distal end of carpoperite beyond proximal 0.3 of chela. Major chela about 2.4 times as long as broad, bearing scattered long setae on inner face, especially on inferior and superior margins of palm and on superior margin of immovable finger. Fingers occupying slightly less than distal 0.3 of chela. Movable finger opening and closing in obliquely horizontal plane, regularly arched in profile, slightly compressed laterally and bluntly rounded at tip; tip slightly overreaching tip of immovable finger. Immovable finger with tip directing slightly upward and outward. Palm with superior and inferior transverse grooves. Superior transverse groove narrow, connecting to very slight, short depression on inner palmar face and connecting to long longitudinal groove (superior groove), groove spreading from proximal superior margin of palm and leading to dactylar articulation on outer palmar face; shoulder proximal to transverse groove slightly overhanging groove in inner view.

Superior crest distal to transverse groove terminating distally in strong tooth at dactylar articulation, tip directing downward. Ridge to palmar plaque on outer palmar face demarked on inferior side by shallow, but distinct longitudinal groove (palmar groove); groove reaching proximally short of mid-length of palm. Inferior crest rounded on surface and terminating in acute tooth flanking dactylar articulation. Inferior transverse groove shallow, connecting to very shallow, short longitudinal depression on inner palmar face and connecting to deep, broad longitudinal depression (inferior groove) on outer palmar face; inferior margin distal to transverse groove almost straight. Merus about 1.5 times as long as broad; inferior inner margin bearing 9 to 10 small movable spines besides several long setae and bearing strong acute immovable spine at distal end. Ischium bearing 5 to 6 movable spines on inferior inner margin.

Minor chela of first pereopods (Figure 7g,h) about 2.7 times as long as broad, with fingers occupying distal 0.45. Palmar sculpturing same as that of major chela. Movable finger working at horizontal direction, compressed laterally, forming lamellar expansion, about 2.8 times as long as broad; inferior margin strongly concave proximally. Immovable finger strongly directing downward, with superior margin broadened proximally. Chela bearing scattered long setae on inner face, especially on inferior distal portion. Merus about 1.7 times as long as broad; inferior inner margin bearing 9 to 10 movable spines besides several long setae and bearing small acute immovable spine at distal end. Ischium with 5 to 6 movable spines on inferior inner margin.

Second pereopod (Figure 7i) reaching distal end of carpoperite beyond almost proximal end of first carpal segment. Fingers of chela slightly longer than palm. First segment of carpus about 1.9 times as long as second; second segment 1.6 times as long as third; fourth segment 1.3 times as long as third and 0.8 times as long as fifth; fifth segment subequal to second.

Dactylus of third pereopod (Figure 7j) about  $\frac{1}{3}$  times as long as propodus, bearing very small tooth on distal  $\frac{1}{5}$  of superior margin. Propodus about 1.2 times as long as carpus; inferior margin bearing 7 movable spines and 6 adjacent movable spines and bearing pair at distal end; superior distal margin bearing one movable spine. Carpus bearing 3 movable spines along distal  $\frac{2}{3}$  of inferior margin and tooth-like process on superior distal margin. Merus about 1.6 times as long as carpus, 5.5 times as long as broad and armed with one fairly blunt immovable tooth on inferior distal margin. Ischium with one rather strong movable spine.

Fourth pereopod almost same as third pereopod. Ischium with one rather strong movable spine.

Carpus of fifth pereopod with no movable spines on inferior margin. Ischium with no movable spine.

Pleura (Figure 7k) of first four abdominal somites broadly rounded; pleuron of fifth somite broadly triangular on posterior ventral margin. Abdominal sternite with no spine at midline. Appendix masculina slightly longer than appendix interna.

Telson (Figure 71) about 1.7 times as long as broad at anterior end and armed with two pairs of rather stout dorsal spines and with no longitudinal median depression on dorsal surface. Posterior margin rounded, armed with pair of spines at each lateral end; inner spine very strong, almost two times as wide as and three times as long as outer one.

Uropodal endopod bearing conspicuous small spines on distal margin, laterally more strong and with inner depression at anterior half very slight. Uropodal exopod bearing rather long movable spine flanked laterally by acute immovable tooth and internally by rather blunt tooth; movable spine overreaching distal margin of uropodal exopod; transverse suture forming two shallow convex lobes, inner one more shallow.

VARIATIONS.—Three specimens (2 males, cl 5.9 mm, 6.4 mm, from sta 169-34, one male, cl 5.9 mm, from sta 149-34) have one movable spine on the ischium of each fifth pereopod. One aberrant specimen (female, cl 7.8 mm, from sta 169-34) has no right ocular tooth. One specimen (male, cl 7.5 mm, from sta 169-34) shows that the rostrum is shorter than the ocular tooth. The strength of the spines on the third maxilliped varies among specimens. The movable finger of minor chela of female is not much laminate compared with that of male. The pleuron of the second abdominal somite in female is much broader than that of male.

HABITAT.—Dredged at 9 to 128 m, some among red algae.

DISTRIBUTION.—Gorgona Island, Colombia; Galapagos Islands.

REMARKS.—The present species is similar to *A. bellimanus* and *A. rectus* in the shape of the anterior region of carapace and in the laminate shape of movable finger of minor chela of the first pereopod. The present species has a blunt tooth on each inferior distal margin of the third through fifth pereopods and has three movable spines on each inferior margin of carpi of the third and fourth pereopods, but in *A. bellimanus* or *A. rectus*, there are no spines on the meri and carpi of the third through fifth pereopods. *A. clamator* has a tooth on the inferior distal margin of the third pereopod but also has the deep sulcus between ocular hood and rostral carina. In *A. clamator* the movable finger of minor chela of the first pereopod is not laminate. Therefore, the present species also can be easily distinguished from *A. clamator*.

ETYMOLOGY.—The specific name *hoonsooi* is in honor of Hoon Soo Kim of the Department of Zoology, Seoul National University, who has contributed a great deal to the knowledge of Korean Crustacea.

#### 4. *Alpheus barbara* Lockington, 1878

*Alpheus barbara* Lockington, 1878:471.—Kingsley, 1883:117; 1899:716.—Coutière, 1899:29.—Holmes, 1900:185.—Rathbun, 1904:108.—Word and Charwat, 1976:40.—Wicksten, 1984:187.

*Alpheus clamator*.—Kingsley, 1878a:197 [not *Alpheus clamator* Lockington, 1877.]

*Crangon barbara*.—Schmitt, 1921:76.

DESCRIPTION.—The following is the description by Kingsley

(1878a:197) with some modification of terms:

Basal spine of antennule [stylocerite] stout, short, not reaching to second segment of peduncle; third segment half as long as preceding. Antennae without spine on basal joint [basicerite]. Antennal scale [scaphocerite] narrow, spine at antero-exterior angle acute, slender, reaching to end of antennular peduncle.

Third maxilliped rather broad, extending slightly beyond antennal scale.

Chelae of first pair of pereopods unequal. Merus smooth, with very slender spine on distal portion above. Major chela compressed, constriction of each margin at about middle, spine above articulation of movable finger, behind which sulcus running obliquely across superior margin. Second spine on outside; immovable finger slender; movable finger compressed, semicircular in outline viewed from side, slightly longer than immovable finger.

Minor chela with both margins constricted; superior margin of palm tuberculate; spine above articulation of movable finger; fingers about equal to palm, completely closing.

Ischia and meri of second pair of pereopods equal; carpus five segmented, first two segments equal, and each as long as third and fourth; third segment equal to fourth; fifth segment nearly as long as first.

Meri of posterior pairs of pereopods without spine. Propodus spinulose on inferior margin. Dactylus slender.

TYPE-LOCALITY.—Santa Barbara, California.

DISTRIBUTION.—Santa Barbara, California.

REMARKS.—*Alpheus barbara* has not been found since the description by Kingsley in 1878 of an imperfect specimen (noted as *Alpheus clamator*) from Santa Barbara, California. Lockington (1878:471) noted that this species, characterized by the absence of a spine on the basal joint of the antenna (basicerite) and the lack of meral spines on the posterior pereopods, is quite distinct from *A. clamator*. He also noted that this species may be distinguished from *A. bellimanus* by the presence of a slender spine on the distal extremities of the meral segments of the first pereopods, by the want of the antennal basal spine, the less complex sulcation of the major chela, the absence of an external spine on the minor chela, and the equal length of the first two carpal segments of the second pereopod. Because the absence of a lateral spine on the basicerite is a quite distinct and important character, this species is treated as a valid species in the present study until more information is available.

#### 5. *Alpheus clamator* Lockington, 1877

FIGURE 8

*Alpheus clamator* Lockington, 1877a:43; 1878:469.—Bate, 1888:540.—Nobili, 1897:5.—Kingsley, 1899:716.—Coutière, 1899:28.—Holmes, 1900:182, pl. 2: figs. 39, 40.—Baker, 1912:106.—Holthuis, 1952:49.—Word and Charwat, 1976:45.—Wicksten, 1984:189.—A. Banner and D. Banner, 1984:37.

*Alpheus transverso-dactylus* Kingsley, 1878a:196; 1878c:58.

*Alpheus candei*.—Kingsley, 1883:124 [not *Alpheus candei* Guérin-Méneville].

*Alpheus dentipes*.—Rathbun, 1904:108 [not *Alpheus dentipes* Guérin-Méneville].—Luke, 1977:4.

*Crangon clamator*.—Rathbun, 1910:606.—Schmitt, 1946:209.

*Crangon dentipes*.—Schmitt, 1921:74, fig. 50 [not *Alpheus dentipes* Guérin-Méneville].—Ricketts and Calvin, 1962:148.

MATERIAL EXAMINED.—Corona Del Mar, California: 1 ♂, 2 ♀, 3 ovig; 31 Oct 1932, coll. by G.E. and N. MacGinitie.

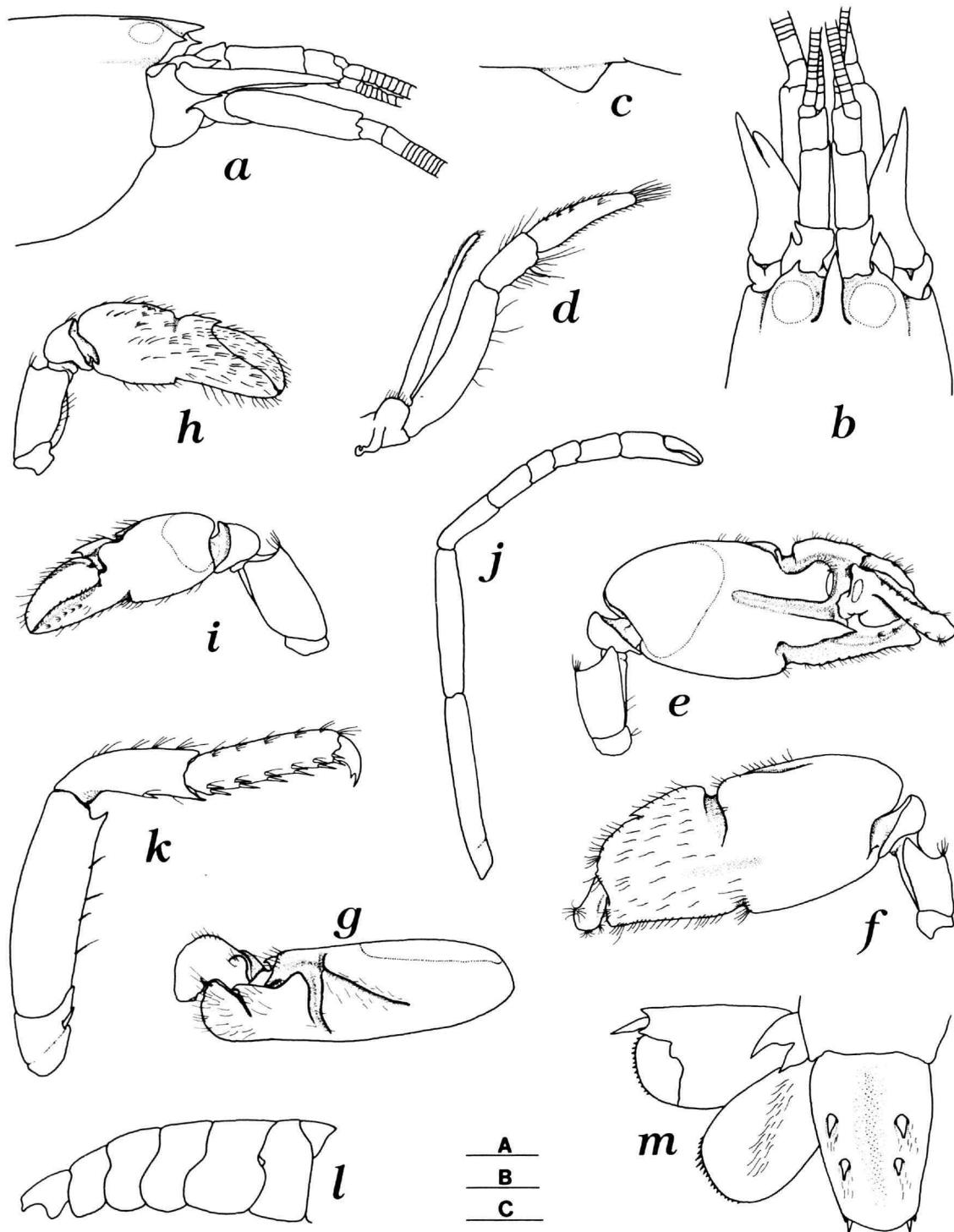


FIGURE 8.—*Alpheus clamator*, male, cl 11.4 mm, from Corona Del Mar, California: *a*, anterior region, lateral view; *b*, same, dorsal view; *c*, carina below right first antennular segment; *d*, right third maxilliped; *e*, major first pereopod, outer face; *f*, same, inner face; *g*, same, major chela, dorsal view; *h*, minor first pereopod, inner face; *i*, same, outer face; *j*, right second pereopod; *k*, right third pereopod; *l*, abdomen; *m*, telson and uropods. (Scale A = 4 mm: *e*–*i*, *l*; scale B = 2 mm: *a*, *b*, *d*, *j*, *k*, *m*; scale C = 1 mm: *c*.)

MEASUREMENTS.—Male, cl 11.4 mm; females, cl 13.4–13.6 mm; ovigerous females, cl 10.2–13.0 mm.

DESCRIPTION.—Rostrum (Figure 8*a,b*) broadly triangular, reaching to middle of visible part of first antennular segment and extending posteriorly to end of eye as broadly rounded carina; lateral margin of rostral carina slightly convex at middle and overhanging orbitorostral groove.

Ocular hood armed with sharp tooth, separated from rostral carina by orbitorostral groove; groove deep and broad anteriorly. Ocular tooth slightly directing inward, reaching to almost half of rostrum. Anterior margin between base of ocular tooth and rostrum bearing blunt process at middle.

Carapace with pterygostomian margin slightly produced anteriorly below base of basicerite.

First antennular segment bearing triangular carina extending from ventral inner margin; ventral part blunt (Figure 8*c*). Second segment about 2.3 times as long as broad, 1.6 times as long as visible part of first segment and 1.6 times as long as third segment. Stylocerite narrowing to sharp point, not reaching to distal margin of first segment.

Scaphocerite with lateral margin concave near middle. Distal spine reaching to distal end of antennular peduncle. Inner blade narrow distally, falling far short of tip of distal spine. Cleft between inner blade and distal spine fairly deep, arising from about distal 0.4 of scaphocerite.

Carpocerite overreaching distal end of antennular peduncle by  $\frac{2}{3}$  length of third antennular segment. Basicerite with sharp, long triangular lateral spine; spine very broad at base, reaching to tip of stylocerite.

Third maxilliped (Figure 8*d*) slightly overreaching distal end of carpacerite. Ultimate segment about 1.7 times as long as penultimate and 3.8 times as long as broad near proximal end, tapering distally, bearing fairly dense tufts of setae on inner face. Penultimate segment about 2.2 times as long as broad near distal end, bearing scattered long setae on superior and inferior margins. Exopod reaching to almost middle of penultimate segment. Precoxa with one arthrobranch near distal end but with no supplementary arthrobranch.

Major chela of first pereopods (Figure 8*e-g*) about 2.6 times as long as broad, bearing scattered short setae on anterior half of inner face. Fingers occupying slightly more than distal 0.3 of chela. Movable finger opening and closing in almost horizontal plane, laterally compressed proximally and bluntly bulbous at tip; tip far overreaching tip of short blunt immovable finger. Palm with superior and inferior transverse grooves. Superior transverse groove broad and deep, connecting to distinct transverse depression on inner palmar face and connecting to long longitudinal groove (superior groove), groove spreading from proximal part of superior margin of palm and leading to dactylar articulation on outer face. Superior crest distal to transverse groove terminating distally in strong tooth at dactylar articulation, tip directing downward. Ridge to palmar plaque on outer palmar face demarked on inferior side by fairly deep and broad longitudinal groove (palmar groove), groove extending proximally to about half length of

palm. Inferior crest rounded on surface and terminating in acute tooth flanking dactylar articulation and demarked on inferior side by deep, broad longitudinal depression (inferior groove). Inferior transverse groove broad and shallow, connecting to inferior groove on outer palmar face; inferior margin distal to transverse groove slightly tuberculate, bearing short setae along margin. Inner palmar face with superior transverse depression extending to midwidth of palm and with slight inferior depression and round longitudinal depression below superior transverse depression. Merus with inferior inner margin almost smooth and no spine at distal end.

Minor chela of first pereopods (Figure 8*h,i*) compressed, about 2.6 times as long as broad, with fingers occupying distal 0.4 and bearing dense short setae on inner face. Palm with superior and inferior transverse grooves and superior crest terminating in sharp tooth distally. Outer palmar face with longitudinal superior groove and with short inferior depression. Inner palmar face with narrow superior transverse depression, tuberculate posterior to superior transverse groove. Merus with inferior inner margin almost smooth and no spine at distal end.

Second pereopod (Figure 8*j*) reaching distal end of carpacerite beyond proximal end of carpus. Fingers of chela subequal to palm. First segment of carpus about 1.3 times as long as second; second segment 1.9 times as long as third; fifth segment about 1.5 times as long as fourth; fourth segment subequal to third.

Third pereopod (Figure 8*k*) fairly broad. Dactylus about  $\frac{1}{4}$  times as long as propodus, biunguiculate and its superior margin semicircular. Propodus about 1.2 times as long as carpus, bearing 5 pairs of movable spines on inferior margin and pair at distal end. Carpus with inferior margin bearing one movable spine at middle and terminating distally in sharp strong tooth. Merus about 1.7 times as long as carpus, 3.3 times as long as broad and armed with one fairly strong immovable tooth a short distance behind distal end of inferior margin. Ischium with one rather strong movable spine.

Fourth pereopod almost same as third pereopod. Merus with immovable tooth on inferior margin. Ischium with movable spine.

Fifth pereopod much smaller than third pereopod. Merus with no tooth and ischium with no movable spine.

Pleura (Figure 8*l*) of first four abdominal somites broadly rounded; pleuron of fifth somite slightly elongate on posterior ventral margin. Abdominal sternite with no spine at midline. Appendix masculina clearly overreaching distal end of appendix interna.

Telson (Figure 8*m*) about 1.5 times as long as broad at anterior end and armed with two pairs of rather stout dorsal spines and with broad longitudinal median depression on dorsal surface. Posterior margin slightly convex, armed with pair of spines at each lateral end; inner spine very strong, more than two times as long as outer one.

Uropodal endopod bearing conspicuous small spines on distal margin and with no distinct inner depression at anterior

half. Uropodal exopod bearing rather long movable spine flanked by acute immovable tooth both laterally and internally; movable spine clearly overreaching distal margin of uropodal exopod; outer lobe of transverse suture very convex and inner lobe flat.

**VARIATIONS.**—Each carpus of the fourth and fifth pereopods bears a small movable spine about at middle of inferior margin and seta at distal  $\frac{1}{4}$ . But some specimens show a very small spine instead of seta in the same region. The inferior inner margin of merus of the major first pereopod is almost smooth but also bears very tiny spinules along margin in some specimens. Female pleopods are provided with dense, long hairs along inner and outer margins of the protopodites.

**HABITAT.**—Lives in pools on rocky reefs at low tide level (Lockington, 1878:470); found in common sponge masses and kelp holdfast (Baker, 1912:106); tides of  $-0.31$  to  $0.49$  m (Word and Charwat, 1976:46).

**COLOR.**—In alcohol, a light flesh tint, much deeper on the major chela. A darker spot on the upper surface of the carapace, also on the anterior edge of the first two abdominal somites (Lockington, 1878:470).

**TYPE-LOCALITY.**—Santa Barbara Island.

**DISTRIBUTION.**—Horseshoe Cave, Sonora County, California; Santa Barbara Island, Santa Cruz Island, San Bartolome Bay, west coast of Baja California.

## 6. *Alpheus inca* Wicksten and Méndez, 1981

FIGURE 9

*Alpheus inca* Wicksten and Méndez, 1981:137, figs. 1–16.—Méndez, 1981:97, pl. 39: figs. 291, 292, 292a, 293, 293a,b.

**MATERIAL EXAMINED.**—Peru: Lobos de Afeura (sta 391-35: 4 ♂, 2 ♀); San Juan Bay (sta 825-38: 1 ♂).

Chile: Valparaiso Prov., Algarrobo, ca. 7 km S. of Valparaiso: 1 ♂, 1 ovig; 19 Mar 1974, coll. by C.E. Dawson.

**MEASUREMENTS.**—Males, cl 5.2–16.9 mm; females, cl 5.2–5.3 mm; ovigerous female, cl 10.1 mm.

**DESCRIPTION.**—Rostrum (Figure 9a,b) short, regularly triangular, about 0.7 times as long as broad at base and reaching to proximal  $\frac{1}{3}$  of visible part of first antennular segment. Rostrum not carinate posteriorly.

Ocular hood not clearly inflated dorsally, armed with small median tooth reaching to distal  $\frac{1}{3}$  of rostrum. Anterior margin between ocular tooth and base of rostrum sinuous, slightly convex to concave. Orbitorostral groove invisible.

First antennular segment bearing very deep carina extending from ventral inner margin; ventral part rounded distally (Figure 9c). Second segment more than 2 times as long as broad, about 1.5 times as long as visible part of first segment and 2.0 times as long as third segment. Stylocerite narrowing to sharp point, falling far short of distal margin of first segment.

Scaphocerite about 2.5 times as long as broad. Lateral margin slightly concave at middle. Distal spine reaching to

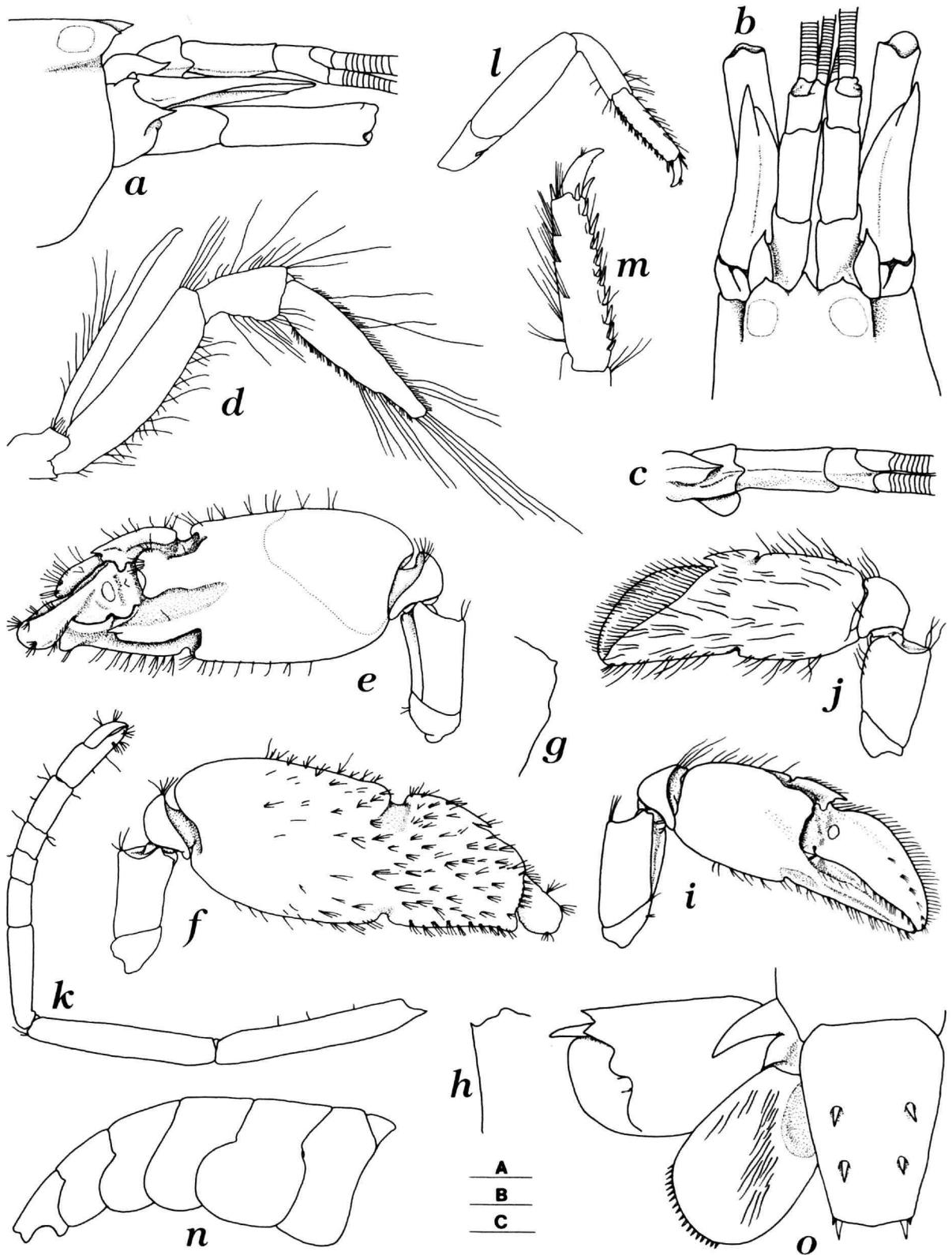
distal end of antennular peduncle and falling far short of distal end of carpocerite. Inner blade narrower than adjacent distal spine, falling far short of tip of distal spine. Cleft between inner blade and distal spine shallow, arising from less than distal  $\frac{1}{4}$  of scaphocerite.

Carpocerite overreaching distal end of antennular peduncle by almost length of third antennular segment. Basicerite with sharp, triangular lateral spine; spine very broad at base and rather long, slightly overreaching tip of stylocerite.

Third maxilliped (Figure 9d) overreaching distal end of carpocerite by half length of ultimate segment. Ultimate segment tapering distally, about 1.8 times as long as penultimate. Penultimate segment about 1.5 times as long as broad at distal end, bearing scattered stiff long setae on inferior margin. Exopod reaching to proximal  $\frac{1}{3}$  of penultimate segment. Precoxa with one arthrobranch near distal end but with no supplementary arthrobranch.

Major first pereopod (Figure 9e,f) overreaching distal end of carpocerite by almost length of chela. Major chela slightly compressed, about 2.6 times as long as broad with fingers occupying distal  $\frac{1}{3}$ . Movable finger moving in almost horizontal plane, constricted laterally on proximal region; superior distal margin regularly arched and tip inflated and bluntly bulbous. Immobile finger with inferior margin slightly concave at distal  $\frac{1}{3}$  and with tip short, strongly directed downward and outward; anterior margin above tip dentate on inner face. Superior crest of palm rounded dorsally, terminating in strong acute tooth flanking dactylar articulation and merging proximally with superior edge of palm. Superior transverse groove very broad, spreading down to  $\frac{1}{3}$  width of palm on inner face and connecting to rather short superior groove on outer face; proximal shoulder slightly overhanging transverse groove. Palmar plaque rather broad, separated from wide longitudinal grooves superiorly (superior groove) and inferiorly (palmar groove). Superior groove on outer palmar face not extending posterior to proximal shoulder of superior margin; palmar groove arising from distal  $\frac{1}{3}$  of palm. Inferior crest narrowly rounded on surface and terminating in acute tooth flanking dactylar articulation. Inferior transverse groove narrow, but deep, connecting to narrow, longitudinal depression below inferior crest on outer palmar face and extending to short depression on inner palmar face. Chela moderately setose, with numerous groups of setae on anterior  $\frac{1}{3}$  of inner face and on superior and inferior margins. Merus about 1.8 times as long as broad; inferior inner margin smooth and armed with very small spine at distal end.

FIGURE 9.—*Alpheus inca*, male, cl 16.9 mm, from Valparaiso, Chile: a, anterior region, lateral view; b, same, dorsal view; c, carina below right first antennular segment; d, right third maxilliped; e, major first pereopod, outer face; f, same, inner face; g, same, distal end of inferior inner margin of merus; h, same, distal end of inferior inner margin of merus (ovigerous female, cl 10.1 mm, from Valparaiso, Chile); i, minor first pereopod, outer face; j, same, inner face; k, right second pereopod; l, right third pereopod; m, same, dactylus and propodus; n, abdomen; o, telson and uropods. (Scale A = 4 mm: e, f, i–l, n; scale B = 2 mm: a–d, m, o; scale C = 1 mm: g, h.)



Minor chela of first pereopods (Figure 9*i,j*) strongly compressed laterally, about 2.6 times as long as broad with fingers occupying distal  $\frac{1}{2}$ . Palm with superior crest well developed, ending in acute tooth flanking dactylar articulation. Inferior crest indistinct but ending in very small acute tooth flanking dactylar articulation on outer palmar face. Superior transverse groove narrow and leading to distinct longitudinal superior groove on outer palmar face but palmar groove less distinct. Inferior transverse groove distinct and leading to longitudinal inferior groove on outer palmar face. Movable finger working at horizontal direction, flattened, and about 2.6 times as long as broad; inferior margin slightly concave at proximal half. Immobile finger with superior margin flattened proximally; inferior margin almost straight. Chela densely setose, bearing dense setae on superior margin of immobile finger and on inner surface of movable finger and bearing scattered long setae on inner palmar face. Merus about 2.2 times as long as broad, bearing several setae on distal  $\frac{1}{3}$  of inferior inner margin and very small acute spine at distal end (not seen in largest specimen).

Second pereopod (Figure 9*k*) reaching distal end of carpoperite beyond proximal  $\frac{1}{3}$  of first carpal segment. Fingers of chela subequal to or slightly longer than palm. First segment of carpus about 2.1 times as long as second; second segment about 1.7 times as long as third; third segment subequal to fourth; fifth segment slightly longer than second and 1.9 times as long as fourth.

Dactylus of third pereopod (Figure 9*l,m*) about 0.3 times as long as propodus, bearing very small tooth on distal 0.3 of superior margin and minute tooth on distal  $\frac{1}{4}$  of inferior margin; distal  $\frac{1}{3}$  much narrower than rest of dactylus. Propodus about 1.2 times as long as carpus, bearing 9 movable spines and 2 irregular adjacent spines on inferior margin and pair at distal end; superior distal margin bearing two movable spines. Merus about 3.3 times as long as broad and 1.8 times as long as carpus. Ischium bearing one rather small movable spine.

Fourth pereopod almost same as third pereopod. Ischium bearing one movable spine.

Ischium of fifth pereopod bearing movable spine.

Pleura (Figure 9*n*) of abdominal somites broadly rounded in both sexes. Abdominal sternite with no spine at midline. Appendix masculina more than 1.5 times as long as appendix interna.

Telson (Figure 9*o*) rather wide, about 1.3 times as long as broad at anterior end, armed with two pairs of rather stout dorsal spines and with no longitudinal median depression on dorsal surface. Lateral margin almost straight. Posterior margin straight to produced at middle, armed with pair of spines at each lateral end; inner spine very strong, more than two times as wide as and three times as long as outer one.

Uropodal endopod bearing small seta-like spines on distal margin, laterally more strong and with inner depression at anterior half very distinct. Uropodal exopod bearing movable spine flanked laterally by acute immobile tooth and internally

by broadly acute tooth; movable spine slightly overreaching distal margin of uropodal exopod; transverse suture forming two convex lobes, outer one more convex.

VARIATIONS.—The meri of the first pereopods of this species have a very small spine on distal end of each inferior inner margin. The presence of this spine on the merus of major first pereopod is consistent, but the size varies (Figure 9*g,h*). The largest male (cl 16.9 mm) has no spine on distal end of the inferior inner margin of merus of the minor first pereopod.

HABITAT.—On a bottom of large rocks surrounded by muddy sand (Wicksten and Méndez, 1981:141); shore.

TYPE-LOCALITY.—Bahia de los Mejillones, Chile (22.8°S, 70.5°W).

DISTRIBUTION.—Peru: Punta Brava, Islas San Gallen; Lobos de Afuera; Punta Ripic, Pisco; San Jusan Bay. Chile: Bahia de los Mejillones; Valparaiso.

### 7. *Alpheus grahami* Abele, 1975

FIGURE 10

*Alpheus grahami* Abele, 1975:72, figs. 29A-C,E-J.—Wicksten, 1983:44.

MATERIAL EXAMINED.—Holotype: Ovigerous female, cl 11.1 mm, from Malpelo Island, Colombia.

MEASUREMENTS.—Holotype, ovigerous female, cl 11.1 mm; paratypes, ovigerous female, cl 12.3 mm, juveniles, cl 3.7, 4.2 mm (Abele, 1975).

DESCRIPTION.—Rostrum (Figure 10*a,b*) short and triangular, scarcely reaching to middle of visible part of first antennular segment.

Ocular tooth triangular, subacute and scarcely extending to apex of rostrum. Anterior margin between ocular tooth and rostrum very concave and slightly depressed.

Carapace with pterygostomian margin very slightly produced anteriorly below base of basicerite.

Antennules rather broad. First antennular segment bearing deep, triangular carina extending from ventral inner margin; ventral part acute (Figure 10*c*). Second segment about 1.9 times as long as broad, 1.5 times as long as visible part of first segment; first segment subequal to third segment. Stylocerite tapering to narrow point, clearly overreaching distal margin of first segment.

Scaphocerite with lateral margin very slightly concave at middle. Distal spine small, falling slightly short of distal end of antennular peduncle. Inner blade falling short of tip of distal spine. Cleft between inner blade and distal spine very shallow, arising from less than distal  $\frac{1}{10}$  of scaphocerite.

Carpocerite overreaching distal end of antennular peduncle by  $\frac{1}{3}$  length of third antennular segment. Basicerite with sharp, long triangular lateral spine; spine very broad at base.

Third maxilliped (Figure 10*d*) reaching beyond distal end of carpoperite by distal  $\frac{1}{3}$  of ultimate segment. Ultimate segment slender, about 1.5 times as long as penultimate; penultimate segment elongate, 3 times as long as broad.

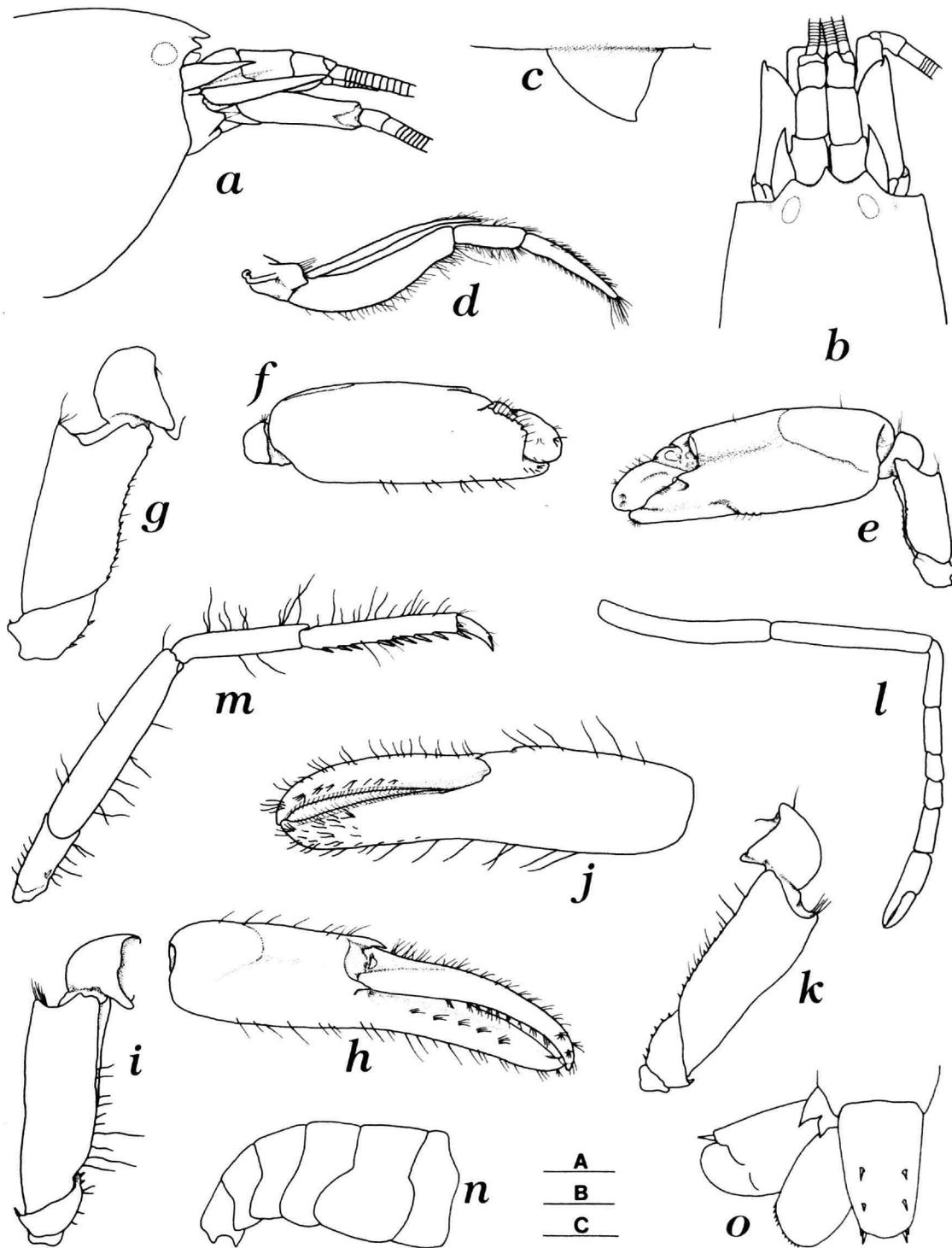


FIGURE 10.—*Alpheus grahami*, holotype ovigerous female, cl 11.1 mm, from Malpelo Island, Colombia: *a*, anterior region, lateral view; *b*, same, dorsal view; *c*, carina below right first antennular segment; *d*, right third maxilliped; *e*, major first pereopod, outer face; *f*, same, chela, inner face; *g*, same, except chela, inner face; *h*, minor first pereopod, chela, outer face; *i*, same, except chela, outer face; *j*, same, chela, inner face; *k*, same, except chela, inner face; *l*, right second pereopod; *m*, right third pereopod; *n*, abdomen; *o*, telson and uropods. (Scale A = 4 mm: *e, f, n*; scale B = 2 mm: *a, b, d, g-m, o*; scale C = 0.5 mm: *c*.)

Exopod reaching to proximal  $\frac{1}{3}$  of penultimate segment. Precoxa with one arthrobranch near distal end but with no supplementary arthrobranch.

Major chela of first pereopods (Figure 10e-g) about 2.8 times as long as broad, free from prominent setae. Fingers occupying about distal 0.3 of chela. Movable finger slightly compressed and very blunt at tip. Immovable finger blunt at tip, margin behind finger on inner face high and crenulate. Palm with no superior transverse groove but with shallow inferior transverse notch in outer view. Outer palmar face with shallow, short longitudinal groove (superior groove) above palmar plaque; palmar groove extending posteriorly to oblique suture and depressed along suture. Inferior transverse notch connecting to longitudinal groove, groove extending to distal margin of immovable finger on outer palmar face; several tubercles present proximal to transverse notch. Palm with pair of large, acute teeth, one on either side near base of movable finger, flanking dactylar articulation. Merus with inferior inner margin bearing several small movable spines and produced broadly at distal end, but no spine; inferior outer margin slightly crenulate. Ischium bearing 3 to 4 small movable spines on inferior inner margin and one small movable spine on lobe on superior distal margin.

Minor chela of first pereopods (Figure 10h-k) about 3.8 times as long as broad, bearing scattered setae along margins. Fingers rather slender, occupying distal 0.55 of chela. Palm with two strong teeth, one on either side near base of movable finger, flanking dactylar articulation and with very shallow median longitudinal depression on outer face. Merus with inferior inner margin bearing very small movable spines behind distal one-third and no spine at distal end. Ischium bearing about 6 small movable spines on inferior inner margin and small movable spine on lobe on distal superior margin.

Second pereopod (Figure 10l) extending beyond distal end of carapocerite by distal three segments of carpus. Fingers of chela slightly longer than palm. First segment of carpus about 1.4 times as long as second; second segment 1.7 times as long as third; fourth segment subequal to third; fifth segment subequal to second.

Dactylus of third pereopod (Figure 10m) about 0.3 times as long as propodus, bearing very small tooth on distal  $\frac{1}{5}$  of superior margin. Propodus about 1.2 times as long as carpus, bearing 9 movable spines on inferior margin and pair at distal end. Merus about 5 times as long as broad and 1.7 times as long as carpus. Ischium with small movable spine (in three of the four available specimens, according to Abele, 1975:74).

Fourth pereopod almost same as third pereopod. Ischium with small movable spine.

Ischium of fifth pereopod with no movable spine.

Pleura (Figure 10n) of first three abdominal somites broadly rounded, those of fourth and fifth somites subtriangular on posterior ventral margin. Abdominal sternite with no spine at midline.

Telson (Figure 10o) about 1.6 times as long as broad at anterior end and armed with two pairs of normal size of dorsal

spines and with no longitudinal median depression on dorsal surface. Posterior margin slightly convex, armed with pair of spines at each lateral end; inner spine about 2 times as long as outer one.

Uropodal endopod bearing very small spines on distal margin and with no distinct inner depression at anterior half. Uropodal exopod bearing movable spine flanked laterally by subacute immovable tooth and internally by blunt lobe; movable spine falling short of distal margin of uropodal exopod; transverse suture forming two shallow convex lobes.

HABITAT.—Rocks, coral and shingle, shore to 40 m (Abele, 1975:72; Wicksten, 1983:44).

COLOR IN LIFE.—Carapace and abdomen translucent brown with oblique translucent white lines edged with blue; tail fan edged with blue and red; chelae reddish with violet tips (Wicksten, 1983:44).

TYPE-LOCALITY.—Southeastern side of Isla Malpelo, Colombia.

DISTRIBUTION.—Gulf of California; Isla Malpelo, Colombia.

REMARKS.—This species is rare. Wicksten (1983) reported this species for the second time.

### 8. *Alpheus websteri* Kingsley, 1880

FIGURE 11

*Alpheus websteri* Kingsley, 1880:416.—Wicksten, 1983:42.

*Alpheus ridleyi* Pocock, 1890:518.

*Alpheus nigro-spinatus* Rankin, 1898:249, pl. 30: fig. 6.

*Alpheus ridleyi*.—Chace, 1972:69.

*Crangon arenensis* Chace, 1937:119, fig. 4.

MATERIAL EXAMINED.—Costa Rica: Guanacaste, Playa del Coco (sta 1566: 1 ♂, 1 ovig); Puntarenas, Golfo de Nicoya, Isla Tolinga (sta 1567: 5 ♀, 1 ovig).

Panama: Pedro Gonzales, Perlas Islands (sta 33-4: 2 ♂).

TYPE-SPECIMEN.—USNM 84329, male, cl 6.5 mm, Key West, Florida.

MEASUREMENTS.—Males, cl 6.1–10.0 mm; females, cl 4.5–9.0 mm; ovigerous females, cl 6.6–6.7 mm.

DESCRIPTION.—Rostrum (Figure 11a,b) narrowly triangular, almost reaching to middle of visible part of first antennular segment and bearing several setae near base; rostrum extending posteriorly as narrowly raised carina, passing to posterior end of eye.

Ocular hood strongly inflated dorsally, separated from rostral carina by rather deep, distinct depression and armed with sharp tooth directing inward at tip. Ocular tooth reaching to distal  $\frac{1}{3}$  of rostrum. Anterior inner margin of ocular hood strongly slanting anteriorly from base of rostrum to ocular tooth, very concave near base of rostrum.

First antennular segment bearing shallow, round carina extending from ventral inner margin (Figure 11c). Second segment about 2.1 times as long as broad, almost as long as visible part of first segment and 1.5 to 2 times as long as third segment. Stylocerite narrowing to long sharp point, scarcely

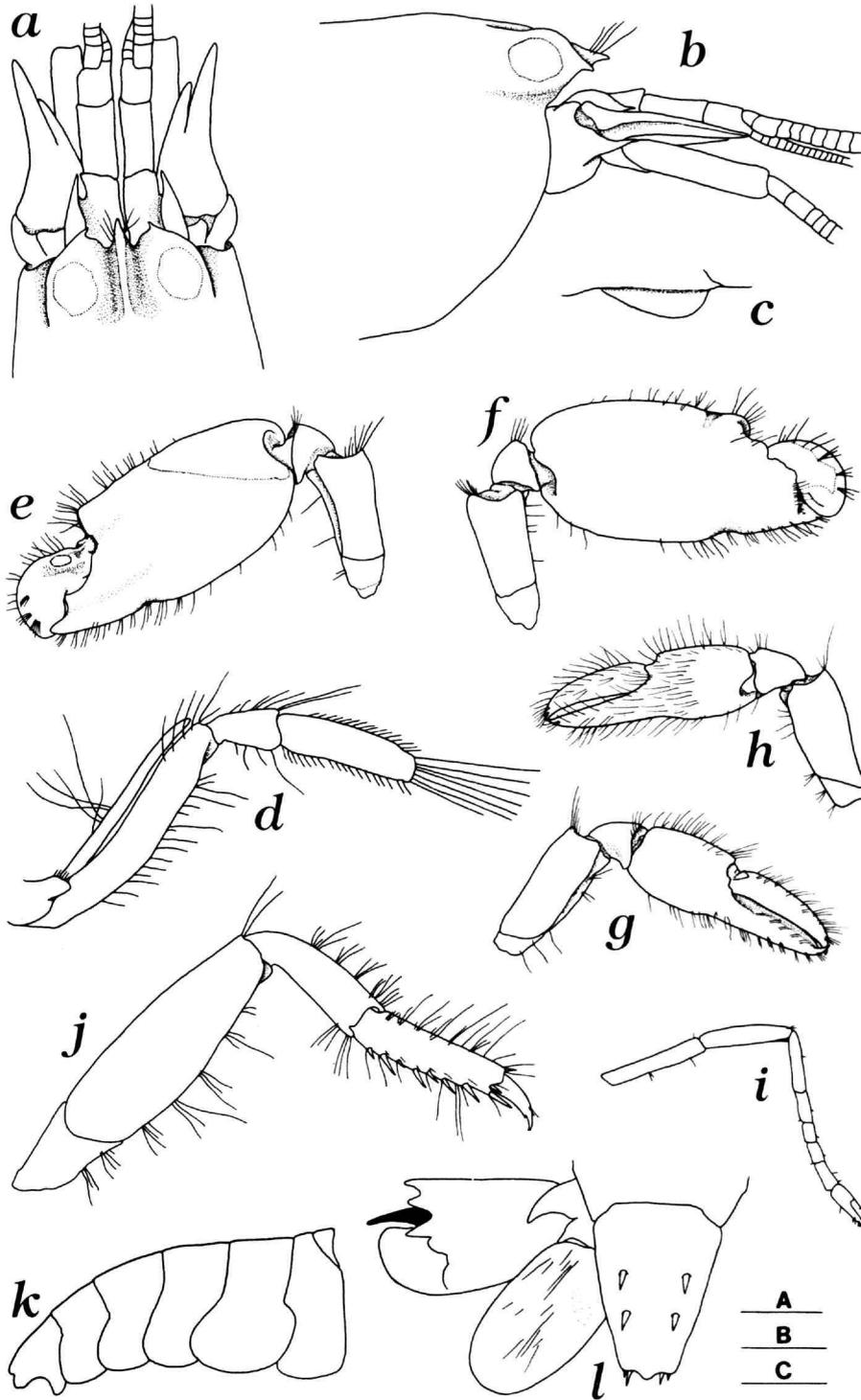


FIGURE 11.—*Alpheus websteri*, ovigerous female, cl 6.7 mm, from sta 1566: *a*, anterior region, dorsal view; *b*, same, lateral view; *c*, carina below right first antennular segment; *d*, right third maxilliped; *e*, major first pereopod, outer face; *f*, same, inner face; *g*, minor first pereopod, outer face; *h*, same, inner face; *i*, right second pereopod; *j*, right third pereopod; *k*, abdomen (male, cl 7.7 mm, from sta 1566); *l*, telson and uropods. (Scale A = 2 mm: *e-i, k*; scale B = 1 mm: *a, b, d, j, l*; scale C = 0.5 mm: *c*.)

reaching to distal margin of first segment.

Scaphocerite with lateral margin strongly concave at middle. Distal spine overreaching distal end of antennular peduncle and slightly falling short of distal end of carpoperite. Inner blade narrower than adjacent distal spine, reaching to distal  $\frac{1}{4}$  of scaphocerite. Cleft between inner blade and distal spine deep, arising from distal  $\frac{1}{2}$  of scaphocerite.

Carpocerite overreaching distal end of antennular peduncle by  $\frac{2}{3}$  length of third antennular segment. Basicerite with sharp, triangular lateral spine; spine long, very broad at base, reaching to or overreaching distal margin of first antennular segment.

Third maxilliped (Figure 11*d*) overreaching distal end of carpoperite by  $\frac{1}{2}$  to entire length of ultimate segment. Ultimate segment truncate at distal end, about 3.4 times as long as broad at proximal end and 2.1 times as long as penultimate, bearing long setae on distal margin. Penultimate segment about 1.5 times as long as broad at distal end. Exopod reaching to distal end of ultimate segment. Precoxa with one arthrobranch near distal end but with no supplementary arthrobranch.

Major chela of first pereopods (Figure 11*e,f*) about 2.3 times as long as broad with fingers occupying distal 0.3. Movable finger opening and closing in almost vertical plane, regularly arched in profile, compressed laterally, bluntly rounded distally and extending somewhat beyond tip of immovable finger. Immovable finger with inferior margin slightly sinuous, with very slight longitudinal groove in outer face; groove arising from region above inferior shallow transverse depression. Palm with trace of longitudinal depression behind dactylar articulation on outer face and with obliquely transverse superior groove most marked on inner face, but terminating abruptly without extending far onto either lateral face. Inferior transverse depression at base of immovable finger very shallow. Merus about 2.2 times as long as broad with no distinct spine (or with trace of very small spine) on distal end of inferior inner margin.

Minor chela of first pereopods (Figure 11*g,h*) about 2.9 times as long as broad, fingers occupying 0.54 length of chela. Inner face of palm bearing acute, subrectangular tooth flanking dactylar articulation. Palm with no trace of sculpturing except trace of very slight depression on inferior margin at base of immovable finger. Entire chela, especially fingers provided with numerous tufts of setae on inner face. Merus about 2.3 times as long as broad with no distinct spine on distal end of inferior inner margin.

Second pereopod (Figure 11*i*) reaching distal end of carpoperite beyond part of merus. Fingers of chela almost as long as palm. First segment of carpus about 2.1 times as long as second; second segment 1.5 times as long as third; third segment subequal to fourth; fifth segment slightly shorter than second and 1.4 times as long as third.

Dactylus of third pereopod (Figure 11*j*) about  $\frac{1}{3}$  length of propodus, with very small tooth on distal  $\frac{1}{4}$  of inferior margin. Propodus about 1.1 times as long as carpus, with 7 movable spines on inferior margin and pair at distal end, and its superior margin provided with tufts of long setae and bearing one

movable spine at distal end. Merus fairly stout, about 3.1 times as long as broad and bearing several tufts of long setae on inferior margin. Ischium with no movable spine.

Fourth pereopod almost same as third pereopod. Dactylus with small tooth on inferior margin. Ischium with no movable spine.

Fifth pereopod much narrower than third pereopod. Ischium with no movable spine.

Pleura (Figure 11*k*) of abdominal somites broadly rounded. Abdominal sternite with no spine at midline. Appendix masculina clearly overreaching distal end of appendix interna.

Telson (Figure 11*l*) about 1.4 times as long as broad at anterior end, armed with two pairs of rather stout dorsal spines (color of spine brown in some specimens preserved in alcohol) and with no longitudinal median depression on dorsal surface. Posterior margin produced at middle, armed with pair of spines at each lateral end; inner spine almost 2 times as long as outer one.

Uropodal endopod with inner depression at anterior half invisible. Uropodal exopod with lateral margin terminating in two immovable teeth, and strong dark colored movable spine overreaching distal margin of uropodal exopod, flanked internally by strong immovable tooth; transverse suture forming two convex lobes, outer one much more narrow and convex.

VARIATIONS.—The rostrum of this species is longer than the ocular tooth, but one male specimen shows that the rostrum is shorter than the ocular tooth. The relative length of the second antennular segment varies from 1.5 times to 2 times as long as the third segment.

HABITAT.—Rock, sand beach, tide pools. Intertidal zone to 6 m, among rocks or coral (Wicksten, 1983:42).

TYPE-LOCALITY.—Key West, Florida.

DISTRIBUTION.—Eastern Atlantic; Caribbean region; southern Gulf of California; Isla Socorro; Costa Rica; Panama; Colombia and Galapagos Islands.

REMARKS.—The present specimens show one additional tooth on each inferior margin of dactyli of the third through fifth pereopods. The previous descriptions and figures did not notice this character, which seems to have been overlooked by previous authors. Wicksten (1983) synonymized *A. arenensis*, *A. ridleyi*, and *A. fagei* with *A. websteri*. The first author examined the type specimen of *A. websteri* and specimens identified as *A. ridleyi* and *A. fagei* at the Smithsonian's National Museum of Natural History. We agree with Wicksten's decision of synonymizing *A. websteri* with *A. ridleyi* and *A. arenensis* even though the latter species shows a few differences. The following features between the present specimens and the type specimen of *A. websteri* are noteworthy. The present specimens have no distinct spine on distal end of the inferior inner margin of merus of the first pereopod, if present, the spine is very minute and almost invisible, while the type specimen of *A. websteri* has a distinct spine; the present specimens have more slender minor chelae and broader meri of the third pereopods than those of type

specimen of *A. websteri*. According to Crosnier and Forest (1966:236), *A. fagei* can be distinguished from *A. arenensis* or *A. ridleyi* by having a spine on basicerite shorter than stylocerite and by having the propodus of the third pereopod without a spine distally. Based upon our examination, the tip of movable finger of major chela in the present specimens is broadly rounded but that of *A. fagei* is more acutely triangular in shape. In the present study, *A. fagei* is not treated as a junior synonym of *A. websteri*.

### 9. *Alpheus malleator* Dana, 1852

FIGURE 12

*Alpheus malleator* Dana, 1852:557; 1855:23, pl. 31: figs. 9a-h.—Sharp, 1893:113.—Coutière, 1899:16, figs. 49, 140, 184, 262.—Sivertsen, 1933:4.—Holthuis, 1951:73.—Sourie, 1954:112.—Crosnier and Forest, 1965b:605; 1966:240, fig. 10a-i.—Chace, 1972:68.—Abele, 1975:72.—Brusca, 1980:252.—Wicksten, 1983:43.—A. Banner and D. Banner, 1984:42.

*Alpheus pugilator* A. Milne Edwards, 1878:229.

*Alpheus tuberculosus*.—Balss, 1914:98, figs. 1–5.

*Alpheus malleator edentatus*.—Balss, 1916:22.

*Crangon malleator*.—Rathbun, 1910:606.—Schmitt, 1924a:64; 1936:367; 1939:24.

MATERIAL EXAMINED.—MEXICO: Jalisco, Bahía Cuastecoma, north of Barra Navidad (sta 1559: 2 ♂, 2 juv).

COSTA RICA: Puntarenas, Golfo de Nicoya, Isla Tolinga (sta 1567: 2 ♂, 1 ♀).

MEASUREMENTS.—Males, cl 5.9–11.5 mm; female, cl 4.1 mm.

DESCRIPTION.—Rostrum (Figure 12a,b) small, triangular and falling short of or reaching to middle of visible part of first antennular segment; rostrum extending posteriorly as flattened dorsal surface with lateral margin overhanging orbitorostral groove.

Ocular hood separated from rostral carina by rather deep, broad depression and armed with sharp tooth directing inward at tip. Ocular tooth reaching to or overreaching tip of rostrum. Anterior margin between ocular tooth and base of rostrum bearing small process near base of ocular tooth.

First antennular segment bearing deep, round carina extending from ventral inner margin (Figure 12c). Second segment about 2.3 times as long as broad and 1.3 times as long as third segment; third segment subequal to visible part of first segment. Stylocerite narrowing to sharp point, not reaching to distal margin of first segment.

Scaphocerite bearing blunt process at proximal end. Distal spine overreaching distal end of antennular peduncle and falling far short of distal end of carapocerite. Inner blade very narrow, reaching to middle of third antennular segment. Cleft between inner blade and distal spine deep, arising from distal 1/2 of scaphocerite.

Carpocerite overreaching distal end of antennular peduncle by at least length of third antennular segment. Basicerite with large lateral spine; spine long, very broad at base, almost

reaching to distal 1/2 of second antennular segment.

Third maxilliped (Figure 12d) very stout. Ultimate segment about 2.5 times as long as broad at middle and 2.5 times as long as penultimate, truncate at distal end and bearing long coarse setae on margins. Penultimate segment almost as long as broad at distal end. Exopod scarcely reaching to distal end of ultimate segment. Precoxa with one arthrobranch near distal end but with no supplementary arthrobranch.

Major chela of first pereopods (Figure 12e,f) about 2.2 times as long as broad with fingers occupying distal 0.2 of chela. Movable finger hammer shaped, very blunt distally, extending far beyond tip of immovable finger. Immovable finger with inferior margin rounded, with very slight longitudinal groove on outer face, extending to almost middle of palm. Palm tuberculate with tufts of setae on upper portion. Superior distal part of palm with two blunt processes and more acute tooth above dactylar articulation on inner face. Merus with margins smooth, no spine at distal end of inferior inner margin.

Minor chela of first pereopods (Figure 12g,h) about 2.5 times as long as broad with fingers narrower than palm, occupying 0.45 length of chela. Palm tuberculate on upper portion, bearing acute, triangular tooth above dactylar articulation on inner face. Entire chela, particularly fingers, provided with numerous tufts of setae on inner face. Merus very broad with inferior inner margin dentate and setose, but no spine at distal end.

Fingers of chela of second pereopod (Figure 12i) almost as long as palm. First segment of carpus about 2.8 times as long as second; second segment 1.5 times as long as third; third segment subequal to fourth; fifth segment slightly longer than second, 1.7 times as long as fourth.

Dactylus of third pereopod (Figure 12j,k) about 1/3 length of propodus, with small tooth on distal 1/3 of inferior margin. Propodus about 1.2 times as long as carpus and bearing 5 movable spines on inferior margin and pair at distal end. Merus fairly stout, about 2.8 times as long as broad and with inferior margin slightly dentate. Ischium with no movable spine.

Fourth pereopod almost same as third pereopod. Ischium with no movable spine.

Fifth pereopod much narrower than third pereopod. Ischium with no movable spine.

Pleura (Figure 12l) of first four abdominal somites broadly rounded; pleuron of fifth somite subtriangular on posterior ventral margin. Abdominal sternite with no spine at midline. Appendix masculina very strong, about 2 times as long as and more than 3 times as wide as appendix interna.

Telson (Figure 12m) about 1.2 times as long as broad at anterior end, armed with two pairs of dorsal spines (color of spine brown in specimens preserved in alcohol), and with distinct longitudinal median depression on dorsal surface. Posterior margin convex, armed with pair of spines at each lateral end; inner spine more than 2 times as long as outer one.

Uropodal endopod bearing inconspicuous seta-like spines on distal margin and with no distinct inner depression at anterior half. Uropodal exopod bearing inconspicuous setae-

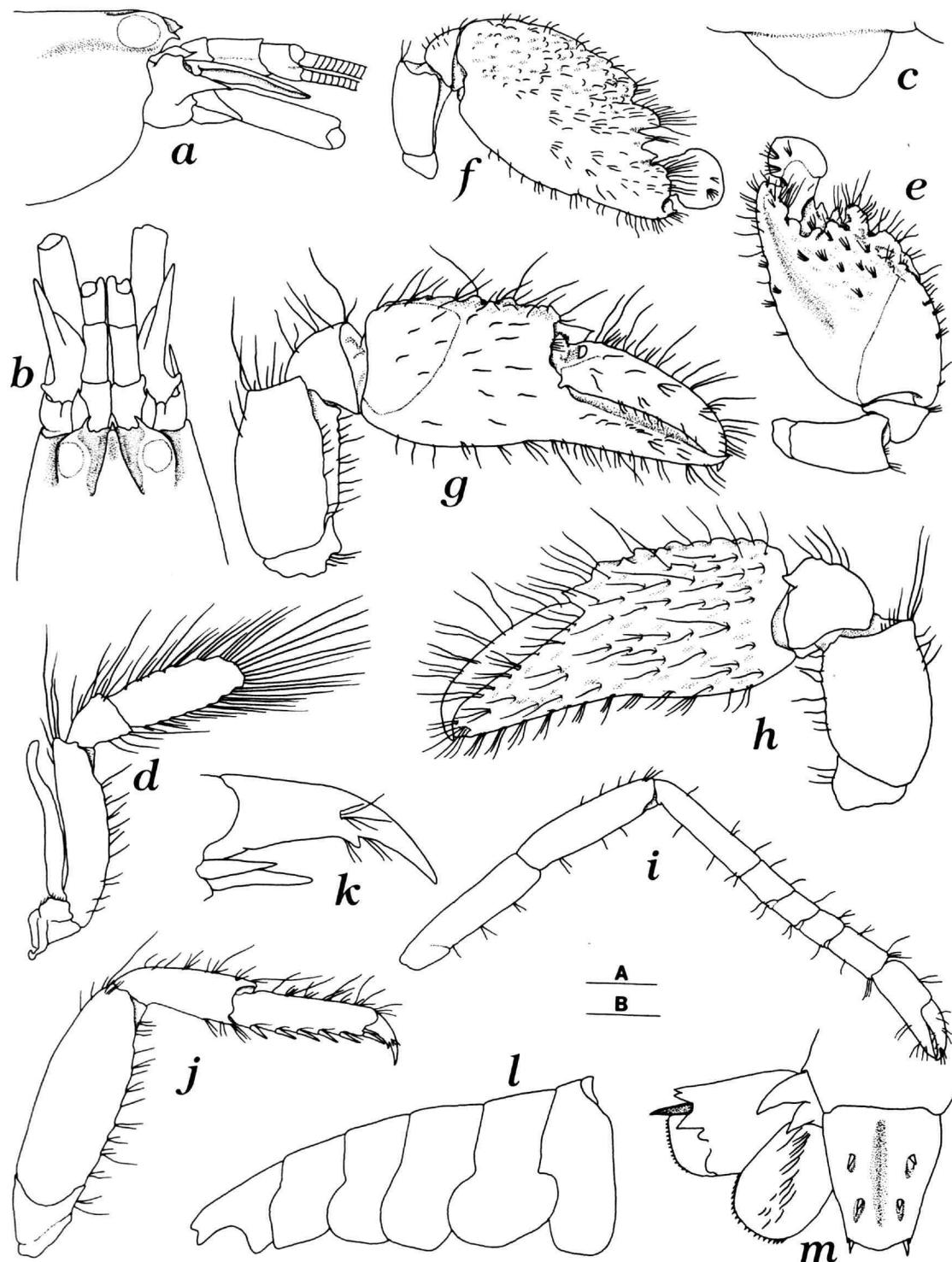


FIGURE 12.—*Alpheus malleator*, male, cl 11.5 mm, from sta 1567: a, anterior region, lateral view; b, same, dorsal view; c, carina below right first antennular segment; d, right third maxilliped; e, major first pereopod, outer face; f, same, inner face (e, f, male, cl 6.3 mm, from sta 1559); g, minor first pereopod, outer face; h, same, inner face; i, right second pereopod; j, right third pereopod; k, same, dactylus; l, abdomen; m, telson and uropods. (Scale A = 2 mm: a, b, d-j, l, m; scale B = 0.5 mm: c, k.)

form spines on distal margin and with lateral margin terminating in two immovable teeth, and strong dark colored movable spine overreaching distal margin of uropodal exopod, flanked internally by strong immovable tooth; transverse suture forming two convex lobes, outer one much more narrow and convex.

**VARIATIONS.**—The length of rostrum varies among specimens: the tip of rostrum falls short of middle of visible part of the first antennular segment in some specimens, while in other specimens the tip of rostrum reaches to middle of the first antennular segment.

**HABITAT.**—Fine sand and rock; 0–1.0 m.

**COLOR IN LIFE.**—Palm and movable finger of cheliped marbled, tip of immovable finger satan red; pereopods almost solid purple and poppy red; chela on top burnt umber, on sides a greenish sepia; body and carapace clove to real brown; white-grayish transverse bands across hind third of carapace and across anterior end of each somite except first, hazel spot on anterior center of each somite; epimeres white on side of carapace; eggs hazel; abdomen of large animals with white splotchy bars, smaller shrimp with irregular splotchy transverse bars of white across anterior edge of each somite; tail fan reddish, terminal fringe golden tawny (color note by W.L. Schmitt, unpublished; Wicksten, 1983:43).

**TYPE-LOCALITY.**—Rio de Janeiro, Brazil?

**DISTRIBUTION.**—Eastern Atlantic from Senegal to Congo; in western Atlantic, Puerto Rico to Estado de São Paulo, Brazil; in eastern Pacific from Gulf of California, southwestern Mexico, Ecuador, Costa Rica, Malpelo and Galapagos Islands.

## 10. *Alpheus lottini* Guérin-Méneville, 1829

FIGURE 13

*Cancer sublucanus* Forskål, 1775:94.

*Alpheus Lottini* Guérin-Méneville, 1829[1829–1844], pl. 3: fig. 3.

*Alpheus Lottinii*.—Guérin-Méneville, 1830[1838]:38.—Kingsley, 1883:113.

*Alpheus ventrosus* H. Milne Edwards, 1837:352.—De Man, 1911:207.—Gravely, 1930:78, pl. 1: figs. 2a, 3b.—Banner, 1958:164, fig. 4.—Luke, 1977:4.

*Alpheus laevis* Randall, 1839:141.

*Alpheus lottinii*.—Sharp, 1893:113.

*Alpheus lottini*.—Stebbing, 1915:82.—Barnard, 1950:748, fig. 141e–j.—Holthuis, 1958:22; 1961:168.—Chace, 1962:608.—Tiwari, 1963:285, fig. 8.—A. Banner and D. Banner, 1966:91, fig. 31; 1984:42.—D. Banner and A. Banner, 1981:34; 1982:65, fig. 15.—Abele, 1975:72; 1979:274.—Abele and Patton, 1976:38.—Bruce, 1976:44.—Brusca, 1980:252.—Wicksten, 1983:42.

*Alpheus sublucanus*.—Holthuis, 1979:9; 1980b:122.

*Crangon ventrosus*.—Chace, 1937:118.—Hult, 1939:4.—Armstrong, 1941:9.

*Crangon latipes* Banner, 1953:82, fig. 27 [juvenile form].

*Crangon ventrosa* Banner, 1953:84, fig. 28.—Hertlein and Emerson, 1957:6.

**MATERIAL EXAMINED.**—Mexico: Isabel Island, Sinaloa (sta 124-33: 3 ♂, 2 ♀, 1 ovig); Sulphur Bay, Clarion Island (sta 140-34: 5 ♂, 5 ovig); Braithwaite Bay, Socorro Island (sta 131-34: 2 ♂, 1 ♀, 4 ovig).

Panama: Perlas Island (sta 32: 1 ♂); Chapera, Perlas Island

(sta 37: 2 ♂, 2 ♀, 4 ovig, sta 39: 1 ♂); Pedro Gonzales, Perlas Islands (sta 33-4: 3 ♂, 4 ♀, 5 ovig); Bay of Panama (LGA 69-33: 5 ♂, 1 ♀, 4 ovig, 1 juv, LGA 69-35: 4 ♂, 1 ovig).

Galapagos Islands: Darwin Bay, Tower Island (sta 101a-33: 2 ♂, 1 ♀, 1 ovig).

**MEASUREMENTS.**—Males, cl 5.6–9.5 mm; females, cl 4.1–7.8 mm; ovigerous females, cl 6.4–11.9 mm.

**DESCRIPTION.**—Body very compressed laterally and carapace with pterygostomian margin produced anteriorly below base of basicerite. Rostrum (Figure 13a,b) acute, long, almost reaching to distal margin of first antennular segment, bearing short setae along lateral margins. Rostral carina broadened and flattened posteriorly, separated from ocular hood by deep and narrow orbitorostral groove on each side.

Ocular hood rounded laterally, bearing acute tooth; tooth arising slightly behind anterior margin and inside of middle part of hood, and directing slightly inward.

Antennules short and stout. First antennular segment bearing very deep carina extending from ventral inner margin; ventral part with very small acute projection (Figure 13c). Second segment variable but usually 1.6 times as long as broad, only slightly longer than visible part of first segment and 1.8 times as long as third segment. Stylocerite elongate, reaching to middle of second antennular segment.

Scaphocerite with lateral margin almost straight. Distal spine far overreaching distal end of antennular peduncle and reaching to distal end of carpocerite. Inner blade narrow distally, far overreaching distal end of antennular peduncle. Cleft between inner blade and distal spine arising from distal 1/3 of scaphocerite.

Carpocerite overreaching distal end of antennular peduncle by length of third antennular segment. Basicerite with lateral spine, very broad at base, slightly overreaching distal margin of first antennular segment.

Third maxilliped (Figure 13d) stout. Ultimate segment broad at middle, tapering distally, about 2.4 times as long as penultimate. Penultimate segment very broad, bearing movable spines on inferior margin. Antepenultimate segment bearing movable spines along distal 2/3 of inferior margin. Exopod reaching to proximal 1/3 of penultimate segment. Precoxa with one arthrobranch near distal end but with no supplementary arthrobranch.

Major chela of first pereopods (Figure 13e,f) compressed laterally, about 2.3 times as long as broad, with no grooves or sculpturing except shallow longitudinal median depression on outer face of immovable finger; superior and inferior margins rounded. Fingers occupying distal 0.3 of chela, bearing scattered setae on both superior and inferior margins. Movable finger not strongly arcuate, tip bluntly rounded. Merus rather broad with superior margin convex; inferior inner margin bearing 4 to 5 movable spines and one strong immovable spine at distal end.

Minor chela of first pereopods (Figure 13g,h) almost as long as major chela but more slender, about 2.7 times as long as broad with fingers about equal in length to palm. Palm with

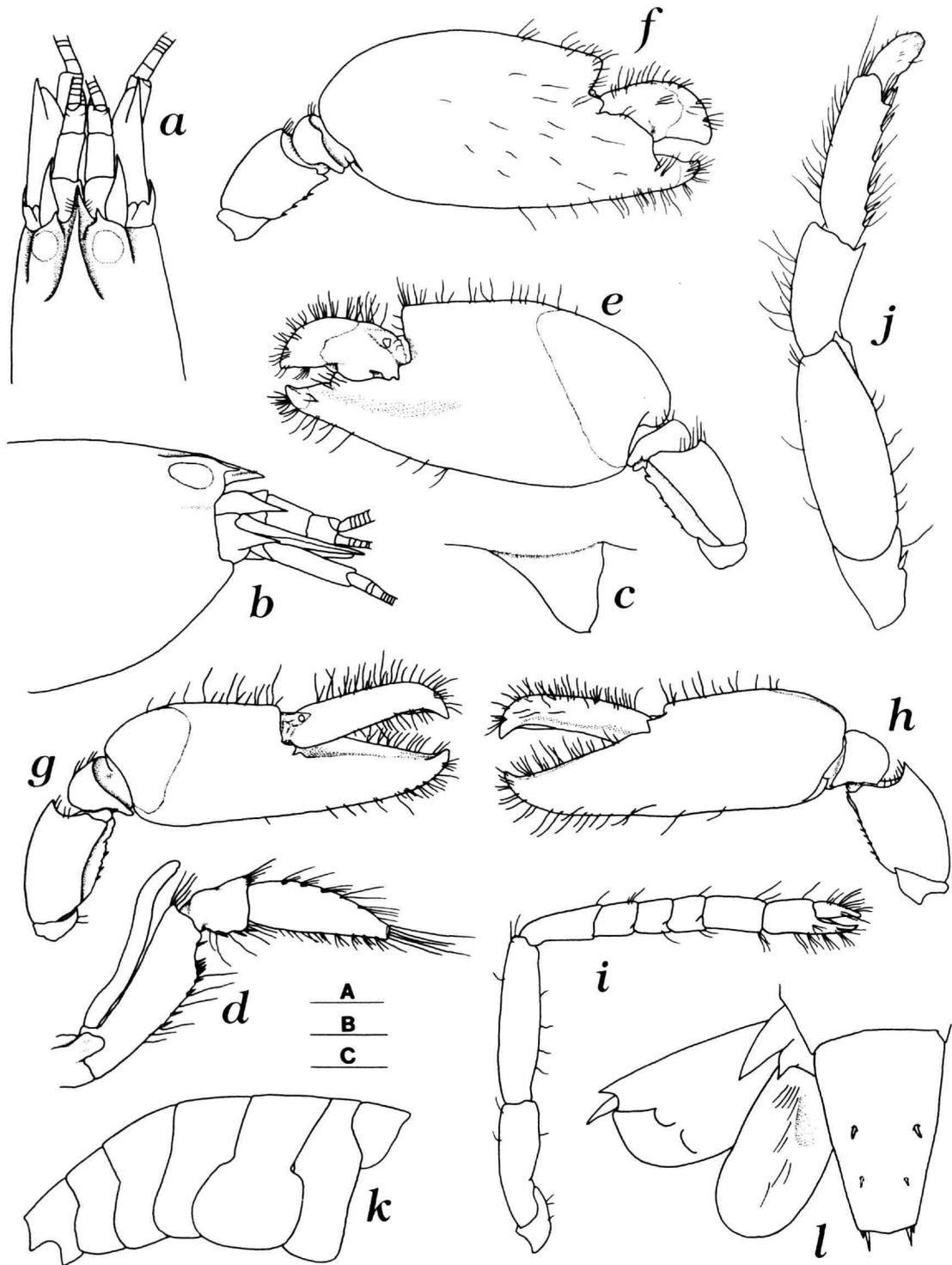


FIGURE 13.—*Alpheus lottini*, male, cl 6.6 mm, from sta 32: *a*, anterior region, dorsal view; *b*, same, lateral view; *c*, carina below right first antennular segment (*a*, *b*, *c*, male, cl 7.7 mm, from sta 37); *d*, right third maxilliped; *e*, major first pereopod, outer face; *f*, same, inner face; *g*, minor first pereopod, outer face; *h*, same, inner face; *i*, right second pereopod; *j*, right third pereopod; *k*, abdomen; *l*, telson and uropods. (Scale A = 2 mm: *a*, *b*, *e*–*h*, *k*; scale B = 1 mm: *d*, *i*, *j*, *l*; scale C = 0.5 mm: *c*.)

small blunt tooth flanking dactylar articulation on inner face. Movable finger much narrower than immovable finger, strongly curved at tip, crossing tip of immovable finger when closed. Inner margin of cutting face of immovable finger with distinct lamellar ridge along entire length and inferior margin of immovable finger regularly rounded. Merus with inferior inner margin bearing 6 to 7 movable spines and more strong immovable spine at distal end; superior margin fairly convex and produced distally.

Second pereopod (Figure 13i) overreaching distal end of carapocerite beyond distal  $\frac{1}{3}$  of carpus. Fingers of chela almost as long as palm. First segment of carpus about 1.8 times as long as second; second segment very slightly longer than third; third segment subequal to fourth; fifth segment longer than second, more than 1.5 times as long as fourth.

Dactylus of third pereopod (Figure 13j) heavy, blunt, laterally compressed, about  $\frac{1}{3}$  length of propodus. Propodus about 1.3 times as long as carpus, bearing 5 movable spines on inferior margin and pair at distal end. Carpus with inferior margin bearing acute tooth at distal end. Merus stout, about 2.7 times as long as broad. Ischium bearing small movable spine.

Fourth pereopod almost same as third pereopod. Ischium bearing almost invisible movable spine.

Fifth pereopod much narrower than third pereopod. Ischium bearing no movable spine.

Pleura (Figure 13k) of first four abdominal somites broadly rounded; pleuron of fifth somite subrectangular on posterior ventral margin. Abdominal sternite with no spine at midline. Appendix masculina at least 1.5 times as long as appendix interna.

Telson (Figure 13l) regularly tapering posteriorly, about 1.6 times as long as broad at anterior end, armed with two pairs of dorsal spines and with no longitudinal median depression on dorsal surface. Posterior margin slightly produced at middle and bearing pair of spines at each lateral end; inner spine about 2 times as long as outer one.

Uropodal endopod with inner depression at anterior half shallow. Uropodal exopod bearing rather long movable spine flanked laterally by acute immovable tooth and internally by subacute lobe; movable spine overreaching distal margin of uropodal exopod; transverse suture forming two convex lobes, outer one more convex.

HABITAT.—Exclusively in coral Pocilloporidae (Abele and Patton, 1976:38).

COLOR IN LIFE.—Usually orange-red on upper surface, sometimes longitudinally striped with deeper red along dorsal surface of carapace and abdomen; mottled with spots of deeper red along superior and superior lateral portion of both major and minor chela (Banner, 1953:86).

TYPE-LOCALITY.—Red Sea.

DISTRIBUTION.—Red Sea; South Africa; Indian Ocean; tropical western Pacific to Hawaii; eastern Pacific from southern Gulf of California through Panama to Colombia, Clipperton, and Galapagos Islands.

REMARKS.—This well-known species has been figured and

described many times. This species is the most easily recognized and the most surely identified in its adult form in the whole genus by the unique development of the dactyli of the walking legs (D. Banner and A. Banner, 1982:67).

The present specimens are different from the description of D. Banner and A. Banner (1982:67) in some characters. According to D. Banner and A. Banner (1982:67), the fifth carpal segment of the second pereopod is subequal to the fourth and the ischium of the third pereopod has no spine, but in the present specimens, the fifth carpal segment of the second pereopod is about 1.5 times as long as the fourth and the ischium of the third pereopod has a movable spine in most specimens (no spine in 4 ovigerous females and 1 male from sta 33-4 and in 3 ovigerous females from sta 37). Banner (1958) discussed the variation about the shape of rostrum and dactylus of the third pereopod in detail.

Holthuis (1979, 1980b) used *Alpheus sublucanus* (Forskål, 1775) as a senior synonym of the present species. A. Banner and D. Banner (1981) and D. Banner and A. Banner (1982) discussed the history of synonymy of the present species. The use of the name *Alpheus sublucanus* (Forskål, 1775) was subsequently suppressed by plenary action of the International Commission on Zoological Nomenclature in Opinion 1367 (ICZN, 1985:361-364).

## 11. *Alpheus normanni* Kingsley, 1878

FIGURE 14

*Alpheus affinis* Kingsley, 1878a:195.—Lockington, 1878:476. [Preoccupied by *Alpheus affinis* Guise, 1854.]

*Alpheus normanni* Kingsley, 1878b:93; 1878c:58.—Christoffersen, 1979:322 [in part, specimens from eastern Pacific].—Brusca, 1980:252.—Wicksten, 1983:44 [in part, specimens from eastern Pacific].

*Alpheus normanii*.—Kingsley, 1883:118.

*Alpheus Normanni*.—Coutière, 1899:29.

*Crangon normanni*.—Chace, 1937:122.

MATERIAL EXAMINED.—Mexico: Agua Verde Bay, Baja California (sta 663-37: 1 juv); Concepcion Bay, Baja California (sta 585-36: 2 ♂, 1 ♀, 4 ovig); San Gabriel Bay, Espiritu Santo Island, Baja California (sta 506-36: 2 ♂).

Costa Rica: Parker Bay (sta 469-35: 1 ♂, 1 ovig, sta 470-35: 1 ♂, 1 ovig).

Panama: Secas Isle (sta 450-35: 1 ♂); west of Canal (sta 161-1: 1 juv, sta 161-2: 1 juv, 3 spec).

MEASUREMENTS.—Males, cl 4.4-7.7 mm; females, cl 7.4-7.8 mm; ovigerous females, cl 6.3-7.9 mm.

DESCRIPTION.—Rostrum (Figure 14a,b) long, reaching to distal  $\frac{1}{3}$  of visible part of first antennular segment and bearing several short setae along lateral margins. Rostral carina narrowly raised dorsally, extending far behind eye.

Ocular hood strongly produced anteriorly and dorsally above level of middle part of rostral carina, separated from rostral carina by deep, narrow distinct depressions. Anterior inner margin of ocular hood slightly slanting anteriorly from base of rostrum to middle of ocular hood.

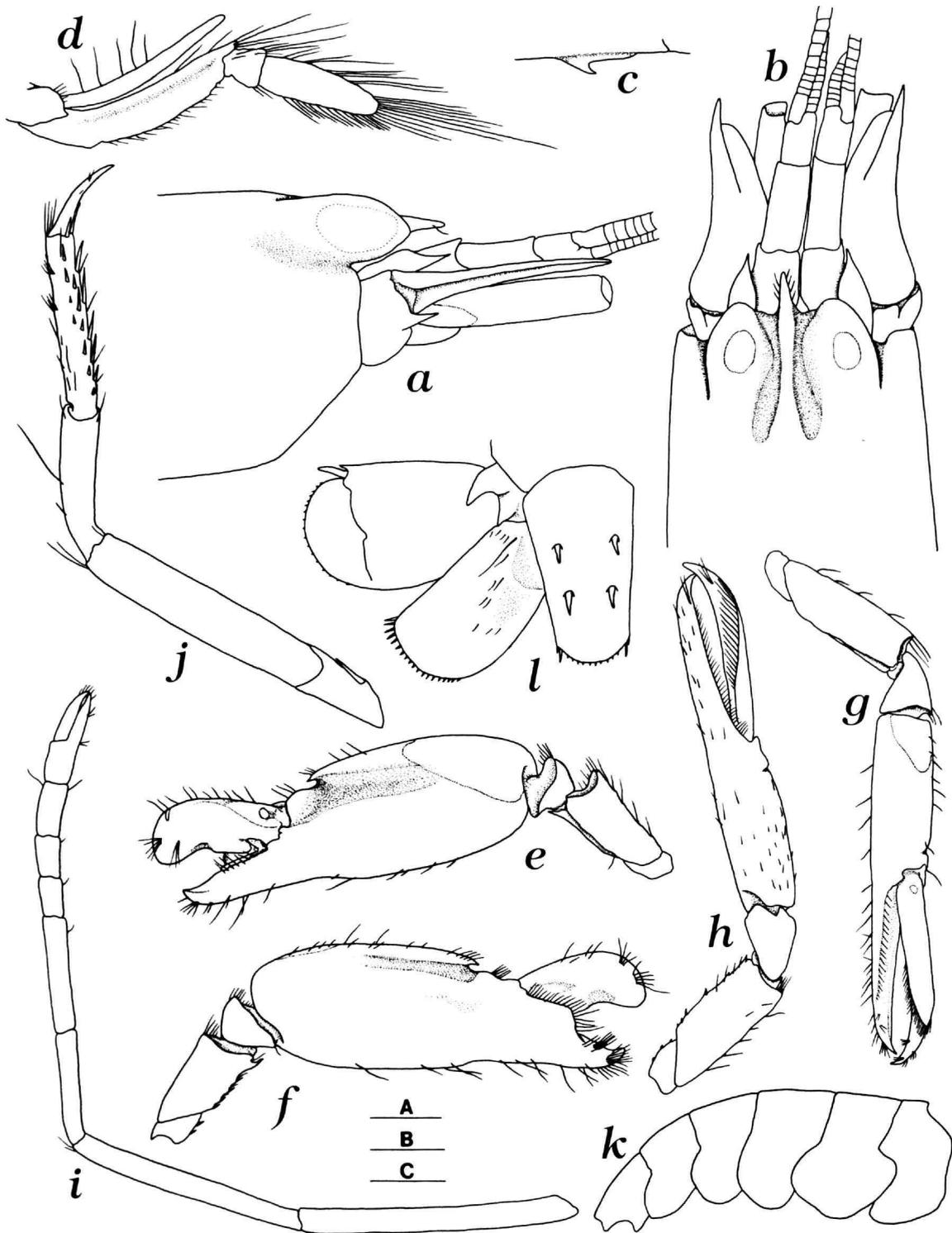


FIGURE 14.—*Alpheus normanni*, male, cl 7.7 mm, from sta 469-35: *a*, anterior region, lateral view; *b*, same, dorsal view; *c*, carina below right first antennular segment; *d*, right third maxilliped; *e*, major first pereopod, outer face; *f*, same, inner face; *g*, minor first pereopod, outer face; *h*, same, inner face; *i*, right second pereopod; *j*, right third pereopod; *k*, abdomen; *l*, telson and uropods. (Scale A = 2 mm: *e-h*, *k*; scale B = 1 mm: *a*, *b*, *d*, *i*, *j*, *l*; scale C = 0.5 mm: *c*.)

Carapace with pterygostomian margin slightly produced anteriorly below base of basicerite.

First antennular segment with narrow, hook-like spine extending from ventral inner margin (Figure 14c). Second segment about 2.4 times as long as broad, 1.3 times as long as visible part of first segment and 1.5 times as long as third segment. Stylocerite broad proximally, abruptly narrowing to sharp point, almost reaching to distal margin of first segment.

Scaphocerite about 3 times as long as broad. Lateral margin concave at proximal  $\frac{1}{3}$ . Distal spine overreaching distal end of antennular peduncle and reaching to or slightly overreaching distal end of carpoperite. Inner blade rounded distally, reaching to distal end of antennular peduncle. Cleft between inner blade and distal spine rather deep, arising from slightly less than distal  $\frac{1}{2}$  of scaphocerite.

Carpocerite overreaching distal end of antennular peduncle by  $\frac{1}{2}$  length of third antennular segment. Basicerite with narrow, sharp lateral spine falling slightly short of tip of stylocerite.

Third maxilliped (Figure 14d) reaching slightly over midlength of carpoperite. Ultimate segment about 2.8 times as long as penultimate and 2.9 times as long as broad at proximal end, tapering distally; tip rounded. Penultimate segment almost as long as broad, bearing long setae on superior margin distally. Antepenultimate segment with inferior margin slightly dentate, bearing sparse short setae and with superior distal margin projected anteriorly, bearing long setae. Exopod reaching to distal end of superior margin of antepenultimate segment. Precoxa with one arthrobranch near distal end and also bearing small supplementary arthrobranch near proximal end.

Major chela of first pereopods (Figure 14e,f) about 3.1 times as long as broad with fingers occupying slightly more than distal  $\frac{1}{3}$ . Movable finger elongate in profile, compressed and bluntly rounded distally. Immobile finger with inferior margin almost straight on middle part. Palm elongate, about 2 times as long as broad. Superior margin of palm rounded, ending distally in acute tooth directing downward. Inferior margin of palm rounded, fairly constricted at level of tooth on superior margin. Outer palmar face with fairly deep superior longitudinal depression extending posteriorly to oblique suture. Inner palmar face with narrow superior longitudinal depression and slightly depressed region below longitudinal depression. Merus with superior distal margin slightly projected anteriorly and inferior inner margin bearing 4 to 5 small movable spines and acute immovable spine at distal end; inferior outer margin slightly dentate. Ischium bearing 2 to 3 movable spines on inferior inner margin.

Minor chela of first pereopods (Figure 14g,h) very slender, about 5.8 times as long as broad, fingers occupying slightly more than  $\frac{1}{2}$  length of chela. Superior margin of palm with slight notch behind dactylar articulation. Inner face of palm with blunt tooth flanking dactylar articulation. Fingers with tips well crossing when closed. Movable finger balaeniceps in male. Immobile finger bearing setose crest on each of both lateral faces. Merus bearing 7 or 8 movable spines on inferior

inner margin and small acute immovable spine at distal end; inferior outer margin slightly dentate. Ischium with 2 to 3 movable spines on inferior inner margin.

Second pereopod (Figure 14i) reaching distal end of carpoperite beyond proximal end of first carpal segment. Fingers of chela about 1.3 times as long as palm. First segment of carpus about 0.9 times as long as second; second segment 3.0 times as long as third; third segment subequal to fourth; fifth segment 1.3 times as long as fourth.

Dactylus of third pereopod (Figure 14j) slender, slightly less than 0.5 times as long as propodus. Propodus about 1.4 times as long as carpus, bearing 6 movable spines, 6 adjacent movable spines and 4 irregular additional spines on inferior margin and pair at distal end. Merus slender, about 5.1 times as long as broad and with inferior distal margin rectangular. Ischium with one rather strong movable spine.

Fourth pereopod almost same as third pereopod. Ischium with one rather strong movable spine.

Ischium of fifth pereopod with movable spine.

Pleura (Figure 14k) of abdominal somites broadly rounded. First four abdominal sternites with spine at midline of each sternite. Appendix masculina falling short of distal end of appendix interna.

Telson (Figure 14l) about 1.8 times as long as broad at anterior end, armed with two pairs of rather stout dorsal spines and with no distinct longitudinal median depression on dorsal surface. Lateral margin almost straight. Posterior margin regularly convex, bearing series of seta-like spines and armed with pair of spines at each lateral end; inner spine more than two times as long as outer one.

Uropodal endopod bearing inconspicuous small spines on distal margin, laterally more strong and with inner depression at anterior half fairly distinct. Uropodal exopod with distal margin bearing seta-like spines and with transverse suture forming two very shallow convex lobes; lateral margin terminating in immovable tooth flanking movable spine, spine not overreaching distal margin of uropodal exopod; tooth inside of movable spine rounded at tip.

HABITAT.—Usually subtidal to 73 m, on rocks, sand or shell (Wicksten, 1983:44).

TYPE-LOCALITY.—Pacific coast of Panama.

DISTRIBUTION.—Eastern Pacific from the Gulf of California, Isla Clarion, Panama, and Galapagos Islands. Now reported from Costa Rica.

REMARKS.—Chace (1937:122) compared his "Zaca" specimen with specimens of "*A. packardii* Kingsley" from the Bermudas and failed to disclose a single character by which the Atlantic and Pacific forms can be distinguished. However, the present specimens from the eastern Pacific show a different character compared with the specimens from Florida. Male minor chelae of the first pereopods in the eastern Pacific specimens are consistently more elongate than minor chelae of specimens from Florida. Only one male from Espiritu Santo Island, Baja California, shows that minor chela is more broad

and similar to minor chelae of specimens from Florida. Therefore in the present study, the eastern Pacific forms are treated as a different species from the Atlantic form.

## 12. *Alpheus panamensis* Kingsley, 1878

FIGURE 15

*Alpheus panamensis* Kingsley, 1878a:192; 1878c:58; 1883:113.—Lockington, 1878:473.—Holthuis, 1954:160.—Abele, 1976:273.—Abele and Patton, 1976:37.

*Alpheus Panamensis*.—Coutière, 1899:29, fig. 50.

*Alpheus formosus*.—Christoffersen, 1979:314 [in part, specimens from the eastern Pacific].

*Crangon panamensis*.—Rathbun, 1910:607.

**MATERIAL EXAMINED.**—Costa Rica: Guanacaste, Playa del Coco (sta 1566: 6 ♂, 2 ♀, 6 ovig, 1 juv); Puntarenas, Golfo de Nicoya, Isla Tolinga (sta 1567: 2 ♂, 1 ♀, 1 ovig, 1 juv).

Panama: Punta Paitilla (sta 129-2-b: 1 ♀, sta 52-1: 1 ovig, LGA 69-64: 1 ♂, LGA 74-1: 2 ♂, 1 ovig, 1 spec); Punta Paitilla Beach (sta 25-3: 2 ♂); Whorehouse Reef (sta 133-5-b: 1 ♂, sta 166-1: 4 ♂, 3 ovig, 1 juv); Venado Beach (sta 111-4: 1 ♂, 2 ♀, sta 23-1: 1 ovig, sta 23-2: 1 ovig, sta 54: 3 ♂, 3 ovig, sta 86-4: 1 ovig, sta 88-2: 1 ♂, 1 ovig, sta 88-4: 1 ♂, 2 ovig, sta 132-1-c: 1 ♂, 2 ♀); Fort Kobbe Beach (sta 108-7: 1 ♂, 1 ovig); Casa de Putas Reef (sta 92-1: 1 ♂); Old French Fort Reef (sta 58-4: 1 ♀); Bay of Panama (LGA 69-33: 1 juv); Panama City (LGA 69-29: 4 ♂, 4 ovig); Panama Canal (LGA 69-42: 1 ♂, 1 ovig). Venado Beach: 4 ♂, 5 ovig; 29 Sep 1973. Perlas Islands (Pocillopora coral): 3 ♂, 1 ♀, 2 ovig, 12–13 Jun 1973, coll. by W. Patton, and G. Glamm. Amador Causeway: 1 ♂, 19 Jan 1971. Ft. Amador Causeway (JEM 71-7: 3 ♂, 4 ovig), 29 Jan 1971.

Ecuador: La Libertad (sta 12-33: 1 juv).

**MEASUREMENTS.**—Males, cl 4.1–12.8 mm; females, cl 5.1–12.1 mm; ovigerous females, cl 6.1–12.2 mm.

**DESCRIPTION.**—Rostrum (Figure 15a,b) extending posteriorly as dorsally flattened surface far posterior to eye, reaching to distal  $\frac{1}{4}$  of visible part of first antennular segment and about 1.8 times as long as broad at posterior end. Dorsally flattened surface of rostrum with lateral margin bearing stiff, short setae, slightly concave at middle, and well overhanging orbitorostral groove.

Ocular hood moderately inflated dorsally, separated from rostral carina by deep, narrow, distinct depression and armed with sharp tooth on anterior slope of ocular hood; tooth directing inward and overreaching anterior margin of ocular hood.

Carapace with pterygostomian margin slightly produced anteriorly below base of basicerite.

First antennular segment with deep, triangular carina extending from ventral inner margin; ventral part of carina acute, directing forward (Figure 15c). Second segment about 1.5 times as long as broad, almost as long as visible part of first segment and 1.3 times as long as third segment. Stylocerite rather regularly narrowing to long sharp point, well overreach-

ing distal margin of first segment.

Scaphocerite about 2.5 times as long as broad. Lateral margin very slightly concave at proximal  $\frac{1}{3}$ . Distal spine overreaching distal end of antennular peduncle or carpoperite. Inner blade narrow distally, falling short of tip of distal spine. Cleft between inner blade and distal spine arising from distal 0.4 of scaphocerite.

Carpocerite reaching to or very slightly overreaching distal end of antennular peduncle. Basicerite with sharp, triangular lateral spine; spine broad at base, almost reaching to distal margin of first antennular segment.

Third maxilliped (Figure 15d) overreaching distal end of carpoperite by length of ultimate segment. Ultimate segment about 1.6 times as long as penultimate, 5.6 times as long as broad near proximal end, tapering distally and with scattered long setae on superior and inferior margins as well as on distal margin; tufts of setae on inner face rather dense. Penultimate segment elongate, about 3 times as long as broad, with scattered long setae on superior and inferior margins. Antepenultimate segment bearing scattered short setae on inferior margin and bearing sparse long setae near superior distal margin. Exopod slightly overreaching distal end of antepenultimate segment. Precoxa with one arthrobranch near distal end but with no supplementary arthrobranch.

Major first pereopod (Figure 15e–h) overreaching distal end of carpoperite by most part of chela. Major chela about 3 times as long as broad with fingers occupying distal 0.4. Movable finger opening and closing near vertical plane, very shallowly arched in profile, slightly compressed laterally and bluntly rounded at tip; inferior margin posterior to tip fairly concave; tip overreaching tip of immovable finger. Immovable finger with tip directing upward and outward. Palm lacking sculpturing and with very acute triangular tooth flanking dactylar articulation on inner face. Merus with inferior inner margin slightly dentate and bearing strong acute spine at distal end; superior distal margin produced anteriorly.

Minor chela of first pereopods (Figure 15i,j) about 4.1 times as long as broad with fingers occupying distal  $\frac{1}{2}$ . Palm lacking sculpturing and bearing very acute tooth near dactylar articulation on inner face. Movable finger narrow, balaeniceps in both sexes. Immovable finger bearing dense long setae on crest of each of both lateral faces. Merus with inferior inner margin slightly dentate and bearing small acute spine at distal end; superior distal margin produced anteriorly.

Fingers of chela of second pereopod (Figure 15k) slightly longer than palm. First segment of carpus about 2.9 times as long as second; second segment 1.3 times as long as third; third segment subequal to fourth; fifth segment slightly longer than second, 1.8 times as long as fourth.

Dactylus of third pereopod (Figure 15l) about  $\frac{1}{4}$  length of propodus, bearing very small tooth on distal  $\frac{1}{5}$  of superior margin. Propodus bearing 7 movable spines on inferior margin and pair at distal end. Carpus with tooth-like process on superior distal margin. Merus slightly less than 4.8 times as long as broad. Ischium with one rather strong movable spine.

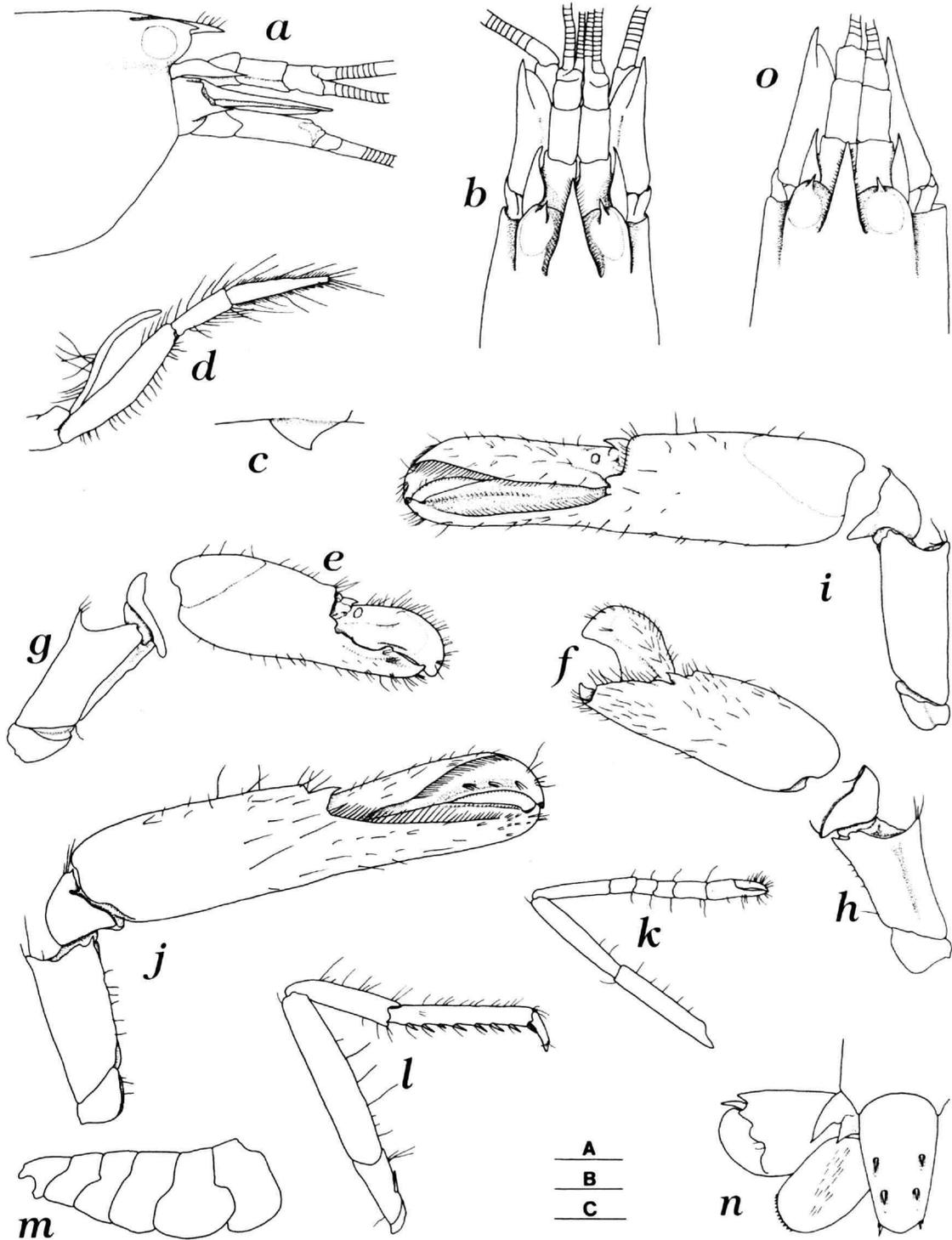


FIGURE 15.—*Alpheus panamensis*, male, cl 10.8 mm, from sta 166-1: a, anterior region, lateral view; b, same, dorsal view; c, carina below right first antennular segment; d, right third maxilliped; e, major first pereopod, chela, outer face; f, same, chela, inner face; g, same, except chela, outer face; h, same, except chela, inner face; i, minor first pereopod, outer face; j, same, inner face; k, right second pereopod; l, right third pereopod; m, abdomen; n, telson and uropods. *Alpheus formosus*, male, cl 10.9 mm, from Florida Dade county: o, anterior region, dorsal view. (Scale A = 4 mm: e, f, m; scale B = 2 mm: a, b, d, g-l, n, o; scale C = 1 mm: c.)

Fourth pereopod almost same as third pereopod. Ischium with one rather strong movable spine.

Ischium of fifth pereopod with no movable spine.

Pleura (Figure 15*m*) of first three abdominal somites broadly rounded; pleura of fourth and fifth somites broadly triangular on posterior ventral margin. Abdominal sternite with no spine at midline. Appendix masculina clearly longer than appendix interna.

Telson (Figure 15*n*) about 1.8 times as long as broad at anterior end, armed with two pairs of rather stout dorsal spines and with no longitudinal median depression on dorsal surface. Posterior margin produced at middle, armed with pair of spines at each lateral end; inner spine almost two times as long as outer one.

Uropodal endopod bearing inconspicuous seta-like spines on distal margin, laterally more strong and with no distinct inner depression at anterior half. Uropodal exopod with transverse suture forming two convex lobes, outer one very convex and inner one shallow; lateral margin terminating in acute immovable tooth flanking movable spine, spine not overreaching distal margin of uropodal exopod; immovable tooth inside of movable spine acute but more blunt than lateral immovable tooth.

HABITAT.—0–1 m; tidal; rock, mud, sand, and sand gravel.

TYPE-LOCALITY.—Acajutla, Central America, and Panama.

DISTRIBUTION.—Costa Rica, Panama to Peruvian Sea.

REMARKS.—Christofferson (1979:315) considered this species as a junior synonym of *A. formosus* Gibbes. We compared the specimens from the eastern Pacific with the specimens from the Atlantic at the Smithsonian's National Museum of Natural History. It was really difficult to distinguish two groups of specimens, but as a result of comparison, we felt that the consistent characters might be valuable to distinguish two groups of specimens.

The orbitorostral groove in *A. panamensis* consistently far overreaches the posterior end of eye, while in *A. formosus*, the orbitorostral groove consistently reaches to the posterior end of eye (Figure 15*a,o*). The base of rostral carina in *A. panamensis* is more broad than that of *A. formosus*. The color of the movable spine on the uropodal exopod is dark brown in *A. formosus* (specimens preserved in alcohol), but the movable spine of *A. panamensis* does not show any trace of dark brown color in the specimens preserved in alcohol.

### 13. *Alpheus felgenhaueri*, new species

FIGURE 16

MATERIAL EXAMINED.—Holotype: Male, cl 9.7 mm, outer Miramar Bay on Cape Haro, north of Guaymas, Sonora, Mexico; 1 Jan 1971, coll. by R. Brusca.

Mexico: Isabel Island, Sinaloa (sta 124-33: 1 ♂, 1 ♀).

MEASUREMENTS.—Males, cl 5.3–9.7 mm; female, cl 6.5 mm.

DESCRIPTION.—Rostrum (Figure 16*a,b*) elongate, extending posteriorly as dorsally rounded carina and well overreaching middle of visible part of first antennular segment; tip directing

downward.

Ocular hood inflated dorsally below level of rostral carina, armed with sharp, small tooth directing inward and hood separated from rostral carina by shallow, but distinct depression ending just before posterior end of ocular hood. Ocular tooth reaching to distal 1/2 of rostrum. Anterior inner margin of ocular hood slanting anteriorly from base of rostrum to ocular tooth, slightly concave near base of rostrum.

Antennular peduncle stout. First antennular segment with deep, semicircular carina extending from ventral inner margin; ventral part of carina rounded (Figure 16*c*). Second segment about 1.4 times as long as broad, 1.3 times as long as visible part of first segment and 1.4 times as long as third segment. Stylocerite regularly narrowing to sharp point, reaching to proximal 1/3 of second segment.

Scaphocerite about 2.4 times as long as broad. Lateral margin almost straight. Distal spine overreaching distal end of antennular peduncle and slightly falling short of distal end of carapocerite. Inner blade rather broad, far wider than adjacent distal spine and almost reaching to tip of distal spine. Cleft between inner blade and distal spine rather shallow, arising from distal 0.3 of scaphocerite.

Carpocerite overreaching distal end of antennular peduncle by length of third antennular segment. Basicerite with sharp, triangular lateral spine; spine relatively long, very broad at base, almost reaching to distal margin of first antennular segment.

Third maxilliped (Figure 16*d*) rather narrow, overreaching distal end of carapocerite by length of ultimate segment. Ultimate segment tapering distally, slightly truncate at tip, about 1.8 times as long as penultimate and about 5.7 times as long as broad at proximal end, bearing sparse long setae on distal margin. Penultimate segment rather elongate, about 2.5 times as long as broad near distal end, bearing few long setae on distal margin. Exopod far overreaching distal end of antepenultimate segment. Precoxa with one arthrobranch near distal end but with no supplementary arthrobranch.

Major first pereopod (Figure 16*e,f*) overreaching distal end of carapocerite by length of chela. Major chela about 3.0 times as long as broad with fingers occupying distal 1/3. Movable finger shallowly arched on superior margin, slightly compressed laterally and bluntly rounded at tip; tip far overreaching tip of immovable finger. Immovable finger with inferior margin almost straight; tip rather blunt, slightly directing upward. Palm lacking distinct sculpturing, regularly narrowing towards tip of chela. Each of lateral faces of palm bearing very blunt tooth flanking dactylar articulation but tooth on outer face almost indistinct. Chela bearing very sparse, scattered weak setae on anterior half of inner face. Merus about 1.9 times as long as broad, with superior distal margin projected anteriorly; inferior inner margin bearing 4 to 5 small movable spines and acute spine at distal end.

Minor chela of first pereopods (Figure 16*g,h*) very narrow, about 4.6 times as long as broad with fingers occupying slightly less than distal 1/2. Palm lacking sculpturing and bearing acute

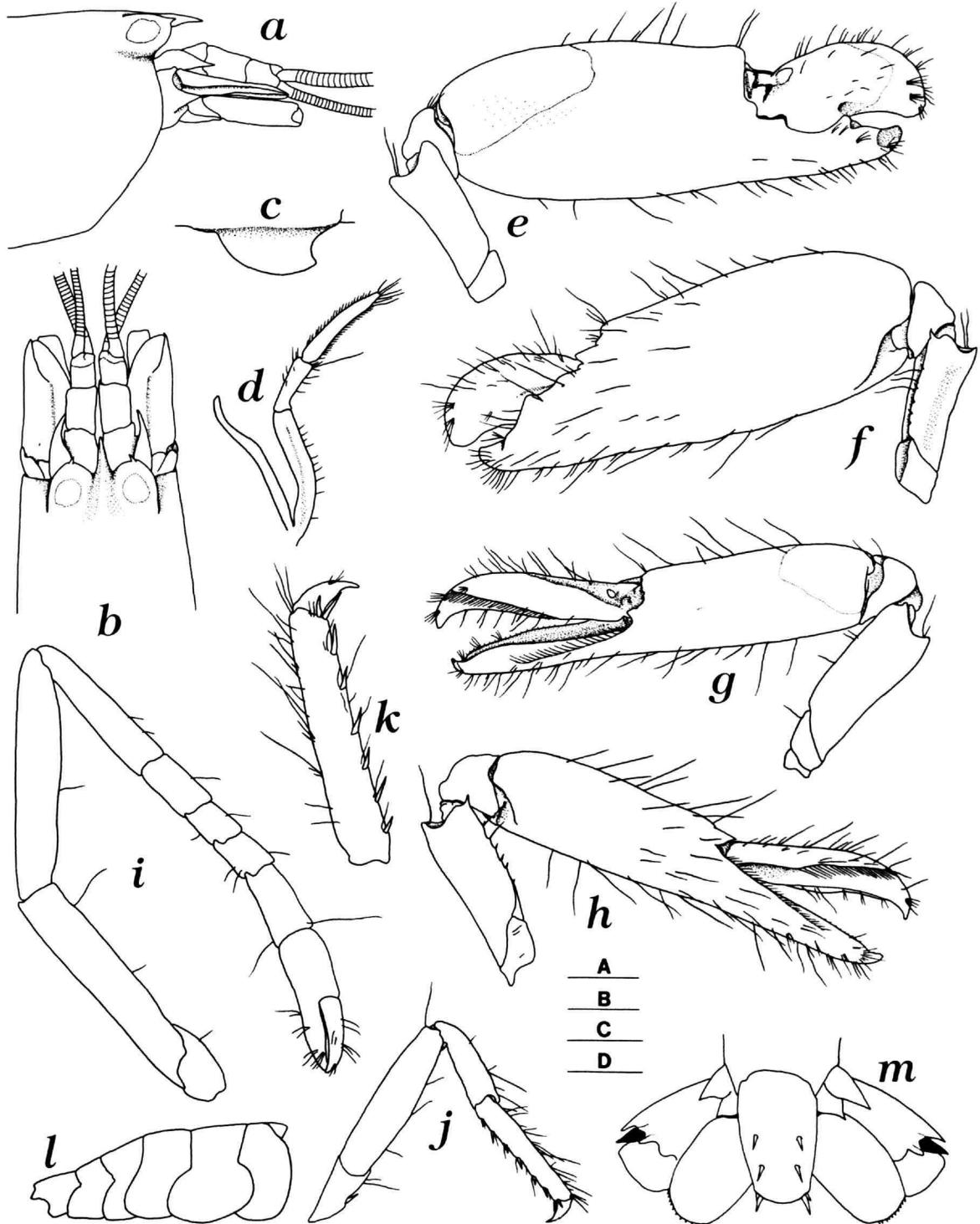


FIGURE 16.—*Alpheus felgenhaueri*, new species, male holotype, cl 9.7 mm, from Sonora, Mexico: *a*, anterior region, lateral view; *b*, same, dorsal view; *c*, carina below right first antennular segment; *d*, right third maxilliped; *e*, major first pereopod, outer face; *f*, same, inner face; *g*, minor first pereopod, outer face; *h*, same, inner face; *i*, right second pereopod; *j*, right third pereopod; *k*, same, dactylus and propodus; *l*, abdomen; *m*, telson and uropods. (Scale A = 4 mm: *l*; scale B = 2 mm: *a*, *b*, *d*–*h*, *j*, *m*; scale C = 1 mm: *i*, *k*; scale D = 0.5 mm: *c*.)

tooth flanking dactylar articulation on inner face. Movable finger forming balaeniceps in male and with inferior margin concave at distal  $\frac{1}{2}$ . Immovable finger bearing longitudinal rows of setae on both lateral faces from base to distal  $\frac{1}{4}$  and with longitudinal groove on superior distal surface. Chela bearing scattered long setae on anterior half of inner face as well as inferior, superior margins. Merus about 2.7 times as long as broad, with superior distal margin projected anteriorly; inferior inner margin with 5 to 6 movable spines and acute spine at distal end.

Second pereopod (Figure 16*i*) reaching distal end of carpopercite beyond proximal end of third carpal segment. Fingers of chela as long as palm. First segment of carpus about 2.3 times as long as second; second segment 1.5 times as long as third; third segment subequal to fourth; fifth segment slightly longer than second, 1.7 times as long as fourth.

Dactylus of third pereopod (Figure 16*j,k*) very broad proximally, ending in narrow point at tip and bearing very small tooth on distal  $\frac{1}{4}$  of superior margin. Propodus about 3.3 times as long as dactylus and 1.2 times as long as carpus, bearing 6 movable spines on inferior margin and pair at distal end; distalmost spine reaching to distal  $\frac{1}{3}$  of dactylus. Carpus with superior distal margin very bluntly produced. Merus about 1.5 times as long as carpus and slightly less than 3.9 times as long as broad. Ischium bearing one rather strong movable spine.

Fourth pereopod almost same as third pereopod. Ischium bearing one movable spine.

Ischium of fifth pereopod with no movable spine.

Pleura (Figure 16*l*) of first three abdominal somites broadly rounded; pleura of fourth and fifth somites subtriangular on posterior ventral margin. Abdominal sternite with no spine at midline. Appendix masculina almost 1.5 times as long as appendix interna.

Telson (Figure 16*m*) about 1.9 times as long as broad at anterior end, armed with two pairs of rather stout dorsal spines and with no longitudinal median depression on dorsal surface. Posterior margin rounded, armed with pair of spines at each lateral end; inner spine strong, almost two times as long as outer one.

Uropodal endopod bearing indistinct seta-like spines on distal margin and with inner depression at anterior half invisible. Uropodal exopod bearing dark, very stout movable spine flanked laterally by strong immovable tooth and internally by well-defined tooth; movable spine almost reaching to distal margin of uropodal exopod; transverse suture forming two convex lobes, inner one more flat.

HABITAT.—Shore, rocky intertidal.

DISTRIBUTION.—Sonora, Sinaloa, Mexico.

REMARKS.—The present species is similar to *A. panamensis* in many characters, but can be easily distinguished from the latter species by the following characteristics: the rostrum of the present species extends posteriorly as the narrowly rounded carina and does not bear setae on the rostrum or on the lateral margin of rostral carina, and the ocular tooth arises from the

anterior margin of ocular hood, while in *A. panamensis* the rostrum extends posteriorly as the dorsally flattened rostral carina and bears short setae on the lateral margins of rostrum and rostral carina, and the ocular tooth arises from the slope of ocular hood, not from the anterior margin.

ETYMOLOGY.—The specific name *felgenhaueri* is for Bruce E. Felgenhauer of the Department of Biological Science, Florida State University, who has, in various ways, aided us in doing this project.

#### 14. *Alpheus sulcatus* Kingsley, 1878

FIGURE 17

*Alpheus sulcatus* Kingsley, 1878a:193.—Lockington, 1878:475.—Coutière, 1899:29.—Sivertsen, 1933:3, pl. 1: figs. 6–8.—Crosnier and Forest, 1965a:355, figs. 1a–g, 2a–d; 1966:237, fig. 9.—Méndez, 1981:97.—D. Banner and A. Banner, 1982:79, fig. 20.—A. Banner and D. Banner, 1984:43.—Wicksten, 1983:46.—Wicksten and Méndez, 1983:78, figs. 6–10. *Alpheus macrochirus* Richters, 1880:164, pl. 17: figs. 31–33.—De Man, 1902:863.—Coutière, 1905:882 [part].—Crosnier and Forest, 1965a:356, figs. 1, 2. *Alpheus luciae* Barnard, 1947:389; 1950:755, figs. 143j–m. *Crangon sulcatus*.—Hult, 1939:4.

MATERIAL EXAMINED.—Mexico: San Gabriel Bay, Espiritu Santo Island, Baja California (sta 638-37: 1 juv); cove south of Ballena Bay, Espiritu Santo Island, Baja California (sta 510-36: 1 ♀); Nayarit, northeast of beach of Isla Jaltimba, off Rincon de los Guayabitos (sta 1558: 1 juv).

Costa Rica: Guanacaste, Playa del Coco (sta 1566: 7 ♂, 4 ♀, 2 ovig, 9 juv); Puntarenas, Golfo de Nicoya, Isla Tolinga (sta 1567: 10 ♂, 10 ♀, 9 ovig, 13 juv, 2 spec).

Colombia: Port Utria (sta 239a-34: 2 ♂, 1 ♀, 2 ovig).

Galapagos Islands: Academy Bay, Indefatigable Island (sta 168-34: 2 ♂, 1 ♀).

MEASUREMENTS.—Males, cl 9.0–15.0 mm; females, cl 7.0–18.1 mm; ovigerous females, cl 7.9–12.5 mm.

DESCRIPTION.—Rostrum (Figure 17*a,b*) about 1.2 times as long as wide at posterior end, not reaching to middle of visible part of first antennular segment and bearing long stiff setae on sides of rostrum.

Ocular hood with anterior margin narrowly rounded, bearing no tooth. Groove between rostrum and ocular hood very deep, sharply cut off from ocular hood.

First antennular segment bearing deep, broad triangular carina extending from ventral inner margin; ventral part rounded (Figure 17*c*). Second segment 2.3 times as long as broad, 1.4 times as long as visible part of first segment and 1.6 times as long as third segment. Stylocerite acute, reaching to distal margin of first antennular segment.

Scaphocerite with lateral margin slightly concave at proximal  $\frac{1}{3}$ . Distal spine slightly overreaching distal end of antennular peduncle and falling far short of distal end of carpopercite. Inner blade narrow distally, falling short of tip of distal spine. Cleft between inner blade and distal spine arising from distal  $\frac{1}{3}$  of scaphocerite.

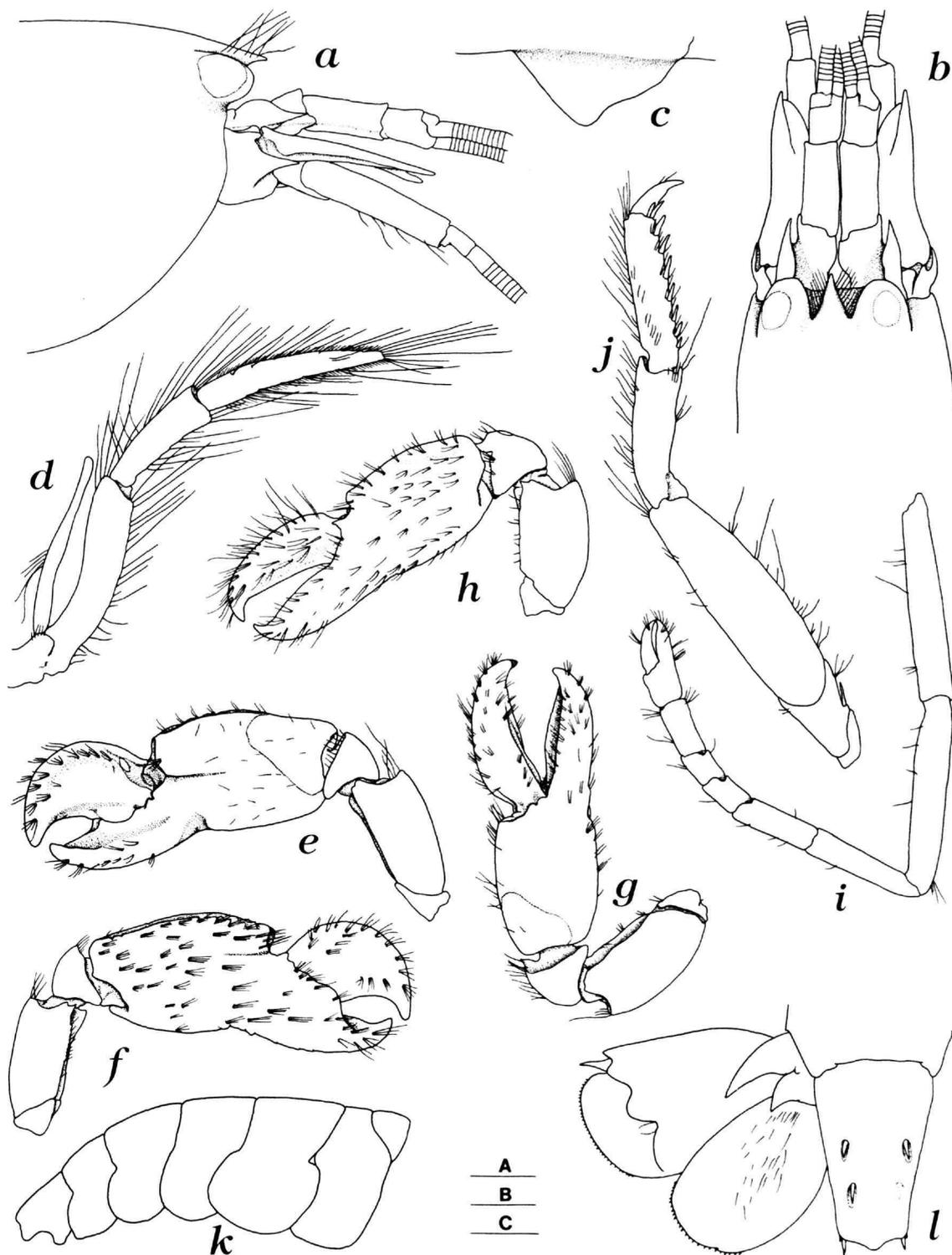


FIGURE 17.—*Alpheus sulcatus*, male, cl 15.0 mm, from sta 168-34: *a*, anterior region, lateral view; *b*, same, dorsal view; *c*, carina below right first antennular segment; *d*, right third maxilliped; *e*, major first pereopod, outer face; *f*, same, inner face; *g*, minor first pereopod, outer face; *h*, same, inner face; *i*, right second pereopod; *j*, right third pereopod; *k*, abdomen; *l*, telson and uropods. (Scale A = 4 mm: *e-h*, *k*; scale B = 2 mm: *a*, *b*, *d*, *i*, *j*, *l*; scale C = 0.5 mm: *c*.)

Carpocerite overreaching distal end of antennular peduncle by more than  $\frac{2}{3}$  length of third antennular segment. Basicerite with sharp, triangular lateral spine; spine rather long, very broad at base, almost reaching to tip of stylocerite.

Third maxilliped (Figure 17*d*) overreaching distal end of carpoperite by distal  $\frac{2}{3}$  of ultimate segment. Ultimate segment very narrowly elongate, about 6.4 times as long as broad near proximal end, and slightly tapering distally. Penultimate rather elongate, 2.9 times as long as broad near distal end and 0.6 times as long as ultimate. Exopod slightly overreaching distal end of antepenultimate segment. Precoxa with one arthrobranch near distal end but with no supplementary arthrobranch.

Major chela of first pereopods (Figure 17*ef*) compressed, about 2.7 times as long as broad, with fingers heavy and occupying distal 0.4. Outer face of palm hairless except along superior and inferior margins and with narrow, deep longitudinal groove arising near middle of palm and extending to dactylar articulation. Inferior margin of chela with shallow notch and depression on outer face at middle. Superior margin of palm with low, rounded longitudinal ridge arising near carpal articulation and terminating above palmar adhesive plaque. Inner face of palm with longitudinal groove similar to that of outer face, but short and less distinct; face bearing heavy bosses on superior ridge and light bosses or indentations at mesial part; long, heavy setae in patches arising from bosses or indentations; inferior margin at midlength of chela bearing several heavy bosses. Both fingers with patches of setae. Movable finger heavy, tip acute or acutely rounded; superior margin circular in shape. Immobile finger with tip strongly directed upward, acute or acutely rounded; inferior margin fairly convex; outer face with very shallow, median longitudinal groove. Merus about 2.2 times as long as broad; inferior inner margin slightly serrate, with short setae and bearing subacute spine at distal end.

Minor chela of first pereopods (Figure 17*g,h*) about 3 times as long as broad with fingers slightly narrower and longer than palm. Palm with same kinds of ridge, bosses and setae of major chela, but much less distinct; longitudinal grooves lacking on both lateral faces; inner face bearing acute triangular tooth flanking dactylar articulation. Fingers densely setose, especially on inner face; tips very acute, crossing when closed. Merus with superior margin slightly convex; inferior inner margin irregularly serrate and with subacute tooth at distal end.

Second pereopod (Figure 17*i*) reaching distal end of carpoperite beyond distal end of first carpal segment. Fingers of chela about 1.4 times as long as palm. First segment of carpus about 1.5 times as long as second; second segment 2 times as long as third; third segment subequal to fourth; fifth segment 1.4 times as long as fourth.

Dactylus of third pereopod (Figure 17*j*) about 0.3 times as long as propodus, with blunt unguis on distal  $\frac{1}{3}$  of inferior margin. Propodus with 7 movable spines on inferior margin and pair at distal end. Carpus with superior distal margin projecting as tooth-like process, inferior margin slightly projecting distally. Merus about 3.7 times as long as broad and

2 times as long as carpus, bearing patches of setae on inferior margin. Ischium bearing movable spine.

Fourth pereopod almost same as third pereopod. Ischium bearing movable spine.

Fifth pereopod much narrower than third pereopod. Ischium bearing no movable spine.

Pleura (Figure 17*k*) of abdominal somites broadly rounded. Abdominal sternite with no spine at midline. Appendix masculina almost 1.5 times as long as appendix interna.

Telson (Figure 17*l*) about 1.5 times as long as broad at anterior end, regularly tapering posteriorly and armed with two pairs of rather stout dorsal spines and with no longitudinal median depression on dorsal surface. Posterior margin produced at middle, armed with pair of spines at each lateral end; inner spine almost 2 times as long and wide as outer one.

Uropodal endopod with no distinct inner depression at anterior half and bearing inconspicuous seta-like spines on distal margin. Uropodal exopod with distal margin bearing inconspicuous seta-like spines; lateral margin terminating in acute tooth flanking movable spine; spine not overreaching distal margin of uropodal exopod; immovable tooth inside of movable spine bluntly rounded; transverse suture forming two convex lobes, outer one much more convex.

HABITAT.—Shore to 1.3 m; sand, rock, and coral.

COLOR IN LIFE.—Body and chelae orange-red, translucent; dots of white on dorsal midline and along sides of carapace and abdomen (Wicksten, 1983:46).

TYPE-LOCALITY.—Bay of Panama; Zorritas, Peru.

DISTRIBUTION.—Eastern Atlantic (São Tome and Congo); east and south Africa, Red Sea, Australia, to Society Islands; eastern Pacific from Gulf of California, Bay of Panama, Galapagos Islands and Peru. Now reported from Costa Rica and Colombia.

REMARKS.—D. Banner and A. Banner (1982) synonymized *Alpheus macrochirus* Richters with *Alpheus sulcatus* Kingsley. The first author compared *A. sulcatus* with the specimens identified as *A. macrochirus* at the Smithsonian's National Museum of Natural History, and as a result, quite agrees with the decision of Banner and Banner.

### 15. *Alpheus cristulifrons* Rathbun, 1900

FIGURE 18

*Alpheus obeso-manus*.—Pocock, 1890:520 [not *Alpheus obesomanus* Dana, 1852].

*Alpheus cristulifrons* Rathbun, 1900b:152 [nom. nov. of *A. obesomanus*, sensu Pocock]; 1901:106.—Coutière, 1910:485.—Chace, 1956:146; 1972:64.—Crosnier and Forest, 1965b:606; 1966:260, figs. 17, 18a–j.—Fausto-Filho, 1970:56; 1974:5.—Coelho and Ramos, 1972:149.—Pequegnat and Ray, 1974:246, figs. 49c, 50.—Christoffersen, 1979:308.—Wicksten, 1983:44.

*Crangon cristulifrons*.—Schmitt, 1924a:65; 1924c:73; 1935:143; 1936:368; 1939:28.

MATERIAL EXAMINED.—Mexico: Isabel Island, Sinaloa (sta 124-33: 1 ♀).

Costa Rica: Puntarenas, Golfo de Nicoya, Isla Tolinga (sta

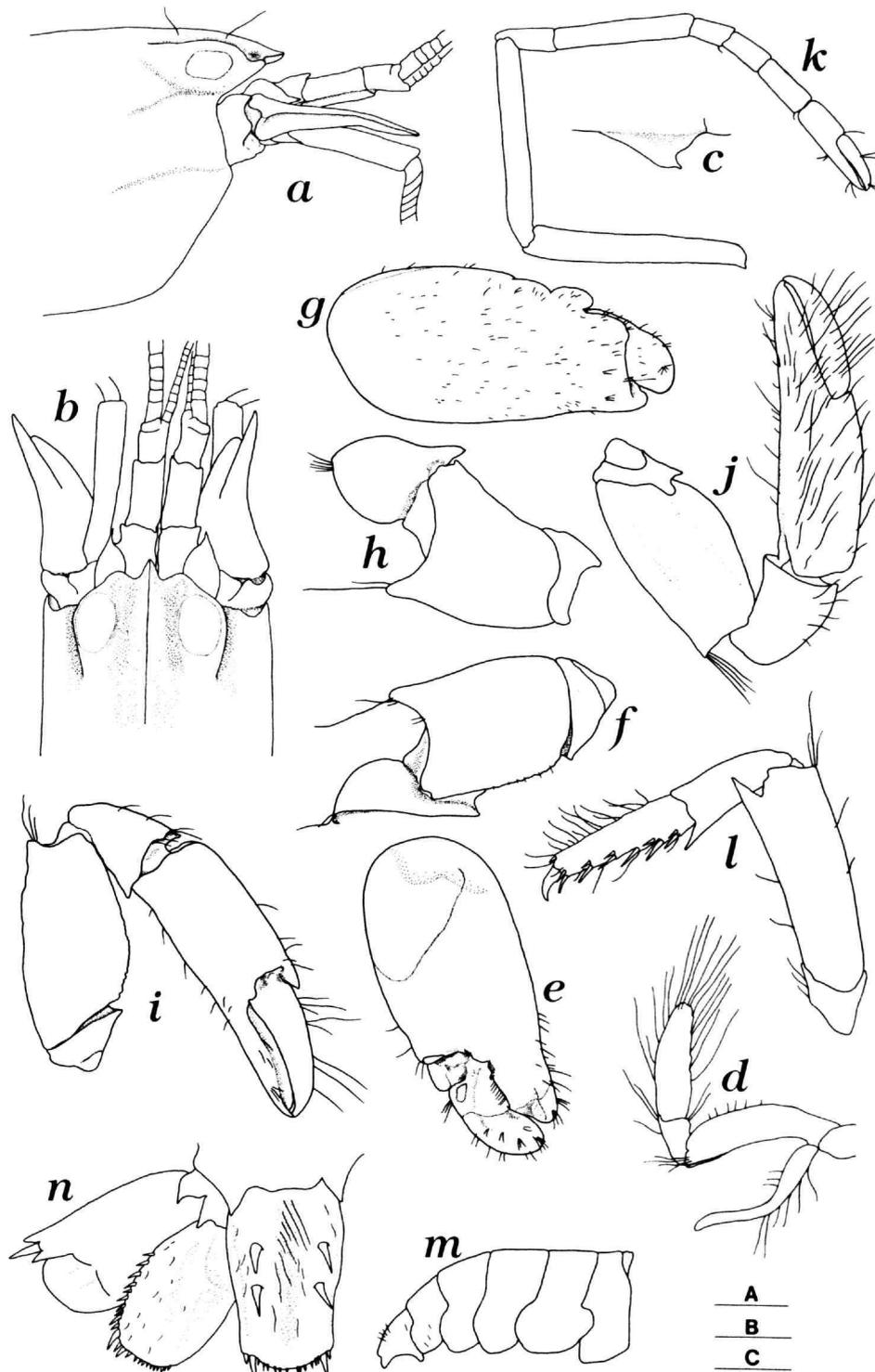


FIGURE 18.—*Alpheus cristulifrons*, male, cl 5.8 mm, from sta 39: *a*, anterior region, lateral view; *b*, same, dorsal view; *c*, carina below right first antennular segment; *d*, right third maxilliped; *e*, major first pereopod, chela, outer face; *f*, same, except chela, outer face; *g*, same, chela, inner face; *h*, same, except chela, inner face; *i*, minor first pereopod, outer face; *j*, same, inner face; *k*, right second pereopod; *l*, left third pereopod; *m*, abdomen; *n*, telson and uropods. (Scale A = 2 mm: *e*, *g*, *m*; scale B = 1 mm: *a*, *b*, *d*, *f*, *h*–*l*, *n*; scale C = 0.5 mm: *c*.)

1567: 2 ♂).

Panama: Perlas Islands (sta 32: 1 ♂); Pajaros, Perlas Islands (sta 42: 1 ♂); Pedro Gonzales, Perlas Islands (sta 33-4: 1 ♂); Chapera, Perlas Islands (sta 39: 1 ♂, 1 ♀); Punta Paitilla Beach (sta 25-1: 1 ♂); Taboga, dredging: 1 ovig; 10 May 1969.

MEASUREMENT.—Males, cl 4.0–5.8 mm; females, cl 3.5–6.1 mm.

DESCRIPTION.—Rostrum (Figure 18a,b) small, triangular, bearing several setae at lateral margins and not reaching to middle of visible part of first antennular segment. Rostral carina rather high and narrow, bearing several setae, extending posteriorly to distal  $\frac{1}{3}$  of carapace.

Ocular hood elevated dorsally below level of rostral carina and produced anteriorly as rounded process. Orbitorostral groove very broad and deep, not clearly delimited posteriorly. Anterolateral margin of carapace slightly produced anteriorly near base of basicerite; longitudinal depression below ocular hood very distinct.

First antennular segment bearing deep, hook-like carina extending from ventral inner margin (Figure 18c). Second segment about 2 times as long as broad, 1.3 times as long as visible part of first segment, and 1.5 times as long as third segment. Stylocerite broad proximally and abruptly narrowing to sharp point, not reaching to distal margin of first segment.

Scaphocerite about 2.7 times as long as broad. Lateral margin strongly concave at middle. Distal spine slightly overreaching distal end of antennular peduncle and falling slightly short of distal end of carapace. Inner blade narrow almost as wide as adjacent distal spine, reaching to distal  $\frac{1}{3}$  of third antennular segment. Cleft between distal spine and inner blade deep, arising from distal  $\frac{1}{2}$  of scaphocerite.

Carpocerite overreaching distal end of antennular peduncle almost by  $\frac{1}{2}$  length of third antennular segment. Basicerite with no distinct lateral spine.

Third maxilliped (Figure 18d) reaching distal end of carapace beyond distal  $\frac{1}{2}$  of ultimate segment. Ultimate segment about 2.6 times as long as penultimate segment, bearing very long stiff setae distally; distal end not much narrower than proximal end. Penultimate segment about 1.5 times as long as broad at distal end. Exopod reaching to distal end of antepenultimate segment. Precoxa with one arthrobranch near distal end but with no supplementary arthrobranch.

Major chela of first pereopods (Figure 18e-h) fairly stout about 2.3 times as long as broad, with fingers occupying distal  $\frac{1}{3}$  of chela. Movable finger shallowly arched at superior distal margin; tip bulbous, overreaching tip of immovable finger. Immovable finger with tip very blunt. Palm fairly stout with no distinct sculpturing except slightly depressed part on superior margin behind dactylar articulation in inner view. Merus very broad, about 1.2 times as long as broad, produced on superior distal margin; inferior outer margin very slightly dentate and inferior inner margin smooth with immovable spine at distal end.

Minor chela of first pereopods (Figure 18i,j) about 3.2 times as long as broad, with fingers occupying slightly less than

distal 0.5 of chela and bearing dense long setae on inner face. Movable finger not balaeniceps in both sexes. Palm lacking sculpturing and bearing rather long, subtriangular tooth flanking dactylar articulation on inner face. Merus fairly broad at middle, 1.9 times as long as broad; inferior outer margin slightly dentate and inferior inner margin smooth, no distinct spine at distal end.

Second pereopod (Figure 18k) reaching distal end of carapace beyond part of merus. Fingers of chela about 1.3 times as long as palm. First segment of carpus about 0.4 times as long as second; second segment 3.3 times as long as third; third segment slightly less than fourth; fifth segment 1.3 times as long as fourth.

Third pereopod (Figure 18l) rather short and stout. Dactylus short, conical, slightly less than  $\frac{1}{4}$  length of propodus. Propodus about 1.2 times as long as carpus, bearing 6 pairs of strong spines on inferior margin and one spine on superior distal margin. Carpus bearing strong acute immovable spine on inferior distal margin. Merus about 2 times as long as carpus, 3 times as long as broad, and bearing very strong tooth just before distal end of inferior margin. Ischium with no spine.

Fourth pereopod very similar to third pereopod, but distal tooth on inferior margin of merus usually less distinct. Ischium with no movable spine.

Fifth pereopod much smaller than third pereopod. Ischium with no movable spine.

Pleura (Figure 18m) of first four abdominal somites broadly rounded in both sexes; pleuron of fifth somite subrectangular on posterior ventral margin. Abdominal sternite with no spine at midline. Appendix masculina very long, at least 1.5 times as long as appendix interna.

Telson (Figure 18n) about 1.6 times as long as broad at anterior end, armed with very stout dorsal spines and with broad longitudinal median depression and long setae along depression on dorsal surface. Lateral margin slightly concave at posterior  $\frac{1}{3}$ . Posterior margin regularly convex, bearing series of small spines and armed with pairs of stout spines at each lateral end, inner spine more than two times as long as outer one.

Uropodal endopod bearing series of rather strong spines on distal and lateral margins and with inner depression at anterior half very distinct. Uropodal exopod with transverse suture forming two short sinuous lobes; lateral margin ending in acute immovable tooth flanking rather long movable spine; spine overreaching distal margin of uropodal exopod, and internally flanked by acute immovable tooth.

HABITAT.—Reef edges near tide level and associated with rocks and coral, including *Pocillopora* and *Porites* (Chace, 1972:65); 0–1.0 m; sand beach, rock outcrops.

COLOR IN LIFE.—Brownish orange with scattered white dots over carapace, abdomen and major chela. Chela with lighter background color than carapace and abdomen. Black areas on head, thorax, and near tip of major chela (Pequegnat and Ray, 1974:246).

TYPE-LOCALITY.—Fernando de Noronha (off Brazil).

DISTRIBUTION.—Eastern tropical Atlantic from São Tome and Principe; western Atlantic from Dry Tortugas to Fernando de Noronha and westward to the Yucatan peninsula; Flower Garden Reefs off Texas; eastern Pacific from Gulf of California, western Mexico to Panama. Now reported from Costa Rica.

### 16. *Alpheus cylindricus* Kingsley, 1878

FIGURE 19

*Alpheus cylindricus* Kingsley, 1878a:196; 1878c:58; 1883:120.—Lockington, 1878:478.—Coutière, 1899:29, figs. 44, 278.—Zimmer, 1913:394.—Crosnier and Forest, 1965b:606; 1966:257, figs. 16a–h.—Hendrix, 1971:71.—Coelho and Ramos, 1972:149.—Chace, 1972:65.—Pequegnat and Ray, 1974:246, fig. 49d.—Christoffersen, 1979:310.—Wicksten, 1983:43.

*Alpheus vanderbilii* Boone, 1930b:163, fig. 5A–C, pl. 58.

*Crangon cylindricus*.—Schmitt, 1924c:74; 1939:24.—Chace, 1937:121.—Pearse, 1950:150.

MATERIAL EXAMINED.—Mexico: San Gabriel Bay, Espiritu Santo Island, Baja California (sta 634-37: 1 ♂, 1 ovig, sta 638-37: 2 ♂, 1 ♀, 3 ovig); Isabel Island, Sinaloa (sta 124-33: 1 ♂, 1 ovig).

Costa Rica: Puerto Culebra (sta 256-34: 1 ♀, sta 258-34: 1 ♀); Parker Bay (sta 473-35: 1 ♂).

Panama: Pinas Bay (sta 436-35: 1 ovig, sta 437-35: 1 ♂, 1 ♀, sta 444-35: 5 ♂, 2 ovig); Bahia Honda (sta 861-38: 2 ♂); Secas Isle (sta 446a-35: 1 ♂).

Colombia: Port Utria (sta 232-34: 2 ♂, sta 234-34: 2 ♂, sta 239-34: 1 ovig, sta 413-35: 1 ovig, "sta 414 or 419-35": 5 ♂, 1 ♀, sta 419-35: 1 ♂, 1 ♀, 1 ovig); Cupica Bay (sta 427-35: 1 ovig); Gorgona Island (sta 411-35: 1 ♀, 1 ovig).

MEASUREMENTS.—Males, cl 6.1–9.5 mm; females, cl 4.8–7.6 mm; ovigerous females, cl 5.6–9.3 mm.

DESCRIPTION.—Rostrum (Figure 19a,b) blunt, shallowly triangular, slightly produced anteriorly and directing downward at tip.

Ocular hood not inflated dorsally, with anterior margin sinuous.

First antennular segment bearing deep, hook-like carina extending from ventral inner margin; ventral part of carina very acute (Figure 19c). Second segment very long about 3.2 times as long as broad, 1.9 times as long as visible part of first segment and 2.4 times as long as third segment. Stylocerite short, blunt at tip and slightly overreaching middle of first segment.

Scaphocerite about 3.1 times as long as broad. Lateral margin concave at middle. Distal spine reaching to distal  $\frac{1}{3}$  of third antennular segment. Inner blade vestigial, reaching to distal  $\frac{1}{5}$  of second antennular segment. Cleft between inner blade and distal spine invisible, arising from distal  $\frac{1}{4}$  of scaphocerite.

Carpocerite reaching to distal end of antennular peduncle. Basicerite with no distinct lateral spine.

Third maxilliped (Figure 19d) reaching to distal end of carpo-cerite beyond distal half of ultimate segment. Ultimate

segment about 1.3 times as long as penultimate, tapering distally, bearing scattered setae on superior and inferior margins as well as on distal margin; tufts of setae on inner face very dense. Penultimate segment rather elongate, about 3 times as long as broad, bearing seta-like movable spines along distal  $\frac{2}{3}$  of inferior margin and superior distal margin; inferior margin bearing scattered long setae. Antepenultimate segment bearing seta-like movable spines along distal  $\frac{1}{2}$  of inferior margin and scattered long setae on entire inferior margin. Exopod reaching to proximal  $\frac{1}{3}$  of penultimate segment. Precoxa with one arthrobranch near distal end but with no supplementary arthrobranch.

Major first pereopod (Figure 19e,f) overreaching distal end of carpo-cerite by length of chela. Major chela about 3.0 times as long as broad with fingers occupying distal  $\frac{1}{4}$ . Movable finger opening and closing in obliquely horizontal plane, elongated cylindrical in shape and bulbous at tip; middle part of finger fitting into concavity near immovable finger. Immovable finger very small. Palm swollen laterally with superior and inferior margins rounded, lacking transverse grooves. Outer face of palm with two longitudinal grooves; groove above inferior crest extending posteriorly just before half length of palm; groove below inferior crest extending posteriorly to half of superior groove and anteriorly to middle of immovable finger. Inferior crest ending in bluntly acute tooth flanking dactylar articulation. Inner face of palm with short, broad superior longitudinal groove behind dactylar articulation. Merus about 1.9 times as long as broad; inferior inner margin smooth, with no spine at distal end.

Minor chela of first pereopods (Figure 19g,h) about 3.9 times as long as broad with fingers occupying distal  $\frac{1}{2}$ ; fingers much narrower than palm, strongly deflexed inward and slightly directed downward. Palm swollen laterally and lacking sculpturing. Chela bearing scattered long setae on inferior margin. Merus about 2.1 times as long as broad; inferior inner margin smooth and superior margin very convex.

Second pereopod (Figure 19i) reaching distal end of carpo-cerite beyond part of first carpal segment. Fingers of chela about 1.9 times as long as palm. First segment of carpus 1.7 times as long as second; second segment 3 times as long as third; third segment subequal to fourth; fifth segment shorter than second, 2 times as long as fourth.

Dactylus of third pereopod (Figure 19j) very small, biunguiculate, strongly deflexed downward, about  $\frac{1}{5}$  length of propodus. Propodus slightly shorter than carpus, bearing 7 movable spines on inferior margin and pair at distal end; distalmost spine reaching to distal  $\frac{1}{3}$  of dactylus. Carpus with tooth-like process on superior distal margin. Merus broad at middle, about 3.2 times as long as broad and 1.5 times as long as carpus. Ischium with no movable spine.

Fourth pereopod almost same as third pereopod. Ischium with no movable spine.

Fifth pereopod much narrower than third pereopod. Ischium with no movable spine.

Pleura (Figure 19k) of first four abdominal somites broadly

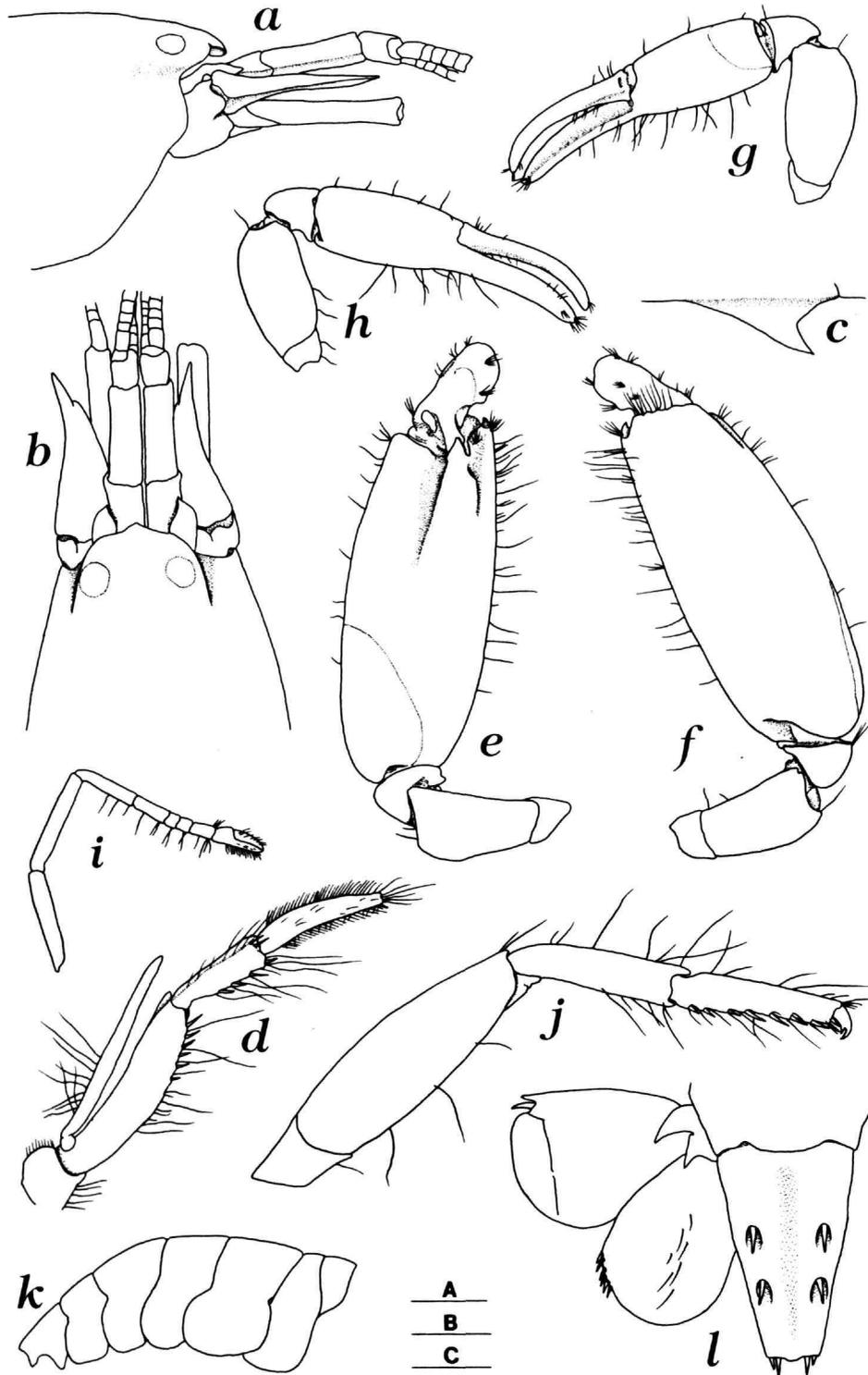


FIGURE 19.—*Alpheus cylindricus*, male, cl 7.8 mm, from sta 634-37: *a*, anterior region, lateral view; *b*, same, dorsal view; *c*, carina below right first antennular segment; *d*, right third maxilliped; *e*, major first pereopod, outer face; *f*, same, inner face; *g*, minor first pereopod, outer face; *h*, same, inner face; *i*, right second pereopod; *j*, right third pereopod; *k*, abdomen; *l*, telson and uropods. (Scale A = 2 mm: *e*–*i*, *k*; scale B = 1 mm: *a*, *b*, *d*, *j*, *l*; scale C = 0.5 mm: *c*.)

rounded; pleuron of fifth somite broadly rectangular. Abdominal sternites with no spine at midline. Appendix masculina clearly longer than appendix interna.

Telson (Figure 19*l*) regularly tapering posteriorly, about 1.5 times as long as broad at anterior end, armed with two pairs of rather stout dorsal spines and with slight longitudinal median depression on dorsal surface. Posterior margin straight to produced at middle, armed with pair of stout spines at each lateral end; inner spine very strong, about 1.5 times as long as outer one.

Uropodal endopod bearing fairly strong spines along distolateral margin and with inner depression at anterior half invisible. Uropodal exopod with transverse suture forming two straight lobes; lateral margin terminating in sharp immovable tooth flanking movable spine; spine reaching to distal margin of uropodal exopod; immovable tooth inside of movable spine acute.

HABITAT.—Shore to 37 m; sand, rock, and coral clumps.

COLOR IN LIFE.—Carapace spotted on sides, whitish; whole animal pale white on middorsum, sides and head to hind end vermilion, pale; chelae suffused ochraceous-rufous (color note by W.L. Schmitt, unpublished; Wicksten, 1983:44).

TYPE-LOCALITY.—Archipelago de la Perlas, Gulf of Panama.

DISTRIBUTION.—Eastern Atlantic from Islands of Principe, São Tome and Annobon Islands; western Atlantic from Bimini, Bahamas, Bermudas, and Florida through Barbados to Bahia, Brazil; Flower Garden Reefs off Texas; eastern Pacific from Gulf of California, Colombia, Gulf of Panama and Galapagos Islands. Now reported from Costa Rica.

### 17. *Alpheus paracrinitus* Miers, 1881

FIGURE 20

*Alpheus paracrinitus* Miers, 1881b:365, pl. 16: fig. 6.—Kingsley, 1883:123.—Osorio, 1887:230; 1889:137; 1898:194.—Coutière, 1899:34; 1905:901, pl. 82: fig. 38 [part].—Rahbun, 1900a:313.—Balss, 1916:2.—Schmitt, 1939:12.—Holthuis, 1951:74.—Chace, 1962:609; 1972:69.—A. Banner and D. Banner, 1964:92; 1966:115, fig. 41; 1967:278; 1984:42.—D. Banner and A. Banner, 1981:37.—Crosnier and Forest, 1965b:605; 1966:253, figs. 15a-f.—Pequegnat and Ray, 1974:246, figs. 49e, 51.—Miya, 1974:157, pl. 31.—Abele, 1979:275.—Carvacho, 1979:454.—Brusca, 1980:252.—Wicksten, 1983:45.

*Alpheus ascensionis* Ortman, 1893:45.

*Alpheus paracrinitus* var. *bengalensis* Coutière, 1905:901, pl. 82: figs. 37–37e [part].—Banner, 1956:358; 1957:204; 1958:168.

*Alpheus bengalensis* Holthuis, 1958:25.

*Crangon paracrinitus*.—Schmitt, 1939:12.

*Crangon togatus* Armstrong, 1940:2, fig. 1.

*Crangon paracrinia*.—Banner, 1953:110.

*Crangon paracrinia* var. *bengalensis*.—Banner, 1953:110, fig. 40a-k.

MATERIAL EXAMINED.—MEXICO: San Gabriel Bay, Espiritu Santo Island, Baja California (sta 604-36: 2 ♂, 1 ovig, sta 634-37: 1 ♂, 1 ♀, 3 ovig, sta 638-37: 3 ♂, 1 ovig); San Francisco Island, Baja California (sta 652-37: 1 ♂); Sulphur Bay, Clarion Island (sta 140-34: 2 ♂, 3 ♀, 2 ovig).

COSTA RICA: Playa Blancas (sta 465-35: 1 ♂); Guanacaste,

Playa del Coco (sta 1566: 1 ovig, 1 juv).

Panama: Secas Isle (sta 447-35: 1 ovig); Pedro Gonzales, Perlas Island (sta 33-4: 1 juv).

Galapagos Islands: Black Beach Anchorage, Charles Island (sta 33-33: 1 ♂, 2 ovig); Albemarle Island, Cartago Bay (sta 73-33: 1 ♂, 1 ♀, 2 ovig); Hood Island (sta 357-35: 2 ♂, 1 ovig); Gardner Bay, Hood Island (sta 25-33: 1 juv, sta 28-33: 3 ♂); South Seymour Island (sta 789-38: 1 ♂, 1 ovig); Charles Island (sta 351-35: 1 ♀, 2 ovig); Tower Island, Darwin Bay (sta 94-33: 1 ovig, sta 98-33: 1 ovig, sta 101-33: 1 ♀); Barrington Island (sta 811a-38: 2 ♂, 1 ovig); James Island, Sullivan Bay (sta 343-35: 1 ♂, 1 ♀); Academy Bay, Indefatigable Island (sta 168-34: 1 ♀).

MEASUREMENTS.—Males, cl 2.7–6.2 mm; females, cl 3.5–6.7 mm; ovigerous females, cl 5.1–8.1 mm.

DESCRIPTION.—Rostrum (Figure 20*a,b*) triangular, acute, somewhat longer than wide at base, scarcely reaching to middle of visible part of first antennular segment and bearing several short setae along lateral margins. Rostral carina slightly extending posteriorly, rounded dorsally.

Ocular hood not inflated dorsally, slightly produced anteriorly; anterior margin very convex and very concave near base of rostrum. Orbitorostral groove weak, fairly distinct just behind anterior margin near base of rostrum.

First antennular segment bearing shallowly triangular carina extending from ventral inner margin; ventral part ending in acute spine (Figure 20*c*). Second segment about 1.7 times as long as broad, slightly longer than visible part of first segment; first segment slightly longer than third segment. Stylocerite narrowing to long sharp point, almost reaching to distal margin of first segment.

Scaphocerite with lateral margin very slightly concave to almost straight. Distal spine directing slightly inward, scarcely reaching to distal end of antennular peduncle and falling short of distal end of carapocerite. Inner blade narrowly rounded distally, falling far short of tip of distal spine. Cleft between inner blade and distal spine arising from distal 0.3 of scaphocerite.

Carpocerite overreaching distal end of antennular peduncle by almost length of third antennular segment. Basicerite with small, sharp lateral spine; spine broad at base.

Third maxilliped (Figure 20*d*) slightly overreaching distal end of carapocerite. Ultimate segment slender, about 6 times as long as broad at proximal end, 2.4 times as long as penultimate, tapering distally, with long setae on superior and inferior margins as well as on distal margin; tufts of setae on inner face dense. Penultimate segment about 2 times as long as broad with scattered long setae on superior and inferior margins. Antepenultimate segment produced on superior distal margin and with sparse short setae on inferior margin. Exopod slightly overreaching distal end of antepenultimate segment. Precoxa with one arthrobranch near distal end and also with small supplementary arthrobranch near proximal end.

Major first pereopod (Figure 20*e,f*) overreaching distal end of carapocerite by almost length of chela. Major chela slightly

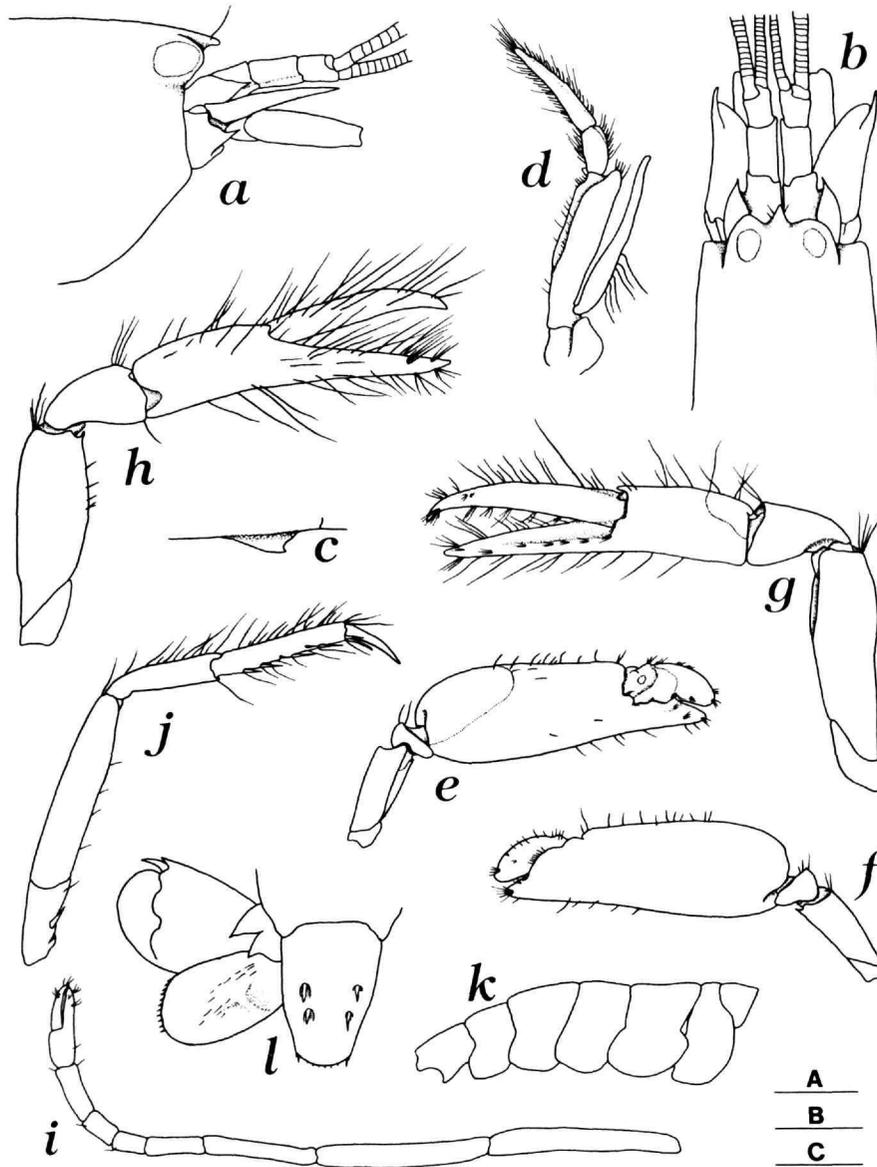


FIGURE 20.—*Alpheus paracrinitus*, male, cl 4.9 mm, from sta 343-35: *a*, anterior region, lateral view; *b*, same, dorsal view; *c*, carina below right first antennular segment; *d*, left third maxilliped; *e*, major first pereopod, outer face; *f*, same, inner face; *g*, minor first pereopod, outer face; *h*, same, inner face; *i*, right second pereopod; *j*, right third pereopod; *k*, abdomen; *l*, telson and uropods. (Scale A = 2 mm: *e*, *f*, *k*; scale B = 1 mm: *a*, *b*, *d*, *g*-*j*, *l*; scale C = 0.5 mm: *c*.)

compressed laterally, lacking sculpturing, about 3.1 times as long as broad with fingers occupying slightly less than distal 0.3. Movable finger shallowly arched in profile with tip blunt, slightly overreaching tip of immovable finger. Merus about 2 times as long as broad; inferior inner margin smooth, bearing one acute spine at distal end.

Minor chela of first pereopods (Figure 20*g,h*) about 5 times as long as broad and bearing dense long setae on inner face,

especially on fingers. Fingers occupying slightly less than 0.6 length of chela. Palm with blunt tooth flanking dactylar articulation on inner face. Merus with inferior inner margin smooth, bearing spine at distal end.

Second pereopod (Figure 20*i*) reaching distal end of carpoerite beyond proximal part of first carpal segment. Fingers of chela about 1.3 times as long as palm. First segment of carpus about 2 times as long as second; second segment

subequal to or slightly longer than fifth, about 1.7 times as long as third; third segment subequal to fourth.

Dactylus of third pereopod (Figure 20j) simple, slightly curved and elongate, about  $\frac{2}{5}$  length of propodus. Propodus about 1.3 times as long as carpus and armed with 7 movable spines in irregular line on inferior margin and pair at distal end. Carpus with both superior and inferior distal margins slightly projected anteriorly but rounded. Merus about 5 times as long as broad and 2 times as long as carpus. Ischium bearing movable spine.

Fourth pereopod almost same as third pereopod. Ischium bearing movable spine.

Ischium of fifth pereopod bearing movable spine.

Pleura (Figure 20k) of abdominal somites broadly rounded. First four abdominal sternites of male with spine at midline of each sternite, but spines of third and fourth sternites less distinct; in female, abdominal sternite with no spine. Appendix masculina clearly overreaching distal end of appendix interna.

Telson (Figure 20f) about 1.4 times as long as broad at anterior end, armed with two pairs of rather stout dorsal spines and with no distinct longitudinal median depression on dorsal surface. Posterior margin rounded, bearing indistinct seta-like spines and armed with pair of spines at each lateral end; inner spine almost 2 times as long as outer one.

Uropodal endopod bearing seta-like spines on distal margin and with inner depression at anterior half fairly distinct. Uropodal exopod bearing slender movable spine flanked laterally by very acute immovable tooth and internally by rounded lobe; movable spine not overreaching distal margin of uropodal exopod; transverse suture forming two convex lobes.

**HABITAT.**—Shore to 5 m; rocky, coral, and coral clump. On turtle grass and *Porites* flats (Chace, 1972:69).

**COLOR IN LIFE.**—Translucent white with bands of red on thorax and abdomen, chelae with red mottling, eggs yellow to greenish (Banner, 1953:112).

**TYPE-LOCALITY.**—Goree, Senegal.

**DISTRIBUTION.**—Pantropical. Western Atlantic, Bermuda to Tobago; Flower Garden Reefs off Texas; eastern Atlantic, West Africa; Indian Ocean; tropical Indo-West Pacific to Hawaii; eastern Pacific from Gulf of California, western Mexico, Islas Clarion, Panama, Clipperton and Galapagos Islands.

### 18. *Alpheus rostratus*, new species

FIGURE 21

**MATERIAL EXAMINED.**—Holotype: Male, cl 4.8 mm, Darwin Bay, Tower Island, Galapagos Islands (sta 784-38).

Mexico: San Gabriel Bay, Espiritu Santo Island, Baja California (sta 634-37: 2 ♀, 4 juv); Isabel Island, Sinaloa (sta 124-33: 1 ovig).

Costa Rica: Parker Bay (sta 473-35: 1 ♀, 1 ovig).

Galapagos Islands: Hood Island (sta 357-35: 1 ovig); Barrington Island (sta 47-33: 1 ♂); James Island, Sullivan Bay

(sta 344-35: 1 ♂).

**MEASUREMENTS.**—Males, cl 4.8–5.0 mm; females, cl 3.8–5.3 mm; ovigerous females, cl 4.9–6.1 mm.

**DESCRIPTION.**—Rostrum (Figure 21a,b) very long, carinate posteriorly and almost reaching to distal end of visible part of first antennular segment; rostral carina rounded and raised dorsally.

Ocular hood lying dorsally below level of middle part of rostral carina. Anterior margin sinuous. Orbitorostral groove narrow and shallow, reaching posteriorly to middle of eye, not clearly delimited posteriorly.

Carapace with pterygostomial margin slightly produced anteriorly below base of basicerite.

First antennular segment with broad hook-like carina extending from ventral inner margin; ventral tip acute (Figure 21c). Second segment about 1.5 times as long as broad, slightly less than 1.2 times as long as visible part of first segment and slightly more than 1.2 times as long as third segment. Stylocerite broad proximally, narrowing to sharp point, reaching to distal margin of first segment.

Scaphocerite rather narrow with lateral margin slightly concave at proximal  $\frac{1}{3}$ . Distal spine slightly overreaching distal end of carapocerite. Inner blade fairly narrow distally, far shorter than adjacent distal spine, reaching to distal end of antennular peduncle. Cleft between inner blade and distal spine very deep, arising from slightly less than  $\frac{1}{2}$  of scaphocerite.

Carpocerite overreaching distal end of antennular peduncle by  $\frac{1}{3}$  length of third antennular segment. Basicerite with narrow lateral spine.

Third maxilliped (Figure 21a) rather slender, overreaching distal end of carapocerite beyond distal  $\frac{1}{3}$  of ultimate segment. Ultimate segment about 2.0 times as long as penultimate. Penultimate segment about 2 times as long as broad. Exopod reaching to at least middle of penultimate segment. Precoxa with one arthrobranch near distal end and also with small supplementary arthrobranch near proximal end.

Major first pereopod (Figure 21d,e) overreaching distal end of carapocerite almost beyond proximal end of chela. Major chela about 2.8 times as long as broad with fingers occupying distal  $\frac{1}{3}$ . Movable finger shallowly arched on superior margin, compressed laterally and very bluntly rounded at tip; tip slightly overreaching tip of immovable finger. Palm little stout, with no sculpturing; inferior margin opposite to dactylar articulation slightly concave. Merus with inferior inner margin smooth and bearing small spine at distal end.

Minor chela of first pereopods (Figure 21f,g) slender, about 4 times as long as broad; middle of inferior margin slightly concave. Fingers slightly more than 1.2 times as long as palm. Inner faces of both fingers bearing dense, stiff setae. Movable finger not balaeniceps in both sexes. Palm bearing dense long, stiff setae on anterior half of inner face and with blunt tooth above dactylar articulation on inner face. Merus with inferior inner margin smooth and bearing small spine at distal end.

Second pereopod (Figure 21h) overreaching distal end of carapocerite beyond distal part of merus. Fingers of chela 1.2

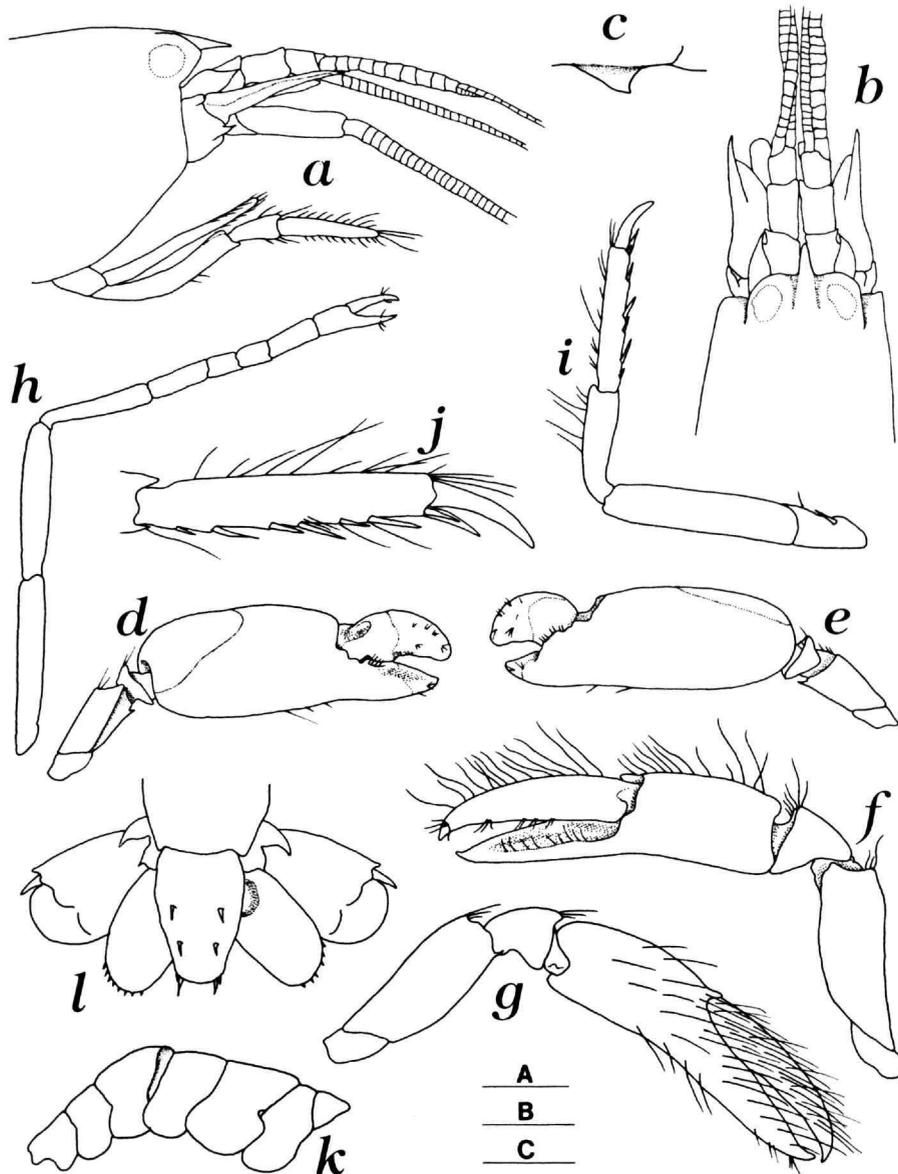


FIGURE 21.—*Alpheus rostratus*, new species, holotype male, cl 4.8 mm, from sta 784-38: *a*, anterior region, lateral view; *b*, same, dorsal view; *c*, carina below right first antennular segment; *d*, major first pereopod, outer face; *e*, same, inner face; *f*, minor first pereopod, outer face; *g*, same, inner face; *h*, right second pereopod; *i*, right third pereopod; *j*, same, dactylus and propodus; *k*, abdomen; *l*, telson and uropods. (Scale A = 2 mm: *d, e, k*; scale B = 1 mm: *a, b, f-i, l*; scale C = 0.5 mm: *c, j*.)

times as long as palm. First segment of carpus about 1.8 times as long as second; second segment 2 times as long as third; third segment subequal to fourth; fifth segment very slightly shorter than second.

Dactylus of third pereopod (Figure 21*i*) simple, slender, about  $\frac{2}{5}$  times as long as propodus with tip slightly directed downward. Propodus about 1.3 times as long as carpus, with 6 movable spines on inferior margin and pair at distal end;

distalmost spine reaching to distal  $\frac{1}{2}$  of dactylus. Merus slender, about 4.5 times as long as broad and 1.8 times as long as carpus. Ischium bearing movable spine.

Fourth pereopod almost same as third pereopod. Ischium bearing movable spine.

Fifth pereopod much narrower than third pereopod. Ischium bearing inconspicuous movable spine.

Pleura (Figure 21*j*) of abdominal somites broadly rounded

in both sexes. Abdominal sternites bearing one blunt spine at midline of each of first two sternites in male. Appendix masculina overreaching distal end of appendix interna.

Telson (Figure 21k) about 1.7 times as long as broad at anterior end, armed with two pairs of dorsal spines and with no longitudinal median depression on dorsal surface. Lateral margin fairly rounded at middle. Posterior margin regularly rounded, armed with pair of spines at each lateral end; inner spine two times as long as outer one.

Uropodal endopod bearing inconspicuous seta-like spines on distal margin and with inner depression at anterior half fairly distinct. Uropodal exopod bearing rather slender movable spine flanked laterally by acute immovable tooth and internally by rounded lobe; movable spine almost reaching to distal margin of uropodal exopod; transverse suture forming two convex lobes.

VARIATIONS.—This species shows the sexual dimorphism in the abdominal sternites. The first two abdominal sternites bear a blunt spine at midline of each sternite in male, but there is no spine in female.

HABITAT.—Shore to 5.5 m; rock and coral.

DISTRIBUTION.—Baja California; Sinaloa, Mexico; Costa Rica; Galapagos Islands.

REMARKS.—The present species is very similar to *A. paracrinitus*. The following features are the main differences between the two species. (1) The rostrum of the present species is very long and almost reaches to the distal margin of the first antennular segment and does not bear setae on the lateral margins. In *A. paracrinitus*, the rostrum is rather short, reaches at most to middle of the visible part of the first antennular segment and bears several setae on the lateral margins. (2) The scaphocerite of the present species, especially the inner blade is more narrow than that of *A. paracrinitus*. (3) The antepenultimate segment of the third maxilliped is not much produced anteriorly on superior distal margin in the present species, but in *A. paracrinitus*, the antepenultimate segment is much produced anteriorly on superior distal margin.

ETYMOLOGY.—The long rostrum of the species is the different character compared with the short rostrum of the most similar species *A. paracrinitus*. The specific name is from the Latin *rostratus* (beaked at the end).

### 19. *Alpheus floridanus* Kingsley, 1878

FIGURE 22

*Alpheus floridanus* Kingsley, 1878a:193; 1878c:58; 1883:123, pl. 2: fig. 8; 1899:717, fig. 42.—Lockington, 1878:476.—Rathbun, 1901:107.—Zimmer, 1913:398, figs. C<sup>1</sup>–J<sup>1</sup>.—Hendrix, 1971:75.—Chace, 1972:65, figs. 17–20.—Christoffersen, 1979:311, figs. 6–8.—Hendrickx et al., 1983:74.—Wicksten, 1983:45.

*Alpheus Floridanus*.—Coutière, 1899:29.

*Alpheus floridanus* var. *africanus* Balss, 1916:21, fig. 5.

*Alpheus platycheirus* Boone, 1927:131, figs. 29, 30; 1930a:49, figs. 9, 9a.

*Alpheus floridanus africanus*.—Holthuis, 1951:79, fig. 15a–e.—Buchanan, 1958:24.—Longhurst, 1958:31.—Rossignol, 1962:131.—Crosnier and Forest,

1965a:358; 1965b:606; 1966:269, figs. 20b, 21a–e.—Coelho and Ramos, 1972:150.

*Alpheus floridanus floridanus*.—Holthuis, 1951:80, fig. 15f–g.—Crosnier and Forest, 1965b:606; 1966:267, figs. 20a, 21f–i.—Coelho and Ramos, 1972:150.

*Crangon floridanus*.—Schmitt, 1924a:65; 1935:144; 1936:368.—Pearse, 1950:150.

MATERIAL EXAMINED.—MEXICO: Willards Pt., Gonzaga Bay, Baja California (sta 714-37: 2 ♂, 1 ♀); Middle of Angeles Bay, Baja California (sta 536-36: 1 ♂); Agua Verde Bay, Baja California (sta 655-37: 1 ♂); Isabel Island, Sinaloa (sta 870-38: 1 ♂).

Panama: East of Canal channel (sta 150-A: 1 ovig, 1 spec, sta 150-C: 1 ♀, 1 ovig); Venado Beach (sta 132-2: 1 ♂, 1 ♀, 1 ovig); Naos Island causeway (sta 141-B: 2 ♂).

Ecuador: Cape San Francisco (sta 216-34: 2 ♂, 1 ♀, sta 850-38: 1 ♂).

MEASUREMENTS.—Males, cl 5.8–11.7 mm; females, cl 5.7–6.8 mm; ovigerous females, cl 5.3–9.0 mm.

DESCRIPTION.—Rostrum (Figure 22a,b) narrowly triangular, overreaching middle of visible part of first antennular segment and bearing several short setae near base; rostral carina narrowly raised dorsally, passing far behind posterior end of eye.

Ocular hood produced anteriorly and dorsally above level of middle part of rostral carina, separated from rostral carina by rather deep, distinct depression. Anterior margin of ocular hood slightly concave near base of rostrum. Carapace with pterygostomian margin produced anteriorly below base of basiscerite.

First antennular segment bearing deep, hook-like triangular carina extending from ventral inner margin; tip very acute, directing forward (Figure 22c). Second segment very long, more than 3 times as long as broad, 1.8 times as long as visible part of first segment and 2.2 times as long as third segment. Stylocerite broad proximally, abruptly narrowing to sharp point, clearly not reaching to distal margin of first segment.

Scaphocerite rather narrow, about 3.4 times as long as broad. Lateral margin very slightly concave at middle. Distal spine overreaching distal end of antennular peduncle and scarcely reaching to distal end of carapocerite. Inner blade narrow distally, reaching to distal end of antennular peduncle. Cleft between inner blade and distal spine arising from slightly less than distal 0.3 of scaphocerite.

Carpocerite overreaching distal end of antennular peduncle by length of third antennular segment. Basiscerite with sharp lateral spine almost reaching to tip of rostrum.

Third maxilliped (Figure 22d) reaching to distal end of carapocerite. Ultimate segment about 2.5 times as long as penultimate and about 5.7 times as long as broad at middle, tip rounded with very long setae on distal margin; tufts of setae on inner surface dense. Penultimate segment about 1.7 times as long as broad at distal end, broadened on inferior distal margin, with very long setae on inferior distal margin; setae overreaching distal end of ultimate segment. Exopod reaching

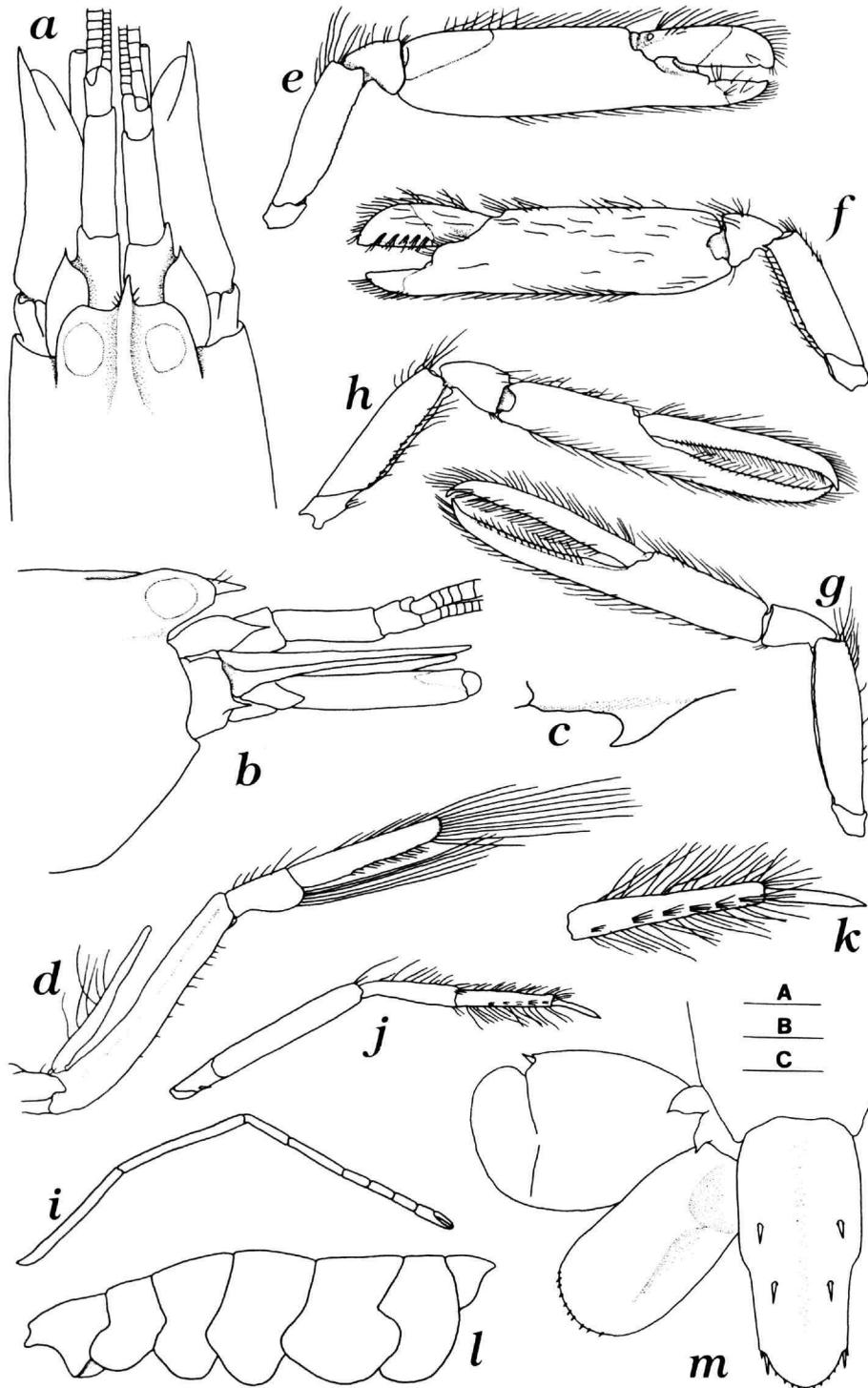


FIGURE 22.—*Alpheus floridanus*, male, cl 8.1 mm, from sta 216-34: *a*, anterior region, dorsal view; *b*, same, lateral view; *c*, carina below left first antennular segment; *d*, right third maxilliped; *e*, major first pereopod, outer face; *f*, same, inner face; *g*, minor first pereopod, outer face; *h*, same, inner face; *i*, right second pereopod; *j*, right third pereopod; *k*, same, dactylus and propodus; *l*, abdomen; *m*, telson and uropods. (Scale A = 2 mm: *e-j*, *l*; scale B = 1 mm: *a, b, d, k, m*; scale C = 0.5 mm: *c*.)

to distal  $\frac{1}{3}$  of antepenultimate segment. Precoxa with one arthrobranch near distal end and also with small supplementary arthrobranch near proximal end.

Major first pereopod (Figure 22*e,f*) overreaching distal end of carpoperite by length of chela. Major chela strongly compressed laterally, elongate, about 4.2 times as long as broad with fingers occupying slightly more than distal  $\frac{1}{3}$ . Chela bearing dense long setae on superior and inferior margins. Palm lacking grooves or sculpturing. Movable finger compressed laterally, with proximal superior margin almost straight, shallowly arched distally and blunt at tip; inferior margin with very shallow broad tooth. Immobile finger with superior margin almost straight. Merus about 3.3 times as long as broad; inferior outer margin dentate and inferior inner margin bearing 5 to 6 small movable spines and acute spine at distal end. Ischium dentate on inferior inner margin.

Minor chela of first pereopods (Figure 22*g,h*) very narrow, about 5.9 times as long as broad; fingers longer than palm, occupying distal 0.6 of chela. Chela bearing dense long setae on superior and inferior margins, especially on inferior margin of movable finger and superior margin of immobile finger. Fingers well crossing and shallowly gaping when closed. Immobile finger with inferior margin slightly convex, especially near distal end. Merus about 3.8 times as long as broad with 5 to 6 movable spines on inferior inner margin and small acute spine distally; inferior outer margin slightly dentate. Ischium slightly dentate on inferior inner margin.

Second pereopod (Figure 22*i*) reaching distal end of carpoperite beyond part of first carpal segment. Fingers of chela about 1.4 times as long as palm. First segment of carpus about 0.7 times as long as second; second segment 2.4 times as long as third; third segment subequal to fourth; fifth segment slightly shorter than fourth.

Dactylus of third pereopod (Figure 22*j,k*) subspatulate, about 0.5 times as long as propodus. Propodus almost as long as carpus, tapering distally, without movable spines on inferior margin and with very long setae on superior and inferior margins. Carpus bearing scattered long setae on superior margin. Merus about 1.7 times as long as carpus and more than 6 times as long as broad. Ischium with rather small movable spine.

Fourth pereopod almost same as third pereopod. Ischium with one rather small movable spine.

Ischium of fifth pereopod with movable spine.

Pleura (Figure 22*l*) of abdominal somites broadly rounded, not much overlapping in ventral regions in male. Abdominal sternite with no spine at midline. Appendix masculina clearly overreaching distal end of appendix interna.

Telson (Figure 22*m*) elongate, about 2.3 times as long as broad at anterior end, armed with two pairs of rather stout dorsal spines and with very shallow longitudinal median depression on dorsal surface. Posterior margin very convex, bearing sparse seta-like spines and armed with pair of spines at each lateral end; inner spine almost two times as long as outer one.

Uropodal endopod bearing sparse seta-like spines on distal margin and with inner depression at anterior half very distinct. Uropodal exopod with transverse suture forming two straight lobes; lateral margin terminating in very small immovable tooth flanking small movable spine; lobe inside of movable spine very rounded at tip.

HABITAT.—Shore to 37 m; mud, coralline, sand, and rocks.

COLOR IN LIFE.—Body speckled by green and brown chromatophores; traces of blue or black pigment pleura, uropods and telson. Chelae with irregular greenish brown stains, spaces between these sometimes speckled by blue chromatophores; major chela with finger tips between brown and pink (Christoffersen, 1979:313).

TYPE-LOCALITY.—Fort Jefferson, Dry Tortugas, Florida.

DISTRIBUTION.—Eastern Atlantic from Guinea to Congo and Ilha do Principe; western Atlantic from Gulf of Mexico to Estado da Bahia, Brazil; eastern Pacific from Gulf of California and Panama. Now from Cape San Francisco, Ecuador.

REMARKS.—The considerable variability of this species was discussed by Chace (1972:65). The southern limit of distribution in the eastern Pacific now extends to Cape San Francisco, Ecuador.

## 20. *Alpheus aequus*, new species

FIGURE 23

MATERIAL EXAMINED.—Holotype: Female, cl 6.8 mm; Playa Blancas, Costa Rica (sta 465-35).

Galapagos Islands: Barrington Island (sta 47-33: 1 ♂).

MEASUREMENTS.—Male, cl 4.3 mm; female, cl 6.8 mm.

DESCRIPTION.—Rostrum (Figure 23*a,b*) short, obtusely triangular, not reaching to middle of visible part of first antennular segment. Rostral carina very low, linear dorsally, slightly overreaching posterior end of eye. Anterior inner margin of ocular hoods almost straight.

Orbitorostral groove shallow, not clearly delimited posteriorly.

Antennules stout. First antennular segment bearing broadly triangular carina extending from ventral inner margin; ventral tip acute (Figure 23*c*). Second segment about 1.3 times as long as broad, almost as long as visible part of first segment and 1.3 times as long as third segment. Stylocerite rounded distally, reaching near distal margin of first segment.

Scaphocerite with lateral margin slightly concave at middle. Distal spine rather stout, well overreaching distal end of antennular peduncle and reaching to distal end of carpoperite. Inner blade slightly narrower than adjacent distal spine, far overreaching distal end of antennular peduncle. Cleft between inner blade and distal spine arising from distal 0.3 of scaphocerite.

Carpocerite overreaching distal end of antennular peduncle by 1.5 times length of third antennular segment. Basicerite with no lateral spine.

Ultimate segment of third maxilliped (Figure 23*d*) truncate distally, about 1.8 times as long as penultimate, bearing long

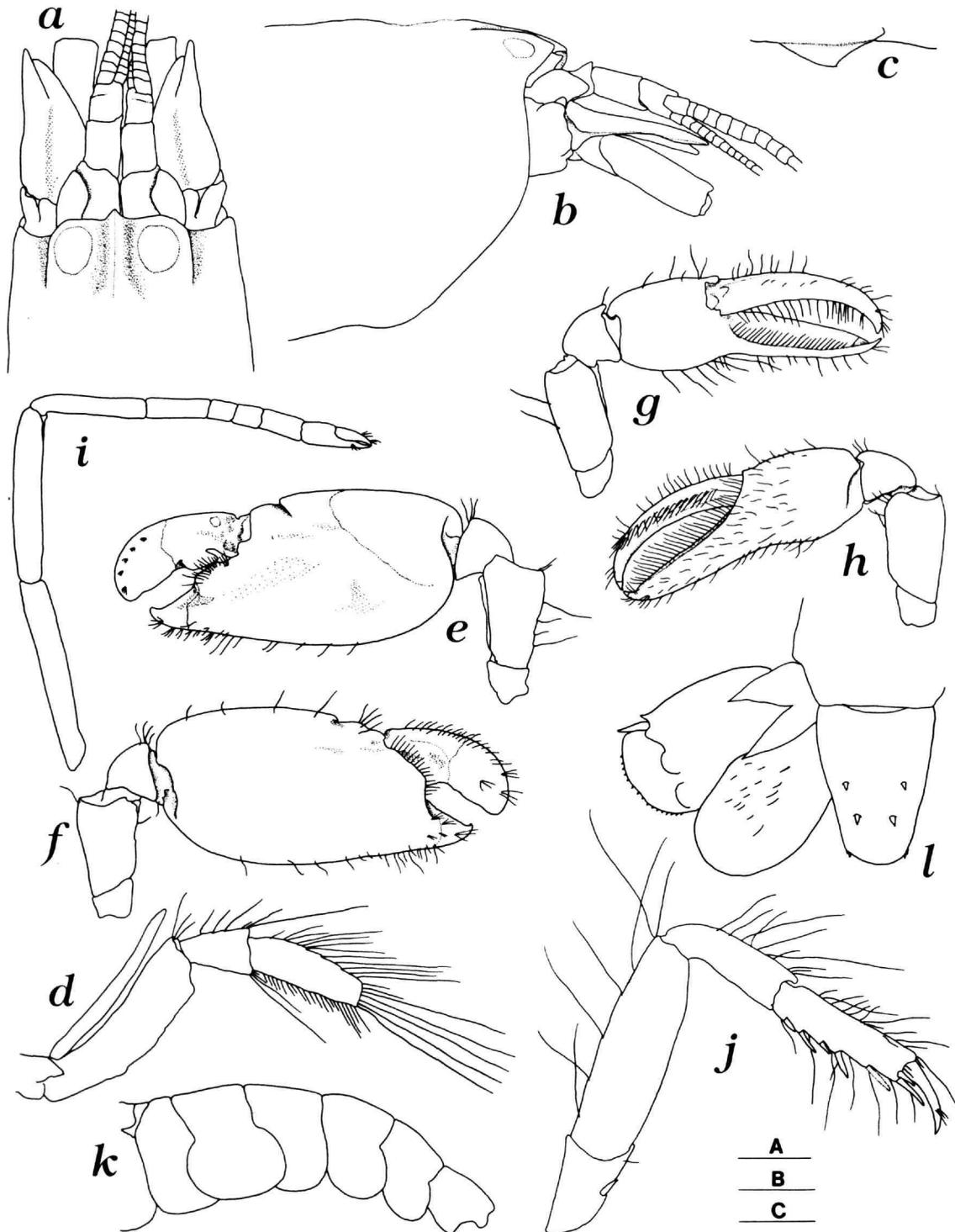


FIGURE 23.—*Alpheus aequus*, new species, holotype female, cl 6.8 mm, from sta 465-35: *a*, anterior region, dorsal view; *b*, same, lateral view; *c*, carina below right first antennular segment; *d*, right third maxilliped; *e*, major first pereopod, outer face; *f*, same, inner face; *g*, minor first pereopod, outer face; *h*, same, inner face; *i*, right second pereopod; *j*, right third pereopod; *k*, abdomen; *l*, telson and uropods. (Scale A = 2 mm: *e-h*, *k*; scale B = 1 mm: *a*, *b*, *d*, *i*, *j*, *l*; scale C = 0.5 mm: *c*.)

setae on distal margin. Penultimate segment very broad distally, about 1.4 times as long as broad at distal end. Inferior margin of antepenultimate segment irregular. Exopod slightly overreaching distal end of antepenultimate segment. Precoxa with one arthrobranch near distal end and also with small supplementary arthrobranch near proximal end.

Major chela of first pereopods (Figure 23e,f) noticeably compressed laterally, somewhat trapezoid, about 2.2 times as long as broad with fingers occupying slightly more than distal  $\frac{1}{3}$ . Superior margin of palm bearing narrow and curving transverse groove proximal to movable finger. Inferior margin rounded without grooves or indentations. Outer face of palm with shallow, broad longitudinal groove extending from near middle of palm to middle of immovable finger. Movable finger with superior margin shallowly rounded and tip bluntly rounded, far overreaching tip of immovable finger. Merus with inferior inner margin slightly rough, no spine at distal end; superior margin with several long setae.

Minor chela of first pereopods (Figure 23g,h) about 3 times as long as broad with fingers 1.5 times as long as palm. Fingers gaping and tips crossing when closed. Both inner and outer faces of fingers bearing long setae. Palm very convex inferiorly, bearing scattered stiff setae on inner face. Merus about 2 times as long as broad, with inferior inner margin smooth and no spine at distal end.

Second pereopod (Figure 23i) reaching distal end of carapace beyond proximal  $\frac{1}{3}$  of second carpal segment. Fingers of chela slightly less than 1.5 times as long as palm. First segment of carpus about 1.7 times as long as second; second segment 2.6 times as long as third; third segment subequal to fourth; fifth segment about 1.5 times as long as fourth.

Dactylus of third pereopod (Figure 23j) simple, conical, about  $\frac{1}{2}$  length of propodus. Propodus about 1.2 times as long as carpus, bearing 5 movable spines on inferior margin and pair at distal end. Carpus bearing long setae on superior margin, projecting as tooth-like process on superior distal margin. Merus about 1.7 times as long as carpus, 3 times as long as broad and bearing several long setae on superior margin. Ischium bearing movable spine.

Fourth pereopod almost same as third pereopod. Ischium bearing movable spine.

Fifth pereopod much narrower than third pereopod. Ischium bearing movable spine.

Pleura (Figure 23k) of abdominal somites broadly rounded in female. Abdominal sternite with no spine at midline. Appendix masculina slightly longer than appendix interna.

Telson (Figure 23l) about 1.8 times as long as broad at anterior end, armed with two pairs of dorsal spines and with no distinct longitudinal median depression on dorsal surface. Lateral margin almost straight. Posterior margin regularly rounded with pair of small spines at each lateral end.

Uropodal endopod with no distinct inner depression at anterior half. Uropodal exopod with distal margin bearing series of seta-like spines; lateral margin ending in acute

immovable tooth flanking movable spine; spine almost reaching to distal margin of uropodal exopod, flanked internally by rounded lobe; transverse suture forming two very convex lobes.

HABITAT.—Shore to 5.0 m; shale beach.

DISTRIBUTION.—Playa Blancas, Costa Rica and Barrington Island, Galapagos Islands.

REMARKS.—The present species is very close to *A. barbatus* from the Indian Ocean and the south Pacific Ocean. The several different features of the present species compared with *A. barbatus* are the following. (1) The anterior inner margin of the ocular hood is straight rather than concave as in *A. barbatus*. (2) The scaphocerite is more narrow than that of *A. barbatus*. (3) The movable finger of major chela is narrowly elongate and its tip is bluntly rounded and far overreaches the tip of immovable finger, but in *A. barbatus*, tip is bulbous (D. Banner and A. Banner, 1982:165) or acute (Coutière, 1899, fig. 280) and reaches to the tip of immovable finger. (4) The fingers of the second pereopod are slightly less than 1.5 times as long as the palm, but the fingers are clearly shorter than palm in the figure of *A. barbatus* (D. Banner and A. Banner, 1982, fig. 49g). (5) The second carpal segment of second pereopod is more than 1.5 times as long as fifth, but in *A. barbatus* the second segment is subequal to the fifth segment. (6) The inferior inner margin of the merus of the first pereopod is more smooth than that of *A. barbatus*. The above characters used for comparisons between the present species and *A. barbatus* may be variable; however, we describe the present species as a new species for the time being in view of the distance involved.

ETYMOLOGY.—The Latin *aequus* (flat) was suggested by the shape of the major chela, which is flattened laterally.

## 21. *Alpheus fasciatus* Lockington, 1878

*Alpheus fasciatus* Lockington, 1878:478.—Coutière, 1899:29; 1905:902.—D. Banner and A. Banner, 1981:8.

DESCRIPTION.—The following is the description of Lockington (1878:478) with some modification of terms.

Small; carapace smooth; no ocular spines; eye-shields scarcely produced forwards; rostrum about equal to diameter of eye; surface between rostrum and eyes slightly depressed, but with no distinct sulcus.

Basal spine [stylocerite] of antennule longer than first segment of peduncle; segments of peduncle nearly equal in length; inner branch of flagellum twice as long as outer, and rather longer than carapace.

Small spine present on basal joint [basicerite] of antenna below; spine of basal scale [scaphocerite] about equal to peduncle; flagella wanting or broken in all the specimens under examination.

Third maxillipeds reaching to end of basal joint of antennae.

Meri of first pair of pereopods without spines; major chela smooth, nearly cylindrical, tapering towards movable finger; finger smooth, semicircular in profile,  $\frac{1}{4}$  length of palm, and working vertically. Minor chela very small, smooth, cylindrical, slender; movable finger equal to palm; immovable finger as long as movable finger; long hairs on inner faces of fingers.

Carpi of second pair of pereopods five-segmented; second segment  $\frac{2}{3}$  length of first, but equal to third and fourth together; fifth slightly shorter than second. Posterior pairs of pereopods cylindrical joints; propodi spinulose beneath.

Telson elongate, tapering, rounded at end.

Color after a short time in alcohol: carapace and abdomen alternately banded with bright red and white; major chela red, with marblings of white in some cases.

Length of a large female 18 mm.

TYPE-LOCALITY.—Port Escondido, Gulf of California.

DISTRIBUTION.—Only from the type-locality.

REMARKS.—*Alpheus fasciatus* has not been found since the original description by Lockington in 1878. The stylocerite of this species overreaches the distal margin of the first antennular segment and this feature is quite important in keying out the species of *Alpheus* from the eastern Pacific. Only four other species from the eastern Pacific (*A. grahmi*, *A. lottini*, *A. panamensis*, and *A. felgenhaueri*) have the stylocerite that overreaches the distal margin of the first antennular segment. These four species have the ocular tooth, while in *A. fasciatus* there is no ocular tooth. Therefore, *A. fasciatus* is treated as a valid species in the present study until more information about this species is available.

## 22. *Alpheus bouvieri* A. Milne Edwards, 1878

FIGURE 24

*Alpheus Edwardsii*.—Dana, 1852:542; 1855:11, pl. 34: fig. 2a-f.—Pocock, 1890:518 [part]. [Not *Athanas Edwardsii* Audouin, 1826.]

*Alpheus Bouvieri* A. Milne Edwards, 1878:231.—Coutière, 1898:131, fig. 1 [part]; 1899:15, fig. 291; 1905:907, pl. 85: fig. 44 [part].

*Alpheus heterochaelis*.—Kingsley, 1878a:194 [part].—Rathbun, 1900b:152 [part].—Luederwaldt, 1919:429 [part]. [Not *Alpheus heterochaelis* Say, 1818.]

*Alpheus edwardsii*.—Bate, 1888:542, pl. 97: fig. 1.

*Alpheus Edwardsii*.—De Man, 1899:311 [part].

*Alpheus bouvieri*.—Rathbun, 1900a:312 [part].—Sourie, 1954:253.—Forest and Guinot, 1958:9.—Ribeiro, 1964:5.—Crosnier and Forest, 1965b:606; 1966:273, fig. 22a-j.—Uschakov, 1970:444.—Fausto-Filho and Furtado, 1970:286.—Chace, 1972:63.—Fausto-Filho, 1974:5; 1975:79.—Gore et al., 1978:225.—Christoffersen, 1979:303, figs. 2-5.

*Alpheus bouvieri* var. *chilensis*.—Schmitt, 1924b:162. [Not *Alpheus chilensis* Coutière, 1902.]

*Crangon [Alpheus] Bouvieri*.—Monod, 1933:462, fig. 1A-C.

MATERIAL EXAMINED.—Costa Rica: Salinas Bay (sta 474-35: 8 ♂, 1 ♀, 6 ovig); Golfito: 1 ♂, 2 ovig; Jul 1978.

Panama: Northeast Taboguilla Island (sta 59: 1 ♂, 2 ovig); Amador, Naos Island (sta 105: 1 ♂, 4 ovig); Punta Paitilla (sta 107-1: 1 ♂, 1 ♀, 1 juv); Fort Kobbe Beach (sta 108-2: 1 juv, sta 108-7: 1 ovig); Farfan Point (sta 56-1: 1 ovig, sta 113-1: 2 ♂, 1 ovig).

Colombia: Gorgona Island (sta 405-35: 3 ♂).

Ecuador: Manta (sta 400-35: 3 ♂, 1 ♀, 1 ovig); Cape San Francisco (sta 848-38: 1 ♂, 2 ovig).

MEASUREMENTS.—Males, cl 4.0–8.0 mm; females, cl 3.5–5.9 mm; ovigerous females, cl 5.4–7.5 mm.

DESCRIPTION.—Rostrum (Figure 24a,b) short, triangular, carinate posteriorly and not reaching to middle of visible part of first antennular segment; tip directing forward. Rostral carina shallow, narrowly rounded dorsally and slightly widened posteriorly.

Ocular hood slightly inflated dorsally above level of middle part of rostral carina. Orbitorostral groove shallow but distinct and reaching far posterior to eye; posterior end of groove not clearly delimited. Anterior inner margin of ocular hoods almost straight.

First antennular segment with very shallow and broadly rounded carina extending from ventral inner margin (Figure 24c). Second segment about 1.5 times as long as broad, 1.3 times as long as visible part of first segment and 1.2 times as long as third segment. Stylocerite broad proximally and abruptly narrowing to sharp point reaching to distal margin of first segment.

Scaphocerite about 3 times as long as broad. Lateral margin almost straight or very slightly concave at proximal  $\frac{1}{3}$ . Distal spine overreaching distal end of antennular peduncle and falling far short of distal end of carapocerite. Inner blade regularly narrowing distally, far shorter than adjacent distal spine and reaching to distal end of antennular peduncle. Cleft between inner blade and distal spine arising from distal 0.4 of scaphocerite.

Carpocerite overreaching distal end of antennular peduncle by at least length of third antennular segment. Basicerite with small, sharp lateral spine.

Third maxilliped (Figure 24d) reaching distal end of carapocerite beyond distal  $\frac{1}{2}$  of ultimate segment. Ultimate segment about 2.4 times as long as penultimate, slightly tapering distally; distal margin truncate, not much narrower than proximal end and bearing sparse long setae; superior margin bearing scattered few setae. Penultimate segment about 1.7 times as long as broad near distal end. Exopod slightly overreaching distal end of antepenultimate segment. Precoxa with one arthrobranch near distal end and also with small arthrobranch near proximal end.

Major first pereopod (Figure 24e,f) reaching distal end of carapocerite beyond small part of carpus. Major chela about 2.5 times as long as broad, bearing scattered setae on inner face, especially distally. Fingers occupying distal 0.3 of chela, much narrower than palm. Movable finger compressed laterally, regularly and highly arched throughout length of superior margin in profile; tip bluntly rounded, overreaching tip of immovable finger. Immobile finger with tip directing slightly upward and outward; inferior margin slightly convex, especially posteriorly. Superior transverse groove of palm deep, broad, U-shaped with proximal shoulder not overhanging groove. Superior outer palmar depression well defined, narrowly quadrangular, extending to oblique suture; inferior distal part slightly extending downward. Superior inner palmar depression transversely elongate U-shaped, reaching down to 0.3 width of palm; inferior margin slanting upward posteriorly. Inferior transverse groove very deep and broad; proximal shoulder heavy and rounded. Inferior outer palmar depression narrow, inverse V-shaped, continuing up to 0.3 width of palm; margins well delimited posteriorly but not clearly delimited anteriorly. Inferior inner palmar depression broad, not clearly delimited anteriorly. Merus about 2.3 times as long as broad

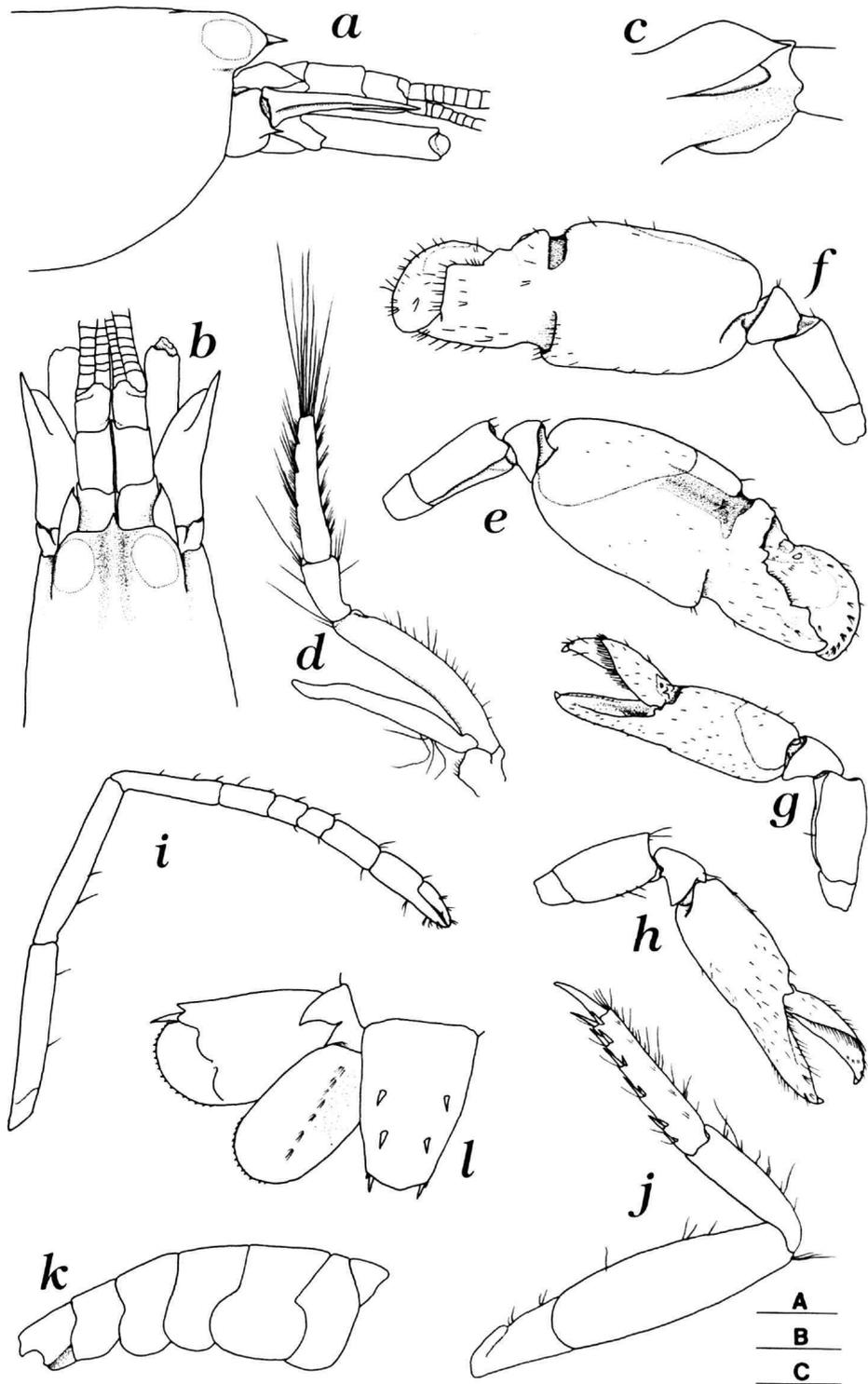


FIGURE 24.—*Alpheus bouvieri*, male, cl 5.9 mm, from sta 474-35: *a*, anterior region, lateral view; *b*, same, dorsal view; *c*, carina below right first antennular segment; *d*, right third maxilliped; *e*, major first pereopod, outer face; *f*, same, inner face; *g*, minor first pereopod, outer face; *h*, same, inner face; *i*, right second pereopod; *j*, left third pereopod; *k*, abdomen; *l*, telson and uropods. (Scale A = 2 mm: *e-h*, *k*; scale B = 1 mm: *a*, *b*, *d*, *i*, *j*, *l*; scale C = 0.5 mm: *c*.)

with inferior inner margin very smooth and without spine at distal end.

Minor chela of first pereopods (Figure 24*g,h*) about 3.3 times as long as broad, bearing fairly dense long setae on anterior half of inner face. Fingers occupying slightly less than distal 0.5 of chela and with acute tips overlapping, but not gaping. In males, movable finger balaeniceps with characteristic rows of setae on outer and inner faces meeting on dorsal surface. In females, movable finger not balaeniceps. Immobile finger bearing very slight fringe of setae on lateral faces. Palm with bluntly acute tooth above dactylar articulation on inner face. Merus about 2.1 times as long as broad with inferior inner margin very smooth and no spine at distal end.

Second pereopod (Figure 24*i*) reaching distal end of carpoperite beyond  $\frac{1}{2}$  of first carpal segment. Fingers of chela almost as long as palm. First segment of carpus about 2.1 times as long as second; second segment almost as long as fifth and 1.7 times as long as third; third segment slightly longer than fourth.

Dactylus of third pereopod (Figure 24*j*) slightly more than  $\frac{1}{3}$  length of propodus, simple and rather broad at base; tip slightly directing downward. Propodus about 1.2 times as long as carpus, with 5 pairs of movable spines on inferior margin and pair at distal end; distalmost spine reaching to distal  $\frac{1}{2}$  of dactylus; superior and inferior margins bearing scattered setae. Merus broad, about 3.3 times as long as broad and 1.8 times as long as carpus, bearing few setae on inferior margin. Ischium with no movable spine.

Fourth pereopod almost same as third pereopod. Ischium with no movable spine.

Fifth pereopod much narrower than third pereopod. Ischium with no movable spine.

Pleura (Figure 24*k*) of first four abdominal somites broadly rounded in both sexes; pleuron of fifth somite bluntly triangular on posterior ventral margin. Abdominal sternite with no spine at midline. Appendix masculina slightly overreaching distal end of appendix interna.

Telson (Figure 24*l*) about 1.6 times as long as broad at anterior end, armed with two pairs of rather stout dorsal spines and with no distinct longitudinal median depression on dorsal surface. Lateral margin slightly produced at middle. Posterior margin slightly produced at middle, armed with pair of spines at each lateral end; inner spine more than 2 times as wide and long as outer one. Lateral margin slightly produced at middle.

Uropodal endopod bearing inconspicuous seta-like spines on distal margin and with inner depression at anterior half very slight. Uropodal exopod with transverse suture forming two convex lobes and bearing inconspicuous seta-like spines on distal margin; lateral margin terminating in acute immovable tooth flanking rather slender movable spine; spine slightly overreaching distal margin of uropodal exopod; tooth inside of movable spine bluntly rounded.

VARIATIONS.—One male (sta 105, cl 4.5 mm) showed no balaeniceps on the movable finger of minor chela of the first pereopod.

HABITAT.—In and among rocks and dead coral near or above low tide level (Chace, 1972:63). Shore to 1.0 m; sand, mud, and rock.

TYPE-LOCALITY.—Cape Verde Islands.

DISTRIBUTION.—Western Atlantic, Bermudas, east Florida, Cuba, Antigua to Tobago, Aruba, Fernando de Noronha and Ceara to the north of Rio Grande do Sul; eastern Atlantic from the Cape Verde Islands and Senegal to Ilha de São Tomé and Congo; eastern Pacific from Panama, Colombia and Galapagos Islands. Now reported from Costa Rica and Ecuador.

REMARKS.—The categorical status of the present species has been treated as the species level by several authors (Crosnier and Forest, 1966; Chace, 1972; Christoffersen, 1979), but D. Banner and A. Banner (1982) reduced *A. bouvieri* A. Milne Edwards to *A. leviusculus bouvieri* after long discussion of the related species. However, so many other related species of *edwardsii* group in the eastern Pacific are similar to the present species and these species are separated from each other by almost equally weighted characters. Therefore, the present species is treated at the species level rather than the subspecies level because several subspecies cannot be dealt with in the overlapping geographic regions. *Alpheus bouvieri* cannot be easily distinguished from the other related species when specimens of this species are missing the first pereopods.

### 23. *Alpheus chilensis* Coutière, 1902

FIGURE 25

*Alpheus maindroni*.—Lenz, 1902:732. [Not *Alpheus maindroni* Coutière, 1898.]

*Alpheus bouvieri chilensis* Coutière in Lenz, 1902:732.—Boone, 1930b:161, pl. 57.—Sivertsen, 1933:22.

*Alpheus chilensis*.—Holthuis, 1952:43, fig. 9.—Méndez, 1981:92, figs. 286–290.

*Crangon bouvieri chilensis*.—Rathbun, 1910:606.

*Crangon maindroni*.—Rathbun, 1910:606 [part].

DESCRIPTION.—The following is the description of Holthuis, 1952, with some modification of terms, and Figure 25 here was reproduced from the illustrations of Holthuis, 1952.

Rostrum [Figure 25*a,b*] ending in short and sharply pointed tip; tip reaching beyond ocular hoods. Rostrum flat dorsally and widening posteriorly. At each side of rostrum [rostral carina] separated from ocular hoods by deep posteriorly diverging groove [orbitorostral groove], groove ending abruptly and inner margin of which (being at the same time lateral margin of rostrum [rostral carina]) very distinct and rather sharp. Ocular hoods covering eyes entirely, bearing no spines. Laterally of ocular hoods anterior margin of carapace somewhat concave. No spine present on carapace. A rather indistinct cervical groove present and furthermore a more or less sharply defined pit may be observed in median region of carapace somewhat behind rostrum. Cardiac notches distinct.

Eyes wholly covered by carapace. Cornea distinctly pigmented.

Second antennular segment elongate, longer than first segment; third segment again short. Outer flagellum having two rami fused for 20 joints (in small specimen 11 to 13 joints); 2 or 3 joints of shorter ramus free. Stylocerite rather broad, but sharply pointed and almost reaching as far forwards as base of second antennular segment.

Scaphocerite [Figure 25*c*] just failing to reach to end of antennular peduncle,

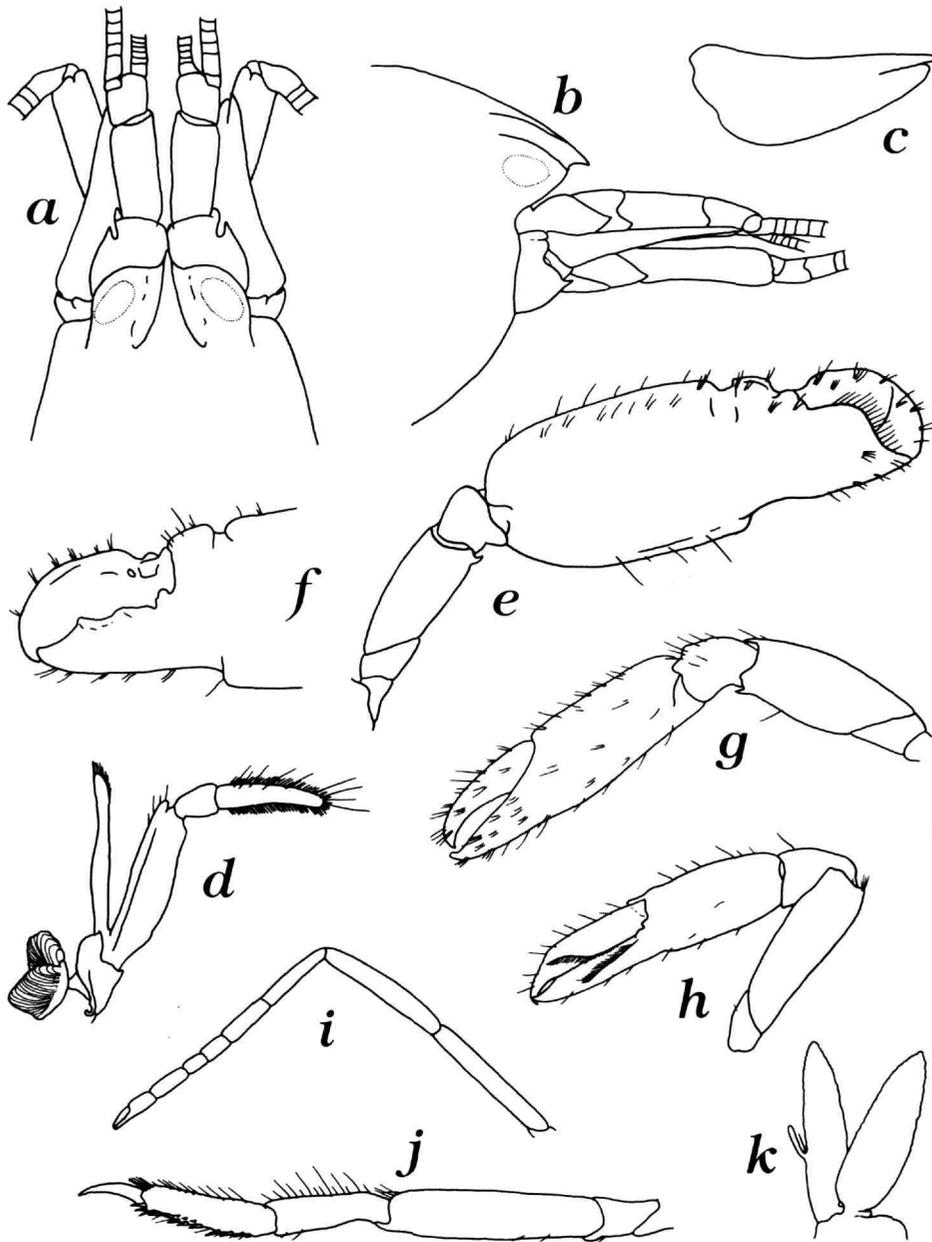


FIGURE 25.—*Alpheus chilensis*: a, anterior region, dorsal view; b, same, lateral view; c, left scaphocerite; d, right third maxilliped; e, major first pereopod, inner face; f, same, anterior part of chela, outer face; g, minor first pereopod in female, inner face; h, same, in male, outer face; i, left second pereopod; j, left third pereopod; k, second pleopod of male. [After Holthuis, 1952.]

2.5 times as long as broad. Lateral margin concave and ending in strong sharp tooth, tooth distinctly overreaching narrow inner blade; blade narrowing regularly distally.

Carpocerite slightly overreaching distal end of antennular peduncle. Basicerite with very small spine.

Third maxilliped [Figure 25d] failing to reach distal end of carpal spine. Ultimate segment more than twice as long as penultimate segment and with apex truncate. Antepenultimate segment slightly longer than distal two segments combined; carina running over posterior surface close near superior

margin. Exopod and epipod well developed, large arthrobranch and very small pluerobranch present.

First pereopods strongly different in shape and size. In largest specimen, right pereopod smaller and reaching with part of palm beyond scaphocerite. Fingers of this smaller pereopod [Figure 25g] unarmed, placed at angle with palm, being directed somewhat more inwards and somewhat shorter than palm; scattered hairs present on palm and especially on fingers; no rows of hairs, which should give chela a balaeniceps shape, present in this female specimen. Except for hairs mentioned here palm smooth. Carpus short and constricted

near base, half as long as palm. Merus longer than palm and triangular in transverse section; inferior inner margin ending in distinct spine. Ischium short and unarmed. In male specimen, chela of smaller first pereopod [Figure 25h] balaeniceps having oblique rows of hairs on movable finger and immovable finger.

Major chela [Figure 25e,f] of first pereopods reaching with larger part of palm beyond scaphocerite. Fingers about half as long as palm. Movable finger compressed and having superior margin evenly convex; cutting edge bearing strong truncate tooth fitting in cavity of immovable finger. At outer side, movable finger somewhat flattened near base, bearing distinct circular spot (plaque adhesive according to Coutière, 1899:214). Immobile finger bearing at its cutting edge deep pit for reception of tooth of movable finger. Inner side of cutting edge considerably heightened and partly covering movable finger. Palm somewhat compressed, less than twice as long as high; superior margin showing deep and broad transverse notch some distance behind base of movable finger; inferior margin bearing distinct, bluntly and broadly rounded tooth just below this dorsal notch. A distinct *linea impressa* [oblique suture] visible in basal part of palm, triangular in outline. Carpus about  $\frac{1}{5}$  of length of palm, narrowing posteriorly and having anterior margin entire. Merus as that of smaller pereopod, provided with tooth on inferior inner margin distally.

Second pereopod [Figure 25i] reaching with larger part of carpus beyond scaphocerite. Chela small, about  $\frac{1}{4}$  of length of carpus; fingers subequal to palm. Carpus consisting of 5 segments; first segment almost 1.5 times as long as second; second segment about as long as third and fourth segments together; fifth segment about half as long as first. Merus slightly shorter than ischium and about 0.6 times as long as carpus.

Third pereopod [Figure 25j] reaching with its dactylus beyond carpus. Dactylus rather narrow and simple, almost half as long as propodus. Propodus somewhat longer than carpus and about  $\frac{3}{5}$  of length of merus, with inferior margin bearing various distinct spinules. Neither carpus nor merus provided with spinules or teeth.

Fourth pereopod very similar to third pereopod.

Fifth pereopod reaching slightly beyond base of scaphocerite. Dactylus simple. Propodus almost 2.5 times as long as dactylus, as long as carpus and distinctly shorter than merus; inferior margin bearing some spinules and numerous transverse rows of hairs in distal portion. No spines present on other joints.

Abdomen smooth, pleura of all somites broadly rounded. Pleuron of second abdominal somite having lateral margin somewhat emarginate. Pleura and posterolateral angles of sixth abdominal somite also rounded. No movable plate present near base of uropods. Sixth somite about as long as fifth. Endopods of second to fifth pleopods provided with distinct appendix interna at each endopod. Endopod of first pleopod small and simple. Appendix masculina [Figure 25k] of second pleopod of male extremely short, well nigh invisible and bearing one hair.

Telson somewhat longer than sixth abdominal somite, bearing two pairs of dorsal spines; anterior spines placed in about middle of telson, posterior ones situated about halfway between anterior pair and posterior margin. Posterior margin broadly rounded and bearing at each angle two spines, a shorter outer and a longer inner; spines of each pair placed close together.

Uropods broad. Uropodal exopod with lateral margin ending in tooth, tooth at its inner side bearing movable not-pigmented spine; transverse suture present.

VARIATIONS (after Holthuis, 1952:47).—The eggs of larger female are 0.6 to 0.7 mm in diameter. Both in the larger and the smaller ovigerous females the eggs are rather few and found only between the anterior pairs of pleopods. In the young female the eggs are irregularly shaped and badly developed.

In the small specimens the lateral margins of the rostrum [rostral carina] are less sharp than in the large specimen. In one of the three small specimens the left first pereopod is the larger, in the other two it is the right that is the larger. In the smaller females the fingers of the smaller pereopod are

relatively longer, being about as long as the palm and lying in the same plane as the palm. One of the females has the inner margin of the lower surface of the merus provided with a spinule in its middle. This obviously is an abnormality as the spinule does not occur in any of the other specimens.

The three smaller specimens probably are not yet adult. The females, it is true, bear eggs, but these are few, rather small and look quite underdeveloped.

HABITAT.—Littoral form (Holthuis, 1952:48).

COLOR.—Gray-brownish green with reddish legs (Holthuis, 1952:48).

TYPE-LOCALITY.—Calbuco, southwest of Puerto Montt, Chile.

DISTRIBUTION.—Eden Island, Galapagos Islands (Schmitt, 1924b:162) Webb Cove, Albemarle Island, Galapagos Islands (Boone, 1930b:161). Puerto Montt, Llanquihue, southern Chile (Lenz, 1902:732). Calbuco, southwest of Puerto Montt (Lenz, 1902:732).

REMARKS.—Holthuis (1952:47) noted that the reexamination of material reported from the Galapagos Islands by Schmitt (1924b:162) and Boone (1930b:161) is very desirable to determine the correctness of their identifications.

## 24. *Alpheus hebes*, new species

FIGURE 26

MATERIAL EXAMINED.—Holotype: Male, cl 7.3 mm; James Island, Galapagos Islands (sta 333-35).

Paratypes: 8 ♂, 2 ♀, 7 ovig, 1 juv (sta 333-35).

Mexico: Tenacatita Bay, Jalisco (sta 121-33: 3 ♂, 4 ♀); Braithwaite Bay, Socorro Island (sta 128-34: 2 juv); Sulphur Bay, Clarion Island (sta 140-34: 1 ♂, 1 ovig, sta 141-34: 2 ♂, 1 ♀, 4 ovig); Isabel Island, Sinaloa (sta 124-33: 3 ♂, 2 ♀, 3 ovig, sta 869-38: 2 ♂, 1 ♀, 2 ovig, sta 749-37: 3 ♂, 4 ovig, 1 juv); Ensenada de San Francisco, Sonora (sta 739-37: 1 ♀); Los Algodones, north of Guaymas, Sonora (sta 1551: 2 ovig); North Bay, San Francisco Island, Baja California (sta 519-36: 2 ♂, 2 ♀, 1 ovig, 1 juv); Willards Point, Gonzaga Bay, Baja California (sta 715-37: 1 ♂, 1 ♀); Escondido Bay, Baja California (sta 670-37: 2 ♀, 1 juv). Costa Rica: Isla del Coco, Chatham Bay (sta 106-33: 2 ♂, 2 ♀, 3 ovig, 3 juv); Isla del Coco, Wafer Bay (sta 105-33: 21 ♂, 4 ♀, 11 ovig, sta 107-33: 9 ♂, 5 ♀, 1 ovig, 6 juv); Salinas Bay (sta 474-35: 2 ♂, 1 ♀, 2 ovig); Parker Bay (sta 466-35: 25 ♂, 5 ♀, 24 ovig, 10 juv).

Panama: Bahia Honda (sta 111-33: 5 ♂, 3 ♀, 2 ovig, 2 juv, sta 861-38: 2 ovig); Jicarita Island (sta 240-34: 1 ♂); Naos Island causeway (sta 106: 2 ovig); by Naos Island (sta 82A: 1 ♂); Chaperera, Perlas Island (sta 38-1: 1 spec, sta 40: 8 ♂, 1 ♀, 5 ovig, 1 juv); Secas Isle (sta 446b-35: 2 juv; sta 452a-35: 1 ♂); Pinas Bay (sta 436-35: 4 ovig); Venado Beach (sta 88: 4 ovig); Punta Paitilla (sta 107: 4 ♂, 1 ♀, 2 ovig, 1 juv).

Colombia: Cabita Bay (sta 229-34: 5 ♂, 2 ♀, 3 ovig); Port Utria (sta 232-34: 2 ♂, 4 ♀, 1 ovig, sta 418-35: 1 ♂, 1 ♀, 1 ovig); Gorgona Island (sta 405-35: 3 ovig, 1 spec); Octavia Bay (sta 433-35: 1 ♀); Cupica Bay (sta 427-35: 2 ♂, 3 ♀, 1 ovig, 1 juv).

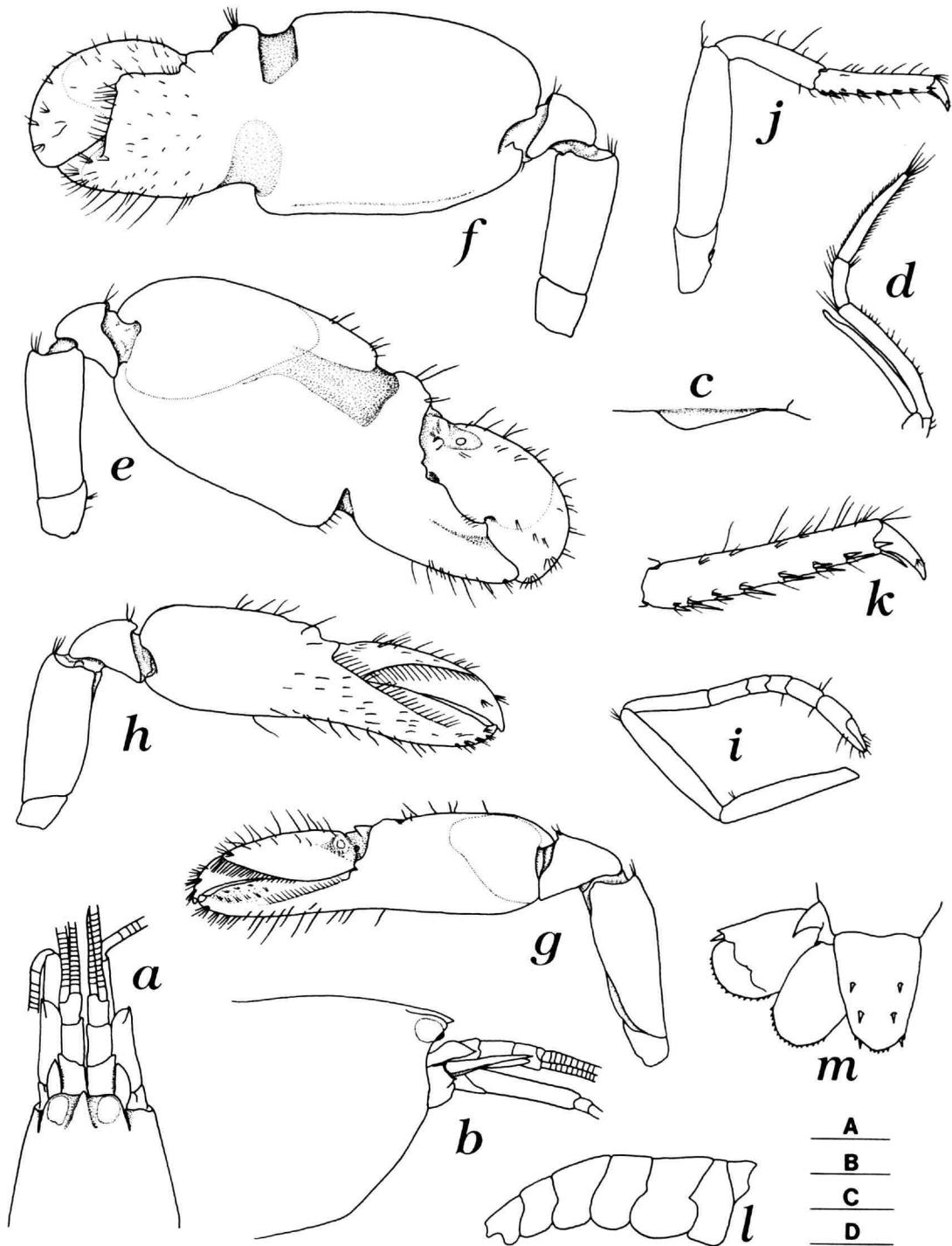


FIGURE 26.—*Alpheus hebes*, new species, male, cl 8.9 mm, from sta 314-35: *a*, anterior region, dorsal view; *b*, same, lateral view; *c*, carina below right first antennular segment (holotype, male, cl 7.3 mm, from sta 333-35); *d*, right third maxilliped; *e*, major first pereopod, outer face; *f*, same, inner face; *g*, minor first pereopod, outer face; *h*, same, inner face; *i*, right second pereopod; *j*, right third pereopod; *k*, same, dactylus and propodus; *l*, abdomen; *m*, telson and uropods (*l*, *m*, male, cl 9.0 mm, from sta 313-35). (Scale A = 4 mm; *l*, scale B = 2 mm; *a*, *b*, *d*-*j*, *m*; scale C = 1 mm; *k*; scale D = 0.5 mm: *c*.)

Ecuador: La Plata Island (sta 211-34: 3 ♂, 1 ♀, 6 ovig); La Libertad (sta 10-33: 1 ♂, 3 ovig, sta 207-34: 3 ♂, 6 ovig); Cape San Francisco (sta 848-38: 1 ovig).

Galapagos Islands: Tower Island, Darwin Bay (sta 93-33: 2 ♂, 2 ♀, 1 ovig, sta 96-33: 16 ♂, 2 ♀, 13 ovig, sta 101-33: 5 ♂, 2 ♀, 1 ovig); Barrington Island (sta 48-33: 4 ♂, 1 ♀, 5 ovig, 2 spec); James Bay, James Island (sta 71-33: 4 ♂, 2 ♀, 2 ovig); Sullivan Bay, James Island (sta 177-34: 1 ♂, 1 ovig); Albemarle Point, Albemarle Island (sta 69-33: 1 ovig); Albemarle Island, Cartago Bay (sta 76-33: 2 ♂, 1 ovig, sta 188-34: 1 ♂); Indefatigable Island (sta 314-35: 23 ♂, 6 ♀, 14 ovig); Academy Bay, Indefatigable Island (sta 52-33: 29 ♂, 12 ♀, 15 ovig, sta 168-34: 9 ♂, 4 ♀, 6 ovig, 1 juv); North Seymour Island (sta 175-34: 18 ♂, 1 ♀, 8 ovig); South Seymour Island (sta 174-34: 1 ♀, 3 ovig); Charles Island (sta 313-35: 8 ♂, 3 ♀, 11 ovig); Post Office Bay, Charles Island (sta 200-34: 1 ♀); Cormorant Bay, Charles Island (sta 58-33: 18 ♂, 5 ♀, 3 ovig, 3 juv); Hood Island (sta 358-35: 3 ♂, 3 ♀); Marchena Island (sta 306-35: 3 ♂, 3 ♀, 2 ovig).

MEASUREMENTS.—Males, cl 3.8–9.8 mm; females, cl 3.7–8.6 mm; ovigerous females, cl 4.5–11.1 mm.

DESCRIPTION.—Rostrum (Figure 26a,b) very short, produced very slightly beyond anterior margin of ocular hood and carinate posteriorly. Tip of rostrum sharply triangular or almost blunt and slanting downward. Rostral carina shallow, rounded dorsally, regularly widened posteriorly.

Ocular hood slightly inflated dorsally, not exceeding above level of middle part of rostral carina. Orbitorostral groove shallow, but visible and reaching far posterior to eye. Anterior margin of orbital hood slightly rounded, very shallowly concave near base of rostrum.

Carapace with pterygostomian margin very slightly produced anteriorly below base of basicerite.

First antennular segment with very shallow, broadly triangular carina extending from ventral inner margin (Figure 26c). Second segment rather stout, about 1.6 times as long as broad and 1.2 times as long as visible part of first segment and very slightly longer than third segment. Stylocerite broad proximally, narrowing to sharp point, or very blunt at tip, not reaching to distal margin of first segment.

Scaphocerite with lateral margin almost straight. Distal spine reaching to distal end of antennular peduncle and falling far short of distal end of carapocerite. Inner blade regularly narrowing distally, slightly shorter than adjacent distal spine. Cleft between inner blade and distal spine arising from distal 0.3 of scaphocerite.

Carpocerite overreaching distal end of antennular peduncle by more than length of third antennular segment. Basicerite with very small, sharp lateral spine.

Third maxilliped (Figure 26d) reaching distal end of carapocerite beyond distal  $\frac{1}{3}$  length of ultimate segment. Ultimate segment slender, regularly tapering distally, about 2.3 times as long as penultimate segment, bearing long setae on distal margin; distal margin truncate, not much narrower than

proximal end. Penultimate segment about 3.1 times as long as broad near distal end, bearing several long setae on superior and inferior margins distally. Antepenultimate segment bearing sparse short setae on inferior margin and few long setae on superior distal margin. Exopod slightly overreaching distal end of antepenultimate segment. Precocxa with one arthrobranch near distal end and also with small supplementary arthrobranch near proximal end.

Major first pereopod (Figure 26e,f) reaching distal end of carapocerite beyond proximal end of chela. Major chela about 2.5 times as long as broad, bearing scattered setae on inner face, especially distally. Fingers narrower than palm, occupying slightly less than distal  $\frac{1}{3}$  of chela. Movable finger compressed laterally, regularly arched throughout superior margin, acutely rounded or elongate at tip. Immobile finger with superior margin slightly concave posterior to tip and with inferior margin regularly rounded. Palm rather elongate. Superior transverse groove deep, broad, U-shaped with proximal shoulder not overhanging groove. Superior outer palmar depression well defined, narrowly quadrangular, extending to oblique suture. Superior inner palmar depression transversely elongate U-shaped, reaching to  $\frac{2}{5}$  width of palm; inferior margin slanting upward posteriorly. Inferior transverse groove very deep, directing upward and with proximal shoulder heavy and rounded. Inferior outer palmar depression narrow, inverse V-shaped, continuing upward to  $\frac{1}{3}$  width of palm and well delimited anteriorly and posteriorly. Inferior inner palmar depression broad, continuing upward slightly more than  $\frac{1}{3}$  width of palm. Inner face of palm with almost invisible longitudinal depression near bottom of palm. Merus about 2.2 times as long as broad; inferior inner margin very smooth and with no spine at distal end.

Minor chela of first pereopods (Figure 26g,h) about 3.4 times as long as broad, fingers occupying slightly less than distal 0.5. Inner palmar face with very blunt tooth above dactylar articulation. Fingers with tips overlapping, but not gaping. In males, movable finger well-developed balaeniceps. Immobile finger bearing slight fringe of setae on both lateral faces. In most females, movable finger not balaeniceps, but some specimens showing imperfectly developed setae. Merus about 2.4 times as long as broad and with inferior inner margin very smooth and with no spine at distal end.

Second pereopod (Figure 26i) reaching distal end of carapocerite beyond  $\frac{1}{2}$  of first carpal segment. Fingers of chela almost as long as palm. First segment of carpus about 2 times as long as second; second segment 1.8 times as long as third; third segment subequal to fourth; fifth segment 1.7 times as long as fourth.

Dactylus of third pereopod (Figure 26j,k) rather broad at base, about 0.3 times as long as propodus. Propodus slightly longer than carpus, bearing scattered setae on superior and inferior margins besides 5 to 7 pairs of movable spines on inferior margin and pair at distal end; distalmost spine reaching to distal  $\frac{1}{3}$  of dactylus. Merus rather broad, about 4.1 times

as long as broad. Ischium with small movable spine.

Fourth pereopod almost same as third pereopod. Ischium with small movable spine.

Ischium of fifth pereopod with no movable spine.

Pleura (Figure 26*l*) of abdominal somites broadly rounded in both sexes. Abdominal sternite with no spine at midline. Appendix masculina slightly overreaching distal end of appendix interna.

Telson (Figure 26*m*) about 1.4 times as long as broad at anterior end, armed with two pairs of rather stout dorsal spines and with no longitudinal median depression on dorsal surface. Posterior margin slightly produced, bearing seta-like spines at middle and armed with pair of spines at each lateral end; inner spine more than two times as long and wide as outer one.

Uropodal endopod bearing seta-like spines on distal margin and with inner depression at anterior half invisible. Uropodal exopod bearing rather slender movable spine flanked laterally by acute immovable tooth and internally by fairly acute tooth; movable spine not reaching to distal margin of uropodal exopod; transverse suture forming two convex lobes.

VARIATIONS.—The present species show some variations in the shapes of the rostrum, stylocerite, and movable finger of minor chela. The tips of the rostrum and stylocerite in the present species are usually blunt, but in many specimens, these are fairly acute. The male specimens of the present species have the minor chela with movable finger showing the balaeniceps. Most female specimens do not show the balaeniceps on the movable finger of minor chela, but some female specimens show imperfectly developed setae on the movable finger of minor chela.

HABITAT.—Shore to 74 m; among sand, mud, rocky reef, and coral clump.

DISTRIBUTION.—Baja California, Costa Rica, through Panama to Ecuador, Galapagos Islands.

REMARKS.—Chace (1972:64) noted:

There is another, possibly undescribed, species in the Galapagos Island, however, as indicated by a male and an ovigerous female without major chelipeds in the Smithsonian collections. These specimens differ from the other species from the eastern Pacific in having the rostrum broadly depressed and noncarinate, as in *A. chilensis*, in having the lower margin of the rostrum slanted slightly downward, rather than nearly horizontal or slanting slightly upward, in having the movable finger of the minor chela "balaeniceps"-shaped, and in having a movable spine on the ischium of the third pereopod, as in *A. leviusculus*.

The present species seems to be the same species as Chace mentioned and possibly is the same species as that which Coutière (1898) reported as *A. bouvieri bastardi* from Panama.

The present species is close to *A. bastardi* Coutière, 1905, from the Gulf of Aden, but *A. bastardi* has a small spine on the inferior inner margin of the merus of the first pereopod, while there is no spine in the present species.

ETYMOLOGY.—The specific name is from the Latin *hebes* (blunt), referring to the blunt tip of the rostrum of most specimens of the species.

## 25. *Alpheus longinquus*, new species

FIGURE 27

?*Alpheus bouvieri*.—Chace, 1962:610. [Not *Alpheus bouvieri* A. Milne Edwards, 1878.]

MATERIAL EXAMINED.—Holotype: Male, cl 5.9 mm; Braithwaite Bay, Socorro Island, Mexico (sta 128-34).

Paratypes: 2 ♂, 3 ♀, 1 ovig (sta 128-34).

Mexico: Tenacatita Bay, Jalisco (sta 121-33: 3 ♂, 1 ♀, 3 ovig); Sulphur Bay, Clarion Island (sta 140-34: 1 juv, sta 141-34: 1 ♀, 1 ovig); Agua Verde Bay, Baja California (sta 522-36: 1 ♀, sta 664-37: 1 juv); North Bay, San Francisco Island, Baja California (sta 519-36: 4 ♂, 1 ♀, 2 ovig); Cabeza Ballena, east of Cape San Lucas, Baja California (sta 623-37: 4 ♂, 3 ♀, 1 ovig); Isabel Island, Sinaloa (sta 124-33: 5 ♂, 4 ♀, 8 ovig; sta 869-38: 1 ♂, 1 ♀, 1 ovig).

Costa Rica: Wafer Bay, Isla del Coco (sta 105-33: 6 ♂, 3 ♀, 1 juv); Parker Bay (sta 466-35: 1 ♂, 2 ♀, 2 ovig).

Panama: Pinas Bay (sta 436-35: 1 ♀); Punta Paitilla (sta 107: 1 ♂, 1 ovig; sta 107-1: 1 ♂, 1 ovig); Farfan Point flats (sta 85-9: 1 ovig); Amador: 1 ♂, 6 Jun 1973, coll. by L.G. Abele.

Colombia: Cabita Bay (sta 229-34: 1 ♂, 3 ♀, 2 ovig); Port Utria (sta 418-35: 1 juv).

Ecuador: La Libertad (sta 10-33: 1 ovig).

Galapagos Islands: Indefatigable Island (sta 314-35: 6 ♂, 3 ♀, 13 ovig); Academy Bay, Indefatigable Island (sta 52-33: 3 ovig, sta 49-33: 2 ♂, 3 ovig, sta 168-34: 12 ♂, 9 ♀, 14 ovig, 1 juv); North Seymour Island (sta 175-34: 7 ♂, 7 ♀, 4 ovig); Charles Island (sta 313-35: 3 ♂, 2 ♀, 1 ovig, sta 166-34: 1 ovig); South Seymour Island (sta 174-34: 3 ♂, 6 ♀, 2 ovig, 1 juv, sta 350-35: 1 ♂, 4 ovig, sta 789-38: 1 ♂, 1 ovig); Black Beach Anchorage, Charles Island (sta 33-33: 2 ♂, 1 ovig); Tower Island, Darwin Bay (sta 93-33: 1 ♀, sta 96-33: 7 ♂, 9 ♀, 9 ovig, sta 98-33: 1 ovig, sta 782-38: 1 ♂, 2 ♀, sta 101-33: 2 ♂, 2 ♀, 3 ovig); Barrington Island (sta 48-33: 1 ♀, 1 ovig); James Island (sta 333-35: 6 ♂, 4 ♀, 10 ovig); James Bay, James Island (sta 71-33: 1 ♀); Sullivan Bay, James Island (sta 796-38: 1 ♂); Albemarle Island (sta 62-33: 1 spec, sta 65-33: 1 ovig, 69-33: 2 ♀, 1 ovig, 1 juv); Albemarle Island, Cartago Bay (sta 76-33: 3 ♂, 2 ♀, 1 ovig); Gardner Bay, Hood Island (sta 24-33: 1 ovig, 1 spec, sta 25-33: 1 juv); Marchena Island (sta 306-35: 2 ♂, 4 ♀, 2 ovig, 4 juv).

MEASUREMENTS.—Males, cl 3.5–7.1 mm; females, cl 4.1–10.8 mm; ovigerous females, cl 5.4–11.4 mm.

DESCRIPTION.—Rostrum (Figure 27*a,b*) short, sharply triangular, carinate posteriorly and falling short of or reaching to middle of visible part of first antennular segment. Rostral carina shallow, narrowly rounded dorsally, slightly widened near posterior end and far passing to posterior end of eye. Tip of rostrum slightly slanting downward.

Ocular hood slightly inflated dorsally above level of middle part of rostral carina. Orbitorostral groove shallow but distinct

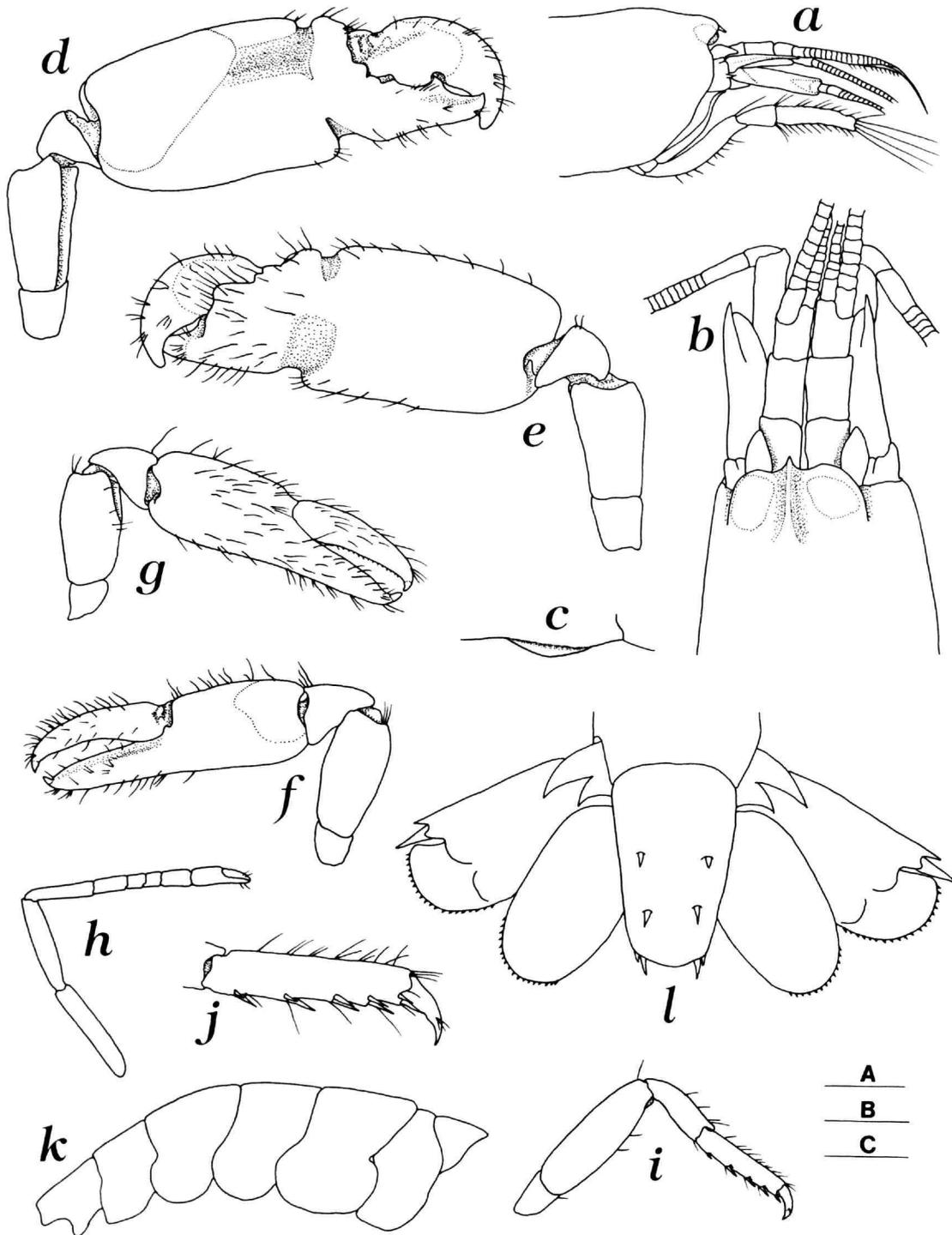


FIGURE 27.—*Alpheus longinquus*, new species, holotype male, cl 5.9 mm, from sta 128-34: *a*, anterior region, lateral view; *b*, same, dorsal view; *c*, carina below right first antennular segment; *d*, major first pereopod, outer face; *e*, same, inner face; *f*, minor first pereopod, outer face; *g*, same, inner face; *h*, right second pereopod; *i*, right third pereopod; *j*, same, dactylus and propodus; *k*, abdomen; *l*, telson and uropods. (Scale A = 2 mm: *a*, *d*–*i*, *k*; scale B = 1 mm: *b*, *j*, *l*; scale C = 0.5 mm: *c*.)

and not clearly delimited posteriorly. Anterior margin of ocular hood slightly rounded and concave near base of rostrum.

First antennular segment with very shallow, indistinct carina extending from ventral inner margin (Figure 27c). Second segment rather stout, about 1.3 times as long as visible part of first segment and 1.2 times as long as third segment. Stylocerite broad proximally, very blunt at tip and not reaching to distal margin of first segment.

Scaphocerite about 3 times as long as broad. Lateral margin very slightly concave at middle. Distal spine slightly directing inward, reaching to or slightly overreaching distal end of antennular peduncle. Inner blade regularly narrowing distally, far shorter than adjacent distal spine, reaching to or falling slightly short of distal end of antennular peduncle. Cleft between inner blade and distal spine arising from slightly more than distal  $\frac{1}{3}$  of scaphocerite.

Carpocerite overreaching distal end of antennular peduncle by more than length of third antennular segment. Basicerite with small, sharp lateral spine.

Third maxilliped (Figure 27a) reaching distal end of carpoperite beyond distal  $\frac{2}{3}$  length of ultimate segment. Ultimate segment about 2 times as long as penultimate segment, slightly tapering distally; distal margin truncate, not much narrower than proximal end and bearing dense long setae on distal margin and scattered few setae on superior margin. Penultimate segment about 2 times as long as broad near distal end, bearing several long setae on superior and inferior margins distally. Antepenultimate segment bearing sparse short setae on inferior margin and few long setae on superior distal margin. Exopod fairly overreaching distal end of antepenultimate segment. Precoxa with one arthrobranch near distal end and also small supplementary arthrobranch near proximal end.

Major first pereopod (Figure 27d,e) reaching distal end of carpoperite beyond most part of carpus. Major chela about 2.8 times as long as broad, bearing scattered setae on inner face, especially distally. Fingers occupying distal 0.3 of chela, much narrower than palm. Movable finger compressed laterally, regularly and highly arched throughout length of superior margin; tip acutely rounded, far overreaching tip of immovable finger. Immovable finger with superior margin concave posterior to tip; inferior margin almost straight. Palm rather elongate. Superior transverse groove deep, broad, U-shaped with proximal shoulder not overhanging groove. Superior outer palmar depression slightly defined, narrowly quadrangular, extending to oblique suture; inferior distal part extending downward. Superior inner palmar depression transversely elongate, U-shaped, reaching to  $\frac{1}{3}$  width of palm; inferior margin slanting upward posteriorly. Inferior transverse groove very deep, broad with proximal shoulder heavy, rounded. Inferior outer palmar depression narrow, inverse V-shaped, continuing upward to  $\frac{1}{3}$  width of palm; margins well delimited posteriorly and fairly delimited anteriorly. Inferior inner palmar depression broad, not clearly delimited anteriorly and superiorly. Merus about 2 times as long as broad with inferior inner margin very smooth and no spine on distal end.

Minor chela of first pereopods (Figure 27f,g) fairly stout, about 3.1 times as long as broad, bearing dense long setae on inner face. Fingers occupying at least distal 0.5 of chela, with acute tips overlapping but not gaping when closed. Inner palmar face with blunt tooth above dactylar articulation. Movable finger not balaeniceps in both sexes. Merus about 2 times as long as broad with inferior inner margin very smooth and no spine on distal end.

Second pereopod (Figure 27h) reaching distal end of carpoperite beyond distal  $\frac{1}{2}$  of first carpal segment. Fingers of chela slightly shorter than palm. First segment of carpus about 2.1 times as long as second; second segment 1.9 times as long as third; third segment slightly shorter than fourth; fifth segment 1.7 times as long as fourth.

Dactylus of third pereopod (Figure 27i,j) simple, broad at base, about 0.3 times as long as propodus. Propodus bearing scattered setae on superior and inferior margins and with 4 pairs of movable spines on inferior margin and pair at distal end; distalmost spine reaching to distal  $\frac{1}{2}$  of dactylus. Carpus about 0.8 times as long as propodus with superior distal margin slightly produced. Merus broad, about 3.2 times as long as broad and 1.5 times as long as propodus. Ischium with no movable spine.

Fourth pereopod almost same as third pereopod. Ischium with no movable spine.

Fifth pereopod much narrower than third pereopod. Ischium with no movable spine.

Pleura (Figure 27k) of abdominal somites broadly rounded in both sexes. Abdominal sternite with no spine at midline. Appendix masculina slightly overreaching distal end of appendix interna.

Telson (Figure 27l) about 1.6 times as long as broad at anterior end, armed with two pairs of rather stout dorsal spines and with no longitudinal median depression on dorsal surface. Lateral margin almost straight. Posterior margin produced at middle, armed with pair of spines at each lateral end; inner spine more than 2 times as wide and long as outer one.

Uropodal endopod bearing inconspicuous seta-like spines on distal margin and with inner depression at anterior half invisible. Uropodal exopod bearing rather slender movable spine flanked laterally by acute immovable tooth and internally by fairly acute tooth; movable spine reaching to or slightly overreaching distal margin of uropodal exopod; transverse suture forming two convex lobes.

HABITAT.—Shore to 36 m; among rock, shingles, and coral clump.

DISTRIBUTION.—Gulf of California, Costa Rica to Ecuador, and Galapagos Islands.

REMARKS.—The present species is very closely related to *A. bouvieri*. Chace (1972:64) noted:

...the pair of specimens from Clipperton Island tentatively identified as *A. bouvieri* by Chace (1962:610), as well as three males and six females (five ovigerous) of the same form in the Smithsonian collections from Santa María Island, Galapagos, are intermediate between *A. bouvieri* and *A. leviusculus*.

They resemble the latter in having the palm of the major chela elongate (1.76 to 1.97 times as long as high) and in having the movable finger of the minor chela rounded, not "balaeniceps"-shaped, but they are more like *A. bouvieri* in having the merus of the major cheliped angularly rounded or subrectangular at the distal angle, in having the tooth on the minor chela at the articulation of the finger subrectangular or broadly and bluntly acute, in having the second article of the carpus of the second pereopod almost invariably longer than the fifth article, and in lacking a movable spine on the ischium of the third pereopod.

The present species seems to be the same species as Chace mentioned and is very closely related to *A. bouvieri* and *A. leviusculus*.

ETYMOLOGY.—The species has a relatively long palm on the major chela compared with those of very similar species. The specific name is from the Latin *longinquus* (long).

## 26. *Alpheus lacertosus*, new species

### FIGURE 28

MATERIAL EXAMINED.—Holotype: Male, cl 15.6 mm; Valparaiso Province, Chile (Algarrobo, CA, 7 km, south of Valparaiso); 19 Mar 1974, coll. by C.E. Dawson.

DESCRIPTION.—Rostrum (Figure 28*a,b*) triangular, carinate posteriorly and scarcely reaching to middle of visible part of first antennular segment. Rostral carina rounded dorsally, widening as triangular shape posteriorly; lateral margin of rostral carina not overhanging orbitorostral groove.

Ocular hood lying below level of rostral carina. Orbitorostral groove deep, broad, reaching far posterior to eye and clearly delimited posteriorly. Anterior margin of ocular hood very round laterally.

First antennular segment with deep, triangular carina extending from ventral inner margin; ventral part of carina acute (Figure 28*c*). Second segment about 2.3 times as long as broad, 1.8 times as long as visible part of first segment and almost 1.8 times as long as third segment. Stylocerite broad proximally, narrowing to sharp point at tip, almost reaching to distal margin of first segment.

Scaphocerite with lateral margin very slightly concave at middle. Distal spine overreaching distal end of antennular peduncle and falling short of distal end of carapocerite. Inner blade regularly narrowing distally, reaching to distal end of antennular peduncle. Cleft between inner blade and distal spine arising from slightly less than distal  $\frac{2}{5}$  of scaphocerite.

Carapocerite overreaching distal end of antennular peduncle by  $\frac{2}{3}$  length of third antennular segment. Basicerite with small, narrow lateral spine.

Third maxilliped (Figure 28*d*) overreaching distal end of carapocerite beyond half of ultimate segment. Ultimate segment slightly tapering distally, 3 times as long as penultimate; distal margin truncate. Penultimate segment very broad distally, about 1.2 times as long as broad. Antepenultimate segment slightly produced on superior distal margin. Exopod reaching to proximal  $\frac{1}{3}$  of penultimate segment. Precoxa with one arthrobranch near distal end and also with small supplementary arthrobranch near proximal end.

Major chela of first pereopods (Figure 28*e,f*) about 2.4 times as long as broad, bearing fairly dense setae on both superior and inferior margins of fingers and short scattered setae on inner face. Fingers occupying distal 0.3 of chela and much narrower than palm. Movable finger regularly arched throughout length of superior margin in profile, compressed laterally and very acute at tip. Immobile finger with inferior margin fairly convex; tip very acute. Superior transverse groove of palm deep, U-shaped with proximal shoulder not overhanging groove. Superior outer palmar depression well defined, narrowly quadrangular, extending to oblique suture. Superior inner palmar depression longitudinally elongated triangular; anterior region very deep and distinct, but posteriorly shallow and less distinct. Inferior transverse groove broadly concave; proximal shoulder heavy, rounded. Inferior outer palmar depression narrow, inverse V-shaped, extending upward  $\frac{1}{3}$  width of palm. Inferior inner palmar depression rounded, inverse U-shaped, extending upward half width of palm; posterior margin fairly defined and connecting inferiorly to shallow longitudinal depression near bottom of palm; anterior margin not clear. Outer face of palm with shallow elongate depression between superior and inferior palmar depressions, leading to middle of immobile finger. Inner face of palm with short slight depression spreading behind dactylar articulation. Merus about 2 times as long as broad; inferior inner margin very smooth and bearing small spine at distal end.

Minor chela of first pereopods (Figure 28*g,h*) rather stout, about 3.1 times as long as broad, fingers occupying less than distal 0.5. Both fingers with acute tips. Movable finger well-developed balaeniceps in male. Immobile finger with fringe of setae medially on both lateral faces. Palm with superior and inferior transverse notches. Outer palmar face with longitudinally elongated rectangular depression spreading from superior notch. Inner palmar face with very slight depressions near superior and inferior notches and bearing very blunt tooth above dactylar articulation. Merus with superior margin slightly convex; inferior inner margin very smooth and bearing very small spine at distal end.

Second pereopod (Figure 28*i*) overreaching distal end of carapocerite beyond proximal end of first carpal segment. Fingers of chela very slightly longer than palm. First segment of carpus almost 1.6 times as long as second; second segment 2.1 times as long as third; third segment subequal to fourth; fifth segment 1.5 times as long as fourth.

Dactylus of third pereopod (Figure 28*j*) simple, about 0.4 times as long as propodus. Propodus about 1.3 times as long as carpus, bearing 8 movable spines and 10 irregular adjacent spines on inferior margin and pair at distal end; distalmost spine reaching to proximal  $\frac{1}{3}$  of dactylus. Merus about 4 times as long as broad and 1.9 times as long as carpus. Ischium bearing movable spine.

Fourth pereopod almost same as third pereopod. Ischium bearing movable spine.

Fifth pereopod much narrower than third pereopod. Ischium bearing movable spine.

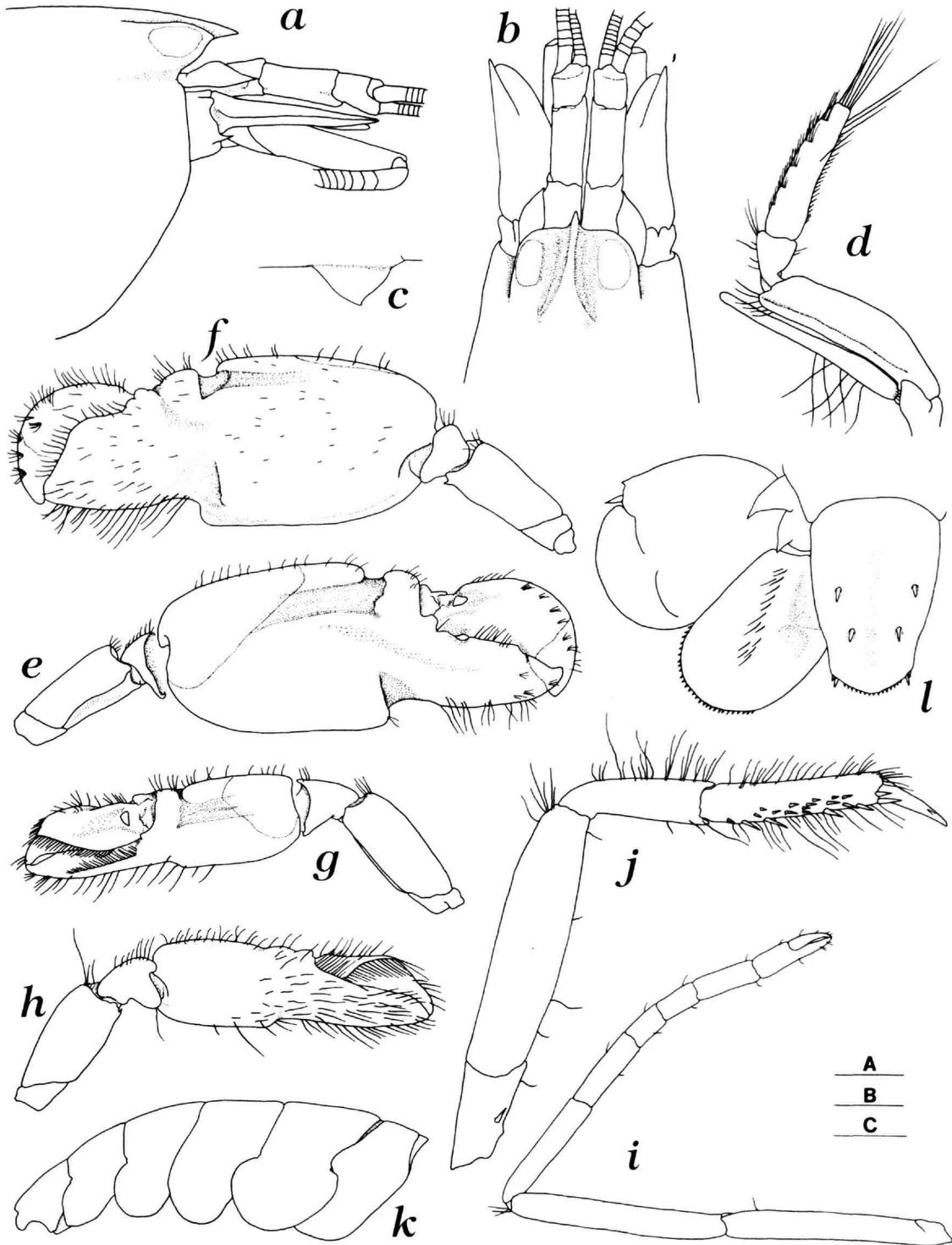


FIGURE 28.—*Alpheus lacertosus*, new species, holotype male, cl 15.6 mm, from Valparaiso Province, Chile: *a*, anterior region, lateral view; *b*, same, dorsal view; *c*, carina below right first antennular segment; *d*, right third maxilliped; *e*, major first pereopod, outer face; *f*, same, inner face; *g*, minor first pereopod, outer face; *h*, same, inner face; *i*, right second pereopod; *j*, right third pereopod; *k*, abdomen; *l*, telson and uropods. (Scale A = 4 mm: *e-h*, *k*; scale B = 2 mm: *a*, *b*, *d*, *i*, *j*, *l*; scale C = 1 mm: *c*.)

Pleura (Figure 28*k*) of first four abdominal somites broadly rounded. First two abdominal sternites with blunt process at midline of each sternite. Appendix masculina almost as long as appendix interna.

Telson (Figure 28*l*) about 1.6 times as long as broad at anterior end, armed with two pairs of dorsal spines and with slight longitudinal median depression on dorsal surface. Posterior margin regularly convex, bearing seta-like spines and armed with pair of spines at each lateral end; inner spine two times as long as outer one.

Uropodal endopod bearing seta-like spines on distal margin and with inner depression at anterior half fairly distinct. Uropodal exopod bearing very short movable spine flanked laterally by minute immovable tooth and internally by round lobe; transverse suture forming two convex lobes.

HABITAT.—Rocks, algae; temperature, 17°C.

DISTRIBUTION.—Valparaiso Province, Chile.

REMARKS.—The present species is very close to *A. californiensis* in many important characters, but also can be distinguished from *A. californiensis* by the different features. The present species is much larger than *A. californiensis* and the rostrum extends posteriorly as the almost regularly widening rostral carina, which is inflated dorsally above the level of ocular hood. In *A. californiensis*, the rostral carina is linearly rounded dorsally to middle of eye, then widened to a regular triangle, of which the lateral margin overhangs the orbitorostral groove, and the ocular hood is inflated dorsally above the level of middle part of the rostral carina.

ETYMOLOGY.—The Latin *lacertosus* (muscular) refers to the big major chela of the species compared with that of the most similar species *A. californiensis*.

## 27. *Alpheus californiensis* Holmes, 1900

FIGURE 29

*Alpheus californiensis* Holmes, 1900:186, pl. 2: fig. 42; pl. 3: figs. 43, 44.—Rathbun, 1904:108.—Word and Charwat, 1976:44.—Wicksten, 1984:189. *Crangon californiensis*.—Schmitt, 1921:76, fig. 52.—MacGinitie, 1937:1032, pl. 1: fig. 2.—Johnson et al., 1947:122–138.—MacGinitie and MacGinitie, 1949:473.—Ricketts and Calvin, 1962:251, pl. 23: fig. 3.

MATERIAL EXAMINED.—2 ♂, 3 ♀; Los Angeles C., northeast shore of Catalina Harbor, Catalina Island, California; 14 Dec 1970.

MEASUREMENTS.—Males, cl 9.0–10.0 mm; females, cl 6.5–8.6 mm.

DESCRIPTION.—Rostrum (Figure 29*a,b*) sharply triangular, carinate posteriorly and reaching to middle of visible part of first antennular segment. Rostral carina narrowly raised dorsally to middle of eye, then widened as triangular shape far posterior to eye; lateral margin of triangular part slightly overhanging orbitorostral groove.

Ocular hood slightly inflated dorsally above level of middle part of rostral carina. Orbitorostral groove distinct and reaching far posterior to eye, well defined posteriorly. Anterior margin

of ocular hood rounded and slightly concave near base of rostrum.

First antennular segment with triangular carina extending from ventral inner margin; ventral part acute (Figure 29*c*). Second segment about 2.3 times as long as broad, 1.9 times as long as visible part of first segment and 2.5 times as long as third segment. Stylocerite broad proximally, narrowing to sharp point at tip, scarcely reaching to distal margin of first segment.

Scaphocerite with lateral margin concave at middle. Distal spine overreaching distal end of antennular peduncle and falling slightly short of distal end of carapocerite. Inner blade regularly narrowing distally, not reaching to distal end of antennular peduncle. Cleft between inner blade and distal spine arising from distal 0.4 of scaphocerite.

Carpocerite overreaching distal end of antennular peduncle by  $\frac{2}{3}$  length of third antennular segment. Basicerite with small, narrow lateral spine.

Ultimate segment of third maxilliped (Figure 29*d*) fairly elongate, about 2.6 times as long as penultimate and 5 times as long as broad at proximal end; distal margin roundly truncate, not much narrower than proximal end and bearing long setae. Penultimate segment about 1.5 times as long as broad. Exopod slightly overreaching distal end of antepenultimate segment. Precoxa with one arthrobranch near distal end and also with small supplementary arthrobranch near proximal end.

Major chela of first pereopods (Figure 29*e,f*) about 2.6 times as long as broad, bearing sparse setae on inner face. Fingers occupying distal  $\frac{1}{3}$  of chela, clearly narrower than palm. Movable finger regularly arched throughout length of superior margin in profile, compressed laterally and acutely rounded at tip; tip slightly overreaching tip of immovable finger. Immovable finger with inferior margin very slightly sinuous. Superior transverse groove of palm deep, U-shaped with proximal shoulder perpendicular to or very slightly overhanging groove. Superior outer palmar depression well defined, narrowly quadrangular, extending to oblique suture. Superior inner palmar depression longitudinally elongated triangular; anterior region deeper than posterior region. Inferior transverse groove very shallow, barely forming angle with inferior margin of immovable finger; proximal shoulder rounded, not produced anteriorly. Inferior outer palmar depression narrow, extending upward to  $\frac{1}{3}$  width of palm; margin not clearly delimited anteriorly. Inferior inner palmar depression broadly triangular, extending upward to half width of palm and connecting inferiorly to shallow longitudinal depression near bottom of palm; margin not clearly delimited anteriorly. Outer palmar face with shallow elongate depression between superior and inferior palmar depressions. Inner palmar face with elongate rounded depression between superior and inferior palmar depressions. Merus about 1.9 times as long as broad; inferior inner margin slightly tuberculate at distal  $\frac{1}{3}$  and bearing very small spine at distal end.

Minor chela of first pereopods in male (Figure 29*g,h*) rather

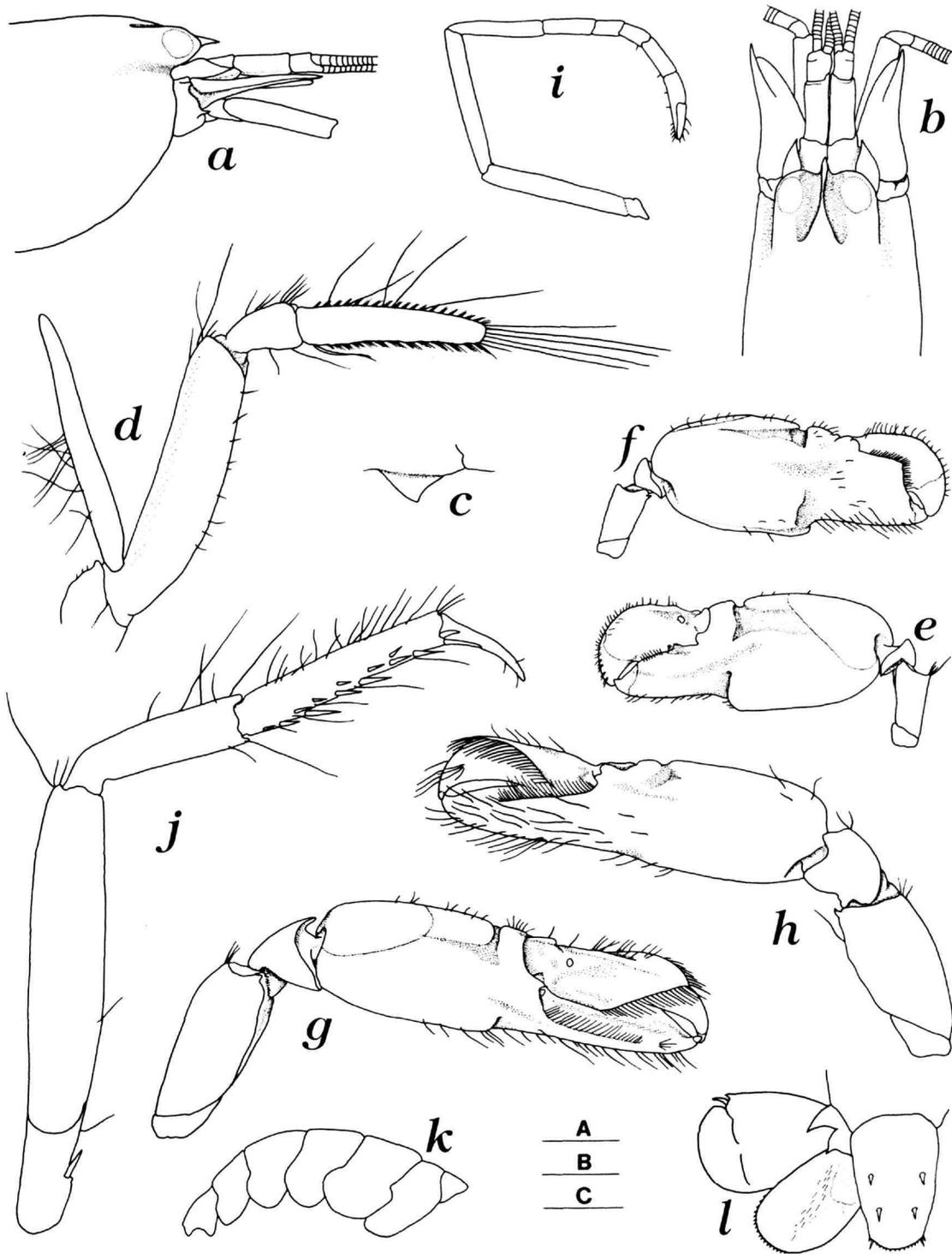


FIGURE 29.—*Alpheus californiensis*, male, cl 9.0 mm, from Catalina Island, California: *a*, anterior region, lateral view; *b*, same, dorsal view; *c*, carina below right first antennular segment; *d*, right third maxilliped; *e*, major first pereopod, outer face; *f*, same, inner face; *g*, minor first pereopod, outer face; *h*, same, inner face; *i*, right second pereopod; *j*, right third pereopod; *k*, abdomen; *l*, telson and uropods. (Scale A = 4 mm: *e, f, k*; scale B = 2 mm: *a, b, g-i, l*; scale C = 1 mm: *c, d, j*.)

stout, about 3.3 times as long as broad, fingers occupying about distal 0.5. Palm with superior and inferior transverse notches. Outer palmar face with elongate depression spreading from superior transverse notch and with slight depression spreading from inferior notch. Inner palmar face with slight depressions near superior and inferior notches and bearing very blunt tooth flanking dactylar articulation. Both fingers with acute tips. Movable finger with superior margin broadened bilaterally, well-developed balaeniceps in male. Immobile finger with fringe of setae medially at both lateral faces. Minor chela of first pereopods in female covered with fairly dense setae; movable finger not balaeniceps and immobile finger with no fringe of setae. Merus about 2.5 times as long as broad; superior margin slightly convex distally and inferior inner margin slightly tuberculate at distal  $\frac{1}{3}$ , bearing very small spine on distal end.

Second pereopod (Figure 29*i*) overreaching distal end of carpoplite beyond most part of first carpal segment. Fingers of chela about 1.2 times as long as palm. First segment of carpus about 2 times as long as second; second segment about 2 times as long as third; third segment subequal to fourth; fifth segment 1.5 times as long as fourth.

Dactylus of third pereopod (Figure 29*j*) simple and slender, about 0.4 times as long as propodus. Propodus about 1.2 times as long as carpus, bearing 7 movable spines and 5 irregular adjacent spines on inferior margin and pair at distal end; distalmost spine reaching to distal  $\frac{1}{2}$  of dactylus. Merus rather slender, about 4.8 times as long as broad and 2 times as long as carpus. Ischium with movable spine.

Fourth pereopod almost same as third pereopod. Ischium with movable spine.

Fifth pereopod much narrower than third pereopod. Ischium with movable spine.

Pleura (Figure 29*k*) of first four abdominal somites broadly rounded in both sexes; pleuron of fifth somite subtriangular on posterior ventral margin. Abdominal sternite with no spine at midline. Appendix masculina slightly overreaching distal end of appendix interna.

Telson (Figure 29*l*) about 1.6 times as long as broad at anterior end, armed with two pairs of rather stout dorsal spines and with no longitudinal median depression on dorsal surface. Posterior margin regularly convex, bearing series of inconspicuous seta-like spines and armed with pair of spines at each lateral end; inner spine two times as long as outer one.

Uropodal endopod bearing inconspicuous seta-like spines on distal margin and with inner depression at anterior half fairly distinct. Uropodal exopod bearing rather slender movable spine flanked laterally by acute, small immobile tooth and internally by round lobe; movable spine not reaching to distal margin of uropodal exopod; transverse suture forming two very shallow convex lobes.

TYPE-LOCALITY.—San Pedro, California.

DISTRIBUTION.—San Pedro, California, to Magdalena Bay, Baja California.

## 28. *Alpheus canalis*, new species

FIGURE 30

MATERIAL EXAMINED.—Holotype: Male, cl 10.8 mm; North Bay, San Francisco Island, Baja California (sta 518-36).

Paratypes: 1 ♂, 1 ♀, 1 juv (sta 518-36).

Mexico: North Bay, San Francisco Island, Baja California (sta 519-36: 3 ♂, 1 ovig, 3 juv); Los Algodones north of Guaymas, Sonora (sta 1551: 3 ♂, 4 ovig, 6 juv); Ensenada de San Francisco, Sonora (sta 739-37: 2 ♂, 4 ♀, 1 ovig); Nayarit, northeast beach of Isla Jaltimba, off Rincon de los Guayabitos (sta 1558: 1 ♂, 1 ♀, 4 juv); Tangola-Tangola (sta 261-34: 2 ♂, 2 ovig); Isabel Island, Sinaloa (sta 869-38: 1 ♀).

El Salvador: La Union, Los Maquilis, west of Punta Amapala (sta 1564: 9 ♂, 1 ♀, 4 ovig, 3 juv).

Costa Rica: Salinas Bay (sta 474-35: 13 ♂, 8 ♀, 4 ovig); Playa Blancas (sta 465-35: 4 ♂, 2 ♀, 2 ovig); Guanacaste, Playa del Coco, 1st beach south of town (sta 1566: 1 ovig, 1 juv); Parker Bay (sta 466-35: 1 ♂, 1 ♀, 1 ovig); Wafer Bay, Isla del Coco (sta 781-38: 1 ♀, LGA 73-60: 3 ♂, 1 ♀).

Panama: Panama (sta 445-35: 16 ♂, 8 ♀, 8 ovig, 5 spec); Wharehouse Reef tide pools (sta 133-5-b: 5 ♂, 4 ovig); Punta Paitilla Beach (sta 25-3: 5 ♂, 1 ♀, 4 ovig); Punta Paitilla (sta 84-B: 2 ♀, sta 107-1: 1 juv, sta 129 (= 1602): 1 ♀, LGA 69-64: 1 ovig); Naos Island (sta 131-1: 6 ♂, 1 ♀); Naos Island causeway (sta 106: 1 ♂, 2 ovig, 2 juv); Ft. Amador (LGA 72-1: 2 ♂, 5 juv, LGA 72-3: 1 ♀); Old French Fort Reef (sta 58: 1 ♂, sta 58-4: 1 ♂, 2 ♀); Venado Beach (sta 111-4: 2 ♂); Fort Kobbe Beach (sta 108-7: 1 ♂, 1 ovig); Casa de Putas Reef (sta 92-5: 9 ♂, 3 ovig); northeast of Taboguilla Island (sta 59: 4 ♂, 2 ovig, 2 juv, sta 59-2: 1 ♂); Farfan Point (sta 113-2: 1 ♂, 1 ♀); Perlas Islands, Isla Pajaros (sta 41-1: 1 ♂); Secas Isle (sta 454-35: 11 ♂, 3 ♀, 7 ovig); Bay of Panama (LGA 69-41: 1 ♂, 1 ♀, 1 ovig); Isla de Chopilla (LGA 69-55: 2 spec); Los Perlas Archipelago (LGA 73-8: 1 ♂). Ft. Amador, bay, Scout Island: 4 ♂, 2 ♀, 1 ovig, 1 juv, 2 Feb 1973, coll. by L.G. Abele. Naos Island (under rock): 2 ovig, 8 Aug 1972, coll. by L.G. Abele, and R.H. Gore.

Colombia: Gorgona Island (sta 405-35: 8 ♂, 4 ♀, 8 ovig, 4 juv); Port Utria (sta 413-35: 10 ♂, 2 ♀, 8 ovig, sta 239a-34: 3 ♂, 2 ovig); Cabita Bay (sta 229-34: 1 ♀, 1 ovig).

Galapagos Islands: Indefatigable Island (sta 314-35: 5 ♂, 1 ♀, 2 ovig); Academy Bay, Indefatigable Island (sta 168-34: 3 ♂, 2 ♀, 2 ovig); Osborn Island (sta 359-35: 15 ♂, 5 ♀, 7 ovig); Gardner Bay, Hood Island (sta 202-34: 1 juv); Stephens Bay, Chatham Island (sta 353-35: 1 ♂).

MEASUREMENTS.—Males, cl 5.8 mm–15.1 mm; females, cl 5.2–14.1 mm; ovigerous females, cl 6.1–15.0 mm.

DESCRIPTION.—Rostrum (Figure 30*a,b*) rather long, sharply triangular, carinate posteriorly and slightly overreaching middle of visible part of first antennular segment. Rostral carina narrow dorsally, slightly depressed at middle and very slightly widened posteriorly.

Ocular hood slightly inflated dorsally above level of middle part of rostral carina. Orbitorostral groove distinct and reaching

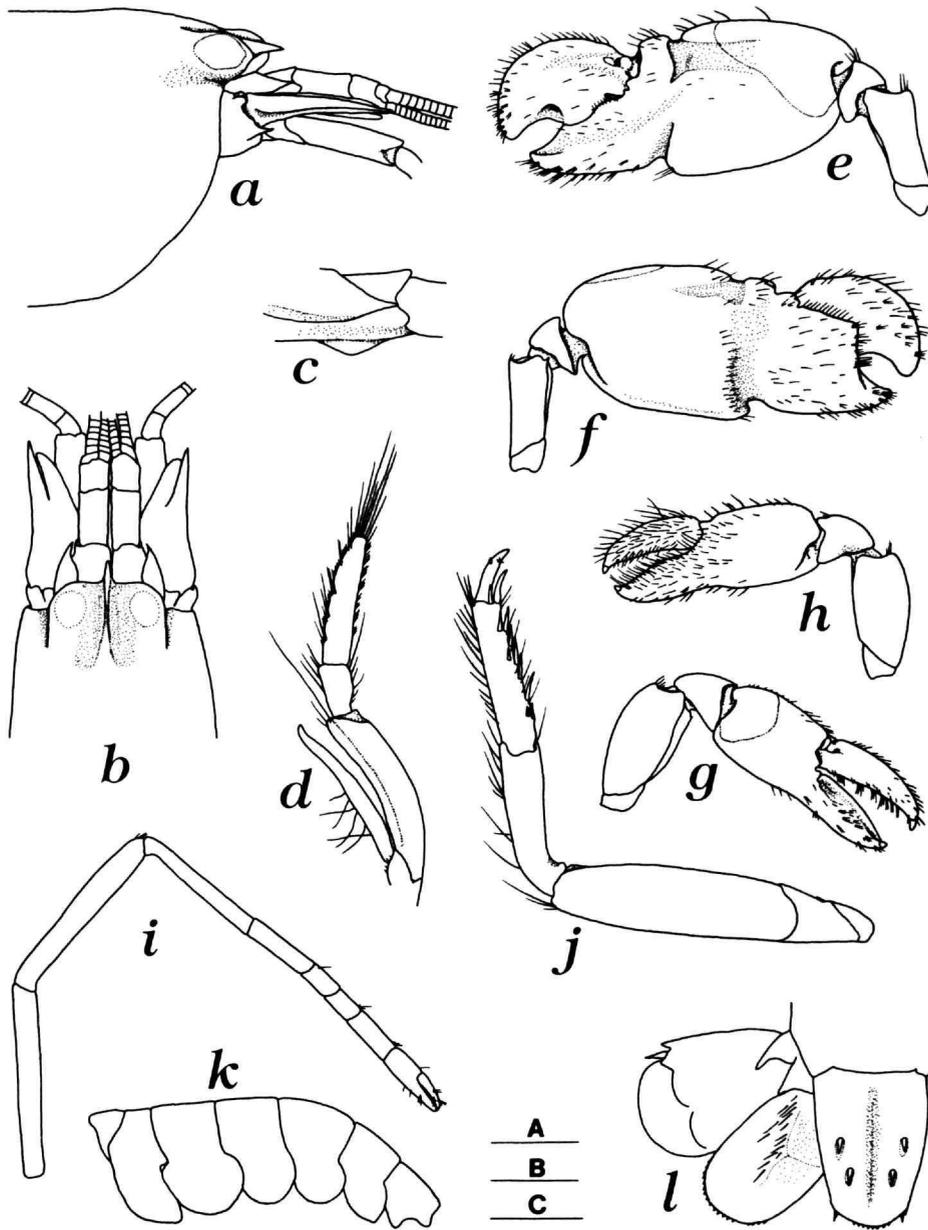


FIGURE 30.—*Alpheus canalis*, new species, holotype male, cl 10.8 mm, from sta 518-36: *a*, anterior region, lateral view; *b*, same, dorsal view; *c*, carina below right first antennular segment; *d*, right third maxilliped; *e*, major first pereopod, outer face; *f*, same, inner face; *g*, minor first pereopod, outer face; *h*, same, inner face; *i*, right second pereopod; *j*, right third pereopod; *k*, abdomen; *l*, telson and uropods. (Scale A = 4 mm: *e-h*, *k*; scale B = 2 mm: *a*, *b*, *d*, *i*, *j*, *l*; scale C = 1 mm: *c*.)

far posterior to eye, not clearly delimited posteriorly. Anterior inner margin of ocular hood almost straight.

First antennular segment with broadly triangular carina extending from ventral inner margin (Figure 30*c*). Second segment about 2 times as long as broad, slightly less than 1.5 times as long as visible part of first segment and slightly more

than 1.5 times as long as third segment. Stylocerite broad proximally, narrowing to sharp point at tip, reaching to distal margin of first segment.

Scaphocerite about 2.6 times as long as broad. Lateral margin slightly concave at proximal 1/3. Distal spine overreaching distal end of antennular peduncle and falling slightly short

of distal end of carpopercite. Inner blade regularly narrowing distally, reaching to distal end of antennular peduncle. Cleft between inner blade and distal spine arising from distal 0.4 of scaphocerite.

Carpocerite overreaching distal end of antennular peduncle by half length of third antennular segment. Basicerite with small, slender lateral spine.

Third maxilliped (Figure 30*d*) overreaching distal end of carpopercite beyond distal  $\frac{1}{3}$  of ultimate segment. Ultimate segment about 2.5 times as long as penultimate and 4.7 times as long as broad at proximal end; distal margin truncate, not much narrower than proximal end and with long setae. Penultimate segment about 1.6 times as long as broad, with several long setae on superior and inferior margins. Exopod slightly overreaching distal end of antepenultimate segment. Precoxa with one arthrobranch near distal end and also with small supplementary arthrobranch near proximal end.

Major first pereopod (Figure 30*e,f*) overreaching distal end of carpopercite beyond proximal end of chela. Major chela about 3.4 times as long as broad, bearing fairly dense setae on inner face, especially anterior half. Fingers almost as broad as palm, occupying distal 0.4 of chela. Movable finger regularly arched throughout length of superior margin in profile, compressed laterally and acutely rounded at tip; inferior margin proximal to tip very concave. Immobile finger with inferior margin slightly convex. Palm with superior transverse groove deep, U-shaped; proximal shoulder not overhanging groove. Superior outer palmar depression well defined, narrowly quadrangular, extending to oblique suture. Superior inner palmar depression longitudinally elongated triangular, rather small, reaching to half length of palm. Inferior transverse groove very deep, directed obliquely upward; proximal shoulder heavy, rounded. Inferior outer palmar depression narrow, inverse V-shaped groove continuing upward to  $\frac{1}{3}$  width of palm. Inferior inner palmar depression elongated rectangular shape, extending upward to half width of palm and connecting posteriorly to shallow longitudinal depression near bottom of palm. Inner palmar face with rather rectangular depression above inferior inner palmar depression and outer palmar face with shallow longitudinal groove running along median part of immobile finger. Merus about 2 times as long as broad; inferior inner margin very smooth and with very small spine at distal end.

Minor chela of first pereopods (Figure 30*g,h*) rather stout, about 2.8 times as long as broad. Fingers occupying distal 0.5 of chela and with acute tips. Movable finger not balaeniceps in both sexes. Palm with dense setae on anterior half of inner face and with acutely triangular tooth above dactylar articulation on inner face. Merus about 2.2 times as long as broad; superior margin fairly convex and inferior inner margin very smooth, bearing very small spine at distal end.

Second pereopod (Figure 30*i*) reaching distal end of carpopercite beyond proximal end of first carpal segment. Fingers of chela almost as long as palm. First segment of carpus about 1.8 times as long as second; second segment about 2.1 times as long as third; third segment subequal to fourth; fifth

segment about 1.6 times as long as fourth.

Dactylus of third pereopod (Figure 30*j*) simple, slightly less than  $\frac{2}{5}$  length of propodus; tip slightly directed downward. Propodus slightly longer than carpus with 6 movable spines and 3 irregular adjacent spines on inferior margin and pair at distal end; distalmost spine overreaching distal  $\frac{1}{2}$  of dactylus. Merus broad, about 1.5 times as long as propodus and 3.6 times as long as broad and 1.6 times as long as carpus. Ischium with inconspicuous movable spine.

Fourth pereopod almost same as third pereopod. Ischium with movable spine.

Fifth pereopod much narrower than third pereopod. Ischium without movable spine.

Pleura (Figure 30*k*) of first four abdominal somites broadly rounded in both sexes; pleuron of fifth somite slightly elongate on posterior ventral margin. Abdominal sternite with no spine at midline. Appendix masculina almost reaching to distal end of appendix interna.

Telson (Figure 30*l*) about 1.4 times as long as broad at anterior end, armed with two pairs of rather stout dorsal spines and with distinct longitudinal median depression on dorsal surface. Posterior margin produced at middle, bearing several inconspicuous seta-like spines and armed with pair of spines at each lateral end; inner spine two times as wide and long as outer one.

Uropodal endopod with inconspicuous seta-like spines on distal margin and with inner depression at anterior half fairly distinct. Uropodal exopod with uncolored slender movable spine flanked laterally by sharp tooth and internally by rather blunt tooth, movable spine not reaching to distal margin of uropodal exopod; transverse suture forming two slightly convex lobes.

VARIATIONS.—One ovigerous female (cl 13.5 mm) from the Punta Paitilla of Panama seems to be an abnormal specimen of the present species. The rostrum of this specimen is very short and the fingers of minor and major chela of the first pereopods are narrower than the palm.

HABITAT.—Shore to 37 m; among sand, mud, rock, coral.

DISTRIBUTION.—Gulf of California, El Salvador through Panama to Colombia and Galapagos Islands.

REMARKS.—The present species is very similar to the Atlantic species, *A. nuttingi* Schmitt, 1924c. These two species have the longitudinal median depression on the dorsal surface of the telson; this character is uncommon among the *edwardsii* group. In his original description of *A. nuttingi*, Schmitt did not point out a small spine on the distal end of inferior inner margin of merus of the first pereopod, but Hendrix (1971) in his dissertation pointed out a small spine on the same region. Hendrix (1971:114) noted that there is no spine on the ischium of the third pereopod in *A. nuttingi* and this character was independently used by Chace (1972:59) in his key of the West Indian *Alpheus*.

The present species is similar to *A. nuttingi* except for the spines on the ischia of the third and fourth pereopods. The present species has a very small spine, smaller than that of *A.*

*armillatus* H. Milne Edwards, 1837, on the distal end of inferior inner margin of merus of the major first pereopod and has a very minute spine on each ischium of the third and fourth pereopods. The other minor feature of the present species is that the tip of movable finger of the major chela in the male is more acute than that of *A. nuttingi*; the tip of the movable finger in *A. nuttingi* is very bluntly rounded.

ETYMOLOGY.—The telson of this species has a distinct longitudinal median depression on the dorsal surface; this feature is uncommon in the *edwardsii* group. The specific name is from the Latin *canalis* (groove).

### 29. *Alpheus hyeyoungae*, new species

FIGURE 31

MATERIAL EXAMINED.—Holotype: Male, cl 8.4 mm; Nayarit, northeast beach of Isla Jaltimba, off Rincon de los Guayabitas, Mexico (sta 1558).

Paratypes: 4 ♂, 9 ♀, 3 ovig, 2 juv (sta 1558).

Costa Rica: Guanacaste, Playa del Coco, 1st beach south of town (sta 1566: 5 ♂, 2 ♀, 1 ovig); Puntarenas, Golfo de Nicoya, Isla Tolinga (sta 1567: 1 ♂, 2 ♀).

Panama: Perlas Islands, Pajaros (sta 41-1: 1 ♂); Venado Island (sta 86-4: 1 ♂).

MEASUREMENTS.—Males, cl 5.8–13.1 mm; females, cl 5.0–8.9 mm; ovigerous females, cl 6.9–10.3 mm.

DESCRIPTION.—Rostrum (Figure 31*a,b*) long, elongate, reaching to distal  $\frac{1}{4}$  of visible part of first antennular segment and bearing small process below base of rostrum. Rostral carina narrowly rounded dorsally, extending posteriorly to base of eye, slightly depressed at middle and then abruptly widened posteriorly; lateral margin of widened part rounded, overhanging orbitorostral groove.

Ocular hood slightly inflated dorsally above level of depressed rostral carina but below level of distal margin of widened part. Orbitorostral groove very wide and deep, reaching far posterior to eye. Anterior inner margin of ocular hood almost straight.

First antennular segment with shallow, broadly rounded carina extending from ventral inner margin; ventral part with sharp spine directing forward (Figure 31*c*). Second segment about 1.8 times as long as broad, slightly longer than visible part of first segment and 1.3 times as long as third segment. Stylocerite broad proximally, abruptly narrowing to sharp point, reaching to distal margin of first segment.

Scaphocerite about 2.9 times as long as broad. Lateral margin strongly concave at proximal  $\frac{1}{3}$ . Distal spine overreaching distal end of antennular peduncle and almost reaching to distal end of carapocerite; tip directing inward. Inner blade regularly narrowing distally, far shorter than adjacent distal spine, slightly overreaching distal end of antennular peduncle. Cleft between inner blade and distal spine rather deep arising from slightly less than distal 0.5 of scaphocerite.

Carpocerite overreaching distal end of antennular peduncle by half length of third antennular segment. Basicerite with

small, sharp, elongate lateral spine.

Third maxilliped (Figure 31*d*) slightly overreaching distal end of carapocerite. Ultimate segment about 4.7 times as long as broad at proximal end and 2.4 times as long as penultimate; distal margin slightly truncate, not much narrower than proximal end and bearing very long setae. Penultimate segment slightly less than 1.5 times as long as broad, with several long setae on superior and inferior margins, especially distally. Exopod slightly overreaching distal end of antepenultimate segment. Precoxa with one arthrobranch near distal end and also with small supplementary arthrobranch near proximal end.

Major first pereopod (Figure 31*e,f*) overreaching distal end of carapocerite by most part of chela. Major chela about 2.4 times as long as broad, bearing fairly dense setae on inner face, especially distally. Fingers occupying distal 0.4 of chela and narrower than palm. Movable finger semicircular in profile, compressed laterally and bluntly triangular at tip; tip slightly overreaching tip of immovable finger. Immovable finger with tip directing upward and outward; inferior margin almost straight along middle part. Superior transverse groove of palm deep, broad, U-shaped with proximal shoulder not overhanging groove. Superior outer palmar depression well defined, quadrangular, extending to oblique suture; narrow groove below superior outer palmar depression extending toward middle part of immovable finger. Superior inner palmar depression longitudinally elongated triangular, reaching posteriorly to proximal  $\frac{1}{3}$  of palm. Inferior transverse groove very deep, directed upward; proximal shoulder heavy, produced anteriorly with small tubercles. Inferior outer palmar depression narrow, extending obliquely upward to  $\frac{1}{3}$  width of palm. Inferior inner palmar depression broad, extending upward to more than  $\frac{1}{2}$  width of palm; posterior margin well delimited with several setae but anteriorly ill defined. Inner palmar face with almost invisible longitudinal depression near bottom of palm. Merus about 2.4 times as long as broad with inferior inner margin slightly tuberculate and bearing acute small spine on distal end with 3 to 4 long setae behind spine.

Minor chela of first pereopods (Figure 31*g,h*) about 3.3 times as long as broad and with very dense long setae on inner face. Fingers occupying more than distal 0.5 of chela and almost as broad as palm. Both fingers with acute tips. Movable finger not balaeniceps in both sexes. Palm with slight inferior transverse notch and with distinct triangular tooth above dactylar articulation on inner face. Merus about 2.3 times as long as broad; inferior inner margin slightly tuberculate, bearing small acute spine at distal end.

Second pereopod (Figure 31*i*) overreaching distal end of carapocerite beyond distal end of first carpal segment. Fingers of chela slightly longer than palm. First segment of carpus about 1.5 times as long as second; second segment about 2.2 times as long as third; third segment slightly longer than fourth; fifth segment shorter than second, 1.6 times as long as fourth.

Dactylus of third pereopod (Figure 31*j*) simple, 0.4 times as long as propodus; tip deflexed downward. Propodus about 1.2 times as long as carpus, bearing 5 movable spines and 5

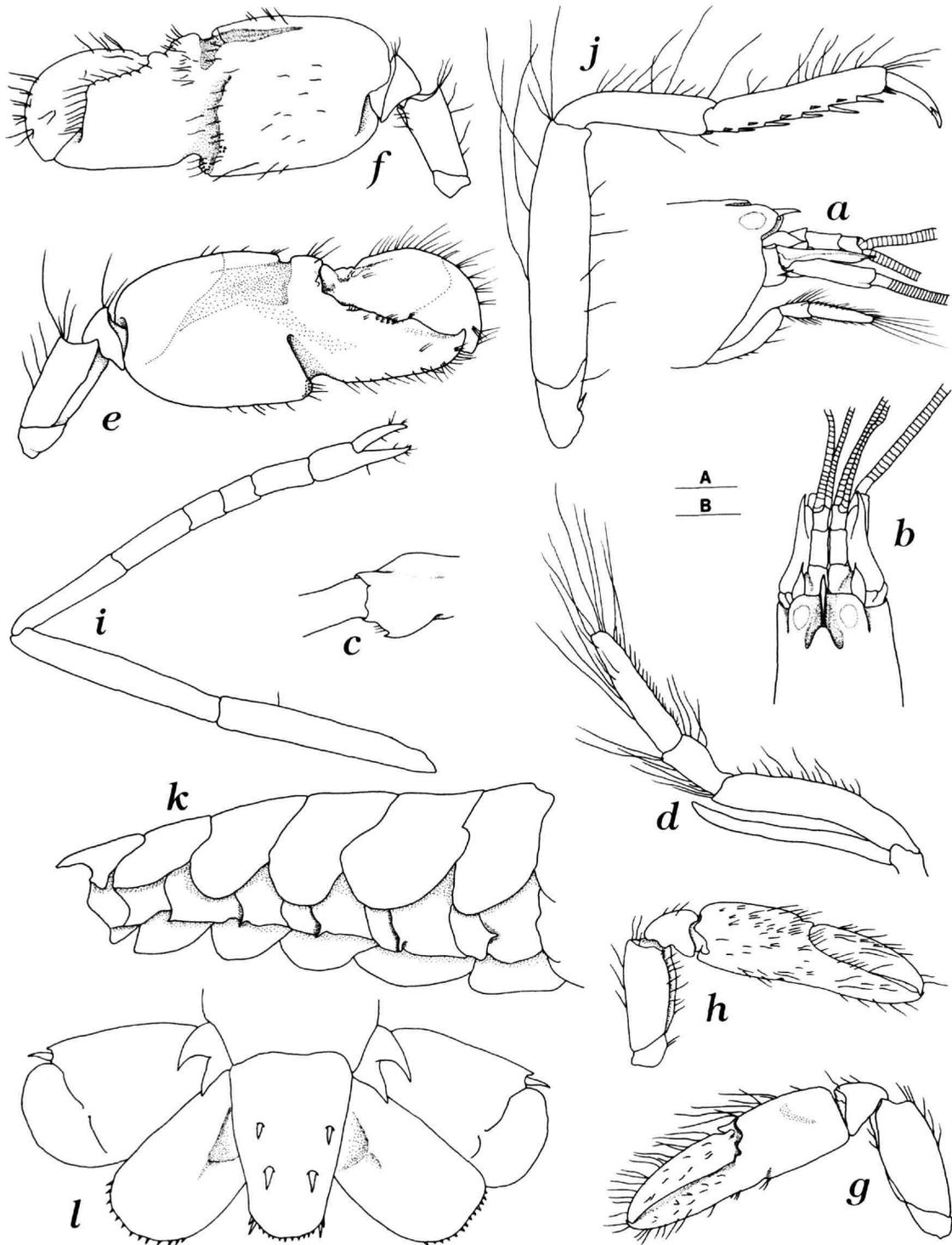


FIGURE 31.—*Alpheus hyeoungae*, new species, holotype male, cl 8.4 mm, from sta 1558: a, anterior region, lateral view; b, same, dorsal view; c, carina below right first antennular segment (male, cl 10.8 mm, from sta 1566); d, right third maxilliped; e, major first pereopod, outer face; f, same, inner face; g, minor first pereopod, outer face; h, same, inner face; i, right second pereopod; j, right third pereopod; k, abdomen (paratype male, cl 10.5 mm, from sta 1558); l, telson and uropods. (Scale A = 2 mm: a, b, f–h, k; scale B = 1 mm: c–e, i, j, l.)

irregular adjacent spines on inferior margin and pair at distal end. Merus about 1.7 times as long as carpus, about 4.3 times as long as broad and bearing 3 to 4 long setae on superior margin. Ischium with movable spine.

Fourth pereopod almost same as third pereopod. Ischium with movable spine.

Fifth pereopod much narrower than third pereopod. Ischium without movable spine.

Pleura (Figure 31*k*) of first four abdominal somites broadly rounded (more narrow in male); pleuron of fifth somite more elongate on posterior ventral margin. First through fifth abdominal sternites bearing rather long spine at midline of each sternite. Appendix masculina reaching to distal end of appendix interna.

Telson (Figure 31*l*) about 1.6 times as long as broad at anterior end, armed with two pairs of rather stout dorsal spines and with no distinct median longitudinal depression on dorsal surface. Posterior margin regularly convex, bearing seta-like spines and armed with pair of spines at each lateral end; inner spine at least two times as wide and long as outer one.

Uropodal endopod bearing seta-like spines on distal margin and with inner depression at anterior half fairly distinct. Uropodal exopod with rather slender movable spine flanked laterally by acute immovable tooth and internally by low triangular lobe; movable spine not reaching to distal margin of uropodal exopod; transverse suture forming two very slight convex lobes.

HABITAT.—Shore to 1.3 m; rock, sand beach, and coral.

DISTRIBUTION.—Nayarit, Mexico; Costa Rica; Panama.

REMARKS.—The present species is similar to *A. armillatus* especially in the shape of the rostrum. In the present species, however, the rostral carina posterior to the eyes is rounded anteriorly and depressed before the tip of the flattened carina; there are small tubercles on the proximal shoulder of the inferior transverse groove of the palm of the major chela; and there is a spine at midline of each sternite of the first through fifth abdominal sternites. In *A. armillatus*, the rostral carina posterior to the eye is triangular, not much depressed anteriorly; there are no tubercles on the proximal shoulder of the inferior transverse groove of the palm of the major chela; and there is a spine at midline of each sternite of the first two abdominal sternites at most.

ETYMOLOGY.—It is a pleasure to name this species for Mrs. Hyeyoung Kim, wife of the first author, who has been patient and understanding of her husband's work.

### 30. *Alpheus scopulus*, new species

FIGURE 32

MATERIAL EXAMINED.—Holotype: Male, cl 11.1 mm; Whorehouse Reef tide pools, Panama (sta 133-5-b).

Paratypes: 9 ♂, 3 ♀, 4 ovig (sta 133-5-b).

Panama: Casa de Puntas Reef (sta 92-5: 1 ovig); Punta Paitilla (sta 84-B: 1 ♂, 1 ovig, sta 129-2-b: 1 ♂, 1 ♀, sta 129 (= 1602): 1 ♂, 1 ovig, LGA 74-1: 1 ♂, 1 ♀); Farfan Point Beach

(sta 134-1-d: 1 ♂), Farfan Point (sta 113-2: 1 ♂, 1 ♀); Venado Beach (sta 23-1: 1 ♂, sta 1523: 1 ♂, sta 54: 7 ♂, 1 ♀, 7 ovig, sta 132-1-c: 1 ♂, 1 ovig, sta 88-4: 1 ♂, sta 132 (= 1607): 10 ♂, 1 ♀, 5 ovig); Venado Island (sta 86-4: 2 ♂, 1 ♀); Old French Fort Reef (sta 58-4: 5 ♂, 2 ovig, sta 58: 3 ♂, 1 ovig); Whorehouse Reef (sta 166-1: 1 ♂, 1 ovig); Fort Kobbe Beach (sta 108-7: 5 ♂, 1 juv). Punta Paitilla, tide pool farthest area from bridge: 1 ovig, 17 Jan 1969, coll. by J. Graham. Ft. Amador Causeway (JEM 71-7): 5 ♂, 2 ♀, 3 ovig, 29 Jan 1971.

Galapagos Islands: Gardner Bay, Hood Island (sta 27-33: 1 ♂, 1 ovig).

MEASUREMENTS.—Males, cl 5.8–16.8 mm; females, cl 5.9–12.9 mm; ovigerous females, cl 8.8–15.2 mm.

DESCRIPTION.—Rostrum (Figure 32*a,b*) narrowly triangular, slightly overreaching middle of visible part of first antennular segment, marked dorsally by low narrow carina, carina extending posteriorly to end of eye and then continuing as abruptly broadened triangular, dorsally flattened carina past to posterior end of eye; middle part of carina depressed and lateral margin of triangular carina convex, overhanging orbitorostral groove.

Ocular hood slightly inflated dorsally above level of middle part of rostral carina. Orbitorostral groove deep, broad, clearly delimited posteriorly. Anterior inner margin of ocular hood almost straight.

First antennular segment with triangular carina extending from ventral inner margin; ventral part acute (Figure 32*c*). Second segment rather slender about 2.2 times as long as broad, about 1.4 times as long as visible part of first segment and slightly more than 1.6 times as long as third segment. Stylocerite broad proximally, abruptly narrowing to sharp point, almost reaching to distal margin of first segment.

Scaphocerite about 2.7 times as long as broad. Lateral margin concave at middle. Distal spine directed inward, well overreaching inner blade, and slightly overreaching distal end of antennular peduncle. Inner blade narrowly rounded distally. Cleft between inner blade and distal spine arising from slightly less than distal  $\frac{2}{5}$  of scaphocerite.

Carpocerite overreaching distal end of antennular peduncle by length of third antennular segment. Basicerite with sharp, slender lateral spine.

Third maxilliped (Figure 32*d*) reaching to distal end of carpacerite. Ultimate segment regularly tapering distally, about 2 times as long as penultimate segment, with long stiff setae on distal margin. Penultimate segment about 2 times as long as broad near distal end. Exopod reaching to or slightly overreaching distal end of antepenultimate segment. Precoxa with one arthrobranch near distal end and also with small supplementary arthrobranch near proximal end.

Major first pereopod (Figure 32*e,f*) overreaching distal end of carpacerite beyond proximal  $\frac{2}{5}$  of chela. Major chela slightly compressed laterally, slightly more than 2.5 times as long as broad. Fingers narrower than palm, occupying distal 0.4 of chela. Movable finger shallowly arched on superior proximal margin; tip blunt, slightly overreaching tip of

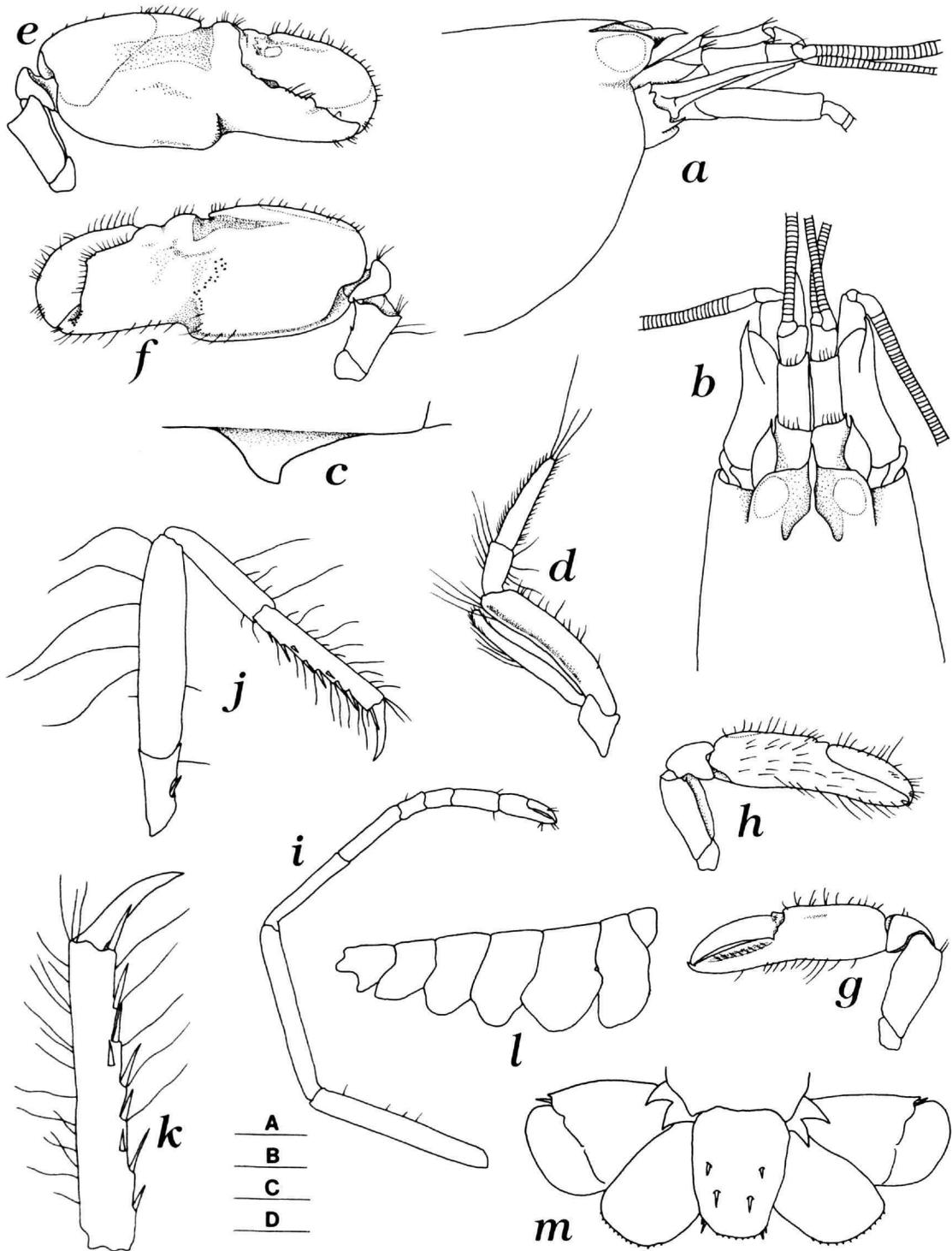


FIGURE 32.—*Alpheus scopulus*, new species, holotype male, cl 11.1 mm, from sta 133-5-b: a, anterior region, lateral view; b, same, dorsal view; c, carina below right first antennular segment; d, right third maxilliped; e, major first pereopod, outer face; f, same, inner face; g, minor first pereopod, outer face; h, same, inner face; i, right second pereopod; j, right third pereopod; k, same, dactylus and propodus; l, abdomen; m, telson and uropods. (Scale A = 4 mm: e-h, l; scale B = 2 mm: a, b, d, i, j, m; scale C = 1 mm: k; scale D = 0.5 mm: c.)

immovable finger. Immovable finger with tip rather blunt and with short, narrow depression distal to socket; inferior margin almost straight distal to inferior transverse groove. Palm rather broad. Superior transverse groove moderately deep with proximal shoulder overhanging groove. Outer palmar face with very shallow depression at middle part of palm below superior outer palmar depression. Superior outer palmar depression well defined, elongated quadrangular, extending to oblique suture; inferior anterior part slightly extending downward. Inner palmar face with shallow broad depression below superior inner palmar depression. Superior inner palmar depression elongated triangular, reaching proximally just past middle of palm. Inferior transverse groove very shallow; shoulder rounded, not produced anteriorly. Inferior outer palmar depression narrow, continuing upward to  $\frac{1}{4}$  width of palm; margins well delimited posteriorly but not clear anteriorly. Inferior inner palmar depression indistinct, continuing to shallow longitudinal depression near bottom of palm; margins not clear except posterior margin. Middle part of inner palmar face with several small granules. Merus about 2 times as long as broad; inferior inner margin with several movable spines and strong spine at distal end.

Minor chela of first pereopods (Figure 32*g,h*) about 3.5 times as long as broad. Fingers narrower than palm, occupying slightly less than distal 0.5 of chela and no balaeniceps in either sex. Palm with scattered long setae and bearing bluntly triangular tooth above dactylar articulation on inner face. Merus with small spine at distal end of inferior inner margin.

Second pereopod (Figure 32*i*) reaching distal end of carpoperite beyond proximal end of first carpal segment. Fingers of chela very slightly longer than palm. First segment of carpus about 1.4 times as long as second; second segment about 2.6 times as long as third; third segment subequal to fourth; fifth segment about 1.7 times as long as fourth.

Dactylus of third pereopod (Figure 32*j,k*) simple, slightly deflexed below, about 0.4 times as long as propodus. Propodus about 1.2 times as long as carpus, with 6 strong spines and 2 adjacent spines on inferior margin and one spine at distal end. Merus 4.5 times as long as broad, with 9 to 10 very long setae on superior margin. Ischium with strong movable spine.

Fourth pereopod almost same as third pereopod. Ischium with movable spine.

Ischium of fifth pereopod with movable spine.

Pleura (Figure 32*l*) of abdominal somites broadly rounded, but not much overlapping in ventral regions in male; pleuron of fifth somite subtriangular on posterior ventral margin. Abdominal sternite with no spine at midline. Appendix masculina distinctly shorter than appendix interna.

Telson (Figure 32*m*) rather broad, about 1.5 times as long as broad at anterior end, armed with two pairs of rather stout dorsal spines and with no longitudinal median depression on dorsal surface. Lateral margin slightly rounded. Posterior margin regularly convex, bearing inconspicuous seta-like spines and armed with pair of spines at lateral end; inner spine very stout, 2 times as long as outer one.

Uropodal endopod with inconspicuous seta-like spines on distal margin and with inner depression at anterior half very shallow, but distinct. Uropodal exopod with transverse suture forming two straight lobes; lateral margin terminating in small acute immovable tooth flanking rather slender short movable spine; spine not overreaching distal margin of uropodal exopod; immovable tooth inside of movable spine rounded at tip.

HABITAT.—Shore to 2 m; among sand, sandy gravel, rock, and silt.

DISTRIBUTION.—Panama; Galapagos Islands.

REMARKS.—The present species is very similar to *A. armillatus*, especially in the shape of rostrum; however, the slight differences exist in the shape of the rostrum between the two species. The posteriorly broadened dorsal part of rostral carina in the present species is convex laterally, and the narrowly raised dorsal carina is depressed just before this broadened part. This feature in the present species is similar to the shape of the rostral carina in *Alpheus verilli* (Schmitt, 1924c:77, pl. 2: figs. 9, 10), which Armstrong (1949:11) considered synonymous with *A. armillatus*. However, in *A. armillatus*, based on our identification of the specimens from the Atlantic side of Panama, the broadened dorsal part is more triangular in shape and is not depressed just before the broadened part. The other distinct character between the two species is that, in the present species, the several movable spines in addition to a distalmost spine are found on the inferior inner margin of merus of the major first pereopod, but in *A. armillatus*, there is only one distalmost spine on the inferior inner margin.

ETYMOLOGY.—The anterior margin of the posterior flattened part of the rostral carina in this species is separated by the steep boundary from the posterior portion of orbitorostral groove. The specific name is from the Latin *scopulus* (a cliff).

### 31. *Alpheus tenuis*, new species

FIGURE 33

MATERIAL EXAMINED.—Holotype: Ovigerous female, cl 11.0 mm; Farfan Point, Panama (sta 56).

Paratypes: 2 ♀ (sta 56).

Panama: Whorehouse Reef (sta 133-5-b:1 ♂, 1 ovig); Venado Beach Spit (sta 132 (= 1607): 1 ♂).

MEASUREMENTS.—Males, cl 8.6–9.6 mm; females, cl 10.1–12.2 mm; ovigerous females, cl 9.4–11.0 mm.

DESCRIPTION.—Rostrum (Figure 33*a,b*) slender, acute at tip, reaching to middle of visible part of antennular segment, marked dorsally by narrow carina extending posteriorly far past to posterior end of eye, where carina broadens in triangular shape; middle part of rostral carina depressed below level of ocular hood.

Ocular hood inflated dorsally above level of middle part of rostral carina, rounded anterolaterally, almost straight on anterior inner margin. Orbitorostral groove very deep and broad, rounded at posterior end.

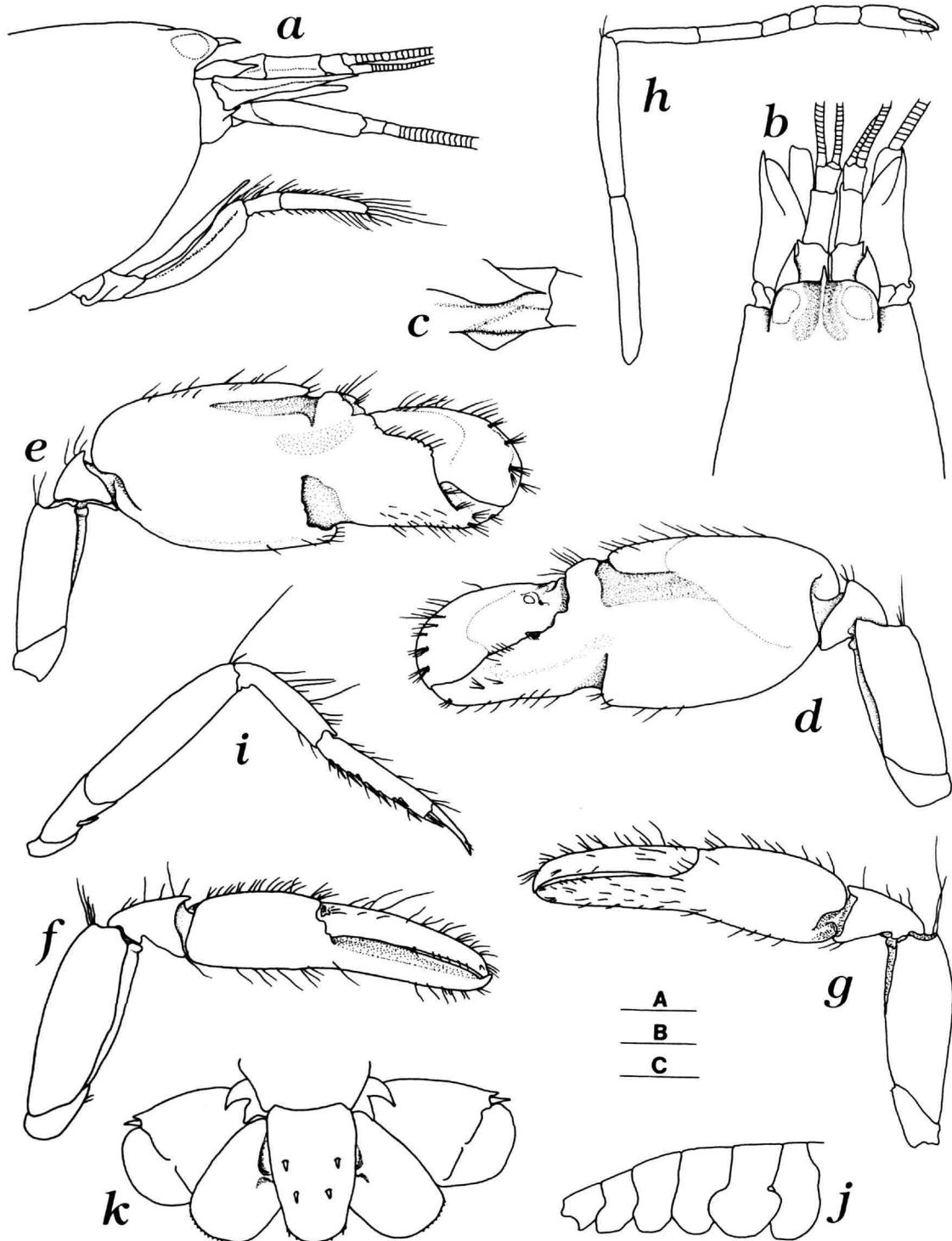


FIGURE 33.—*Alpheus tenuis*, new species, holotype female, cl 11.0 mm, from sta 56: a, anterior region, lateral view; b, same, dorsal view; c, carina below right first antennular segment; d, major first pereopod, outer face; e, same, inner face; f, minor first pereopod, outer face; g, same, inner face; h, right second pereopod; i, right third pereopod; j, abdomen (male, cl 9.6 mm, from sta 133-5-b); k, telson and uropods. (Scale A = 4 mm; j, scale B = 2 mm; a, b, d-i, k, scale C = 1 mm: c.)

First antennular segment bearing shallow triangular carina extending from ventral inner margin (Figure 33c). Second segment about 1.6 times as long as visible part of first segment and 2.1 times as long as third segment. Stylocerite broad proximally, narrowing to acute point at tip, almost reaching to distal margin of first segment.

Scaphocerite about 2.6 times as long as broad with lateral margin slightly concave at middle. Distal spine slightly directed inward at tip, overreaching distal end of antennular peduncle and almost reaching to distal end of carpocerite. Inner blade falling short of distal end of adjacent distal spine, slightly overreaching distal end of antennular peduncle; distal end narrowly rounded. Cleft between distal spine and inner blade arising more than distal 0.4 of scaphocerite.

Carpocerite overreaching distal end of antennular peduncle by half length of third antennular segment. Basicerite with very slender lateral spine.

Third maxilliped (Figure 33a) slightly overreaching distal end of carpocerite. Ultimate segment about 2.4 times as long as penultimate segment, bearing long, stiff setae on distal margin. Penultimate segment with sparse long setae on superior and inferior margins. Antepenultimate segment almost equal to sum of preceding two segments and bearing few long setae on superior distal margin. Exopod almost reaching to middle of penultimate segment. Precoxa with one arthrobranch near distal end and also with small supplementary arthrobranch near proximal end.

Major first pereopod (Figure 33d,e) overreaching distal end of carpocerite by length of chela. Major chela slightly compressed laterally, about 2.5 times as long as broad, fingers occupying slightly more than distal  $\frac{1}{3}$ . Fingers narrower than palm. Movable finger shallowly rounded along superior proximal margin and regularly arched along superior distal margin; tip obtusely rounded, slightly overreaching tip of immovable finger. Immovable finger with very shallow, longitudinal depression along median part of outer face; depression extending posteriorly to region between superior and inferior palmar depressions. Superior transverse groove of palm well defined, with proximal shoulder slightly overhanging groove. Superior outer palmar depression narrowly quadrangular, extending to oblique suture. Superior inner palmar depression longitudinally elongated triangular, extending posteriorly to half length of palm; inferior anterior part extending downward. Inferior transverse groove shallowly broad with proximal shoulder slightly produced. Inferior outer palmar depression narrowly inverse V-shaped; posterior margin well delimited. Inferior inner palmar depression elongated rectangular shape; margins well defined posteriorly and little distinct anteriorly. Inner face of palm with ellipsoid depression below superior inner palmar depression and with indistinct, narrow longitudinal depression near bottom of palm. Merus about 2.6 times as long as broad; inferior inner margin smooth, bearing small spine on distal end.

Minor chela of first pereopods (Figure 33f,g) about 3.9 times

as long as broad. Fingers more than 0.5 times as long as chela, narrower than palm and bearing short setae on inner face. Movable finger not balaeniceps in both sexes. Palm about 1.7 times as long as broad, lacking distinct sculpturing and with very blunt tooth above dactylar articulation on inner face and bearing scattered setae on superior and inferior margins. Merus with inferior inner margin smooth and bearing minute spine at distal end.

Second pereopod (Figure 33h) reaching distal end of carpocerite beyond proximal end of carpus. Fingers of chela almost as long as palm. First segment of carpus about 1.3 times as long as second; second segment 2.3 times as long as third; third segment subequal to fourth; fifth segment 1.5 times as long as fourth.

Dactylus of third pereopod (Figure 33i) simple, about 0.4 times as long as propodus. Propodus about 1.1 times as long as carpus, bearing 7 strong spines and 5 irregular adjacent spines on inferior margin and pair at distal end. Merus about 4.3 times as long as broad and 1.7 times as long as carpus. Ischium with movable spine.

Fourth pereopod almost similar to third pereopod. Ischium with movable spine.

Fifth pereopod much weaker than third pereopod. Ischium with no movable spine.

Pleura (Figure 33j) of first four abdominal somites broadly rounded in female; pleuron of fifth somite roundly elongate on posterior ventral margin. Abdominal sternite with no spine at midline. Appendix masculina falling short of distal end of appendix interna in male.

Telson (Figure 33k) about 1.6 times as long as broad at anterior end, armed with two pairs of rather small dorsal spines and with no longitudinal median depression on dorsal surface.

Uropodal endopod bearing inconspicuous seta-like spines on distal margin and with inner depression at anterior half fairly distinct. Uropodal exopod bearing very small, slender movable spine flanked laterally by acute immovable tooth and internally by subacute lobe; inner transverse suture almost straight, outer lobe slightly convex.

VARIATIONS.—This species has the variations in the following features. (1) Length of carpocerite: holotype has the carpocerite that slightly overreaches the distal end of distal spine, but other specimens show longer carpocerite than that of holotype. (2) Carina below first antennular segment: in female, the shape of carina is a broadly rounded triangle but male specimens show that the carina has an acute spine directing anteriorly at ventral part of carina. (3) Ischium of fifth pereopod: female specimens have no movable spine on each ischium but male specimens have one small movable spine at each ischium. (4) Pleura of abdominal somites: female specimens have broadly rounded pleura while male specimens have narrower pleura than those of female.

HABITAT.—Shore to 1.0 m; sand, sandy mud, and rocks.

DISTRIBUTION.—Panama.

REMARKS.—The present species is undoubtedly closely related to *A. armillatus* in all respects. However *A. armillatus*

has been regarded as a species showing much variation, which casts doubt on the reliability of its status. Therefore, we compared the present species with the specimens that came from the Atlantic side of Panama and should be identified as *A. armillatus* based on our own studies. As a result, the following are the main differences between the two species: *A. armillatus* has a rostrum that extends posteriorly as a dorsally rounded narrow carina to the end of the ocular hood and then abruptly widens into a triangular shape. The lateral margins of the triangular shape are straight and overhang the orbitorostral grooves in all specimens that we examined. On the other hand, the present species has a rostrum similar to that of *A. armillatus*, but the lateral margins of the triangular shape are fairly concave and do not overhang the orbitorostral grooves. The merus of the major first pereopod has a spine on the distal end of the inferior inner margin in both species. Even though the differences are very slight, the spine in the present species is weaker than that of *A. armillatus*. The trace of a transverse notch in the middle of the inferior margin of the minor chela is seen in *A. armillatus* but is not seen in the present species. *A. armillatus* has a spine at the midline of each sternite of the first two abdominal sternites, but there is no spine in the present species.

ETYMOLOGY.—The Latin *tenuis* (slender) refers to the slender minor chela of the species.

### 32. *Alpheus villus*, new species

FIGURE 34

MATERIAL EXAMINED.—Holotype: Male, cl 7.4 mm, spit north of mill site, Angeles Bay, Baja California, Mexico (sta 537-36).

Costa Rica: Wafer Bay, Isla del Coco (sta 105-33: 1 ♂, sta 781-38: 1 ♂, LGA 73-60: 2 ♂).

Panama: Secas Isle (sta 446b-35: 1 ♂).

MEASUREMENTS.—Males, cl 5.8–7.5 mm.

DESCRIPTION.—Rostrum (Figure 34*a,b*) small, triangular, carinate posteriorly, not reaching to middle of visible part of first antennular segment and slanting slightly downward from posterior end of rostral carina toward tip; rostral carina shallow, linear dorsally, passing to posterior end of eye.

Ocular hood very slightly inflated above level of middle part of rostral carina. Orbitorostral groove very shallow, not clearly delimited posteriorly. Anterior inner margin of ocular hood almost straight.

First antennular segment with broadly triangular carina extending from ventral inner margin (Figure 34*c*). Second segment about 1.4 times as long as visible part of first segment and 1.7 times as long as third segment. Stylocerite broad proximally, abruptly narrowing to sharp point, falling short of distal margin of first segment.

Scaphocerite with lateral margin distinctly concave at middle. Distal spine reaching to distal end of antennular peduncle. Inner blade rather broad and rounded distally, slightly shorter than adjacent distal spine. Cleft between inner

blade and distal spine arising from distal  $\frac{1}{3}$  of scaphocerite.

Carpocerite overreaching distal end of antennular peduncle by  $\frac{2}{3}$  length of third antennular segment. Basicerite with very small, slender lateral spine.

Third maxilliped (Figure 34*a,d*) reaching to distal end of carpocerite. Ultimate segment regularly tapering distally, about 1.3 times as long as penultimate segment, with few setae on distal margin; tufts of setae on inner face dense. Penultimate segment rather long, about 2.3 times as long as broad near middle part, bearing dense tufts of stout setae on inferior inner margin; color of setae brown in preserved specimen. Antepenultimate segment with two or three stout setae (same kind of setae found in penultimate) on superior distal margin. Exopod overreaching distal end of antepenultimate segment. Precoxa with one arthrobranch near distal end and also with small supplementary arthrobranch near proximal end.

Major first pereopod (Figure 34*e,f*) overreaching distal end of carpocerite beyond proximal end of chela. Major chela compressed laterally, bearing very short setae on inner face distally, about 2.2 times as long as broad. Fingers much narrower than palm, occupying slightly less than distal 0.4 of chela. Movable finger compressed laterally, regularly arched in profile but rather steep distally; tip roundly triangular, slightly overreaching tip of immovable finger. Immovable finger with very shallow longitudinal depression at median part of outer face. Palm rather broad, without prominent setae on both lateral faces. Superior transverse groove moderately deep with proximal shoulder not overhanging groove. Superior outer palmar depression well defined, rectangular, extending to oblique suture; inferior anterior part slightly extending below; shallow longitudinal depression below superior outer depression continuing to middle of immovable finger. Superior inner palmar depression elongated triangular, reaching proximally just past to middle of palm, slightly directing towards superior margin. Broadly rounded depression below superior inner depression very shallow. Inferior transverse groove broad, deep; proximal shoulder rounded, not much produced anteriorly. Inferior outer palmar depression narrow, slightly oblique inverse V-shaped, continuing upward to  $\frac{1}{3}$  width of palm; anterior and posterior margins fairly well delimited. Inferior inner palmar depression broad, inverse U-shaped and continuing posteriorly to shallow longitudinal depression near bottom of palm; margins fairly well delimited. Merus about 2.3 times as long as broad; inferior inner margin smooth, and with no spine at distal end.

Minor chela of first pereopods (Figure 34*g,h*) about 3.3 times as long as broad. Chela with shallow transverse notch at middle of inferior margin. Outer palmar face with indistinct longitudinal depression near median region. Inner palmar face with bluntly triangular tooth above dactylar articulation and indistinct short depression below tooth. Fingers narrower than palm, occupying more than distal  $\frac{1}{3}$  of chela. Movable finger with well-developed balaeniceps; superior surface fairly broad. Immovable finger with fringes of setae on both lateral faces leading to middle of finger. Merus about 2.5 times as long as

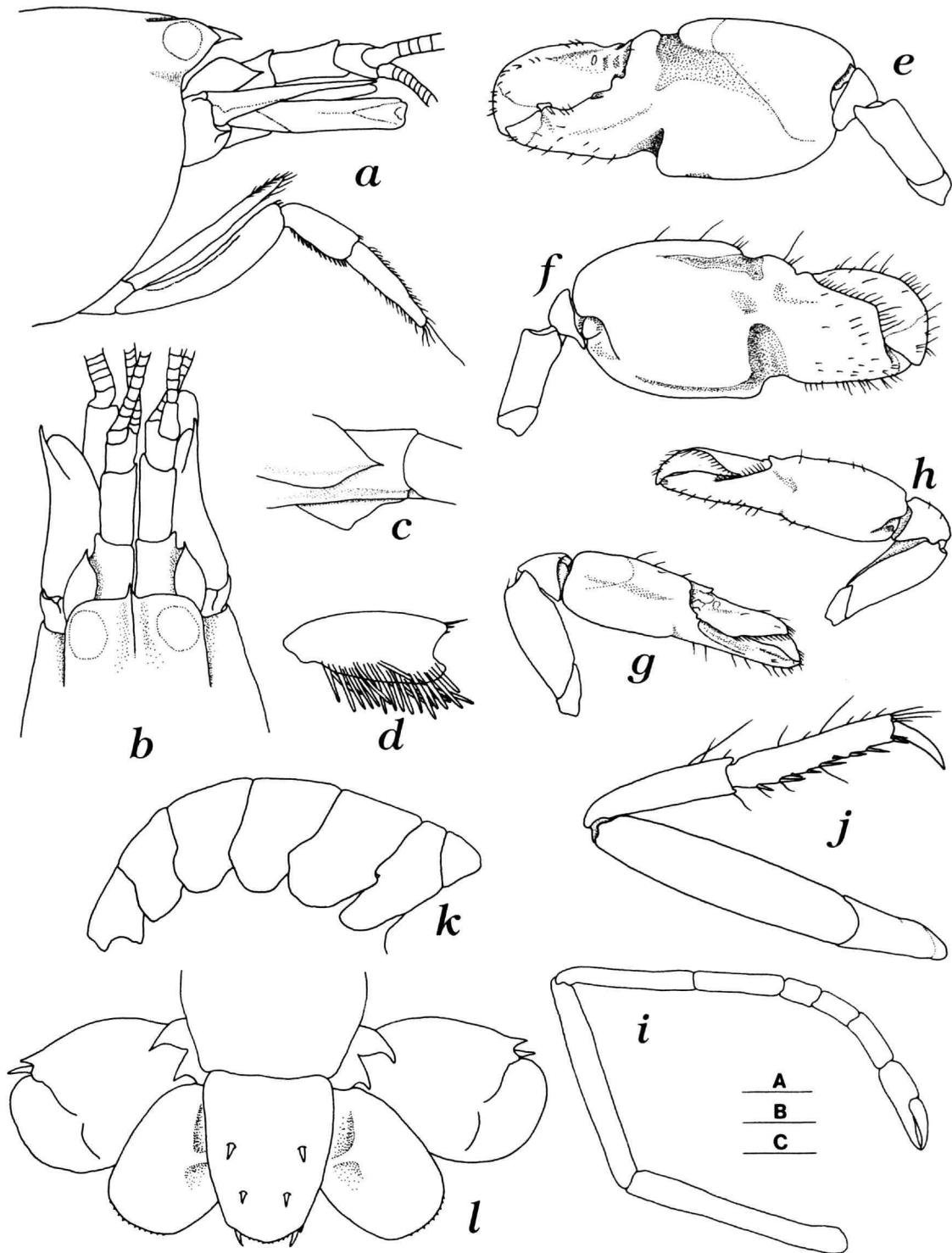


FIGURE 34.—*Alpheus villus*, new species, holotype male, cl 7.4 mm, from sta 537-36: *a*, anterior region, lateral view; *b*, same, dorsal view; *c*, carina below right first antennular segment; *d*, penultimate segment of left third maxilliped, inner face; *e*, major first pereopod, outer face; *f*, same, inner face; *g*, minor first pereopod, outer face; *h*, same, inner face; *i*, right second pereopod; *j*, right third pereopod; *k*, abdomen; *l*, telson and uropods. (Scale A = 2 mm: *e-h*, *k*; scale B = 1 mm: *a*, *b*, *i*, *j*, *l*; scale C = 0.5 mm: *c*, *d*.)

broad; inferior margin very smooth, with no spine at distal end.

Second pereopod (Figure 34*i*) reaching distal end of carpoperite beyond proximal end of first carpal segment. Fingers of chela at least as long as palm. First segment of carpus about 1.5 times as long as second; second segment 2.2 times as long as third; third segment slightly shorter than fourth; fifth segment 0.6 times as long as second and 1.3 times as long as fourth.

Dactylus of third pereopod (Figure 34*j*) simple, slightly directed downward, about 0.4 times as long as propodus. Propodus about 1.2 times as long as carpus, bearing 6 movable spines and 2 adjacent spines on inferior margin and pair at distal end. Merus very smooth, about 1.9 times as long as carpus and 5.1 times as long as broad. Ischium with no movable spine.

Fourth pereopod almost same as third pereopod. Ischia of fourth and fifth pereopods with no movable spines.

Pleura (Figure 34*k*) of abdominal somites narrowly rounded ventrally and not much overlapping in ventral regions; pleuron of fifth somite subtriangular on posterior ventral margin. Abdominal sternite with no spine at midline. Appendix masculina clearly shorter than appendix interna.

Telson (Figure 34*l*) rather wide, about 1.3 times as long as broad at anterior end, armed with two pairs of rather stout dorsal spines and with no longitudinal median depression on dorsal surface. Lateral margin slightly rounded. Posterior margin produced at middle, bearing inconspicuous seta-like spines and armed with pair of spines at each lateral end; inner spine very stout, 2 times as long and wide as outer one.

Uropodal endopod bearing inconspicuous seta-like spines on distal margin and with inner depression at anterior half shallow. Uropodal exopod with slender movable spine, not reaching to distal margin of uropodal exopod, flanked laterally by short, acute immovable tooth and internally by round lobe; transverse suture forming two shallow convex lobes.

VARIATIONS.—Holotype male clearly shows the tufts of stout setae on the inferior inner margin of the penultimate segment of the third maxilliped, but other specimens (three males) show stiff strong setae instead of these stout setae.

HABITAT.—Shore; rock shingle.

DISTRIBUTION.—Baja California; Costa Rica; Panama.

REMARKS.—The present species is characterized by the presence of the tufts of stout setae on the inferior inner margin of penultimate segment of the third maxilliped. But the present species is similar to *A. firmus* by possessing the relatively long penultimate segment of the third maxilliped and by possessing the balaeniceps movable finger of the minor chela. The present species is also very similar to *A. heterochaelis* Say, 1818, in respect to the absence of spine on the distal end of the inferior inner margin of merus of the major first pereopod. The present species has no spine on the distal end of each inferior inner margin of meri of the first pereopods, no spine on ischium of the third pereopod and has the balaeniceps movable finger of the minor chela, while there is a spine on the ischium of the third pereopod in *A. heterochaelis* and *A. firmus*.

ETYMOLOGY.—The specific name is from the Latin *villus* (a tuft of hair), referring to the stout setae on the penultimate segment of the third maxilliped of the species.

### 33. *Alpheus umbo*, new species

FIGURE 35

?*Alpheus schmitti*.—Hendrickx et al., 1983:75.—Wicksten, 1983:49. [Not *Alpheus schmitti* Chace, 1972.]

MATERIAL EXAMINED.—Holotype: Male, cl 7.0 mm, Isabel Island, Sinaloa, Mexico (sta 124-33).

Paratypes: 2 ♂, 3 ♀ (sta 124-33).

Mexico: Puerto Refugio, Angel de la Guardia, Baja California (sta 713-37: 1 ♂); San Francisco Island, Baja California (sta 647-37: 1 ♂); La Paz, Baja California (sta 630-37: 1 ♂); San Gabriel Bay, Espiritu Santo Island, Baja California (sta 634-37: 1 ♂, 1 ♀); Isabel Island, Sinaloa (sta 869-38: 2 ♂).

Costa Rica: Parker Bay (sta 466-35: 1 ♂, 1 ovig, sta 473-35: 1 ♂).

Colombia: Port Utria (sta 232-34: 1 ♂, sta 413-35: 1 ♂, sta 239a-34: 1 ♂, 1 ♀).

MEASUREMENTS.—Males, cl 4.1–7.0 mm; females, cl 3.5–6.9 mm; ovigerous female, cl 5.1 mm.

DESCRIPTION.—Rostrum (Figure 35*a,b*) small, narrowly triangular, not reaching to middle of visible part of first antennular segment, marked dorsally by low narrow carina extending posteriorly just past posterior end of eye.

Ocular hood strongly elevated dorsally above level of rostral carina, rounded and slightly produced anteriorly and unarmed. Orbitorostral groove distinct, but shallow.

Anterolateral margin of carapace produced anteriorly near base of basicerite.

First antennular segment bearing very shallow carina extending from ventral inner margin (Figure 35*c*). Second segment slightly less than 1.5 times as long as visible part of first segment, almost two times as long as third segment. Stylocerite short, falling short of distal margin of first segment.

Scaphocerite about 3 times as long as broad. Lateral margin strongly concave at proximal  $\frac{1}{3}$ . Distal spine very stout, wider than distal portion of inner blade, far overreaching distal end of antennular peduncle. Inner blade small, narrow, reaching to middle of third antennular segment. Cleft between distal spine and inner blade arising from distal  $\frac{1}{2}$  of scaphocerite.

Carpocerite overreaching distal end of antennular peduncle by almost length of third antennular segment. Basicerite with sharp, slender, lateral spine.

Third maxilliped (Figure 35*d*) overreaching distal end of carpoperite by length of ultimate segment. Ultimate segment 2.4 times as long as penultimate segment, bearing very long, stiff setae anteriorly and dense tufts of setae on inner surface. Exopod slightly overreaching distal end of antepenultimate segment. Precoxa with one arthrobranch near distal end but

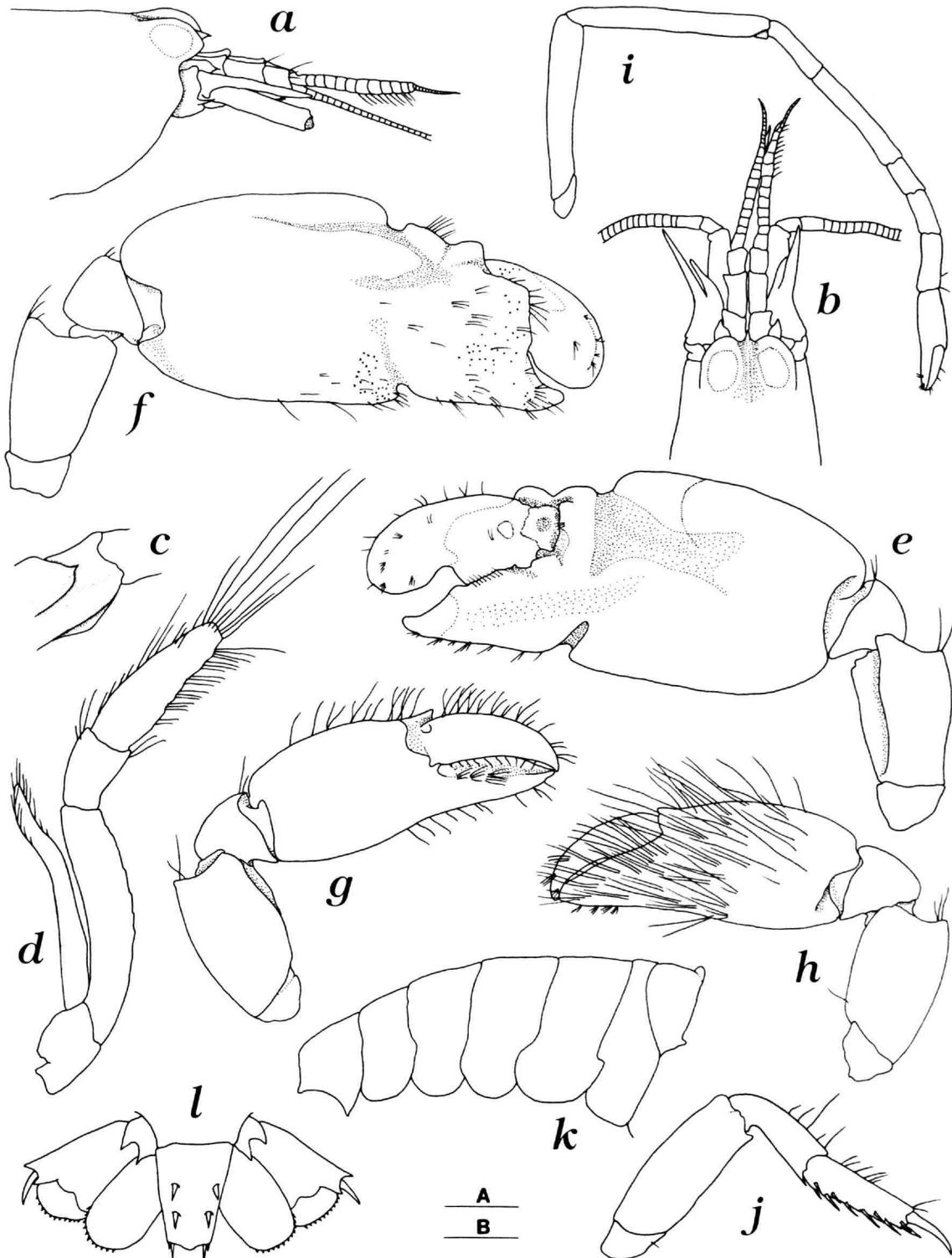


FIGURE 35.—*Alpheus unbo*, new species, male, cl 4.6 mm, from sta 413-35: *a*, anterior region, lateral view; *b*, same, dorsal view; *c*, carina below right first antennular segment; *d*, right third maxilliped; *e*, major first pereopod, outer face; *f*, same, inner face; *g*, minor first pereopod, outer face; *h*, same, inner face; *i*, right second pereopod; *j*, right third pereopod; *k*, abdomen; *l*, telson and uropods. (Scale A = 1 mm: *a*, *b*, *e*-*l*; scale B = 0.5 mm: *c*, *d*.)

with no small supplementary arthrobranch near proximal end.

Major first pereopod (Figure 35e,f) overreaching distal end of carpoperite beyond part of carpus. Chela little compressed laterally, notched superiorly and inferiorly and grooved on both lateral faces. Movable finger opening and closing somewhat obliquely, regularly arched, obtusely rounded distally, with distinct groove in distal part of inner face; tip overreaching tip of immovable finger. Tip of immovable finger deflexed outward. Palm with well-defined longitudinally rectangular depression, passing to oblique suture on outer face; shallow longitudinal depression on median surface of immovable finger, continuing between inferior and superior depressions. Inner face of palm with longitudinally narrow triangular depression spreading from superior transverse groove and bounded inferiorly by elongate boss accentuated by sinuous longitudinal depression extending proximally; narrow oblique groove running backwards from superior margin distal to superior transverse groove and joining longitudinal depression at apex of boss; inferior transverse groove continued on medial surface as shallow, oblique depression. Palm with small granules on proximal portion of inferior transverse groove and on mid-distal end of palm. Merus with inferior inner margin smooth, unarmed at distal end.

Minor first pereopod (Figure 35g,h) overreaching distal end of carpoperite by chela and part of carpus. Movable finger regularly rounded on superior margin, 0.7 times as long as palm in male. Palm not noticeably compressed laterally, 1.7 times as long as broad, without sculpturing and with blunt subtriangular tooth on inner face flanking dactylar articulation. Chela bearing dense long setae on inner face anteriorly from proximal one third. Merus with inferior inner margin smooth, no spine at distal end.

Second pereopod (Figure 35i) overreaching distal end of carpoperite beyond half of merus. Fingers of chela considerably shorter than palm. First segment of carpus about 0.6 times as long as second; second segment about 2.9 times as long as third; third segment subequal to fourth; fifth segment about 1.3 times as long as fourth.

Third pereopod (Figure 35j) overreaching distal end of carpoperite by distal  $\frac{1}{3}$  of propodus. Dactylus simple, conical, half as long as propodus, deflexed below. Propodus with 6 strong spines on inferior margin and about four similar spines in adjacent discontinuous row. Carpus slightly less than propodus, with acute immovable tooth on inferior distal margin. Merus as long as carpus, 2.7 times as long as wide, 1.7 times as broad as carpus, with small blunt tooth on distal end of inferior margin. Ischium with no movable spine.

Fourth pereopod very similar to third pereopod, but distal tooth on inferior margin of merus usually less distinct or absent. Ischium with no movable spine.

Fifth pereopod much smaller than third pereopod. Ischium with no movable spine.

Pleura (Figure 35k) of first through fifth abdominal somites broadly rounded in both sexes. Abdominal sternite with no spine at midline. Appendix masculina distinctly longer than

appendix interna.

Telson (Figure 35l) about 1.4 times as long as broad at anterior end, armed with two pairs of rather stout dorsal spines and with longitudinal median depression on dorsal surface. Posterior margin produced at middle, bearing several seta-like spines and armed with two pairs of stout lateral spines, inner one two times or more as long and wide as outer one.

Uropodal endopod bearing inconspicuous seta-like spines and with inner depression at anterior half very shallow. Uropodal exopod with slender movable spine flanked by acute tooth laterally and internally; movable spine overreaching distal end of uropodal exopod; transverse suture forming two convex lobes.

HABITAT.—Shore; among rock, and coral.

DISTRIBUTION.—Baja California; Costa Rica; Colombia.

REMARKS.—This species is very similar to *Alpheus schmitti* Chace, 1972, in respect to the shapes of major first pereopod and third pereopod. *Alpheus schmitti* can be distinguished from most other members of the *edwardsii* group of the genus by the broadly truncate movable finger of the major chela, by the unusually short fingers of the minor chela, by the intermediate development of the distal tooth on the inferior margin of merus of the third pereopod, and by the unusually small fifth pereopod (Chace, 1972:73). The present species can be distinguished from *A. schmitti* by the following characteristics. (1) The movable finger of major chela of *A. schmitti* is more distorted than that of the present species. (2) The distal spine of scaphocerite is far overreaching the distal end of antennular peduncle in all specimens of the present species, while in *A. schmitti*, not reaching as far as the distal end of antennular peduncle. (3) Carpoperite of the present species is longer than that of *A. schmitti*. (4) Chace (1972:71) noted that the "movable finger [of minor chela] rounded, usually slightly more than half as long as palm in males, often less than half as long as palm in females." The present species show that the finger is 0.61–0.75 times as long as palm in male (6 ♂) and 0.63–0.77 times as long as palm in female (6 ♀). (5) The palm of the minor chela of the present species is much broader than that of *A. schmitti*.

ETYMOLOGY.—The boss on the inner palmar face of major chela in this species is an uncommon feature among the *edwardsii* group. The specific name is from the Latin *umbo* (boss).

#### 34. *Alpheus mazatlanicus* Wicksten, 1983

FIGURE 36

*Alpheus mazatlanicus* Wicksten, 1983:46, figs. 7, 8.

*Alpheus* cf. *A. malabaricus* (Fabricius).—Hendrickx et al., 1983:74.

MATERIAL EXAMINED.—Paratype male, cl 12.2 mm and ovigerous female, cl 10.8 mm from Laguna Caimanero, Mexico.

DESCRIPTION.—Rostrum (Figure 36a,b) short, sharp, barely

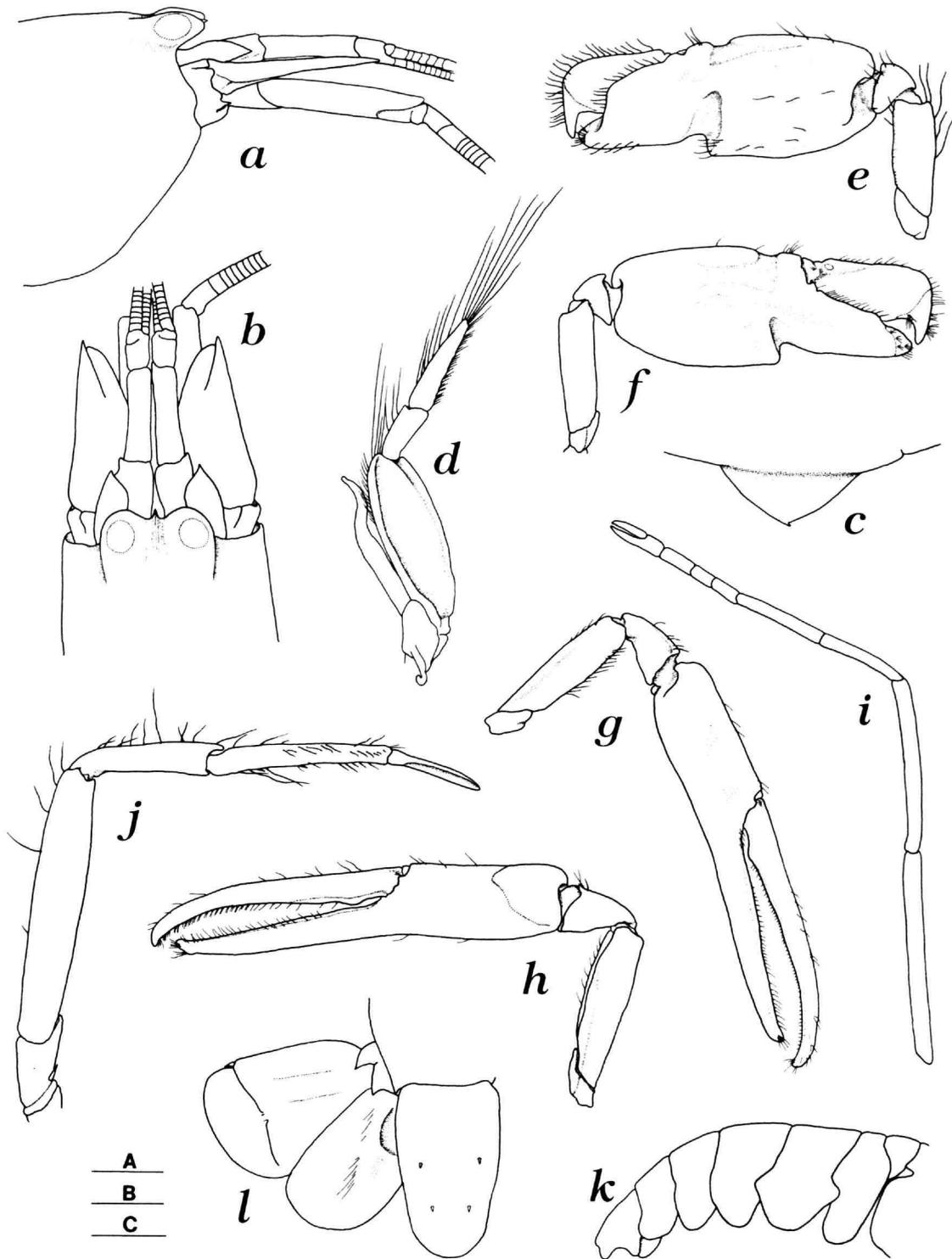


FIGURE 36.—*Alpheus mazatlanicus*, paratype male, cl 12.2 mm, from Laguna Caimanero, Mexico: *a*, anterior region, lateral view; *b*, same, dorsal view; *c*, carina below right first antennular segment; *d*, right third maxilliped; *e*, major first pereopod, inner face; *f*, same, outer face; *g*, minor first pereopod, inner face; *h*, same, outer face; *i*, left second pereopod; *j*, right third pereopod; *k*, abdomen; *l*, telson and uropods. (Scale A = 4 mm: *e-h*, *k*; scale B = 2 mm: *a*, *b*, *d*, *i*, *j*, *l*; scale C = 0.5 mm: *c*.)

exceeding anterior margin of ocular hood ["reaching to middle of first antennular segment in large males" (Wicksten, 1983:46)]. Rostral carina very shallow and narrow, extending to posterior end of eye.

Ocular hood prominently inflated dorsally and produced anteriorly; anterior margin very convex. Orbitorostral groove shallow.

Carapace with pterygostomian margin very slightly produced anteriorly below base of basicerite.

First antennular segment bearing broadly triangular carina extending from ventral inner margin; ventral part with acute, small tooth (Figure 36c). Second segment about 4.0 times as long as broad, 2.0 times as long as visible part of first segment and 2.8 times as long as third segment. Stylocerite not reaching to distal margin of first segment.

Scaphocerite with lateral margin almost straight. Distal spine almost reaching to distal end of antennular peduncle. Inner blade falling short of tip of distal spine. Cleft between inner blade and distal spine arising from slightly less than distal 0.3 of scaphocerite.

Carpocerite overreaching distal end of antennular peduncle by  $\frac{2}{3}$  length of third antennular segment. Basicerite with small sharp spine.

Third maxilliped (Figure 36d) reaching to distal end of carpuce. Ultimate segment about 1.7 times as long as penultimate, tapering distally. Penultimate segment about 2.2 times as long as broad near distal end. Antepenultimate segment fairly broad, about 2.6 times as long as broad. Exopod falling short of distal end of antepenultimate segment. Precoxa with one arthrobranch near distal end and also with small supplementary arthrobranch near proximal end.

Major chela of first pereopods (Figure 36e,f) narrow, about 2.6 times as long as broad and with trace of fine granules at anterior half. Fingers clearly narrower than palm, occupying slightly more than distal 0.3 of chela. Movable finger with superior margin almost straight from proximal end to proximal  $\frac{2}{3}$  and then right angled, with tip narrow and acute. Immobile finger blunt at tip and with inferior margin almost straight. Palm with superior and inferior transverse grooves. Superior transverse groove broad and shallow, continuing to shallow elongated triangular depression on inner face and continuing to shallow elongated rectangular depression on outer face. Inferior transverse groove fairly deep and broad with proximal shoulder abrupt, connecting to inverse V-shaped inferior outer palmar depression and connecting to broad inferior inner palmar depression. Outer palmar face with depressed area below superior outer palmar depression and behind inferior outer palmar depression, and with median depression between above two depressions. Inner palmar face with shallow elongate depression near inferior margin of palm and with depressed area in front of and below superior inner palmar depression. Inferior inner margin of merus with trace of fine granules, bearing very minute movable spinule at middle and no spine at distal end. Inferior outer margin with trace of fine granules and surface between inferior inner and inferior outer

margin also with trace of fine granules.

Minor chela of first pereopods (Figure 36g,h) elongate, about 5.6 times as long as broad, with trace of fine granules inferiorly, and fingers occupying distal 0.6 of chela. Fingers deflexed inward and gaping when closed; movable finger longer than immobile finger in the present male specimen and with inferior margin slightly produced downward near base; tips of fingers blunt. Palm lacking sculpturing, with trace of fine granules on inner face, swollen laterally and thicker than fingers. Merus with inferior inner margin bearing short setae, but no distinct spine.

Second pereopod (Figure 36i) reaching distal end of carpuce beyond distal end of first segment of carpus. Fingers of chela about 1.6 times as long as palm. First segment of carpus about 0.9 times as long as second; second segment about 3.4 times as long as third; fifth segment about 1.2 times as long as fourth; fourth segment almost subequal to third.

Dactylus of third pereopod (Figure 36j) subspatulate, about 0.5 times as long as propodus. Propodus about 1.3 times as long as carpus, with inferior margin bearing two very small movable spines along proximal half. Merus about 5.5 times as long as broad and 2.0 times as long as carpus. Ischium with small movable spine.

Fourth pereopod almost same as third pereopod. Ischium with movable spine.

Ischium of fifth pereopod with no spine.

Pleura (Figure 36k) of first four abdominal somites rounded ventrally, not much overlapping each other on ventral regions; pleuron of fifth somite rounded on posterior ventral margin. Abdominal sternite with no spine at midline.

Appendix masculina very slightly overreaching distal end of appendix interna.

Telson (Figure 36l) about 1.8 times as long as broad at anterior end and armed with two pairs of rather small dorsal spines and with no longitudinal median depression on dorsal surface. Posterior margin very convex, with no lateral spines in the present male specimen.

Uropodal endopod with inner depression at anterior half fairly distinct. Uropodal exopod bearing very small movable spine outside of transverse suture; suture forming almost two straight lobes.

HABITAT.—Near mangroves in sand (Wicksten, 1983:48).

COLOR IN LIFE.—Olive green (Wicksten, 1983:48).

TYPE-LOCALITY.—Laguna Caimanero, Sinaloa, Mexico.

DISTRIBUTION.—Laguna Caimanero, Sinaloa, and head of main channel, Estero de Urias, Sinaloa, Mexico.

REMARKS.—Wicksten noted "basicerite without spines" in her description (Wicksten, 1983:48). However, in paratype male and ovigerous female specimens, there is a lateral spine on basicerite.

### 35. *Alpheus latus*, new species

FIGURE 37

MATERIAL EXAMINED.—Holotype: Ovigerous female, cl 7.4

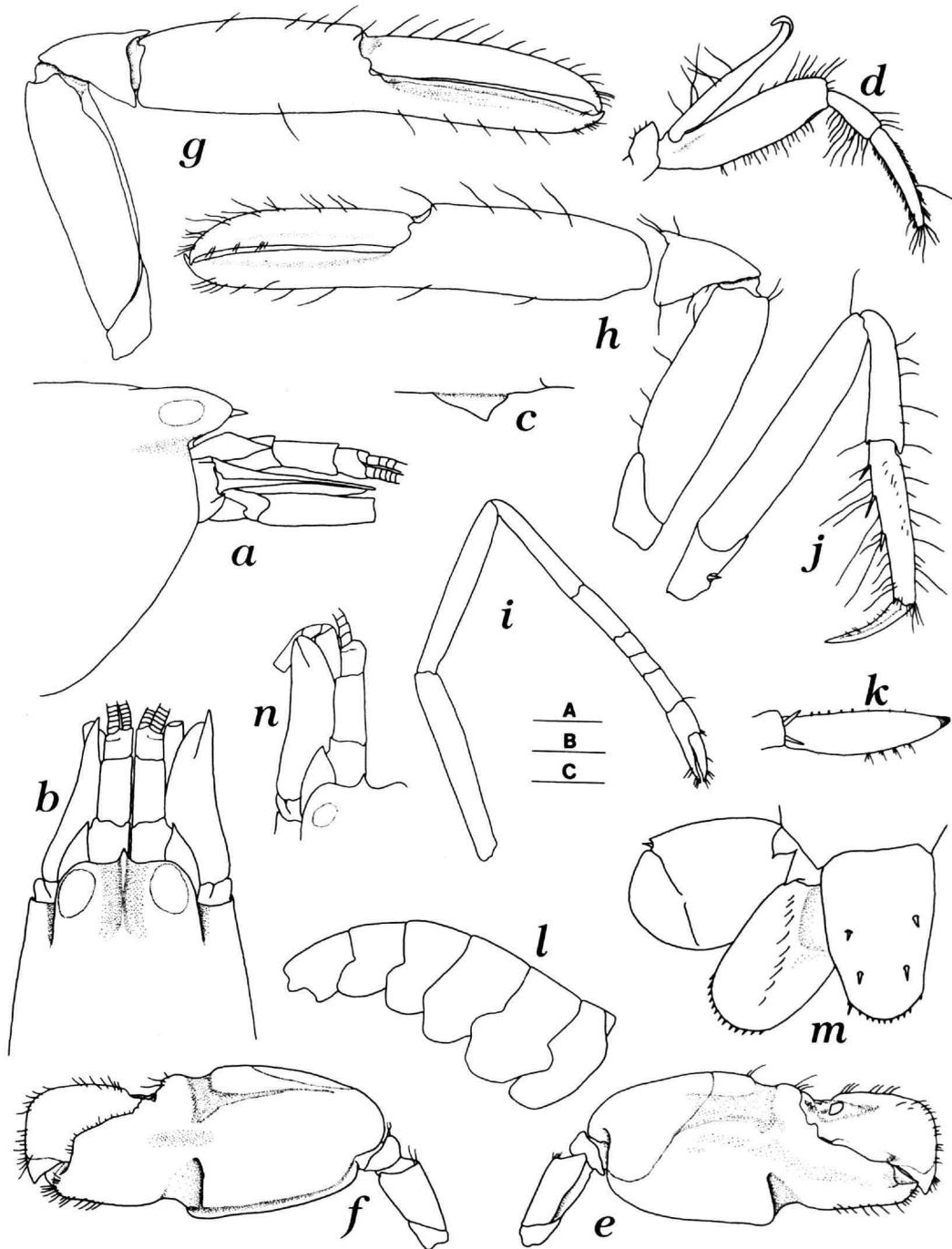


FIGURE 37.—*Alpheus latus*, new species, holotype ovigerous female, cl 7.4 mm, from west side of Panama Canal, Panama: *a*, anterior region, lateral view; *b*, same, dorsal view; *c*, carina below right first antennular segment; *d*, right third maxilliped; *e*, major first pereopod, outer face; *f*, same, inner face (*e*, *f*, male, cl 6.9 mm, from sta LGA-P-71-5); *g*, minor first pereopod, outer face; *h*, same, inner face; *i*, right second pereopod; *j*, right third pereopod; *k*, same, dactylus, ventral view; *l*, abdomen (paratype male, cl 7.2 mm, from west side of Panama Canal, Panama); *m*, telson and uropods; *n*, left scaphocerite (male, cl 6.9 mm, from sta LGA-P-71-5). (Scale A = 2 mm: *d-f*, *l*; scale B = 1 mm: *a*, *b*, *g-j*, *m*, *n*; scale C = 0.5 mm: *c*, *k*)

mm, west side of Panama Canal in mangroves, Panama, 5 Nov 1972, coll. by J.B. Graham.

Paratype: 1 ♂.

Panama: Diablo Heights (LGA-P-71-5: 1 ♂, 1 ovig).

MEASUREMENTS.—Males, cl 6.9–7.2 mm; ovigerous females, cl 6.8–7.4 mm.

DESCRIPTION.—Rostrum (Figure 37*a,b*) rather small, regularly triangular, carinate posteriorly and scarcely reaching to middle of visible part of first antennular segment. Rostral carina very low, rounded dorsally, overreaching posterior end of eye.

Ocular hood inflated dorsally far above level of middle part of rostral carina. Orbitorostral groove very shallow and reaching posterior to eye, not clearly delimited posteriorly. Anterior inner margin of ocular hood broadly concave near base of rostrum.

Antennules rather stout. First antennular segment bearing broadly triangular carina extending from ventral inner margin; ventral part of carina acute (Figure 37*c*). Second segment about 2.1 times as long as broad, 1.7 times as long as visible part of first segment and 2.2 times as long as third segment. Stylocerite broad proximally, narrowing to sharp point at tip, falling slightly short of distal margin of first segment.

Scaphocerite with lateral margin very slightly concave at middle. Distal spine overreaching distal end of antennular peduncle by  $\frac{1}{2}$  length of third segment and slightly overreaching distal end of carpopocerite. Inner blade regularly narrowing distally, slightly overreaching distal end of antennular peduncle. Cleft between inner blade and distal spine shallow, arising from distal  $\frac{1}{4}$  of scaphocerite.

Carpocerite overreaching distal end of antennular peduncle by less than half length of third antennular segment. Basicerite bearing very small lateral spine.

Third maxilliped (Figure 37*d*) overreaching distal end of carpopocerite beyond distal  $\frac{1}{3}$  of ultimate segment. Ultimate segment slender, about 1.3 times as long as penultimate; distal margin with few setae, not strong. Penultimate segment fairly elongate, about 2.7 times as long as broad, bearing several long setae on inferior margin. Antepenultimate segment fairly broad, about 3.3 times as long as broad. Exopod slightly overreaching distal end of antepenultimate segment. Precoxa with one arthrobranch near distal end and also with small supplementary arthrobranch near proximal end.

Major chela of first pereopods (Figure 37*e,f*) about 2.3 times as long as broad with fingers occupying distal  $\frac{1}{3}$ . Fingers slightly narrower than palm. Movable finger compressed laterally, almost right angular on superior distal margin; tip triangular, overreaching tip of immovable finger. Immovable finger with inferior margin almost straight at middle part. Superior transverse groove of palm very broad and shallow, with proximal shoulder not overhanging groove. Superior outer palmar depression well defined, narrowly quadrangular, extending to oblique suture. Superior inner palmar depression longitudinally elongated triangular, becoming much narrower posteriorly. Inferior transverse groove shallow and broad with

proximal shoulder rounded. Inferior outer palmar depression rather broad, inverse V-shaped groove extending upward to  $\frac{1}{3}$  width of palm. Inferior inner palmar depression elongated rectangular in shape, connecting inferiorly to narrow longitudinal depression near bottom of palm; margins of depression well defined posteriorly but indistinct anteriorly. Outer face of palm with shallow, longitudinal depression between superior and inferior palmar depressions, leading to tip of immovable finger. Inner face of palm with short, depressed area between superior and inferior palmar depressions. Merus with inferior inner margin very smooth and with no spine on distal end (based on specimen from LGA-P-71-5).

Minor chela of first pereopods (Figure 37*g,h*) very elongate, about 5.0 times as long as broad, fingers occupying distal 0.5. Palm with no sculpturing, bearing few setae and very blunt tooth flanking dactylar articulation on inner face. Fingers as broad as palm. Movable finger not balaeniceps. Merus elongate, about 3.7 times as long as broad with inferior inner margin very smooth and with no spine at distal end.

Fingers of chela of second pereopod (Figure 37*i*) about 1.2 times as long as palm. First segment of carpus about 1.8 times as long as second; second segment 2.3 times as long as third; third segment subequal to fourth; fifth segment shorter than second, 1.7 times as long as fourth.

Dactylus of third pereopod (Figure 37*j,k*) subspatulate, about 0.6 times as long as propodus. Propodus regularly narrowing distally, about 1.3 times as long as carpus, bearing scattered long setae on inferior and superior margins and with 3 movable spines along proximal  $\frac{2}{3}$  of inferior margin and pair of small spines at distal end. Merus narrow, about 5.3 times as long as broad, and 2.0 times as long as carpus. Ischium bearing very small movable spine.

Fourth pereopod almost same as third pereopod. Ischium bearing movable spine.

Fifth pereopod much narrower than third pereopod. Ischium with no movable spine.

Pleura (Figure 37*l*) of abdominal somites broadly rounded in female (ventral region not much overlapping in male). Abdominal sternite with no spine at midline. Appendix masculina almost reaching to distal end of appendix interna.

Telson (Figure 37*m*) about 1.6 times as long as broad at anterior end, armed with two pairs of rather small dorsal spines and with no longitudinal median depression at middle of dorsal surface. Posterior margin regularly convex, bearing few seta-like spines and armed with pair of very delicate spines laterally.

Uropodal endopod bearing inconspicuous seta-like spines on distal margin and with inner depression at anterior half distinct. Uropodal exopod bearing very small, slender movable spine flanked laterally by small acute immovable tooth and internally by small blunt tooth; transverse suture forming two straight lobes.

VARIATIONS.—The scaphocerites of male and ovigerous female from sta LGA-P-71-5 differ from those of type specimens; distal spine (Figure 37*n*) does not overreach the

inner blade in specimens from sta LGA-P-71-5, while distal spine fairly well overreaches the inner blade in type specimens.

HABITAT.—In mangroves.

DISTRIBUTION.—Panama, Pacific side of Panama Canal.

REMARKS.—The present species is very close to the recently described *A. estuariensis* Christoffersen, 1984, in most characteristics, but the present species differs in the following points from *A. estuariensis*: antepenultimate segment of the third maxilliped fairly broad, about 3.3 times as long as broad, while in *A. estuariensis*, antepenultimate segment 3.75 to 4.5 times longer than wide; opposable margin of immovable finger of major chela with no notch distal to socket, while in *A. estuariensis*, with notch distal to socket.

ETYMOLOGY.—The Latin *latus* (broad) refers to the broad subspatulated dactyli of the third and fourth pereopods.

### 36. *Alpheus hamus*, new species

FIGURE 38

MATERIAL EXAMINED.—Holotype: Male, cl 11.0 mm, Golfito, Costa Rica; Jul 1978.

Panama: Pacific, west side of Panama Canal in mangroves (1 ♂, 1 ovig); 5 Nov 1972, coll. by J.B. Graham; Miraflores Locks (sta 87-3: 1 ♂, 1 ♀).

MEASUREMENTS.—Males, cl 11.0–16.0 mm; female, cl 9.7 mm; ovigerous female, cl 13.6 mm.

DESCRIPTION.—Rostrum (Figure 38*a,b*) small, triangular, not reaching to middle of visible part of first antennular segment and marked dorsally by low rostral carina extending posteriorly about as far as posterior end of ocular hood.

Ocular hood slightly inflated dorsally above middle part of rostral carina (different from Figure 38*a* because of tilted drawing position). Orbitorostral groove very shallow but distinct. Anterior margin of ocular hood rounded.

First antennular segment with triangular carina extending from ventral inner margin (Figure 38*c*). Second segment about 1.4 times as long as visible part of first segment and about twice as long as third segment. Stylocerite broad proximally, narrowing to sharp point at tip, reaching to distal margin of first segment.

Scaphocerite with lateral margin slightly concave at middle. Distal spine acute, not reaching to distal end of antennular peduncle. Inner blade very rounded distally, reaching to tip of distal spine. Cleft between inner blade and distal spine shallow, arising from less than distal 1/4 of scaphocerite.

Carpocerite slightly overreaching distal end of antennular peduncle. Basicerite with small, acute lateral spine.

Third maxilliped (Figure 38*d*) slightly overreaching distal end of carpal. Ultimate segment about 2.5 times as long as penultimate. Exopod reaching to distal end of antepenultimate segment. Precoxa with one arthrobranch near distal end and also with small supplementary arthrobranch near proximal end.

Major first pereopod (Figure 38*e,f*) overreaching distal end of carpal. Major chela about 2.3

times as long as broad with fingers occupying slightly less than distal 0.4; fingers narrower than palm. Movable finger heavy, obliquely straight from superior distal portion to tip; tip ending in very acutely triangular shape and well overreaching tip of immovable finger. Immovable finger with inferior margin slightly concave at middle and with slight longitudinal median depression on outer face. Superior transverse groove of palm fairly deep and broad with proximal shoulder not overhanging groove. Superior outer palmar depression well defined, quadrangular, extending to oblique suture. Superior inner palmar depression longitudinally elongated triangular. Inferior transverse groove very broad with proximal shoulder rounded and not produced anteriorly. Inferior outer palmar depression narrow, inverse V-shaped. Inferior inner palmar depression broadly rectangular in shape, continuing upward to half width of palm and connecting posteriorly to shallow longitudinal groove near bottom of palm. Palm with round depression at inferior proximal region on outer face and sinuous transverse groove at proximal end of immovable finger on inner face. Merus more than 2 times as long as broad with inferior inner margin very smooth and with no spine at distal end.

Minor chela of first pereopods (Figure 38*g,h*) very slender, more than 5 times as long as broad, fingers occupying almost distal 0.5. Palm with no sculpturing. Movable finger not balaeniceps in both sexes. Merus about 4 times as long as broad with no spine on distal end of inferior inner margin.

Second pereopod (Figure 38*i*) reaching distal end of carpal beyond distal 1/3 of merus. Fingers of chela slightly more than 1.5 times as long as palm. First segment of carpus slightly less than 1.5 times length of second; second segment almost 3 times length of third; fourth segment subequal to third; fifth segment slightly longer than fourth.

Dactylus of third pereopod (Figure 38*j,k*) spatulate. Propodus about 2.4 times as long as dactylus with 5 movable spines and pair at distal end. Merus slender, about 5.8 times as long as broad and almost 2 times as long as carpus. Ischium with small movable spine.

Fourth pereopod almost same as third pereopod. Ischium with small movable spine.

Fifth pereopod much narrower than third pereopod. Dactylus subspatulate and ischium with no movable spine.

Pleura (Figure 38*l*) of first four abdominal somites narrowly rounded in both sexes; fifth somite angled, subtriangular on posterior ventral margin. First through fourth pleopods (Figure 38*m*) armed with 9 to 10 immovable spines on each outer margin of protopodites and fifth pleopod with 5 to 6 spines in male (see variation part in female). Abdominal sternites with one spine at midline of each sternite of first through fifth somites in male (see variation part in female). Appendix masculina almost reaching to distal end of appendix interna.

Telson (Figure 38*o*) about 1.3 times as long as broad at anterior end, armed with two pairs of dorsal spines and with no longitudinal median depression on dorsal surface. Posterior margin convex, bearing seta-like spines and armed with pair

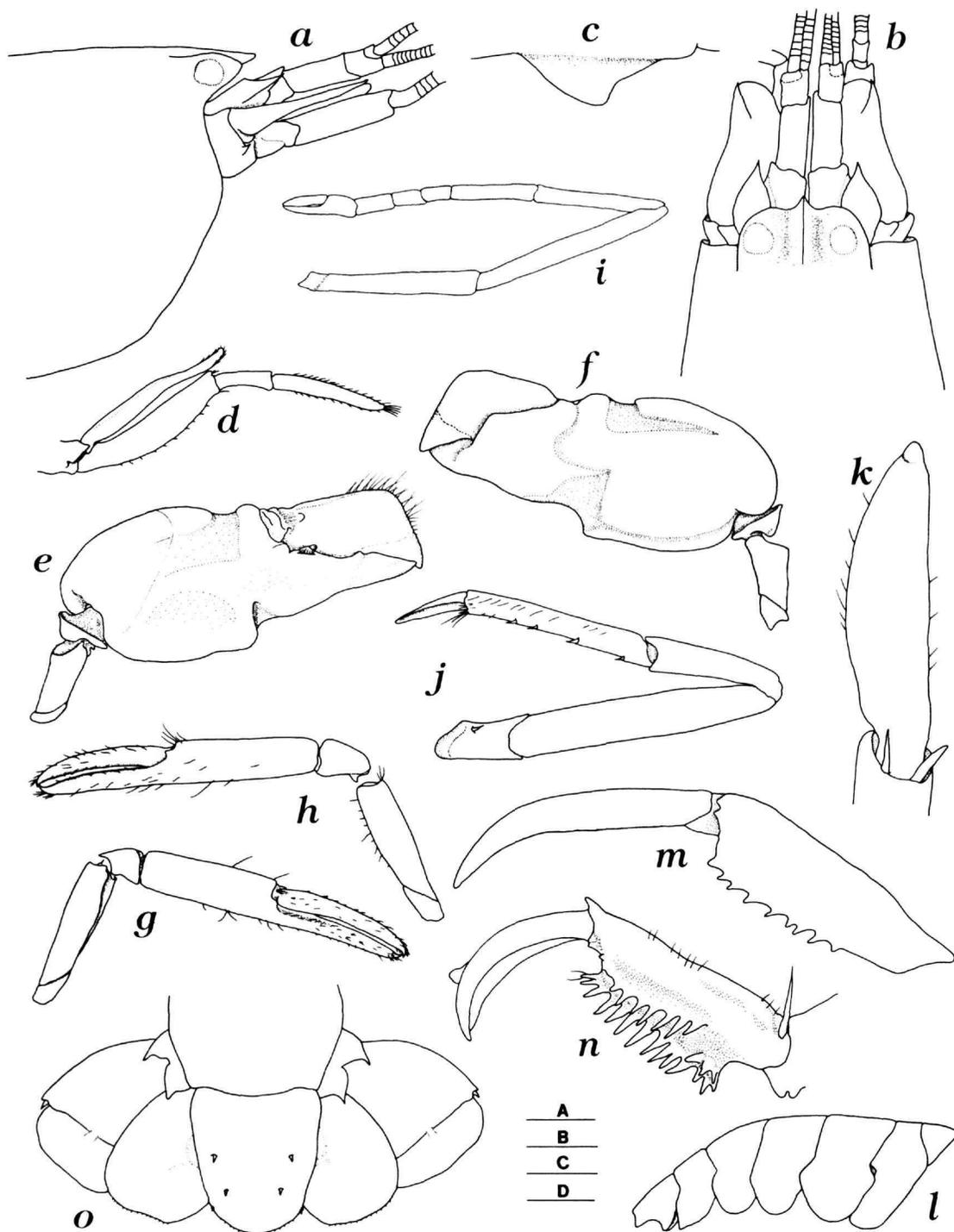


FIGURE 38.—*Alpheus hamus*, new species, male, cl 14.1 mm, from sta 87-3: *a*, anterior region, lateral view; *b*, same, dorsal view; *c*, carina below right first antennular segment; *d*, right third maxilliped; *e*, major first pereopod, outer face; *f*, same, inner face; *g*, minor first pereopod, outer face; *h*, same, inner face; *i*, left second pereopod; *j*, left third pereopod; *k*, same, dactylus, ventral view; *l*, abdomen; *m*, left second pleopod, without setae; *n*, left second pleopod (ovigerous female, cl 15.6 mm, from west side of Panama Canal); *o*, telson and uropods. (Scale A = 4 mm: *e-h, l*; scale B = 2 mm: *a, b, d, i, j, o*; scale C = 1 mm: *k, m, n*; scale D = 0.5 mm: *c*.)

of small spines at each lateral end; inner spine slightly longer than outer one.

Uropodal endopod bearing inconspicuous seta-like spines on distal margin and with inner depression at anterior half fairly distinct. Uropodal exopod with transverse suture forming two straight lobes and lateral margin terminating in small immovable tooth flanking rather small movable spine; spine flanked internally by small lobe.

VARIATIONS.—Variations exist in the number, strength and shape of immovable spines on the outer margins of protopodites of pleopods and in the shape of the abdominal sternal spines. Among the specimens from the Miraflores Locks, Panama Canal, the female specimen (cl 9.7 mm) is relatively smaller than the male specimen (cl 14.1 mm) and the spines of the pleopodal protopodites in female specimen are much weaker and less numerous than those of male specimen. The abdominal sternal spines in female specimen are round at the distal tip especially in the first two sternites, while the abdominal sternal spines in male specimen are spine-like.

Other specimens of this species (one male and one ovigerous female) collected from the west side of the Panama Canal show more striking features on the spines of the pleopodal protopodites (Figure 38*n*) and on the abdominal sternal spines; the male (cl 16.0 mm) is larger than male specimen from the Miraflores Locks and shows two rows of spines. The spines in the upper row are much weaker and less numerous than the spines in the lower row. The strength and number of spines diminish from the first to fifth pleopods. The ovigerous female shows very striking features; two rows of spines exist on each outer margin of protopodites of the first through fifth pleopods. The lower row of spines in the first through third pleopods shows the circular arrangement (5 to 7 spines) at the proximal region. The inner margin of the protopodite of the first pleopod has two large, broad spines near the proximal and distal margins. Each inner margin of the protopodites of the second and third pleopods is expanded laterally and has one large, broad spine near the distal margin. The inner margin of protopodite of the fourth pleopod is slightly expanded laterally and shows a row of spines similar to that of the outer margin instead of one or two large, broad spines. The spines on the inner margin of protopodite of the fifth pleopod are indistinct. The abdominal sternal process of the first somite is bifid, produced anteriorly as an expanded, laterally compressed hook-like shape, the distal one broadly rounded, proximal one sharper than distal one at tip. The abdominal sternal processes of the second through the fourth somites show the posteriorly projecting spine in addition to the abdominal sternal process of the first somite. The abdominal sternal process of the fifth somite shows a posteriorly projecting spine similar to that of male. The expanded bifid hook-like shape in the ovigerous female may be a secondary sexual character because the abdominal sternal process in male is spine-like and the abdominal sternal process in female specimen from the Miraflores Locks, which is small, is similar to that of male but rounded at the tip. Thus the rounded shape at tip reflects the

process that reaches the full grown shape like that of the ovigerous female.

HABITAT.—In mangroves.

DISTRIBUTION.—Golfito, Costa Rica; Panama, Pacific side of Panama Canal.

REMARKS.—The present species is similar to *A. pontederiae*, *A. pacificus*, and *A. strenuus* in the sculpture of the major chela. But the present species can be easily distinguished from the other species of *Alpheus* by the presence of spines on the outer margins of the protopodites of the pleopods.

ETYMOLOGY.—This species has the bizarre feature (i.e., spines on the outer margins of protopodites of the pleopods) that makes it so easily distinguishable from the other species of *Alpheus*. The specific name is from the Latin *hamus* (hook).

### 37. *Alpheus firmus*, new species

FIGURE 39

MATERIAL EXAMINED.—Holotype: Male, cl 9.2 mm; Miraflores Locks, Panama (sta 130-2-b).

Paratypes: 25 ♂, 4 ♀, 13 ovig (sta 130-2-b).

Panama: Miraflores Locks (sta 77-3: 1 ovig, 1 juv, sta 87-3: 2 ♂, 2 ♀, sta 203, 5-U-M-F: 1 ♂, 2 ovig); Punta Paitilla (sta 129: 18 ♂, 13 ovig).

MEASUREMENTS.—Males, cl 5.1–11.3 mm; female, cl 8.9–9.9 mm; ovigerous females, cl 6.8–12.5 mm.

DESCRIPTION.—Rostrum (Figure 39*a,b*) small, triangular, not reaching to middle of visible part of first antennular segment and marked dorsally by very shallow carina; carina extending posteriorly about as far as posterior end of ocular hood.

Ocular hood unarmed, bounded medially by shallow but distinct orbitorostral groove and inflated dorsally almost to same level or slightly exceeding middle part of rostral carina. Anterior margin of ocular hood rounded, fairly concave near base of rostrum.

First antennular segment bearing broadly triangular carina extending from ventral inner margin (Figure 39*c*). Second segment about 2 times as long as visible part of first segment; third segment slightly less than visible part of first segment. Stylocerite broad proximally, narrowing to acute point, reaching nearly to distal margin of first segment.

Scaphocerite with lateral margin slightly concave at middle. Distal spine overreaching distal end of antennular peduncle by half length of third antennular segment and falling far short of distal end of carpoperite. Inner blade narrowly rounded distally, falling far short of tip of distal spine. Cleft between inner blade and distal spine deep, arising from more than distal  $\frac{1}{3}$  of scaphocerite.

Carpocerite overreaching distal end of antennular peduncle by almost length of third antennular segment. Basicerite without or with very small lateral spine.

Third maxilliped (Figure 39*d*) reaching to distal  $\frac{1}{3}$  of carpoperite. Ultimate segment slightly longer than penultimate (ratio: 1.2). Penultimate segment about 3.4 times as long as

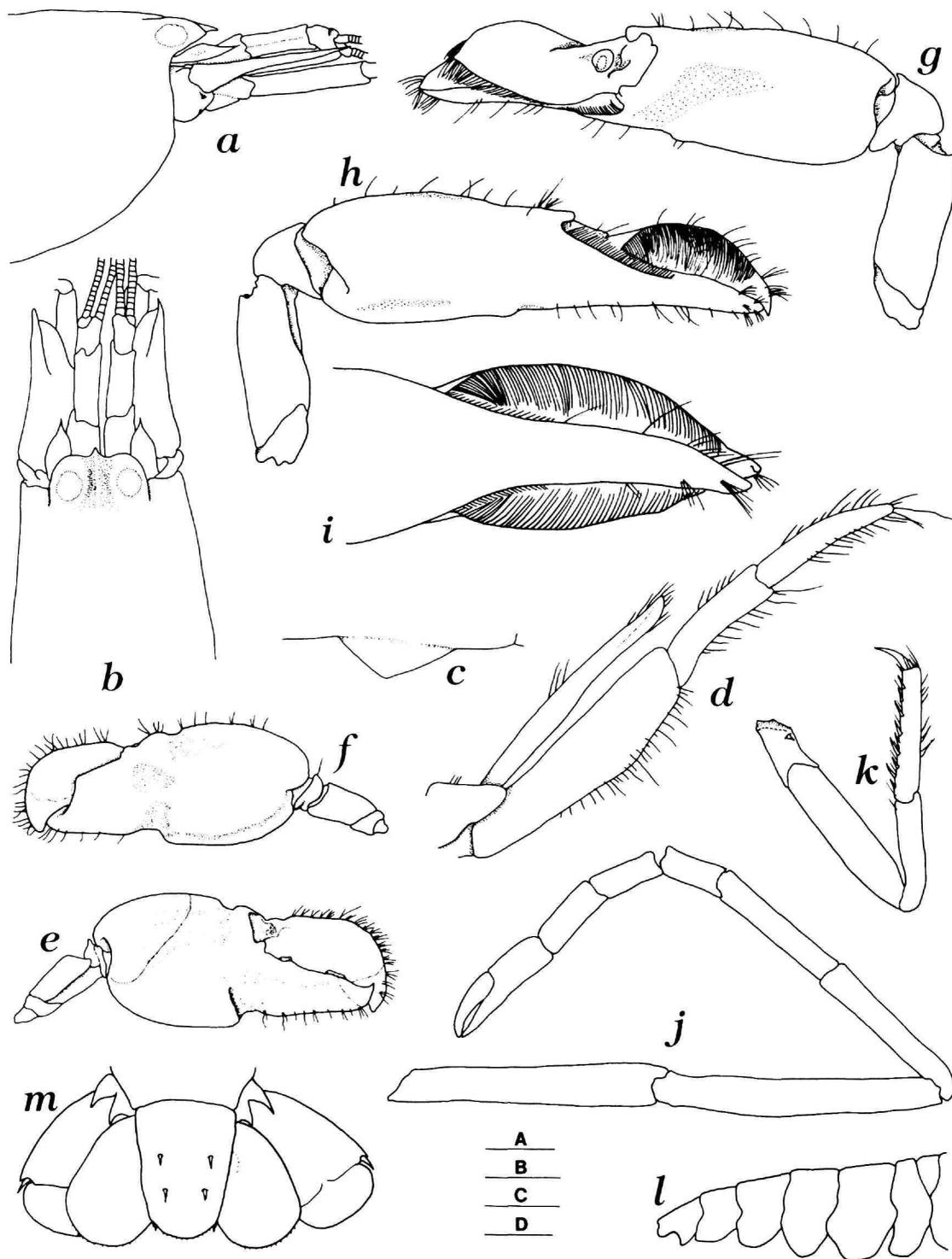


FIGURE 39.—*Alpheus firmus*, new species, holotype male, cl 9.2 mm, from sta 130-2-b: a, anterior region, lateral view; b, same, dorsal view; c, carina below right first antennular segment; d, right third maxilliped; e, major first pereopod, outer face; f, same, inner face; g, minor first pereopod, outer face; h, same, inner face; i, same, fingers, ventral view; j, left second pereopod; k, left third pereopod; l, abdomen; m, telson and uropods. (Scale A = 4 mm: e-h, l; scale B = 2 mm: a, b, d, j, k, m; scale C = 1 mm: i; scale D = 0.5 mm: c.)

broad. Exopod reaching to proximal  $\frac{1}{3}$  of penultimate segment. Precoxa with one arthrobranch near distal end and also with small supplementary arthrobranch near proximal end.

Major first pereopod (Figure 39*e,f*) reaching to distal end of carpoperite beyond proximal part of chela. Major chela about 2.4 times as long as broad with fingers occupying slightly less than distal 0.4. Movable finger rather heavy, regularly convex in profile, with tip ending in acute triangular shape. Immobile finger ending in acute tooth, directing upward. Palm with superior and inferior transverse grooves. Superior transverse groove deep and broad with rounded edges; proximal shoulder not overhanging groove. Superior outer palmar depression elongated quadrangular, extending to oblique suture. Superior inner palmar depression elongated triangular, reaching to proximal  $\frac{1}{3}$  of palm. Inferior transverse groove deep, with proximal shoulder rounded, not produced anteriorly. Inferior outer palmar depression narrow and deep, obliquely inverse V-shaped, well delimited posteriorly. Inferior inner palmar depression broad, inverse U-shaped, not clearly delimited anteriorly and continuing to shallow, longitudinal depression near bottom of palm. Inner palmar face with round depression between superior and inferior depressions and outer palmar face with longitudinal depression between superior and inferior palmar depressions, leading to middle of immovable finger. Merus slightly less than two times as long as broad; inferior inner margin smooth and with no spine at distal end.

Minor chela of first pereopods (Figure 39*g-i*) slightly more than 3.5 times as long as broad in male, with fingers occupying less than  $\frac{1}{2}$  length of chela. Palm with slight inferior transverse notch, with short longitudinal depression near superior margin and with oblique, broad depression on median part of outer face and shallow, longitudinal depression near bottom of palm on inner face; tooth flanking dactylar articulation on inner face very blunt. Movable finger not balaeniceps in female but very well-developed balaeniceps in male; superior surface broadened bilaterally, more than 2 times as long as broad. Immobile finger bearing fringes of setae on crests on both lateral faces. Merus more than 2 times as long as broad; inferior inner margin smooth and with no spine at distal end.

Second pereopod (Figure 39*j*) overreaching distal end of carpoperite beyond middle of first carpal segment. Fingers of chela almost as long as palm. First segment of carpus longest, being slightly less than 1.4 times as long as second; second segment almost 2.2 times as long as third; third segment subequal to fourth; fifth segment almost 1.3 times as long as fourth.

Dactylus of third pereopod (Figure 39*k*) simple, about 0.3 times as long as propodus, slightly hooked. Propodus about 1.4 times as long as carpus, with 8 to 10 movable spines on inferior margin and pair at distal end; distalmost spine reaching to distal  $\frac{1}{2}$  of dactylus. Merus broad, about 4.8 times as long as broad and 1.9 times as long as carpus. Ischium with small movable spine.

Fourth pereopod almost same as third pereopod. Ischium with movable spine.

Fifth pereopod much narrower than third pereopod. Ischium without movable spine.

Pleura (Figure 39*l*) of first four abdominal somites broadly rounded in female, narrowly rounded in male; pleuron of fifth somite subrectangular on posterior ventral margin. Abdominal sternite with no spine at midline. Appendix masculina almost reaching to distal end of appendix interna.

Telson (Figure 39*m*) about 1.4 times as long as broad at anterior end, armed with two pairs of rather stout dorsal spines and with no longitudinal median depression on dorsal surface. Posterior margin regularly convex, bearing several inconspicuous seta-like spines on middle part and armed with pair of small spines at each lateral end; inner spine almost two times as long as outer one.

Uropodal endopod with inconspicuous seta-like spines on distal margin and with inner depression at anterior half fairly distinct. Uropodal exopod with transverse suture forming two slightly convex lobes; lateral margin terminating in immovable tooth; rather slender movable spine inside of immovable tooth, not reaching to distal margin of uropodal exopod.

VARIATIONS.—Variation exists in the basicerite of this species. In some specimens the basicerite has one lateral spine below the base of the scaphocerite and in some specimens the basicerite has no lateral spine. Those specimens with one lateral spine on each basicerite also have a relatively shorter penultimate segment of the third maxilliped than specimens without a lateral spine on the basicerite. The ratio of the ultimate versus penultimate segment of the third maxilliped of specimens with a lateral spine ranges from 1.3 to 1.6, while the ratio is 1.2 in specimens without a lateral spine.

HABITAT.—0 to 1.0 m; under rocks.

DISTRIBUTION.—Panama.

REMARKS.—The present species is most closely related to *A. heterochaelis* in the shape of the ocular hoods and rostrum, and seems to be similar to *A. pontederiae*, *A. strenuus*, and *A. pacificus* in the sculpture of the major chela. However the present species can be easily distinguished from those related species by the ratio of segments of the third maxilliped. The present species has the relatively long penultimate segment of the third maxilliped (the ratio of the ultimate versus penultimate segment, 1.2 to 1.6).

ETYMOLOGY.—The balaeniceps of the minor chela in this species is so distinctive and massive that the minor chela appears strong. The Latin *firmus* (strong) refers to this feature.

### 38. *Alpheus distinctus*, new species

FIGURE 40

MATERIAL EXAMINED.—Holotype: Male, cl 11.5 mm; Punta Paitilla, Panama, LGA 68-27, 7 Dec 1978.

Paratype: 1 ♂, cl 10.3 mm (LGA 68-27).

Panama City (LGA 69-29: 1 ♂, cl 10.5 mm).

MEASUREMENTS.—Males, cl 10.3–11.5 mm.

DESCRIPTION.—Rostrum (Figure 40*a,b*) slender, slightly overreaching middle of visible part of first antennular segment.

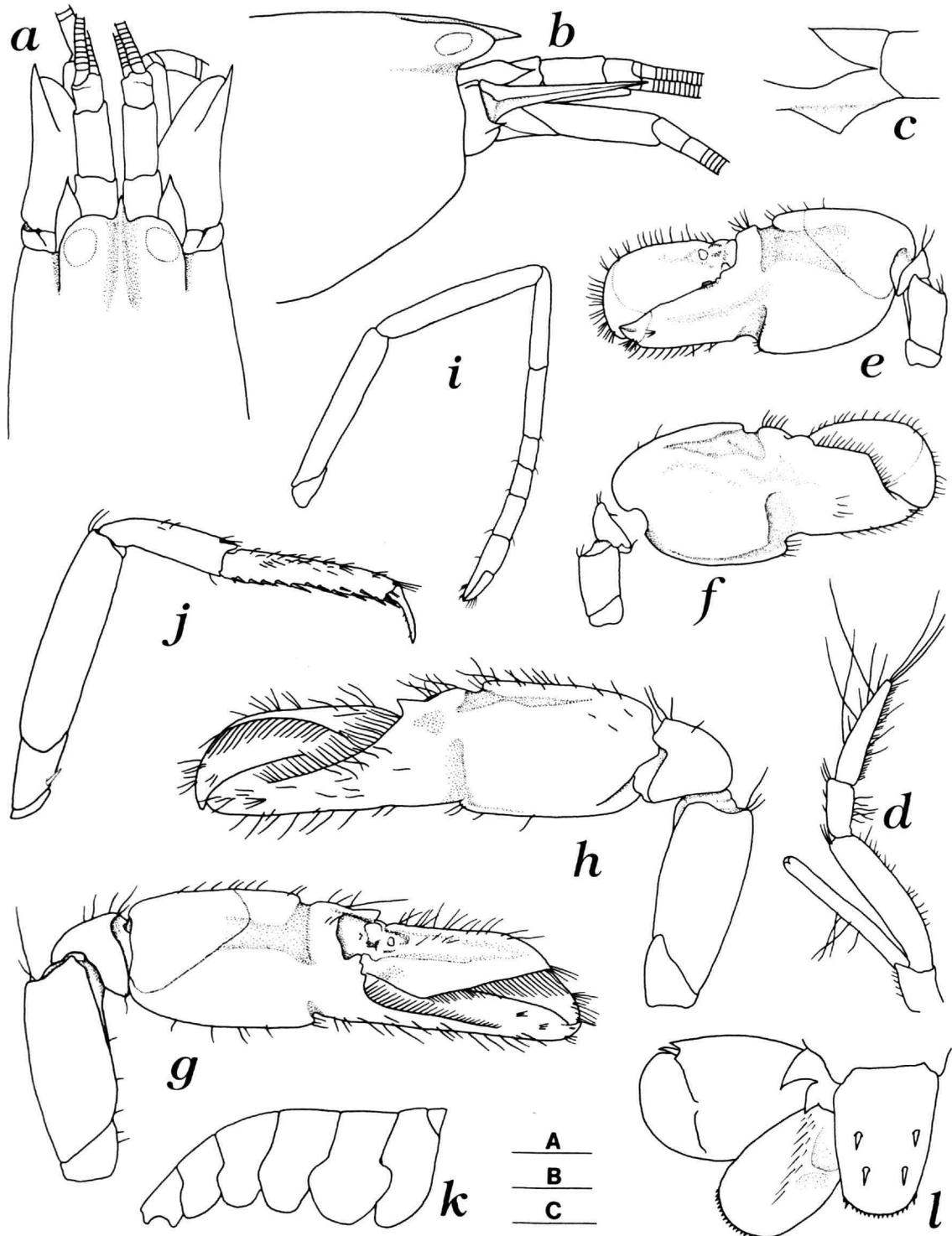


FIGURE 40.—*Alpheus distinctus*, new species, holotype male, cl 11.5 mm, from sta LGA 68-27: *a*, anterior region, dorsal view; *b*, same, lateral view; *c*, carina below right first antennular segment; *d*, right third maxilliped; *e*, major first pereopod, outer face; *f*, same, inner face; *g*, minor first pereopod, outer face; *h*, same, inner face; *i*, right second pereopod; *j*, right third pereopod; *k*, abdomen; *l*, telson and uropods. (Scale A = 4 mm; *e*, *f*, *k*; scale B = 2 mm; *a*, *b*, *d*, *g*-*j*; scale C = 1 mm; *c*.)

Rostrum extending posterior to eye as narrowly raised carina, slightly widened behind eye.

Ocular hood inflated dorsally at same level of middle part of rostral carina; anterior margin rounded, narrowly concave near base of rostrum. Orbitorostral groove moderately deep and extending posterior to eyes, not clearly delimited posteriorly.

First antennular segment bearing broadly triangular carina extending from ventral inner margin, acute at ventral part (Figure 40c). Second segment about 2 times as long as broad, 1.6 times as long as visible part of first segment and 1.9 times as long as third segment. Stylocerite broad proximally, narrowing to sharp point at tip, reaching to distal margin of first segment.

Scaphocerite about 2.5 times as long as broad. Lateral margin slightly concave at middle. Distal spine passing to distal end of carapocerite. Inner blade regularly narrowing distally, reaching to distal end of antennular peduncle. Cleft between inner blade and distal spine rather deep, arising from distal 0.4 of scaphocerite.

Carapocerite overreaching distal end of antennular peduncle by less than half length of third antennular segment. Basicerite bearing small, slender lateral spine.

Ultimate segment of third maxilliped (Figure 40d) tapering distally, 2 times as long as penultimate segment and about 2 times as long as broad. Exopod reaching to proximal  $\frac{1}{3}$  of penultimate. Precoxa with one arthrobranch near distal end and also with small supplementary arthrobranch near proximal end.

Major chela of first pereopods (Figure 40e,f) about 2.3 times as long as broad. Fingers narrower than palm, occupying distal 0.4 of chela. Movable finger regularly arched along superior distal margin, tip bluntly rounded. Immovable finger with inferior margin almost straight at middle part and bearing narrow, longitudinal median depression in outer face. Palm rather broad, about 1.3 times as long as broad. Superior transverse groove moderately deep, proximal shoulder not overhanging groove. Superior outer palmar depression elongated rectangular, distal region more depressed. Superior inner palmar depression elongated triangular. Inferior transverse groove rather broad and shallow, proximal shoulder slightly produced and bearing small granules along margin. Inferior outer palmar depression narrow; posterior margin well delimited and anterior margin less distinct. Inferior inner palmar depression broadly inverse U-shaped; posterior margin well delimited, bearing small granules and inferiorly connecting to narrow longitudinal depression near bottom of palm; anterior margin not well delimited. Inner palmar face with depressed region between superior and inferior palmar depressions. Merus 1.6 times as long as broad; inferior inner margin smooth, with no spine at distal end.

Minor chela of first pereopods (Figure 40g,h) robust, about 3.3 times as long as broad. Fingers slightly narrower than palm, occupying 0.55 length of chela. Movable finger balaniceps in male. Immovable finger bearing dense setae on crests on

both lateral faces and with inferior margin almost straight. Palmar sculpturing same as that of major chela, but less distinct. Merus about 2.4 times as long as broad; inferior inner margin smooth and with no spine at distal end.

Fingers of chela of second pereopod (Figure 40i) almost as long as palm. First segment of carpus 1.4 times as long as second; second segment about 2.3 times as long as third; third segment almost subequal to fourth; fifth segment about 1.4 times as long as fourth.

Dactylus of third pereopod (Figure 40j) simple, conical, about 0.3 times as long as propodus. Propodus about 1.5 times as long as carpus, bearing 10 to 12 movable spines on inferior margin and pair at distal end. Merus about 4.3 times as long as broad and 1.9 times as long as carpus. Ischium with movable spine (in holotype male, without spine on ischium of right pereopod).

Fourth pereopod almost same as third pereopod. Ischium with movable spine.

Fifth pereopod much narrower than third pereopod. Ischium with no movable spine.

Pleura (Figure 40k) of abdominal somites not much overlapping on ventral regions in male; pleuron of fifth somite subtriangular on posterior ventral margin. Abdominal sternite with no spine at midline. Appendix masculina almost reaching to distal end of appendix interna.

Telson (Figure 40l) about 1.4 times as long as broad at anterior end, armed with pair of rather stout dorsal spines and with no longitudinal median depression on dorsal surface. Lateral margin almost straight. Posterior margin regularly convex, bearing series of seta-like spines and armed with pair of rather weak spines at each lateral end.

Uropodal endopod bearing series of seta-like spines on distal margin and with inner depression at anterior half distinct. Uropodal exopod with transverse suture forming two almost straight lobes; lateral margin ending in acute immovable tooth flanking small movable spines; spine flanked internally by shallow, subtriangular tooth.

VARIATIONS.—The ischium of the right third pereopod in holotype male has no spine. Male specimen from sta 69-29 has a longer rostrum, which almost reaches to distal  $\frac{1}{3}$  of visible part of the first antennular segment.

HABITAT.—Low tide, rock, and mud; sewer plant, slime mud rock.

DISTRIBUTION.—Panama.

REMARKS.—The present species is closely related to *Alpheus firmus* in several characters, but can be distinguished from *A. firmus* by the following points: rostrum longer than that of *A. firmus*; spine on basicerite always present and longer than that of *A. firmus*, if present; minor chela with more distinct sculpturing than that of *A. firmus*.

ETYMOLOGY.—The clear sculpturing of the minor chela in this species is almost the same as that of the major chela; this feature is not common among the *edwardsii* group. The specific name is from the Latin *distinctus* (distinction).

### 39. *Alpheus martini*, new species

FIGURE 41

MATERIAL EXAMINED.—Holotype: Male, cl 11.9 mm; Venado Beach, Panama (sta 111-4).

Panama: Whorehouse Reef (sta 133-5-b: 2 ♂, 1 ovig); Farfan Point (sta 113-1: 1 ♂, 1 ovig, sta 113-2: 1 ♂, sta 113-5-b: 1 ♂, sta 56: 1 ♀, sta 56-6: 1 ♂, 1 ovig); Fort Kobbe Beach (sta 108-7: 3 ovig); Aguadluce (sta 20-6: 1 ♂, 1 ♀, 1 ovig); Old French Fort Reef (sta 58: 1 ovig, sta 58-4: 1 ♀); northeast end of causeway to Naos Island (sta 1531: 2 ♂, 1 ovig); Punta Paitilla (LGA 68-27: 2 ovig); Kobbe Beach (LGA 69-49: 2 ♂, 1 ♀, 1 ovig).

MEASUREMENTS.—Males, cl 6.4–14.5 mm; females, cl 4.3–10.0 mm; ovigerous females, cl 6.6–15.0 mm.

DESCRIPTION.—Rostrum (Figure 41*a,b*) narrowly triangular, not reaching to middle of visible part of first antennular segment, marked dorsally by narrow carina to anterior end of eye and slightly constricted here, then spreading flat, elongated triangular carina far behind posterior end of eye; lateral margins of triangular rostral carina overhanging orbitorostral grooves.

Ocular hood slightly inflated dorsally above level of middle part of rostral carina. Orbitorostral groove deep, broad, terminating in sharp triangular shape near posterior end of rostral carina. Anterior margin of ocular hood convex and then concave near base of rostrum.

First antennular segment with broadly shallow carina extending from ventral inner margin; ventral part spined, directing forward (Figure 41*c*). Second segment rather elongate, about 2.7 times as long as broad and 1.4 times as long as visible part of first segment and 2.3 times as long as third segment. Stylocerite broad proximally, abruptly narrowing to sharp point, clearly not reaching to distal margin of first segment.

Scaphocerite about 3 times as long as broad. Lateral margin slightly concave at middle. Distal spine quite well overreaching distal margin of inner blade, slightly overreaching distal end of antennular peduncle. Inner blade narrowly rounded distally. Cleft between inner blade and distal spine arising from distal 0.4 of scaphocerite.

Carpocerite overreaching distal end of antennular peduncle by half length of third antennular segment. Basicerite with sharp, slender lateral spine.

Third maxilliped (Figure 41*a*) overreaching distal end of carpocerite beyond distal  $\frac{1}{3}$  of ultimate segment. Ultimate segment about 2.4 times as long as penultimate segment, truncate distally, with very long, stiff setae on distal margin; tufts of setae on inner surface short and dense. Penultimate segment rather short, broad, about 1.3 times as long as broad near distal end. Exopod slightly overreaching distal end of antepenultimate segment. Precoxa with one arthrobranch near distal end and also with small supplementary arthrobranch near proximal end.

Major first pereopod (Figure 41*d,e*) overreaching distal end of carpocerite beyond proximal  $\frac{1}{10}$  of chela. Major chela

slightly compressed laterally, about 2.3 times as long as broad. Fingers narrower than palm, occupying slightly less than distal  $\frac{2}{5}$  of chela. Movable finger rounded along superior distal margin; tip blunt, slightly overreaching tip of immovable finger. Immovable finger with shallow, longitudinal median groove on outer face and with inferior margin almost straight. Palm rather broad, with fairly dense, short setae on inner face. Superior transverse groove rather narrow, moderately deep with proximal shoulder overhanging groove. Superior outer palmar depression well defined, elongated quadrangular, extending to oblique suture; inferior distal part slightly extending downward. Superior inner palmar depression elongated triangular, reaching to proximal  $\frac{1}{3}$  of palm. Inferior transverse groove deep, obliquely directing proximally; proximal shoulder produced forward. Inferior outer palmar depression very narrow, oblique inverse V-shaped, continuing upward to  $\frac{1}{3}$  width of palm, well delimited posteriorly and fairly delimited anteriorly. Inferior inner palmar depression broad, inverse U-shaped, well defined posteriorly and fairly defined superiorly and anteriorly, and continuing to shallow longitudinal depression near bottom of palm. Palm with round small depression below superior inner depression on inner face. Merus about 1.7 times as long as broad; inferior inner margin smooth and with no spine at distal end.

Minor chela of first pereopods (Figure 41*f,g*) about 3.1 times as long as broad with dense setae on inner face. Fingers slightly narrower than palm, occupying distal 0.6 of chela. Palm with shallow transverse notch on inferior margin below level of dactylar articulation. Inner palmar face with prominent triangular tooth above dactylar articulation. Movable finger not balaeniceps in both sexes. Merus about 2 times as long as broad; inferior inner margin with no spine.

Second pereopod (Figure 41*h*) reaching distal end of carpocerite beyond proximal end of second carpal segment. Fingers of chela slightly longer than palm. First segment of carpus about as long as second; second segment about 2.5 times as long as third; third segment slightly longer than fourth; fifth segment about 1.5 times as long as fourth.

Dactylus of third pereopod (Figure 41*i*) simple, slightly deflexed downward, slightly less than  $\frac{2}{5}$  length of propodus. Propodus  $\frac{1}{3}$  times longer than carpus with 10 strong spines and 6 irregular adjacent spines on inferior margin and pair at distal end. Merus 1.7 times as long as carpus and 4.4 times as long as broad. Ischium with movable spine.

Fourth pereopod almost same as third pereopod. Ischium with movable spine.

Ischium of fifth pereopod with no movable spine.

Pleura (Figure 41*j*) of abdominal somites broadly rounded; pleuron of fifth somite subtriangular on posterior ventral margin. Abdominal sternite with no spine at midline. Appendix masculina falling slightly short of distal end of appendix interna.

Telson (Figure 41*k*) rather broad, about 1.5 times as long as broad at anterior end, armed with two pairs of rather stout dorsal spines and with no median longitudinal depression on

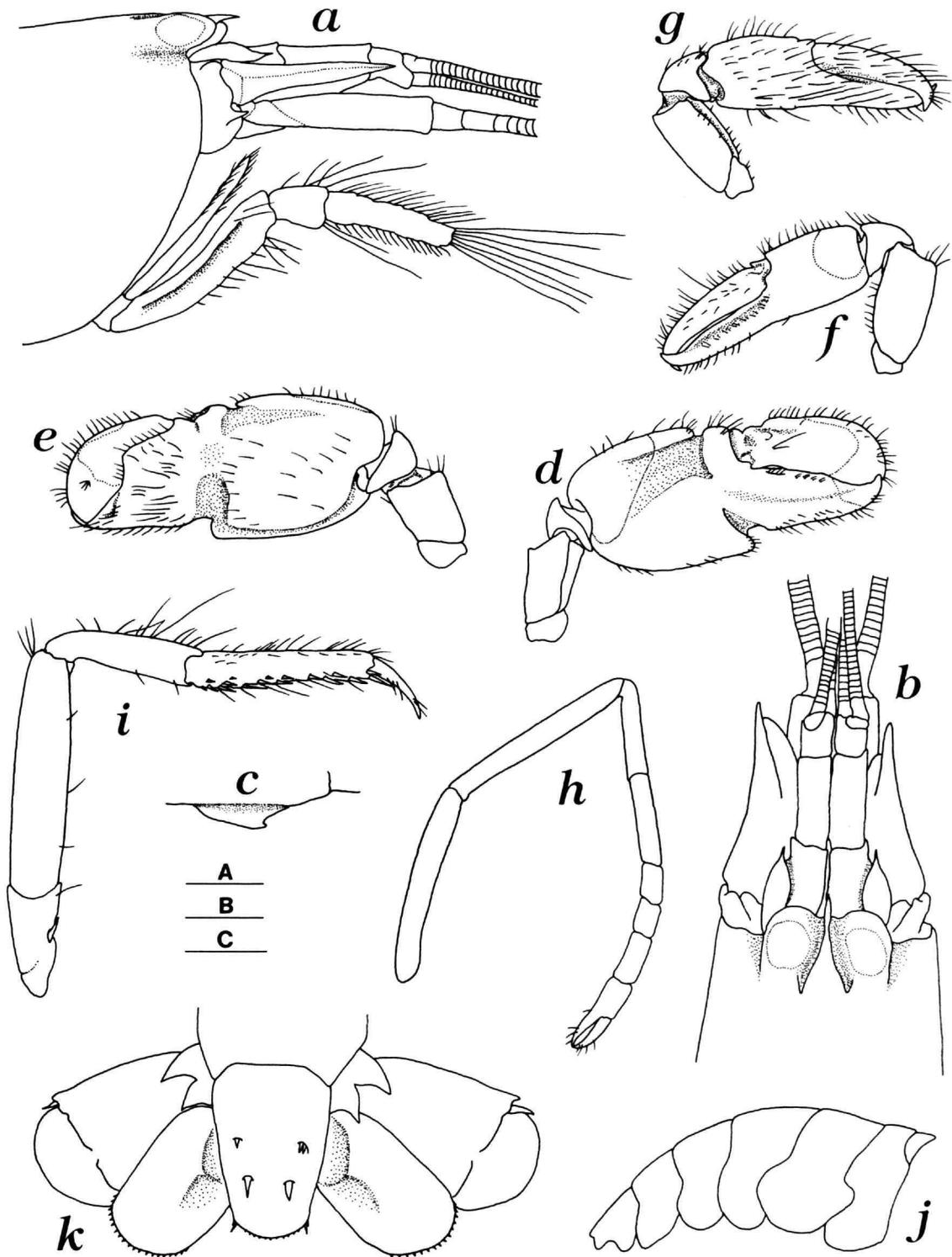


FIGURE 41.—*Alpheus martini*, new species, holotype male, cl 11.9 mm, from sta 111-4: *a*, anterior region, lateral view; *b*, same, dorsal view; *c*, carina below first antennular segment; *d*, major first pereopod, outer face; *e*, same, inner face; *f*, minor first pereopod, outer face; *g*, same, inner face; *h*, right second pereopod; *i*, right third pereopod; *j*, abdomen; *k*, telson and uropods. (Scale A = 4 mm: *d-g, j*; scale B = 2 mm: *a, b, h, i, k*; scale C = 1 mm: *c*.)

dorsal surface. Lateral margin almost straight. Posterior margin regularly rounded, bearing inconspicuous seta-like spines and armed with pair of spines at each lateral end, inner spine 2 times as long as outer one.

Uropodal endopod bearing inconspicuous seta-like spines on distal margin and with inner depression at anterior half fairly distinct. Uropodal exopod with transverse suture forming two straight lobes; lateral margin terminating in acute immovable tooth flanking rather slender movable spine; spine not reaching to distal margin of uropodal exopod; immovable tooth inside of movable spine blunt at tip.

HABITAT.—Shore to 1 m; among sand, sandy mud, mud, silt, and rock.

DISTRIBUTION.—Panama.

REMARKS.—The present species is very close to *A. armillatus*. The rostrum of the present species is similar to that of *A. armillatus*, but the dorsal flattened part of the rostrum is more elongate anteriorly in the present species. Also, there is no spine on the distal end of the inferior inner margin of merus of the first pereopod. The fingers of minor chela of the first pereopod are far longer than the palm, about 1.5 times as long as the palm. In *A. armillatus*, there is a spine on the distal end of the inferior inner margin of the merus of the first pereopod. The fingers of the minor chela are almost as long as the palm.

ETYMOLOGY.—The specific name *martini* is for Joel W. Martin of the Department of Biological Science, Florida State University, who has, in many ways, helped us in doing this project.

#### 40. *Alpheus pacificus* Dana, 1852

FIGURE 42

*Alpheus pacificus* Dana, 1852:544; 1855: pl. 34: fig. 5.—Coutière, 1899:16, fig. 290; 1905:909, pl. 85: fig. 47, 47a, 47b, b', pl. 86: fig. 47c, c'.—Chace, 1962:610.—Tiwari, 1963:315, fig. 30.—A. Banner and D. Banner, 1966:143, fig. 54.—Gillett and Yaldwyn, 1969:70, 110, fig. 41.—Luke, 1977:4.—D. Banner and A. Banner, 1981:37; 1982:217, fig. 68.—A. Banner and D. Banner, 1984:42.

*Alpheus gracilidigitus* Miers, 1884:287.—Nobili, 1899:233.

*Crangon pacifica*.—Banner, 1953:138, fig. 50 [neotype established].

*Crangon pacificus*.—Schmitt, 1939:12.

MATERIAL EXAMINED.—Mexico: Braithwaite Bay, Socorro Island (sta 130-34: 1 ovig).

Costa Rica: Isla del Coco, Wafer Bay (sta 105-33: 1 ♂, 1 ovig).

Galapagos Islands: Gardner Bay, Hood Island (sta 27-33: 1 ♂, 1 ovig).

MEASUREMENTS.—Males, cl 5.1–12.3 mm; ovigerous females, cl 8.0–14.0 mm.

DESCRIPTION.—Rostrum (Figure 42a,b) elongate, slightly overreaching middle of visible part of first antennular segment and bearing few short setae on lateral margins proximally. Rostral carina rounded dorsally, extending backwards beyond posterior end of ocular hood.

Ocular hood slightly inflated dorsally above level of rostral

carina and produced anteriorly to middle of rostrum. Orbito-oral groove moderately deep and reaching far posterior to eye. Anterior margin of ocular hood rounded, very concave near base of rostrum.

First antennular segment bearing very shallow, broadly V-shaped carina extending from ventral inner margin (Figure 42c). Second segment about 2.3 times as long as broad, 1.7 times as long as visible part of first segment and 1.6 times as long as third segment. Stylocerite broad proximally, abruptly narrowing to sharp point, almost reaching to distal margin of first segment.

Scaphocerite about 2.6 times as long as broad with lateral margin slightly concave at proximal  $\frac{1}{3}$ . Distal spine at least reaching to distal end of antennular peduncle and falling short of distal end of carapocerite. Inner blade regularly narrowing distally, far shorter than adjacent distal spine. Cleft between inner blade and distal spine deep, arising from slightly more than distal 0.4 of scaphocerite.

Carapocerite overreaching distal end of antennular peduncle by length of third antennular segment. Basicerite bearing sharp, triangular lateral spine; spine broad at base, almost reaching to tip of stylocerite.

Third maxilliped (Figure 42d) slightly overreaching distal end of carapocerite. Ultimate segment about 5.2 times as long as broad at proximal end and 1.7 times as long as penultimate; distal margin truncate, not much narrower than proximal end and bearing long setae on superior and inferior margins as well as on distal margin; tufts of setae on inner surface dense. Penultimate segment about 2.5 times as long as broad, with dense long setae on superior and inferior margins, especially distally. Antepenultimate segment with sparse setae on inferior margin and few long setae on superior distal margin. Exopod slightly overreaching distal end of antepenultimate segment. Precoxa with one arthrobranch near distal end and also with small supplementary arthrobranch near proximal end.

Major first pereopod (Figure 42e–g) overreaching distal end of carapocerite by length of chela. Major chela about 2.3 times as long as broad with fingers occupying distal  $\frac{1}{3}$ . Movable finger regularly arched in profile, compressed laterally and acutely rounded at tip. Immobile finger with tip directed upward; superior margin just before tip very concave; outer face with very slight longitudinal median depression leading posteriorly below anterior part of superior outer palmar depression. Palm with superior transverse groove very deep with proximal shoulder well overhanging groove. Superior outer palmar depression well defined, quadrangular, extending to oblique suture. Superior inner palmar depression elongated triangular in shape, reaching proximally just past middle of palm, and directing toward superior margin. Inferior transverse groove very deep, slightly slanting posteriorly; proximal shoulder heavy, rounded, slanted distally and bearing small granules. Inferior outer palmar depression very narrow, obliquely inverse V-shaped. Inferior inner palmar depression very broad and not well defined superiorly and anteriorly. Inner face of palm with shallow longitudinal depression near bottom

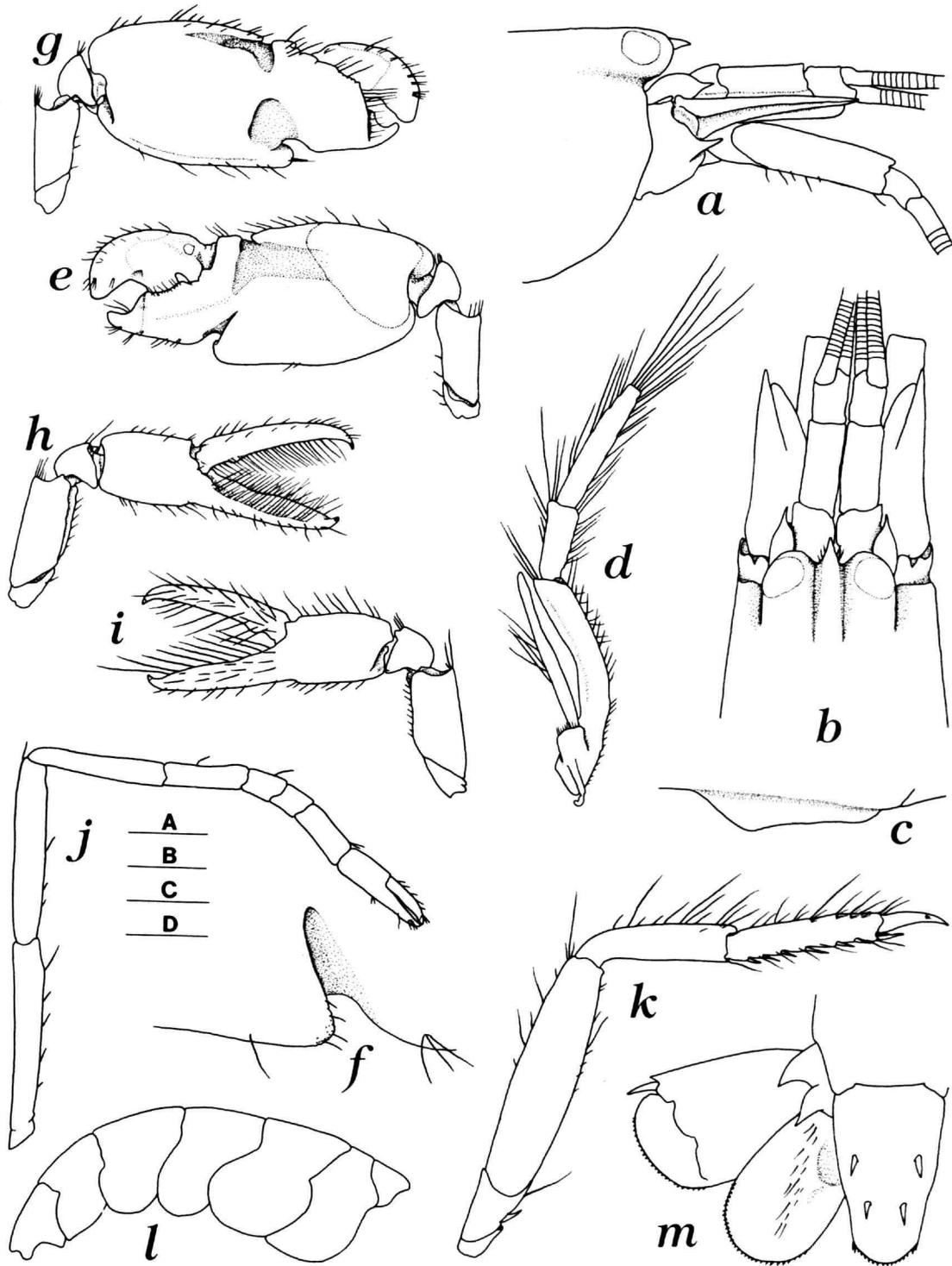


FIGURE 42.—*Alpheus pacificus*, male, cl 12.3 mm, from sta 27-33: a, anterior region, lateral view; b, same, dorsal view; c, carina below right first antennular segment; d, right third maxilliped; e, major first pereopod, outer face; f, same, shoulder proximal to inferior transverse groove (ovigerous female, cl 10.1 mm, from sta 130-34); g, same, inner face; h, minor first pereopod, outer face; i, same, inner face; j, right second pereopod; k, right third pereopod; l, abdomen; m, telson and uropods. (Scale A = 4 mm: e, g-i, l; scale B = 2 mm: a, b, d, j, k, m; scale C = 1 mm: f; scale D = 0.5 mm: c.)

of palm. Merus about 1.8 times as long as broad with inferior inner margin bearing very short setae and no spine at distal end.

Minor chela of first pereopods (Figure 42*h,i*) about 3.5 times as long as broad, fingers occupying slightly more than distal 0.6. Inferior margin of palm with broad transverse notch below level of dactylar articulation. Inner face of palm with very blunt tooth flanking dactylar articulation. Both fingers slender and with acute tips. Movable finger not balaeniceps, bearing on lateral cutting edge dense series of long, forward-sweeping setae; setae crossing similar series of setae on immovable finger. Cutting surface of movable finger with two thin crests near articulation, longer crest placed in proximal 1/4 of cutting surface and fitting into shallow groove in immovable finger when fingers closed; smaller crest not touching superior margin of immovable finger when fingers closed; fingers with tips overlapping, but gaping between tips and crests on movable finger when closed. Minor chela of female smaller, 3.7 times as long as broad with fingers occupying distal 0.6 and bearing only scattered setae instead of rows of long hairs. Merus about 2.5 times as long as broad with very short setae on inferior inner margin and without spine at distal end.

Second pereopod (Figure 42*j*) overreaching distal end of carapocerite by 1/2 of first carpal segment. Fingers of chela almost as long as palm. First segment of carpus about 1.6 times as long as second; second segment 2.6 times as long as third; third segment subequal to fourth; fifth segment shorter than second and 1.8 times as long as fourth.

Dactylus of third pereopod (Figure 42*k*) simple, about 0.4 times as long as propodus. Propodus almost as long as carpus, with 7 movable spines and pair at distal end. Merus about 4.5 times as long as broad, 1.5 times as long as carpus, bearing few stiff setae on inferior margin. Ischium with movable spine.

Fourth pereopod almost same as third pereopod. Ischium with movable spine.

Ischium of fifth pereopod with no movable spine.

Pleura (Figure 42*l*) of first four abdominal somites broadly rounded in both sexes, but pleuron of fifth somite more triangular on posterior ventral margin. Abdominal sternites bearing spine at midline of each sternite of first three somites. Appendix masculina almost as long as appendix interna.

Telson (Figure 42*m*) about 1.6 times as long as broad at anterior end, armed with two pairs of rather stout dorsal spines and with no longitudinal median depression on dorsal surface. Posterior margin rounded, bearing seta-like spines and armed with pair of spines at each lateral end; inner spine almost as long and wide as outer one.

Uropodal endopod with seta-like spines on distal margin and with inner depression at anterior half fairly distinct. Uropodal exopod with seta-like spines on distal margin and bearing rather slender movable spine flanked laterally by acute immovable tooth and internally by blunt lobe; movable spine not overreaching distal margin of uropodal exopod; transverse suture forming two convex lobes, inner one slightly flattened.

HABITAT.—Largely intertidal, living under rocks. From dead coral in water up to 20 meters (D. Banner and A. Banner,

1982:220). Shore; rock shingle, and rock spit.

COLOR.—Tip of major chela brown, rest of fingers and palm banded with irregular white, olive-green, and blue-green. Fingers of small chela light green, distal three-fourths of palm white and olive-green at base. Carpus and dactylus blue. Thoracic pereopods blue with white band at meral-carpal joint. Antennae blue, antennules olive-green. Scaphocerite and carapocerite blue. Carapace and abdomen reddish brown with faint brown line extending from middle of carapace to sixth abdominal somite. On the lateral margins where each abdominal somite meets the next is a diffuse white spot. Telson same color as abdomen, uropods light green (D. Banner and A. Banner, 1982:220).

TYPE-LOCALITY.—Hawaii.

DISTRIBUTION.—Throughout the Indo-Pacific area; Australia; Red Sea and Madagascar; Mombasa, Kenya; eastern Pacific from Gulf of California, Costa Rica, Clipperton Island, and Galapagos Islands.

#### 41. *Alpheus galapagensis* Sivertsen, 1933, new rank

FIGURE 43

*Alpheus strenuus* var. *galapagensis* Sivertsen, 1933:3, pl. 1: figs. 1–5.—D. Banner and A. Banner, 1982:228.

DESCRIPTION.—The following is the description by Sivertsen (1933:3), with some modification of terms. Figure 43 here was reproduced from the figures in Sivertsen, 1933.

3 specimens of this new variety are at hand, one male and two ovig. females, the latter partly defective by lacking the chelipeds. As to the majority of characters, size, proportions and grooves between ocular hoods, antennules and antennae, this variety agrees very well with the typical *A. strenuus* Dana. It differs, however, in the following characters: rostrum [Figure 43*a*] shorter, extending forwards only to half of first antennular segment; spine of antennal scale [scaphocerite] reaching to end of last segment of antennular peduncle, tip of blade only to half of third segment; in major chela [Figure 43*b*], fingers less high in relation to height of palm, and groove on upper inner surface of palm less distinctly triangular; in second pair of pereopods [Figure 43*d*], first segment of carpus one third longer than second and fifth segment slightly longer than first and second combined. By these last characters this new variety may be distinctly separated both from the typical *A. strenuus* Dana and the nearly related *A. crassimanus* Heller. Male, total length 42 mm, cl 14 mm, length of large hand 21 mm, small hand, 14 mm; female, total length 30.5 mm, cl 10.5 mm.

TYPE-LOCALITY.—Floreana, Post Office Bay, Galapagos Islands.

DISTRIBUTION.—Only from the type-locality.

REMARKS.—Sivertsen (1933) reported *Alpheus strenuus* var. *galapagensis* from the Galapagos Islands and noted that this variety agrees very well with the typical *A. strenuus* Dana. He noted several different characters between the two species. In the discussion of *A. strenuus* subspecies, D. Banner and A. Banner (1982:228) suggested that *A. strenuus* var. *galapagensis* may be a separate species inasmuch as Sivertsen depicted the small chela of the male with a simple conical

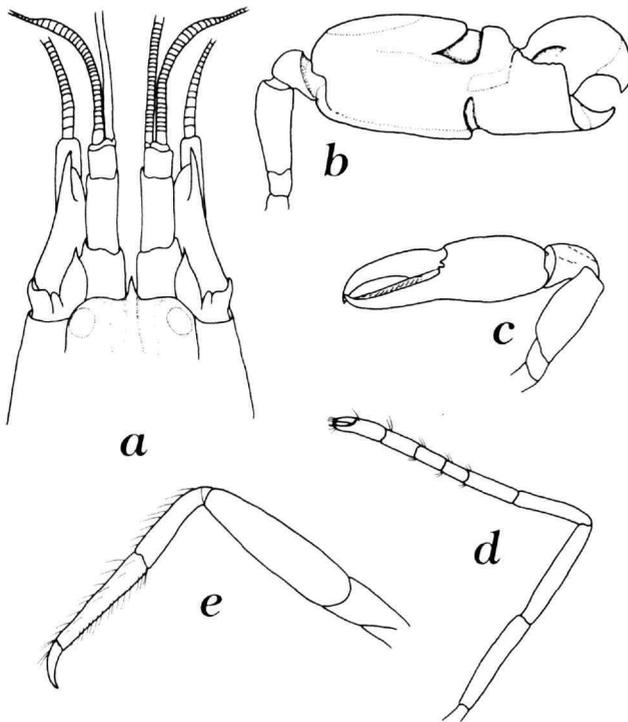


FIGURE 43.—*Alpheus galapagensis*, new rank: a, anterior region, dorsal view; b, major first pereopod, inner face; c, minor first pereopod, outer face; d, second pereopod; e, third pereopod. [After Sivertsen, 1933; note that Sivertsen did not draw a spine on the distal end of the inferior inner margin of the merus of the major first pereopod. This may be an error as there is a spine present in other members of the "strenuus" complex. The present report considers a spine to be present.]

immovable finger. In the present study, *A. strenuus* var. *galapagensis* is treated as *A. galapagensis*, a specific rank until more information is available.

#### 42. *Alpheus spinicaudus* Lockington, 1878

*Alpheus spinicaudus* Lockington, 1878:476.—Coutière, 1899:29.

DESCRIPTION.—The following is the description by Lockington (1878:476) with some modification of terms.

Rostrum very short, continued backwards between eye-shields as low carina; no ocular spines. Spine [stylocerite] at base of antennules nearly as long as basal segment of peduncle; second segment of peduncle one half longer than third; third segment about equal to first; outer branch of flagellum, including its slender terminal portion, nearly equal to inner; inner branch about equal to carapace.

Spine of antennal scale [scaphocerite] longer than laminar portion or than peduncle of antennule, and equal to antennal peduncle [carpocerite]; flagellum twice length of carapace.

Third maxilliped longer than peduncle of antenna [carpocerite]; terminal segment margined with setae, those at tip very long.

Meri of first pair of pereopods spineless, that of smaller hand concave on outer surface.

Chelae of first pair of pereopods unequal, dissimilar. Major chela compressed laterally, smooth, constricted above and below; at about distal third

of its length sulcus, broad at commencement, but rapidly narrowing, running backwards longitudinally at right angles to upper constriction on both outer and inner faces. Movable finger short, working obliquely, with stout basal tooth, closing in deep groove in immovable finger; blunt tip of movable finger crossing sharp extremity of immovable finger. Minor chela rounded, smooth; movable finger half length of palm, working vertically, and equal to immovable finger; tips of both fingers sharp, curved inwards, and crossing each other. Inside of both chelae setose towards distal end, especially in minor chela.

Ischia and meri of second pair of pereopods equal; carpus five-segmented; second segment two thirds longer than first, and longer than third and fourth together; third and fourth equal; fifth and first about equal.

Meral joints of posterior pairs of pereopods without spines; propodi spinulose beneath.

Telson elongate; sides tapering; end slightly convex; two pairs of spinules on dorsal surface, and third pair projecting from extremity, fringed with long setae between posterior spinules.

Prevailing color of specimens, after six months' exposure to alcohol, red; antennae blue.

Length of the largest female 22 mm; length of larger hand 8 mm.

TYPE-LOCALITY.—Port Escondido, Mulege Bay, Gulf of California.

DISTRIBUTION.—Only from the type locality.

REMARKS.—*Alpheus spinicaudus* has not been found since the original description by Lockington, in 1878. This species clearly belongs to the *edwardsii* group judging from the description of Lockington. The movable finger of major chela in this species works obliquely and this feature is uncommon among the *edwardsii* subgroup, which contains the species having the merus of the major first pereopod unarmed on distal end of inferior inner margin. Therefore, in the present study, *Alpheus spinicaudus* is treated as a valid species until more information is available.

#### 43. *Alpheus antepaenultimus*, new species

FIGURE 44

MATERIAL EXAMINED.—Holotype: Male, cl 8.1 mm, Amador, Panama (sta 141-B).

Paratypes: 2 ♂, 1 ovig (sta 141-B).

Costa Rica: Golfito: 1 young male; Jul 1978.

Panama: Naos Island causeway (sta 141-A: 1 ♀); Punta Paitilla (sta 52-2: 1 ♀).

MEASUREMENTS.—Males, cl 6.4–8.1 mm; females, cl 5.8–6.9 mm; ovigerous female, cl 8.2 mm.

DESCRIPTION.—Rostrum (Figure 44a–c) regularly triangular, broad at base, reaching to middle of visible part of first antennular segment; rostral carina very low, broadly rounded dorsally, almost invisible in dorsal view.

Ocular hood slightly inflated dorsally, separated from rostral carina by shallow and indistinct depression; anterior margin slightly concave near base of rostrum.

First antennular segment bearing deep and broad, hook-like carina extending from ventral inner margin; ventral tip spined (Figure 44d). Second segment about 2.5 times as long as broad, slightly longer than visible part of first segment, about 2 times

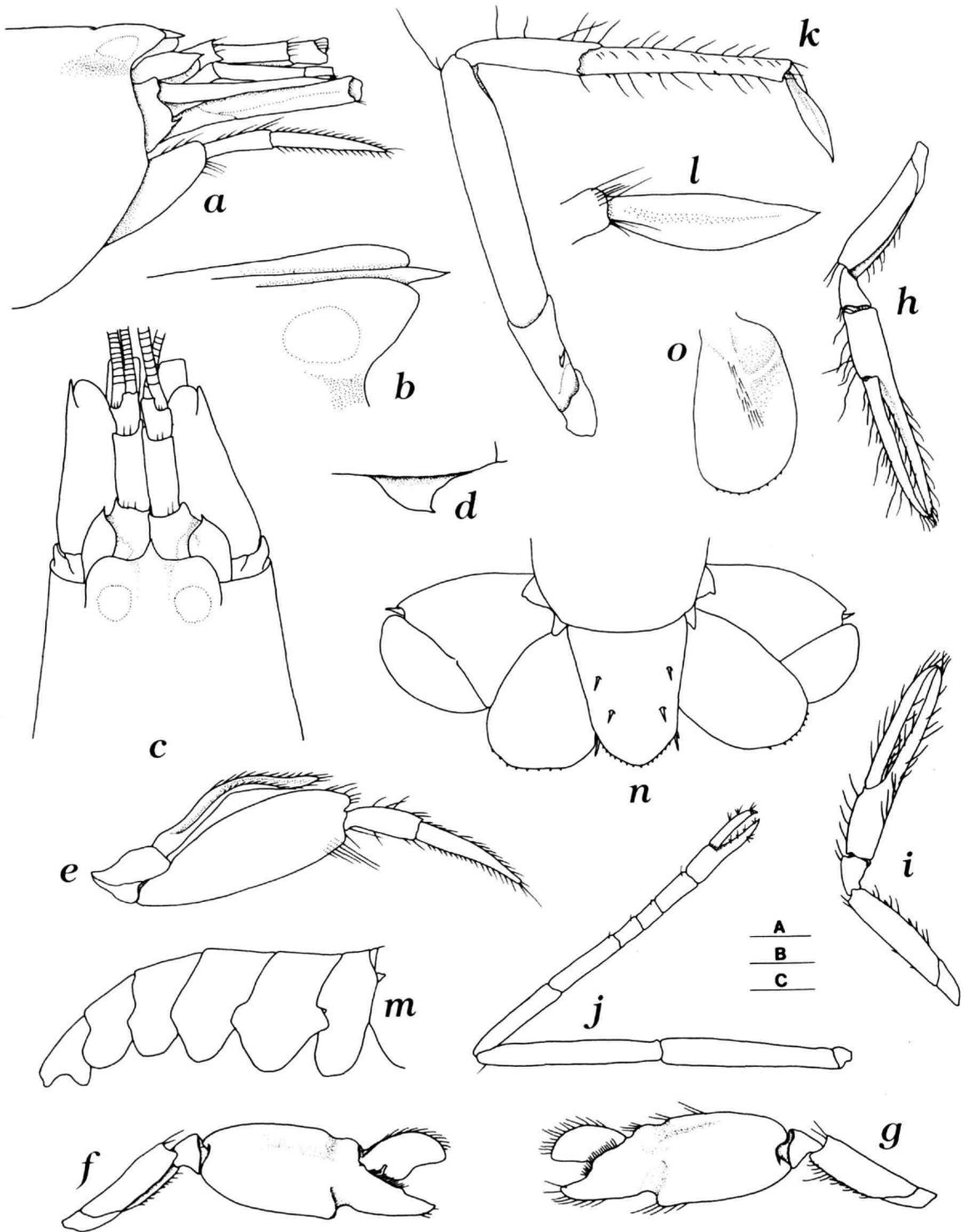


FIGURE 44.—*Alpheus antepaenultimus*, new species, holotype male, cl 8.1 mm, from sta 141-B: *a*, anterior region, lateral view; *b*, same, ocular hoods and rostrum, lateral view; *c*, same, dorsal view; *d*, carina below right first antennular segment; *e*, right third maxilliped; *f*, major first pereopod, outer face; *g*, same, inner face; *h*, minor first pereopod, outer face; *i*, same, inner face (*f*–*i*, young male, cl 3.7 mm, from Golfito, Costa Rica); *j*, right second pereopod; *k*, right third pereopod; *l*, same, dactylus, ventral view; *m*, abdomen; *n*, telson and uropods; *o*, left uropodal endopod. (Scale A = 2 mm; *m*; scale B = 1 mm: *a*, *c*, *e*–*k*, *n*, *o*; scale C = 0.5 mm: *b*, *d*, *l*.)

as long as third. Stylocerite broad proximally, narrowing abruptly into short and acute spine, not reaching to distal margin of first segment.

Scaphocerite with lateral margin almost straight. Distal spine almost reaching to distal end of inner blade. Inner blade very broad and rounded distally, overreaching distal end of antennular peduncle. Cleft between distal spine and inner blade very shallow, arising from less than distal  $\frac{1}{5}$  of scaphocerite.

Carpocerite overreaching distal end of antennular peduncle by length of third antennular segment. Basicerite with small lateral spine.

Third maxilliped (Figure 44e) reaching distal end of carpocerite beyond distal  $\frac{1}{4}$  of ultimate segment. Ultimate segment tapering distally, more than 1.5 times as long as penultimate; penultimate segment about 2.5 times as long as broad. Antepenultimate segment conspicuously enlarged and flattened, about 2.6 times as long as broad and slightly longer than sum of preceding two segments; outer surface smooth and inner surface with sinuous carina bearing long setae. Exopod not reaching to distal end of antepenultimate segment. Precoxa with one arthrobranch near distal end and also with small supplementary arthrobranch near proximal end.

Major chela of first pereopods (Figure 44f,g) rather elongate, about 2.7 times as long as broad. Fingers occupying distal  $\frac{1}{3}$  of chela, narrower than palm. Movable finger shallowly arched along proximal  $\frac{2}{3}$  of superior margin, regularly arched along distal  $\frac{1}{3}$  and bluntly rounded at tip. Immobile finger with inferior margin shallowly rounded. Palm with superior transverse groove very shallow, proximal shoulder not overhanging groove. Superior outer palmar depression shallowly defined, narrowly quadrangular. Superior inner palmar depression longitudinally elongated triangular, rather shallow. Inferior transverse groove rather deep and broad, with proximal shoulder bearing very small granules in outer view. Inferior outer palmar depression narrowly triangular and inferior inner palmar depression narrowly elongated inverse U-shaped; margin not clearly delimited anteriorly. Inner palmar face with very shallow depression between superior and inferior palmar depressions. Merus with inferior inner margin bearing 3 or 4 movable spines and with no distinct spine at distal end.

Minor chela of first pereopods (Figure 44h,i) very elongate, about 5.7 times as long as broad, bearing scattered, long setae along superior and inferior margins. Fingers very long, occupying distal 0.7 of chela, not balaeniceps. Palm with no sculpturing and bearing subacute tooth flanking dactylar articulation on inner face. Merus with inferior inner margin bearing 2 to 3 movable spines and no distinct spine at distal end.

Second pereopod (Figure 44j) reaching distal end of antennular peduncle beyond proximal  $\frac{1}{3}$  of carpus. Chela slightly shorter than sum of three distal segments of carpus, fingers 1.5 times as long as palm. First segment of carpus about 1.3 times as long as second; second segment 3 times as long as third; third segment subequal to fourth; fifth segment 1.5 times as long as fourth.

Dactylus of third pereopod (Figure 44k,l) broadly subspatulate, half as long as propodus. Propodus about 1.6 times as long as carpus, armed with at most four inconspicuous spines along inferior margin, not thicker than long, strong setae found along superior and inferior margins of this segment. Merus about 5.4 times as long as broad and 2.2 times as long as carpus. Ischium with movable spine.

Dactylus of fourth pereopod subspatulate. Ischium with movable spine.

Dactylus of fifth pereopod inconspicuously subspatulate. Ischium with movable spine in male and with no spine in female.

Pleura (Figure 44m) of first four abdominal somites narrowly rounded ventrally, not much overlapping in ventral regions in both sexes; pleuron of fifth somite narrowly rounded on posterior ventral margin. Abdominal sternite with no spine at midline. Appendix masculina reaching to or slightly overreaching distal end of appendix interna.

Telson (Figure 44n) about 1.9 times as long as broad at anterior end, armed with two pairs of rather small dorsal spines and with no longitudinal median depression on dorsal surface. Lateral margin almost straight in dorsal view. Posterior margin very convex, armed with one pair of spines at each lateral end, inner spine almost 2 times as long as outer one; space between spines bearing short seta-like spines.

Uropodal endopod bearing scattered short seta-like spines on distal margin and with inner depression (Figure 44o) at anterior half fairly distinct; middle part of lateral margin of telson fitting into inner depression. Uropodal exopod bearing very short movable spine, flanked laterally by short immovable tooth and internally by round lobe; transverse suture forming almost two straight lobes.

HABITAT.—Sandy mud and mud.

DISTRIBUTION.—Golfito, Costa Rica; Panama.

REMARKS.—The antepenultimate segment of the third maxilliped in the present species is extraordinarily broadened and this feature makes it possible to distinguish very easily the present species from other species except *A. chacei* Carvacho, 1979.

*Alpheus chacei* is the species most similar to the present species in every respect. But one quite distinct feature can separate these two species: the first pereopods of the present species have the movable spines on the inferior inner margins of the meri, while there are no spines on the same regions in *A. chacei*.

ETYMOLOGY.—The Latin *antepaenultimus* (antepenultimate) refers to the extraordinarily broad antepenultimate segment of the third maxilliped in the species.

#### 44. *Alpheus exilis*, new species

FIGURE 45

MATERIAL EXAMINED.—Holotype: Male, cl 5.2 mm, Sullivan Bay, James Island, Galapagos Islands (sta 795a-38).

Mexico: Escondido Bay, off Carmen Island, Baja California

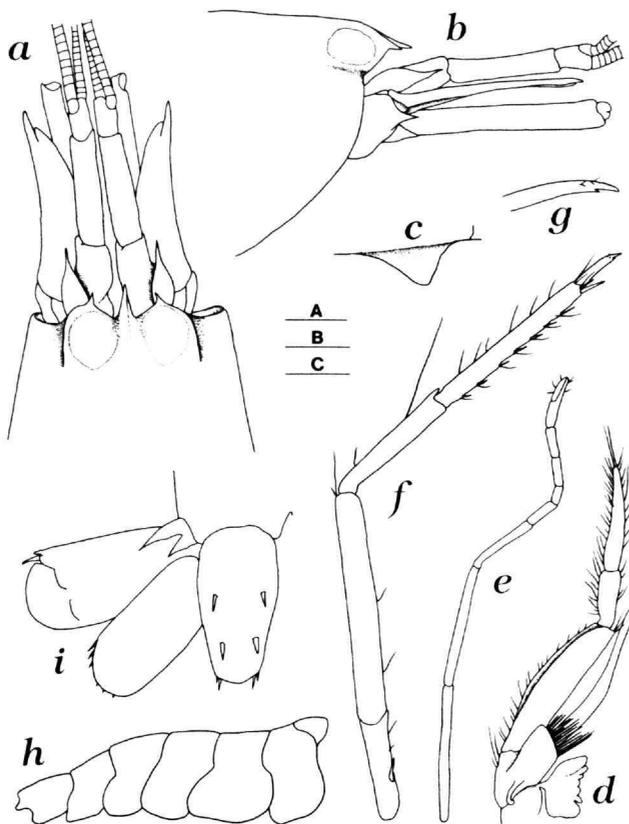


FIGURE 45.—*Alpheus exilis*, new species, holotype male, cl 5.2 mm, from sta 795a-38: *a*, anterior region, dorsal view; *b*, same, lateral view; *c*, carina below right first antennular segment; *d*, left third maxilliped; *e*, right second pereopod; *f*, right third pereopod; *g*, same, dactylus; *h*, abdomen; *i*, telson and uropods. (Scale A = 2 mm: *e*, *h*; scale B = 1 mm: *a*, *b*, *d*, *f*, *i*; scale C = 0.5 mm: *c*, *g*.)

(sta 667-37: 1♀).

MEASUREMENTS.—Male, cl 5.2 mm; female, cl 7.2 mm.

DESCRIPTION.—Rostrum (Figure 45*a,b*) sharply triangular, slightly extending posteriorly as rostral carina and reaching to middle of visible part of first antennular segment.

Ocular hood very slightly produced dorsally, separated from rostral carina by shallow, indistinct depression anteriorly and armed with sharp tooth somewhat directing inward. Ocular tooth reaching to distal  $\frac{1}{4}$  of rostrum. Anterior margin of ocular hood almost straight, slanting anteriorly from base of rostrum to ocular tooth.

Antennules very slender. First antennular segment with deep, triangular carina extending from ventral inner margin; ventral part ending in acute spine or not (Figure 45*c*). Second segment very elongate, about 4 times as long as broad, 1.6 times as long as visible part of first segment and 2.7 times as long as third segment. Stylocerite narrowing to long sharp point, not really reaching to distal margin of first segment.

Scaphocerite rather narrow with lateral margin concave at middle. Distal spine reaching to distal end of antennular

peduncle and falling far short of distal end of carapocerite. Inner blade narrow distally, falling far short of tip of adjacent distal spine. Cleft between inner blade and distal spine very shallow, arising from distal 0.2 of scaphocerite.

Carapocerite very slender, overreaching distal end of antennular peduncle by  $\frac{1}{3}$  length of third antennular segment. Basicerite with sharp, short lateral spine; spine broad at base.

Third maxilliped (Figure 45*d*) slightly overreaching middle of carapocerite. Ultimate segment about 2 times as long as penultimate, tapering distally and bearing several long setae on superior and inferior margins as well as on distal margin; tufts of setae on inner surface rather sparse. Penultimate segment about 2.5 times as long as broad, bearing several scattered setae distally. Antepenultimate segment bearing sparse short setae on inferior margin. Exopod almost reaching to middle of penultimate segment. Endite of basis elongated rectangular in shape bearing dense, stiff long setae on distal margin. Precoxa with one arthrobranch near distal end but with no supplementary arthrobranch.

First pereopods missing in present specimens.

Second pereopod (Figure 45*e*) very slender. Fingers of chela almost as long as palm. First segment of carpus about 2 times as long as second; second segment 1.7 times as long as third; fourth segment 1.5 times as long as third; fifth segment almost subequal to second.

Third pereopod (Figure 45*f,g*) very slender. Dactylus slender, about 0.3 times as long as propodus, bearing very small tooth on distal  $\frac{1}{5}$  of inferior margin. Propodus about 1.4 times as long as carpus, bearing 7 movable spines on inferior margin and pair at distal end. Carpus with superior distal margin produced. Merus very slender, less than 7.7 times as long as broad. Ischium with one rather strong movable spine.

Fourth pereopod almost same as third pereopod. Ischium with one rather strong movable spine.

Ischium of fifth pereopod without movable spine.

Pleura (Figure 45*h*) of first four abdominal somites broadly rounded; pleuron of fifth somite triangular on posterior ventral margin. Abdominal sternite with no spine at midline. Appendix masculina about 2 times as long as appendix interna.

Telson (Figure 45*i*) rather elongate about 2.1 times as long as broad at anterior end, armed with two pairs of rather stout dorsal spines and with no median longitudinal depression on dorsal surface. Lateral margin slightly convex near middle. Posterior margin convex, armed with pair of spines at each lateral end; inner spine strong, almost two times as long as outer one.

Uropodal endopod bearing several conspicuous seta-like spines on distal margin, and with inner depression at anterior half almost invisible. Uropodal exopod bearing slender movable spine flanked laterally by acute immovable tooth and internally by very rounded lobe; movable spine not overreaching distal margin of uropodal exopod; transverse suture forming two shallow, convex lobes.

HABITAT.—64 to 146 m; volcanic sand, mud, and sand.

DISTRIBUTION.—Baja California; James Island, Galapagos

Islands.

REMARKS.—This species can be easily distinguished from the other species by the endite of the basis of the third maxilliped, which is armed with dense stout setae on the distal margin. Unfortunately the first pereopods of the present specimens are missing, but the present species also has the very elongate second antennular segment; this feature is uncommon among the other species having the ocular tooth.

ETYMOLOGY.—The specific name is from the Latin *exilis* (slender), referring to the long, slender antennular peduncle, especially the second antennular segment.

Zoogeographical Considerations

As a result of the present study, 44 species of *Alpheus* are

known to occur in the eastern Pacific region and the distribution of each species is plotted in Table 2.

From Table 2, three major geographical regions are recognized in terms of the number of species. First, the region between about 34°N and 2°S contains most of the species (41/44 = 93%) occurring in the eastern Pacific. In this region, three subregions can be recognized: The subregion between about 12°N and 2°S (west coast of Costa Rica, Panama, Colombia) has the greatest number of species (33/41 = 80%) and of these 33 species, 7 are endemic to this subregion (*A. tenuis*, *A. latus*, *A. hamus*, *A. firmus*, *A. distinctus*, *A. martini*, *A. antepaenultimus*). The subregion between about 34°N and 12°N (west coast of Baja California, Gulf of California, west coast of Mexico) contains 27 species and of these, 4 (*A. felgenhaueri*, *A. fasciatus*, *A. mazatlanicus*, *A. spinicaudus*) are

TABLE 2.—Ranges of latitude of the species in the eastern Pacific. (Symbols: (--) from literature records; (=) Gulf of California; (!) Gulf of California (from literature records); (#) Panama; (\*) Galapagos Islands; (\$) Galapagos Islands (from literature records); (+) other localities; (?) uncertain. The data were derived from the distribution records of the species as cited in the present study, unless otherwise stated.)

Species \ Latitude	40°N	30°	20°	10°	0°	10°	20°	30°	40°	50°S
1. <i>A. bellimanus</i>	-----	=====	+++++	----	# + + ***		<-----	?	----->	
2. <i>A. rectus</i>		=		#						
3. <i>A. hoonsooi</i>					+ ***					
4. <i>A. barbara</i>	-									
5. <i>A. clamator</i>	-----			-						
6. <i>A. inca</i>						+ +++	+ +			
7. <i>A. grahami</i>		====			+					
8. <i>A. websteri</i>		!!!!	-----	+++	#-----	\$\$\$				
9. <i>A. malleator</i>		!!!!!!!!	-----	+	-	\$\$\$				
10. <i>A. lottini</i>		!!!!	++++	---	#-----	***				
11. <i>A. normanni</i>		!!!!	!=	==	+ ##	\$\$\$				
12. <i>A. panamensis</i>				+++	-	----				
13. <i>A. felgenhaueri</i>		= +								
14. <i>A. sulcatus</i>		!!!!!!	!=	+++	+ \$\$\$*	-----				
15. <i>A. cristulifrons</i>		!!!!!!!!	++++	+++						
16. <i>A. cylindricus</i>		!!!!!!	!=	++	+++	+++	\$\$\$			
17. <i>A. paracrinatus</i>		!!!!!!	!=	+++	#	***				
18. <i>A. rostratus</i>		= +		+	***					
19. <i>A. floridanus</i>		!!!!	!!!!	+	-#	+				
20. <i>A. aequus</i>				+	*					
21. <i>A. fasciatus</i>		-								
22. <i>A. bouvieri</i>				+ ##	+ +\$+					
23. <i>A. chilensis</i>										\$
24. <i>A. hebes</i>		====	+ ++	+ ##	+++	+++	+			+
25. <i>A. longinquus</i>		====	+	+ #	++	+++				
26. <i>A. lacertosus</i>										+
27. <i>A. californiensis</i>	+ -	-								
28. <i>A. canalis</i>		= =	++	+	+++	++	+ ***			
29. <i>A. hyeyoungae</i>			+	++	#					
30. <i>A. scopulus</i>					##	*				
31. <i>A. tenuis</i>					#					
32. <i>A. villus</i>		=			#	+				
33. <i>A. umbo</i>		=	!!	!!	+	+				
34. <i>A. mazatlanicus</i>		--								
35. <i>A. latus</i>				#						
36. <i>A. hamus</i>				#	+					
37. <i>A. firmus</i>				#						
38. <i>A. distinctus</i>				#						
39. <i>A. martini</i>				##						
40. <i>A. pacificus</i>		!!!!	+	++	+	*				
41. <i>A. galapagensis</i>										\$
42. <i>A. spinicaudus</i>		-								
43. <i>A. antepaenultimus</i>				#	+					
44. <i>A. exilis</i>		=			*					

endemic to this subregion, and 21 species (21/27 = 78%) are also found in the subregion between 12°N and 2°S. The last subregion, the Galapagos Islands, is located between 1°N and 1°39'S and contains 20 species, and of these, only one (*A. galapagensis*) is endemic and 17 species (17/20 = 85%) are also found in the subregion between 12°N and 2°S. This wide, overlapping distribution of species suggests that all three subregions should be considered as one province. A second region north of about 34°N contains 4 species and of these, *A. barbara* is endemic to this region while *A. clamator* extends as far north as Horseshoe Cave, Sonora County, California (38°19'N). A third region is south of about 2°S and contains 5 species and of these *A. inca*, *A. lacertosus*, and *A. chilensis* are endemic to this region. The latter species extends as far south as Puerto Montt, Chile.

The above data suggest that the species of *Alpheus* occur in three provinces in the eastern Pacific and that the snapping shrimp genus *Alpheus* is a tropical and subtropical taxon. However the paucity of species in the southern subtropical region (the west coast of Ecuador and Peru) might be explained partly by upwelling of cold water around this area and by the lack of collections from these regions. More extensive collections in these regions probably will reveal additional species of *Alpheus*.

Considering the worldwide geographical distribution, the 44 species in the present study are distributed as follows.

EASTERN PACIFIC ONLY.—34 species (77% of total 44 species): *A. bellimanus*, *A. rectus*, *A. hoonsooi*, *A. barbara*, *A. clamator*, *A. inca*, *A. grahami*, *A. websteri*, *A. panamensis*, *A. felgenhaueri*, *A. rostratus*, *A. aequus*, *A. fasciatus*, *A. chilensis*,

*A. hebes*, *A. longinquus*, *A. lacertosus*, *A. californiensis*, *A. canalis*, *A. hyeyoungae*, *A. scopulus*, *A. tenuis*, *A. villus*, *A. umbo*, *A. mazatlanicus*, *A. latus*, *A. hamus*, *A. firmus*, *A. distinctus*, *A. martini*, *A. galapagensis*, *A. spinicaudus*, *A. antepaenultimus*, *A. exilis*.

EASTERN PACIFIC, EASTERN ATLANTIC AND WESTERN ATLANTIC.—5 species (11%): *A. malleator*, *A. cristulifrons*, *A. cylindricus*, *A. floridanus*, *A. bouvieri*.

EASTERN PACIFIC AND INDO-WEST PACIFIC.—2 species (5%): *A. lottini*, *A. pacificus*.

EASTERN PACIFIC AND WESTERN ATLANTIC.—1 species (2%): *A. websteri*.

EASTERN PACIFIC, INDO-WEST PACIFIC AND EASTERN ATLANTIC.—1 species (2%): *A. sulcatus*.

EASTERN PACIFIC, INDO-WEST PACIFIC, EASTERN ATLANTIC AND WESTERN ATLANTIC (panropical).—1 species (2%): *A. paracrinitus*.

From the above data, the eastern Pacific region has a discrete fauna of *Alpheus* with the majority (77%) of species being endemic. This fact supports the suggestion of Chace (1972:5) that the unbroken expanse of deep water between the eastern Pacific and the Indo-West Pacific regions forms an effective barrier to the pantropical distribution of marine species. According to Kim and Abele (1984) and the data of Abele and Kim (unpublished data), the Panama Canal provides an effective barrier to the exchange of decapod species between the eastern Pacific and the western Atlantic. This fact partly explains the reason why only a single species occurs in both the eastern Pacific and western Atlantic.

# Appendix

## Station List

(This list indicates stations at which the specimens were collected and the species taken.)

### Allan Hancock Galapagos Expeditions, 1933

Stops and stations for marine and land collecting by Drs. W.L. Schmitt, J.S. Garth, and F. Ziesenhenné in Mexico, Costa Rica, Panama, Ecuador, and Galapagos Islands.

- 10-33. Ecuador; La Libertad; rocks south of Sta. Elena Pt.; shore collecting; 18 Jan: *A. hebes*, *A. longinquus*.
- 12-33. Ecuador; La Libertad; dredging along village beach; 2-4 m; 19 Jan: *A. panamensis*.
- 24-33. Galapagos Islands; Gardner Bay, Hood Island; small island in bay; 24 Jan: *A. longinquus*.
- 25-33. Galapagos Islands; Gardner Bay, Hood Island; dredging along sand beach, 4-5 m; 24 Jan: *A. paracrinitus*, *A. longinquus*.
- 27-33. Galapagos Islands; Gardner Bay, Hood Island; rocky spit; 25 Jan: *A. scopulus*, *A. pacificus*.
- 28-33. Galapagos Islands; Gardner Bay, Hood Island; diving in 4 m; 25 Jan: *A. paracrinitus*.
- 33-33. Galapagos Islands; Black Beach Anchorage, Charles Island; shore collecting; 27 Jan: *A. paracrinitus*, *A. longinquus*.
- 46-33. Galapagos Islands; Barrington Island; dredging in bay 4-5 m; 2 Feb: *A. bellimanus*.
- 47-33. Galapagos Islands; Barrington Island; diving in bay, about 5 m; 2 Feb: *A. bellimanus*, *A. rostratus*, *A. aequus*.
- 48-33. Galapagos Islands; Barrington Island; shore collecting at head of bay and over rocks to north side; 2 Feb: *A. hebes*, *A. longinquus*.
- 49-33. Galapagos Islands; Academy Bay, Indefatigable Island; shore collecting, southward of landing; 3 Feb: *A. longinquus*.
- 52-33. Galapagos Islands; Academy Bay, Indefatigable Island; shore collecting, south of Rader's place; 4 Feb: *A. hebes*, *A. longinquus*.
- 57-33. Galapagos Islands; Post Office Bay, Charles Island; dredging, 4-5 m; 6 Feb: *A. bellimanus*.
- 58-33. Galapagos Islands; Cormorant Bay, Charles Island; shore collecting, rocks east of Cormorant Point; 6 Feb: *A. hebes*.
- 62-33. Galapagos Islands; Albemarle Island, first point south of rocky shore, black bight; 8 Feb: *A. longinquus*.
- 65-33. Galapagos Islands; Albemarle Island; reef north of Tagus Hill, well out from shore; 9 Feb: *A. longinquus*.
- 69-33. Galapagos Islands; Albemarle Point, Albemarle Island; shore collecting, chiefly porites heads about exposed at low tide; 11 Feb: *A. hebes*, *A. longinquus*.
- 71-33. Galapagos Islands; James Bay, James Island; shore collecting, under and about large boulders on shore; 12 Feb: *A. hebes*, *A. longinquus*.
- 73-33. Galapagos Islands; Cartago Bay, Albemarle Island; north beach, last large beach to north at about end of bay proper; 13 Feb: *A. bellimanus*, *A. paracrinitus*.
- 76-33. Galapagos Islands; Cartago Bay, Albemarle Island; north sandy shore off dead trees, off first beach in big bay, rocks Epizoanthus covered; 14 Feb: *A. hebes*, *A. longinquus*.
- 82-33. Galapagos Islands; Conway Bay, Indefatigable Island; small Island, shore collecting; 17 Feb: *A. bellimanus*.
- 93-33. Galapagos Islands; Darwin Bay, Tower Island; Lagoon Beach, shore collecting, and fiddlers; 22 Feb: *A. hebes*, *A. longinquus*.
- 94-33. Galapagos Islands; Darwin Bay, Tower Island; coral gathered at Seal Beach No. 1 by Carl; 22 Feb: *A. paracrinitus*.
- 96-33. Galapagos Islands; Darwin Bay, Tower Island; Seal Beach No. 1, shore collecting under rocks; 24 Feb: *A. hebes*, *A. longinquus*.
- 98-33. Galapagos Islands; Darwin Bay, Tower Island; Seal Beach No. 1, shore collecting, Fred and John; 25 Feb: *A. paracrinitus*, *A. longinquus*.
- 101-33. Galapagos Islands; Darwin Bay, Tower Island; Seal Beach No. 1, shore collecting; 26 Feb: *A. paracrinitus*, *A. hebes*, *A. longinquus*.
- 101a-33. Galapagos Islands; Darwin Bay, Tower Island; Seal Beach No. 1, few odds and ends from coral clumps; 26 Feb: *A. lottini*.
- 105-33. Costa Rica; Wafer Bay, Isla del Coco; shore collecting, collecting off treasure camp flat; 1 Mar: *A. hebes*, *A. longinquus*, *A. villus*, *A. pacificus*.
- 106-33. Costa Rica; Chatham Bay, Isla del Coco; 1 Mar: *A. hebes*.
- 107-33. Costa Rica; Wafer Bay, Isla del Coco; shore collecting, as in 105 and rocks more to north and westward; 2 Mar: *A. hebes*.
- 111-33. Panama; Bahia Honda; shore near village behind point; 9 Mar: *A. hebes*.
- 113-33. Panama; Bahia Honda; dredging behind point (near village) 4 m; 9 Mar: *A. bellimanus*.
- 121-33. Mexico; Tenacatita Bay, Jalisco; shore collecting, before mouth of lagoon north side; 19 Mar: *A. hebes*, *A. longinquus*.
- 124-33. Mexico; Isabel Island, Sinaloa; shore collecting; 19 Mar: *A. lottini*, *A. felgenhaueri*, *A. cristulifrons*, *A. cylindricus*, *A. rostratus*, *A. hebes*, *A. longinquus*, *A. umbo*.

### Allan Hancock Galapagos Expeditions, 1934

Stops and stations for marine and land collecting by Drs. W.L. Schmitt, C.M. Fraser, W.R. Taylor, J.S. Garth, Fred Ziesenhenné, and others of the Cruiser *Velero III*.

- 128-34. Mexico; Braithwaite Bay, Socorro Island; shore collecting; 2 Jan: *A. hebes*, *A. longinquus*.
- 130-34. Mexico; Braithwaite Bay, Socorro Island; rock shingle; 3 Jan: *A. pacificus*.
- 131-34. Mexico; Braithwaite Bay, Socorro Island; Pocillopora; 3 Jan: *A. lottini*.
- 134-34. Mexico; Sulphur Bay, Clarion Island; dredging 26 m, Null; 5 Jan: *A. bellimanus*.
- 140-34. Mexico; Sulphur Bay, Clarion Island; coral clump; 5 Jan: *A. lottini*, *A. paracrinitus*, *A. hebes*, *A. longinquus*.
- 141-34. Mexico; Sulphur Bay, Clarion Island; shore collecting, shingles; 5 Jan: *A. hebes*, *A. longinquus*.
- 147-34. Galapagos Islands; Tagus Cove, Albemarle Island; dredging in 55 m, south of cove; 13 Jan: *A. hoonsooi*.
- 149-34. Galapagos Islands; Tagus Cove, Albemarle Island; dredging in 37 m, south of cove; 13 Jan: *A. hoonsooi*.
- 155-34. Galapagos Islands; Tagus Cove, Albemarle Island; dredging off cove, 92-110 m; 15 Jan: *A. hoonsooi*.
- 157-34. Galapagos Islands; Tagus Cove, Albemarle Island; dredging in cove, 18-33 m; 15 Jan: *A. hoonsooi*.
- 166-34. Galapagos Islands; Charles Island; shore collecting, Black Beach; 19 Jan: *A. bellimanus*, *A. longinquus*.
- 167-34. Galapagos Islands; Post Office Bay, Charles Island; dredging in 27

- m; 19 Jan: *A. bellimanus*, *A. hoonsooi*.
- 168-34. Galapagos Islands; Academy Bay, Indefatigable Island; shore collecting in front of Rader's; 20 Jan: *A. sulcatus*, *A. paracrinatus*, *A. hebes*, *A. longinquus*, *A. canalis*.
- 169-34. Galapagos Islands; Academy Bay, Indefatigable Island; dredging; 20 Jan: *A. bellimanus*, *A. hoonsooi*.
- 174-34. Galapagos Islands; South Seymour Island; shore collecting by E.E. Smith; 22 Jan: *A. hebes*, *A. longinquus*.
- 175-34. Galapagos Islands; North Seymour Island; shore collecting; 22 Jan: *A. hebes*, *A. longinquus*.
- 177-34. Galapagos Islands; Sullivan Bay, James Island; dredging 9–37 m; 23 Jan: *A. bellimanus*, *A. hoonsooi*, *A. hebes*.
- 183-34. Galapagos Islands; James Bay, James Island; dredging, 92–128 m, near Albany Island; 24 Jan: *A. hoonsooi*.
- 188-34. Galapagos Islands; Cartago Bay, Albemarle Island; shore collecting, north shore of bay; 25 Jan: *A. hebes*.
- 193-34. Galapagos Islands; Post Office Bay, Charles Island; dredging in 15–18 m; 27 Jan: *A. bellimanus*, *A. hoonsooi*.
- 196-34. Galapagos Islands; Charles Island; dredging north of Island, 15–18 m, rocky; 29 Jan: *A. bellimanus*.
- 200-34. Galapagos Islands; Post Office Bay, Charles Island; dredging north of bay, 46–74 m; 30 Jan: *A. hebes*.
- 202-34. Galapagos Islands; Gardner Bay, Hood Island; shore collecting, Osborn Island near Hood; 31 Jan: *A. canalis*.
- 207-34. Ecuador; La Libertad; South of Pt. St. Elena; 8 Feb: *A. hebes*.
- 211-34. Ecuador; La Plata Island; shore collecting, rocky reefs; 10 Feb: *A. hebes*.
- 216-34. Ecuador; Cape San Francisco; dredging in 37 m, muck; 11 Feb: *A. floridanus*.
- 224-34. Colombia; Gorgona Island; dredging near beach, west side, 18 m; 12 Feb: *A. hoonsooi*.
- 229-34. Colombia; Cabita Bay, (Cabo Corriente); dredging northwest of point, 18 m, mud; 13 Feb: *A. hebes*, *A. longinquus*, *A. canalis*.
- 232-34. Colombia; Port Utria; shore collecting, isthmus between 2 "islands"; 14 Feb: *A. cylindricus*, *A. hebes*, *A. umbo*.
- 234-34. Colombia; Port Utria; dredging west side of terminal island, 37 m, sand; 14 Feb: *A. cylindricus*.
- 239-34. Colombia; Port Utria; shore collecting, reef inner side outer isle; 15 Feb: *A. sulcatus* (239a-34), *A. cylindricus*, *A. canalis* (239a-34), *A. umbo* (239a-34).
- 240-34. Panama; Jicarita Island; dredging, east side, 44 m, shelly, gravel; 20 Feb: *A. hebes*.
- 256-34. Costa Rica; Puerto Culebra; shore collecting, south of Mala Point, bayside; 24 Feb: *A. cylindricus*.
- 258-34. Costa Rica; Puerto Culebra; coral clumps; 25 Feb: *A. cylindricus*.
- 261-34. Mexico; Tangola-Tangola; Schmitt's shirtful of coral, Tangola, Island; 1 Mar: *A. canalis*.
- 277-34. Mexico; Isabel Island; dredging, 18–46 m, all around isle; 5 Mar: *A. bellimanus*.
- 344-35. Galapagos Islands; Sullivan Bay, James Island; Bartolomeo Island, coral; 12 Dec: *A. rostratus*.
- 350-35. Galapagos Islands; South Seymour Island; shore; 13 Dec: *A. longinquus*.
- 351-35. Galapagos Islands; Charles Island; shore, cove south of anchorage, C.M. Fraser and Fred Ziesenhenne; 14 Dec: *A. paracrinatus*.
- 353-35. Galapagos Islands; Stephens Bay, Chatham Island; 37 m; 15 Dec: *A. canalis*.
- 357-35. Galapagos Islands; Hood Island; coral, Karl; 17 Dec: *A. paracrinatus*, *A. rostratus*.
- 358-35. Galapagos Islands; Hood Island; shore, bay west of anchorage, C.M. Fraser and Fred Ziesenhenne; 17 Dec: *A. hebes*.
- 359-35. Galapagos Islands; Osborn Island; shore, 5:30 A.M. tide rocks, J.S. Garth, W.L. Schmitt, and Fred Ziesenhenne; 19 Dec: *A. canalis*.
- 391-35. Peru; Lobos de Afeura; shore, main isle west of light, rocks; 17 Jan: *A. inca*.
- 400-35. Ecuador; Manta; shore south of Manta; 19 Jan: *A. bouvieri*.
- 405-35. Colombia; Gorgona Island; shore below sand beach; 22 Jan: *A. bouvieri*, *A. hebes*, *A. canalis*.
- 409-35. Colombia; Gorgona Island; 37 m, off North Point, "nilapores"; 22 Jan: *A. bellimanus*.
- 411-35. Colombia; Gorgona Island; Pocillopora coral off Coconut Beach; 22 Jan: *A. cylindricus*.
- 413-35. Colombia; Port Utria; shore, lee beach of isle; 23 Jan: *A. cylindricus*, *A. canalis*, *A. umbo*.
- 414-35. Colombia; Port Utria; 5 m, lee beach of isle, Pocillopora coral; 23 Jan: *A. cylindricus*.
- 418-35. Colombia; Port Utria; shore, mainland, 1st beach sand; 24 Jan: *A. hebes*, *A. longinquus*.
- 419-35. Colombia; Port Utria; 4 m, coral isle beach; 24 Jan: *A. cylindricus*.
- 427-35. Colombia; Cupica Bay; shore, west side between 2nd island and peninsula; 26 Jan: *A. cylindricus*, *A. hebes*.
- 432-35. Colombia; Octavia Bay; 91 m, outside midchannel, soft mud and fine gravel; 27 Jan: *A. bellimanus*.
- 433-35. Colombia; Octavia Bay; shore, island off peninsula, rock shingle; 27 Jan: *A. hebes*.
- 436-35. Panama; Pinas Bay; shore; 28 Jan: *A. cylindricus*, *A. hebes*, *A. longinquus*.
- 437-35. Panama; Pinas Bay; coral, bay, mainland opposite anchorage; 28 Jan: *A. cylindricus*.
- 444-35. Panama; Pinas Bay; 4–7 m; coral from south of bay, mainland side; 29 Jan: *A. cylindricus*.
- 445-35. Panama; Panama; shore; 2 Feb: *A. canalis*.
- 446a-35. Panama; Secas Isle; outer side of same island (one of most westward of group); 4 Feb: *A. cylindricus*.
- 446b-35. Panama; Secas Isle; shore, main isle to south of anchorage; 4 Feb: *A. hebes*, *A. villus*.
- 447-35. Panama; Secas Isle; coral, main isle to large open cove; 4 Feb: *A. paracrinatus*.
- 448-35. Panama; Secas Isle; 22 m, anchorage from 1st 5 m sand beach; 5 Feb: *A. bellimanus*.
- 450-35. Panama; Secas Isle; 26 m, shells, "nilapores"; 5 Feb: *A. bellimanus*, *A. normanni*.
- 452-35. Panama; Secas Isle; fresh water stream and pools; 5 Feb: *A. hebes* (452a-35).
- 454-35. Panama; Secas Isle; shore, coral tide flat; 6 Feb: *A. canalis*.
- 457-35. Panama; Secas Isle; 22 m; 6 Feb: *A. bellimanus*.
- 458-35. Panama; Secas Isle; 9–37 m; 6 Feb: *A. bellimanus*.
- 465-35. Costa Rica; Playa Blancas; shore, shale beach between beach and rocky reef; 8 Feb: *A. paracrinatus*, *A. aequus*, *A. canalis*.
- 466-35. Costa Rica; Parker Bay; shore, off small Isle to north shore; 9 Feb: *A. hebes*, *A. longinquus*, *A. canalis*, *A. umbo*.
- 469-35. Costa Rica; Parker Bay; 18 m, sand and shells; 9 Feb: *A. normanni*.
- 470-35. Costa Rica; Parker Bay; 9 m, sand and mud; 9 Feb: *A. normanni*.
- 473-35. Costa Rica; Parker Bay; coral; 9 Feb: *A. cylindricus*, *A. rostratus*, *A. umbo*.

#### Allan Hancock Expeditions, 1935 (Dec 1934–Feb 1935)

- 306-35. Galapagos Islands; Marchena Island; shore, reef and spit off north end of island anchorage, lava; 2 Dec: *A. hebes*, *A. longinquus*.
- 313-35. Galapagos Islands; Charles Island; shore, Black Beach anchorage, left cove, W.L. Schmitt and C.M. Fraser; 6 Dec: *A. hebes*, *A. longinquus*.
- 314-35. Galapagos Islands; Indefatigable Island; shore, Academy Bay, "Rader's," "J&F&S&H"; 7 Dec: *A. hebes*, *A. longinquus*, *A. canalis*.
- 333-35. Galapagos Islands; James Island; shore, rocky ledges 2 mi south of James Bay; 11 Dec: *A. hebes*, *A. longinquus*.
- 336-35. Galapagos Islands; Sullivan Bay, James Island; 37 m, red algae; 12 Dec: *A. hoonsooi*.
- 343-35. Galapagos Islands; Sullivan Bay, James Island; J.S. Garth, F. Ziesenhenne, and W.L. Schmitt; 12 Dec: *A. paracrinatus*.

- 474-35. Costa Rica; Salinas Bay; shore, beach beyond reef, sand, stone; 10 Feb: *A. bouvieri*, *A. hebes*, *A. canalis*.

#### Allan Hancock Pacific Expeditions, 1936

- 506-36. Mexico; San Gabriel Bay, Espiritu Santo Island, Baja California; 2-7 m; 22 Feb: *A. normanni*.
- 510-36. Mexico; cove south of Ballena Bay, Espiritu Santo Island, Baja California; shore; 22 Feb: *A. sulcatus*.
- 518-36. Mexico; North Bay, San Francisco Island, Baja California; shore; 25 Feb: *A. canalis*.
- 519-36. Mexico; North Bay, San Francisco Island, Baja California; ; 26 Feb: *A. hebes*, *A. longinquus*, *A. canalis*.
- 521-36. Mexico; Agua Verde Bay, Baja California; 9-18 m; 27 Feb: *A. bellimanus*.
- 522-36. Mexico; Agua Verde Bay, Baja California; west of bay side reef, shore; 27 Feb: *A. longinquus*.
- 529-36. Mexico; off San Francisquito Bay, Baja California; shale and gray mud, 302 m; 1 Mar: *A. bellimanus*.
- 533-36. Mexico; In San Francisquito Bay, Baja California; bark, shingle, sand, 73 m; 2 Mar: *A. bellimanus*.
- 534-36. Mexico; off San Francisquito Bay, Baja California; shale rock, mud and rocks, 229 m; 2 Mar: *A. bellimanus*.
- 536-36. Mexico; middle of Angeles Bay, Baja California; mud, 37 m; 2 Mar: *A. floridanus*.
- 537-36. Mexico; spit north of "Mill Site," Angeles Bay, Baja California; shore; 2 Mar: *A. umbo*.
- 561-36. Mexico; south of Isla Partida, Baja California; coral sand, 73 m; 9 Mar: *A. bellimanus*, *A. rectus*.
- 582-36. Mexico; south of San Marees Island, Baja California; coral sand, 37 m; 14 Mar: *A. bellimanus*.
- 585-36. Mexico; Concepcion Bay, Baja California (Coyote Bay); kelp, 4-5 m; 14 Mar: *A. normanni*.
- 604-36. Mexico; San Gabriel Bay, Espiritu Santo Island, Baja California; coral, shore; 20 Mar: *A. paracrinus*
- 607-36. Mexico; San Lorenze Channel, Espiritu Santo Island, Baja California; corallines, 44 m; 21 Mar: *A. bellimanus*.

#### Allan Hancock Pacific Expeditions, 1937

- 623-37. Mexico; Cabeza Ballena, east of Cape San Lucas, Baja California; shore; 4 Mar: *A. longinquus*.
- 628-37. Mexico; Ensenada de los Muertos, Baja California; coralline, 18-22 m; 5 Mar: *A. bellimanus*.
- 630-37. Mexico; La Paz, Baja California; lighthouse anchorage, "E. L."; 5 Mar: *A. umbo*.
- 633-37. Mexico; San Gabriel Bay, Espiritu Santo Island, Baja California; coralline, 33 m; 6 Mar: *A. bellimanus*.
- 634-37. Mexico; San Gabriel Bay, Espiritu Santo Island, Baja California; coral (2 types), shore; 5 Mar: *A. cylindricus*, *A. paracrinus*, *A. rostratus*, *A. umbo*.
- 638-37. Mexico; San Gabriel Bay, Espiritu Santo Island, Baja California; coral, shore; 7 Mar: *A. sulcatus*, *A. cylindricus*, *A. paracrinus*.
- 647-37. Mexico; San Francisco Island, Baja California; channel, coral, 40 m; 8 Mar: *A. bellimanus*, *A. umbo*.
- 652-37. Mexico; San Francisco Island, Baja California; rock shingle; shore; 9 Mar: *A. paracrinus*.
- 655-37. Mexico; Agua Verde Bay, Baja California; sand, 18 m; 10 Mar: *A. floridanus*.
- 662-37. Mexico; Agua Verde Bay, Baja California; off San Marcial Reef, 15 m; 11 Mar: *A. bellimanus*.
- 663-37. Mexico; Agua Verde Bay, Baja California; 27 m; 11 Mar: *A. bellimanus*, *A. normanni*.
- 664-37. Mexico; Agua Verde Bay, Baja California; San Marcial Reef, shore; 11 Mar: *A. longinquus*.
- 667-37. Mexico; Escondido Bay, Baja California; off Carmen Island; mud

- and sand, 146 m: *A. exilis*.
- 670-37. Mexico; Escondido Bay, Baja California; off Carmen Island, lagoon entrance, shore; 12 Mar: *A. hebes*.
- 702-37. Mexico; Angeles Bay, Baja California; coarse sand, 33 m; 20 Mar: *A. bellimanus*.
- 704-37. Mexico; Puerto Refugio, Angel de la Guardia, Baja California; coralline, 37 m; 20 Mar: *A. bellimanus*.
- 713-37. Mexico; Puerto Refugio, Angel de la Guardia, Baja California; rock, shore; 21 Mar: *A. umbo*.
- 714-37. Mexico; Willards Point, Gonzaga Bay, Baja California; mud, plants, 29-55 m; 23 Mar: *A. floridanus*.
- 715-37. Mexico; Willards Point, Gonzaga Bay, Baja California; land plants, land; 23 Mar: *A. hebes*.
- 739-37. Mexico; Ensenada de San Francisco, Sonora; rock shingle, shore; 30 Mar: *A. hebes*, *A. canalis*.
- 747-37. Mexico; Isabel Island, Sinaloa; west of anchorage, corallines, 18-33 m; 2 Apr: *A. bellimanus*.
- 749-37. Mexico; Isabel Island, Sinaloa; reef, shore; 3 Apr: *A. hebes*.

#### Allan Hancock Pacific Expeditions, 1938

- 781-38. Costa Rica; Wafer Bay, Isla del Coco; shore, rock shingle; 14 Jan: *A. canalis*, *A. villus*.
- 782-38. Galapagos Islands; Darwin Bay, Tower Island; shore, rock (Seal Beach); 16 Jan: *A. longinquus*.
- 784-38. Galapagos Islands; Darwin Bay, Tower Island; shore, rock (Middle Beach); 17 Jan: *A. rostratus*.
- 789-38. Galapagos Islands; South Seymour Island; shore, rock; 19 Jan: *A. paracrinus*, *A. longinquus*.
- 795-38. Galapagos Islands; Sullivan Bay, James Island; 64-73 m, rock, sand; 21 Jan: *A. bellimanus*, *A. exilis* (795a-38).
- 796-38. Galapagos Islands; Sullivan Bay, James Island; shore, rock; 21 Jan: *A. longinquus*.
- 811-38. Galapagos Islands; Barrington Island; coral (Pocillopora); 26 Jan: *A. bellimanus*.
- 811a-38. Galapagos Islands; Barrington Island; coral (Pavonia?); 26 Jan: *A. bellimanus*, *A. paracrinus*.
- 825-38. Peru; San Juan Bay; shore, rocks (Dr. Clark); 7 Feb: *A. inca*.
- 848-38. Ecuador; Cape San Francisco; shore, Drs. Clark and Fred; 23 Feb: *A. bouvieri*, *A. hebes*.
- 850-38. Ecuador; Cape San Francisco; 27 m, mud, rock; 23 Feb: *A. floridanus*.
- 861-38. Panama; Bahia Honda (ocean side of point); shore, rocky, Clark and Fred; 1 Mar: *A. cylindricus*, *A. hebes*.
- 862-38. Panama; Bahia Honda (outside of bay); 55 m, dredge, mud; 1 Mar: *A. rectus*.
- 869-38. Mexico; Isabel Island, Sinaloa; shore, rocky, Petersen; 8 Mar: *A. hebes*, *A. longinquus*, *A. canalis*, *A. umbo*.
- 870-38. Mexico; Isabel Island, Sinaloa; 18-27 m, coralline, Alcyonarian; 8 Mar: *A. floridanus*.

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20. Aguadulce; 24 Apr 1971: *A. martini* (20-6).
23. Venado Beach; 25 Apr 1971: *A. panamensis* (23-1, 23-2), *A. scopulus* (23-1).
25. Punta Paitilla Beach; 26 Apr 1971: *A. panamensis* (25-3), *A. cristulifrons* (25-1), *A. canalis* (25-3).
32. Perlas Islands; 30 Apr 1971: *A. lottini*, *A. cristulifrons*.
33. Pedro Gonzales, Perlas Islands; 30 Apr 1971: *A. websteri* (33-4), *A. lottini* (33-4), *A. cristulifrons* (33-4), *A. paracrinus* (33-4).
37. Chapera, Perlas Islands; 1 May 1971: *A. lottini*.
38. Chapera, Perlas Islands; 1 May 1971: *A. hebes* (38-1).

39. Chapera, Perlas Islands; 1 May 1971: *A. lottini*, *A. cristulifrons*.
40. Chapera, Perlas Islands; 1 May 1971: *A. hebes*.
41. Perlas Islands, Isla Pajaros, northeast of cove, behind east point, shore; intertidal rocks and sand beach, intertidal sandstone caves; sieve, poison, hand nets; 3:00–5:00 P.M., 1 May 1971, collected by R.B. Manning, M.L. Jones, J. Rosewater, and C.A. Child.
- 41-1. In and under intertidal rocks and poison station: *A. canalis*, *A. hyeyoungae*.
42. Perlas Islands, Pajaros; 1 May 1971: *A. cristulifrons*.
52. Just east of Punta Paitilla; cobbles, mud, shell, marl; water temperature, 29.8°C; hand; 3 Nov 1971.
- 52-1. Association with rocks at mean low tide: *A. panamensis*.
- 52-2. Association with mud overlying sandy mud: *A. antepaenulitimus*.
54. Venado Beach, east end, 5 transects each following rising tide; sand, rocks, pools; water temperature, 30.5°C; hand; 4 Nov 1971: *A. panamensis*, *A. scopulus*.
56. Farfan Point, muddy sand flats, 6 transects; sand, sandy mud, pools; salinity 27‰; low flood hand; 5 Nov 1971: *A. bouvieri* (56-1), *A. tenuis*, *A. martini* (56, 56-6).
58. Old French Fort Reef, transects; rock, silt, sandy gravel; water temperature, 32°C; hand; 6 Nov 1971: *A. panamensis* (58-4), *A. canalis* (58, 58-4), *A. scopulus* (58, 58-4), *A. martini* (58, 58-4).
59. Taboguilla Island, north shore, east beach; rocks, sand; water temperature, 28.8°C; salinity 27.5‰; depth 0–0.6 m; hand; 7 Nov 1971: *A. bouvieri*, *A. canalis*.
- 59-2. Association with sand beach: *A. canalis*.
77. Miraflores Locks, upper east chamber; cement, hand; 17 Jan 1972.
- 77-3. On lock bottom and under rocks: *A. firmus*.
82. By Naos Island, southeast side of Perico Island; rocks; depth 0–0.9 m; hand; 12 Apr 1972: *A. hebes* (82-A).
84. Punta Paitilla; rocks, sand, pools; water temperature, 26.2°C; depth, tidal; hand, sieve; 13 Apr 1972: *A. canalis* (84-B), *A. scopulus* (84-B).
85. Farfan Point flats; 9 substations; muddy, sand; water temperature, 26.5°C; salinity 30.0‰; tidal; hand, sieve; 14 Apr 1972: *A. longinquus* (85-9).
86. Venado Beach; rocky intertidal with sand; water temperature, 26.6°C; salinity 34‰; depth, tidal; hand, sieve; 15 Apr 1972: *A. panamensis* (86-4), *A. hyeyoungae* (86-4), *A. scopulus* (86-4).
87. Miraflores Locks; third lock drainage ditch; rock, water temperature, 28.5°C, salinity 10‰; depth, 0.3 m; hand, poison; 16 Apr 1972.
- 87-3. Mainly crustaceans collected from beyond outlet after poisoning for fishes: *A. hamus*.
88. Venado Beach; sand and rock spit; 7 substations; water temperature, 27.7°C; salinity 34‰; depth, 0–0.6 m; hand, poison; 16 Apr 1972: *A. panamensis* (88-2, 88-4), *A. hebes*, *A. scopulus* (88-4).
92. Casa de Putas Reef; sand, rock, pools; water temperature, 28.0°C; salinity 34‰; depth, 0–1 m; capture by hand, sieve, poison; 18 Apr 1972: *A. panamensis* (92-1), *A. canalis* (92-5), *A. scopulus* (92-5).
105. Naos Island; Pilot Pier area; bottom, rock, mud, sand; water temperature, 27.8°C; salinity 26.2‰; depth, tidal; capture by sieve; 1 Nov 1972: *A. bouvieri*.
106. Naos Island causeway, southeast of STRI lab; bottom, rocky; water temperature, 28.0°C; salinity 29.0‰; depth, 0–1 m; capture by poison; 1 Nov 1972: *A. hebes*, *A. canalis*.
107. Punta Paitilla; bottom, rock, mud, sand; water temperature, 27.8°C; salinity 30.0‰; depth, 0–1 m; capture by sieve, poison; 2 Nov 1972: *A. bouvieri* (107-1), *A. hebes*, *A. longinquus* (107, 107-1), *A. canalis* (107-1).
108. Fort Kobbe Beach, southwest end, 8 substations; bottom, rock, mud, sand; water temperature, 27.8°C; salinity 30.0‰; depth, 0–1 m; capture by hand, sieve, poison; 3 Nov 1972: *A. panamensis* (108-7), *A. bouvieri* (108-2, 108-7), *A. canalis* (108-7), *A. scopulus* (108-7), *A. martini* (108-7).
111. Venado Beach, sandbar to island; bottom, rock, sand; water temperature, 28.8°C; salinity 29.0‰; depth, tidal; capture by hand, sieve, poison; 5 Nov 1972: *A. panamensis* (111-4), *A. canalis* (111-4), *A. martini* (111-4).
113. Farfan Point; bottom, rocks; depth, tidal; capture by hand, poison; 7 Nov 1972: *A. bouvieri* (113-1), *A. canalis* (113-2), *A. scopulus* (113-2), *A. martini* (113-1, 113-2, 113-5-b).
- 129 (=1602). Punta Paitilla, east side; bottom, rock, pools; water temperature, 27.0°C; salinity 34‰; depth, 0–1 m; capture by hand, sieve, poison; 1 Apr 1973, collected by Newman, Dawson, Jones: *A. panamensis* (129-2-b), *A. canalis*, *A. scopulus* (129 (=1602), 129-2-b), *A. firmus*.
130. Miraflores Locks; spillway between dam and bridge, 5 substations; bottom, pools; water temperature, 27.5°C; salinity 18–13‰; depth, 0–1 m; hand, sieve, poison; 2 Apr 1973.
- 130-2-b. Tide pools: *A. firmus*.
131. Naos Island; bottom, mud, sand, pools; water temperature, 28.0°C; salinity 30‰; depth, tidal; capture by hand, poison; 3 Apr 1973.
- 131-1. "Scout" Island: *A. canalis*.
- 132 (=1607). Venado Beach sand spit toward island, 5 substations; bottom, sand, mud, rocks; water temperature, 28.7°C; salinity 34‰; depth, 0–1.3 m; capture by hand, sieve, poison; 4 Apr 1973: *A. panamensis* (132-1-c), *A. floridanus* (132-2), *A. scopulus* (132 (=1607), 132-1-c), *A. tenuis*.
133. Whorehouse Reef, off French Fort, 5 substations; bottom, sand, rock; water temperature, 30.2°C; salinity 33‰; depth, 0–1 m; capture by hand, sieve, poison; 5 Apr 1973.
- 133-5-b. Tide pools: *A. panamensis*, *A. canalis*, *A. scopulus*, *A. tenuis*, *A. martini*.
134. Farfan Point Beach, 5 substations; bottom, sand, rock; water temperature, 27.6°C; salinity 32‰; depth, 0–2 m; capture by hand, sieve, poison; 6 Apr 1973: *A. scopulus* (134-1-d).
141. Naos Island causeway, northeast area, 3 sta.; capture by trawls; 10 Apr 73: *A. floridanus* (141-A), *A. antepaenulitimus* (141-A, 141-B).
150. Stations east of Panama Canal channel; depth, 3.9–6.3 m; capture by dredge and trawl; 19 Apr 1973.
- 150-A. 08°53'28"N, 79°33'20"W, 3.9 m: *A. floridanus*.
- 150-C. 08°52'40"N, 79°35'02"W, 4.5 m: *A. floridanus*.
161. Five boat stations of west of Panama Canal; probably 4–7 m, dredge and trawl; 9 Nov 1973.
- 161-1. 08°54'12"N, 79°33'07"W, near Panamarca Rock: *A. normanni*.
- 161-2. 08°53'49"N, 79°33'48"W, southeast of Batele Point: *A. normanni*.
166. Whorehouse Reef, 08°57'04"N, 79°31'38"W; sand; water temperature, 27.5°C; salinity 24‰; 0–1 m; hand, sieve, poison; 13 Nov 1973: *A. panamensis* (166-1), *A. scopulus* (166-1).
203. Miraflores Locks, upper chamber, 08°59'92"N, 79°35'72"W: *A. firmus* (5-U-M-F).

### Other Stations

1523. Panama; Venado Beach, about  $\frac{3}{4}$  way to Venado Island; tidepools and streams on either side of connecting sandbar; small rocks, sandy silt bottomed pools, sandy streams; ichthyocide; water temperature, 28°C;

- salinity 30.2‰; depth, 0–0.6 m; ebb to low flood tide; 16 Jan 1972, collected by C.E. Dawson: *A. scopulus*.
1531. Panama, northeast end of causeway to Naos Island; 08°56'07"N, 79°32'47"W; gravel and sand bottom; ebb-low tide; 24.5°C, 33.5‰, ichthyocide, collected by C.E. Dawson: *A. martini*.
1551. Mexico; Sonora, Los Algodones north of Guaymas, about 1.0 km north of airstrip; rock and pebble beach grading to sand; low-flood tide; water temperature, 30.0°C; salinity 35.0‰; depth, 0–0.6 m; capture by ichthyocide; 14 Jul 1972, collected by Dawson and Child: *A. hebes*, *A. canalis*.
1558. Mexico; Nayarit, northeast beach of Isla Jaltimba, off Rincon de los Guayabitos; rock and coral sand beach; flood tide; depth, 0–1.3 m; capture by ichthyocide; 22 Jul 1972, collected by Dawson and Child: *A. sulcatus*, *A. canalis*, *A. hyeyoungae*.
1559. Mexico; Jalisco, Bahia Cuastecomate, north of Barra Navidad; fine sand, rock; flood tide; water temperature, 32.0°C; depth, 0–1.0 m; capture by ichthyocide; 25 Jul 1972, collected by Dawson and Child: *A. malleator*.
1564. El Salvador; La Union, Los Maquilis, west of Punta Amapala, 13°08'55"N, 87°55'40"W; rock, sand, tidepools; low flood; depth, 0–0.6 m; capture by ichthyocide; 8 Aug 1972, collected by Dawson and Child: *A. canalis*.
1566. Costa Rica; Guanacaste, Playa del Coco, 1st beach south of town; rock, sand beach, tidepools; ebb-flood tide; depth, 0–1.0 m; capture by ichthyocide; 11 Aug 1972, collected by Dawson and Child: *A. websteri*, *A. panamensis*, *A. sulcatus*, *A. paracrinitus*, *A. canalis*, *A. hyeyoungae*.
1567. Costa Rica; Puntarenas, Golfo de Nicoya, Isla Tolinga; sand beach, rock outcrops; ebb-flood tide; depth, 0–1.0 m; capture by ichthyocide; 12 Aug 1972, collected by Dawson and Child: *A. websteri*, *A. malleator*, *A. panamensis*, *A. sulcatus*, *A. cristulifrons*, *A. hyeyoungae*.
- LGA 68-27. Panama, Pacific; Punta Paitilla, Panama City; low tide, rock and mud; 7 Dec 1968, collected by L.G. Abele, Focion, and Soler: *A. distinctus*, *A. martini*.
- LGA 69-29. Panama, Pacific; Panama City—end of Balboa Blvd beyond A. Einstein Institute next to the sewer plant; slime mud rock; 17 Feb 1969, collected by L.G. Abele: *A. panamensis*, *A. distinctus*.
- LGA 69-33. Panama, Pacific; Bay of Panama; off west side of Taboguilla Island; depth, 2 m; water clear, coral bed; formalin washing; 7 Apr 1969, collected by L.G. Abele and A.F. Rodaniche: *A. lottini*, *A. panamensis*.
- LGA 69-35. Panama, Pacific; Bay of Panama; west side of Taboguilla –73 m from small dock on coral reef bed; depth 1.8–6 m; 11 Apr 1969, collected by L.G. Abele, J. Graham, and A.F. Rodaniche: *A. lottini*.
- LGA 69-41. Panama; Bay of Panama; under bridge (Pan American) at entrance to Panama Canal, west side; mud shell bottom; barnacles, oysters and sponges on rocks; 16 Apr 1969, collected by L.G. Abele, and N. Powell: *A. canalis*.
- LGA 69-42. Panama, Pacific; entrance to Panama Canal; Rodman Naval Station on dock, workers removing old wooden pilings covered with oysters, barnacles, bryozoa and sponges; 17 Apr 1969, collected by L.G. Abele: *A. panamensis*.
- LGA 69-49. Panama, Pacific; Kobbe Beach towards Vera Cruz, not swimming beach; Ft. Kobbe, sandy beach into coarse sand-mud with rock outcroppings; low tide; 8 May 1969, collected by L.G. Abele and A. Clarke: *A. martini*.
- LGA 69-55. Panama, Pacific; Isla de Chopilla; intertidal solid flow rock and very little mud and crushed shell side towards land mass in front of church on sides; low tide; 26 May 1969, collected by L.G. Abele: *A. canalis*.
- LGA 69-64. Panama, Pacific; Punta Paitilla; out from sandy beach towards water line at low tide; tide pool green algae stingy type, quinone poison rocks present, coarse sand bottom; 1 Jul 1969, collected by L.G. Abele and J. Graham: *A. canalis*, *A. panamensis*.
- LGA 72-1. Panama, Pacific; Ft. Amador causeway to Naos Island, east side ~800 m from Naos; pile of rocks exposed at low tide, somewhat similar to Paitilla; salinity 30‰ in small pool; rocks, sand, rubble and mud: *A. canalis*.
- LGA 72-3. Panama, Pacific; Ft. Amador causway to Naos Island, east side ~800 m; pile of rocks exposed at low tide; 7 Nov 1972: *A. canalis*.
- LGA 73-8. Panama, Pacific; Gulf of Panama, Los Perlas Archipelago, Pajaro Island; along intertidal, *Alpheus* under rock; 6 Jan 1973: *A. canalis*.
- LGA 73-60. Costa Rica; Wafer Bay, Isla del Coco; marine intertidal rocks, algae mud, tide pools, poisoned tide pools; 14 Aug 1973, collected by L.G. Abele, P.J. Campanella, K. Millard, and J. Graham: *A. canalis*, *A. villus*.
- LGA 74-1. Panama, Pacific; Punta Paitilla; –2.6 tide, at lowest tide; 10 Jan 1974: *A. panamensis*, *A. scopulus*.
- LGA-P-71-5. Panama, Pacific side; Diablo Heights, public boat ramp; mangrove area; much mud-clay; "crab tunnels" present and well developed; sample from exposed pool in swamp; salinity 22.4‰, temperature 27.9°C; 25 Jan 1971, collected by L.G. Abele and T. Biffar: *A. latus*.

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