BENTHIC MARINE AMPHIPODA OF SOUTHERN CALIFORNIA: FAMILIES AORIDAE, PHOTIDAE, ISCHYROCERIDAE, COROPHIIDAE, PODOCERIDAE[1]

By J. Laurens Barnard

Introduction

This report continues the description of the benthic amphipod fauna on the coastal shelf of southern California, based on collections in the Allan Hancock Foundation gathered during a survey of the offshore benthos under support of the California State Water Pollution Control Board. Other families have been considered in Barnard (1954, 1957, 1958a, 1958b, 1959a, 1959b, 1960, 1960a) and Barnard & Given (1960).

The samples were collected in depths of 5 to 100 fathoms from Pt. Conception to the northern border of Mexico, using an orange-peel grab of 0.25 square meters areal capacity. About 500 samples have been examined, and of these 348, covering the 1061 square miles of shelf and slope in the area, form a proportionate grid from which can be calculated the density per square meter of each species in depth classes, sediment classes and communities.

Intertidal amphipods of the area are still so imperfectly known that where advantageous they have been considered in order to bring together all the information of each genus in the area. Collections of intertidal Amphipoda were made by the writer and by others to whom acknowledgment is made in the lists of materials. Full reports on intertidal Amphipoda and additional families of benthic Amphipoda are being prepared, and are to be followed by an ecology of southern California Amphipoda, once the taxonomy has been completed.

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I am indebted also to Mrs. Dorothy M. Halmos, head librarian at the Allan Hancock Library, University of Southern California for the use of that fine reference collection; to Dr. Olga Hartman of U.S.C. for her continued interest in my amphipod work; and to Mr. G. F. Jones and Mr. R. R. Given who helped collect and process many of the samples.

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The drawings signed DMc were made by Mrs. D. McLaughlin under the writer's supervision; those signed LH were made by Mr. Lawrence Hauben; and unsigned drawings were made by the writer but inked and arranged by Mrs. McLaughlin.

See J. L. Barnard (1961: 178) for a list of communities from which amphipods are cited herein.

Authors, dates, and references to names of genera and species not specifically cited herein may be found in J. L. Barnard's (1958) Index to the Gammaridea.

Statistics concerning precise depth distribution on the coastal shelf of southern California are quoted in fathoms because the original plotting systems were based on U. S. maps which utilize fathoms. Records from the literature are usually quoted in meters.

Types are deposited at the Allan Hancock Foundation.

Family AORIDAE

As explained below (c.f. Photidae) I am transferring *Neomegamphopus* Shoemaker (1942) to the Aoridae. The genus differs little from *Microdeutopus* except for the greater depth of insertion of the second antennae and the more setose second gnathopods. It is also closely related to *Coremapus*, differing by the second antennae and the proportions of gnathopods as seen in the following key. *Hansenella* is a genus based on a female having gnathopods like those of male *Microdeutopus* and may simply be an aberrant specimen. *Coremapus* scarcely differs from *Microdeutopus*, except for the highly setose second gnathopods. The use of these minor differentiating criteria must be firmly established by more thorough examination of morphological detail in the species now described.

In addition to those discussed herein the following species of this family from California have been reviewed recently: *Acuminodeutopus heteruropus* J. L. Barnard (1959 and 1961); *Aoroides columbiae* Walker (J. L. Barnard 1959 and 1961); *Microdeutopus schmitti* Shoemaker (J. L. Barnard 1959 and 1961); *Rudilemboides stenopropodus* J. L. Barnard (1959 and 1961).

KEY TO MALE AORIDAE OF THE WORLD

1. Article 4 of gnathopod 1 produced into a long tooth 2
1. Article 4 of gnathopod 1 not produced 4
2. Uropod 3 uniramous ..... *Paraoroides*
2. Uropod 3 biramous 3
3. Accessory flagellum long, composed of 3 or more articles ..... *Aora*
3. Accessory flagellum absent ..... *Aoroides*
4. Article 5 of gnathopod 1 with a strong distal tooth 5
4. Article 5 of gnathopod 1 lacking a strong distal tooth 11
5. Uropod 3 uniramous ..... *Neomicrodeutopus*
5. Uropod 3 biramous 6

6. Gnathopod 1 of both sexes alike ..... *Hansenella*
6. Gnathopod 1 differing in each sex 7
7. Gnathopod 2 heavily setose on anterior edge of article 5 8
7. Gnathopod 2 sparsely setose on anterior edge of article 5 10
8. Article 6 of gnathopod 1 as long and broad as article 5 ..... *Lembopsis*
8. Article 6 of gnathopod 1 shorter and narrower than article 5.... 9
9. Article 5 of gnathopod 2 longest; female gnathopod 1 simple ..... *Neomegamphopus*
9. Article 6 of gnathopod 2 longest; female gnathopod 1 subchelate ..... *Coremapus*
10. Inner ramus of uropod 3 less than half as long as outer ramus ..... *Acuminodeutopus*[2]
10. Rami of uropod 3 subequal ..... *Microdeutopus*
11. Rami of uropod 3 minute, less than half as long as peduncle 12
11. Rami of uropod 3 not minute, as long as or longer than peduncle 13
12. Pleon segment 6 dorsally evanescent ..... *Dryopoides*
12. Pleon segment 6 not evanescent ..... *Paradryope*
13. Gnathopod 1 with article 6 equal to or greater in length and breadth than article 5 14
13. Gnathopod 1 with article 6 shorter and narrower than article 5 15
14. Gnathopod 2 strongly setose, its article 5 bulbous ..... *Xenocheira*
14. Gnathopod 2 usually moderately setose, its article 5 not bulbous ..... *Lembos*
15. Gnathopods fully subchelate ..... *Lemboides*
15. Gnathopods scarcely subchelate ..... *Rudilemboides*[2]

Genus **Lembos** Bate

Lembos audbettius, new species

Fig. 1

DIAGNOSIS OF MALE: Lateral lobes of head broadly and shortly produced; coxa 1 produced forward strongly; article 5 of gnathopod 1 short, cup-shaped, article 2 sublinear but stout, the anterior and posterior edges parallel, the palm transverse, excavated near defining corner, thus producing a long tooth which reaches palmar line; palm between excavation and finger hinge slightly produced and slightly bilobed; article 7 scarcely overlapping palm, bearing an inner bulge near finger hinge; peraeonal sternites 2-7, each with a tooth.

FEMALE: Unknown.

HOLOTYPE: AHF No. 5717, male, 3.8 mm.

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[2]See J. L. Barnard (1958) for a list of genera and add the following: *Acuminodeutopus* J. L. Barnard (1959); *Rudilemboides* J. L. Barnard (1959).

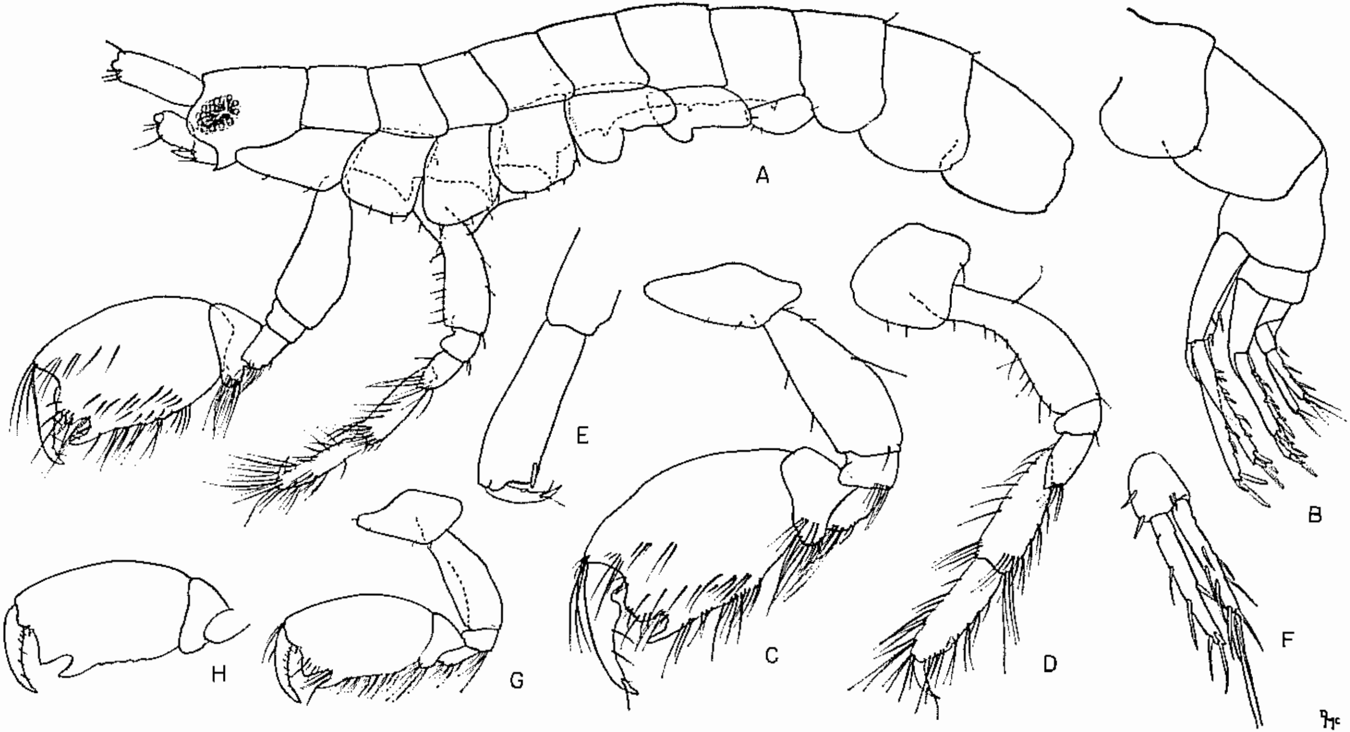

Fig. 1. *Lembos audbettius*, n. sp. Male, holotype, 3.8 mm, sta. 5167: A, lateral view, peraeon and mesosome, minus antennae and peraeopods; E, end of gnathopod 2. Male, 3.5 mm, sta. 5166: B, urosome; C,D, gnathopods 1, 2; F, uropod 3. Young male, 3.0 mm, sta. 5585: G,H, gnathopod 2.

TYPE LOCALITY: Station 5167, off Santa Barbara, 34-21-40 N, 119-40-40 W, 30 fms, July 3, 1957, bottom of green clayey, silty sand.

MATERIAL: 9 specimens from 6 stations.

RELATIONSHIP: This species belongs to the (*Bemlos*) section of the genus *Lembos* in which the fifth article of gnathopod 1 is short and cup-shaped. The species differs from *Lembos hirsutipes* Stebbing (Stebbing 1906) by the absence of a brush of long setae on the distal end of article 2 on male gnathopod 1. It differs from *L. gambiense* Reid (1951) by the subchelate, but not chelate second gnathopod. It differs from *L. kergueleni* Stebbing (1888) by the unexpanded second article of gnathopod 2 and its poorly subchelate condition. This species differs from *L. macromanus* (Shoemaker 1925) and *L. intermedius* Schellenberg (1938) by the first male gnathopod of which the hand (article 6) has its anterior and posterior edges parallel, not convex; it differs especially from *L. macromanus* by the presence of 6 sternal peraeonal teeth, (2 in *L. macromanus*) and the larger eyes. *Lembos audbettius* differs from its generic partner in southern California, *L. concavus* (to follow) by the presence of sternal peraeonal teeth on the male.

Because the writer has not seen females of this species in company with males it is possible that females have been mistakenly identified as some other aorid, particularly *Rudilemboides stenopropodus* J. L. Barnard (1959) or *Aoroides columbiae* Walker.

ECOLOGY: This rare species has a density of 0.1 specimens per square meter on the coastal shelf. It ranges in depth from 20 to 50 fms.

Lembos concavus Stout

Fig. 2

Lembos concavus Stout 1913: 651-653; Shoemaker 1941: 187.

DIAGNOSIS: Coxa 1 acutely produced forward anteriorly but not strongly; male gnathopod 1 with article 5 more than half as long as article 6, the latter rather linear and distally expanding only slightly, the palm short, nearly transverse, bounded by an excavation which is guarded by a short tooth not projecting distally as far as the palm, article 7 overlapping the palm, strongly serrated on inner edge, the lower hind edge of article 2 not bearing a large tuft of setae, the anterior edge of article 6 heavily setose; article 2 of gnathopod 2 with anterodistal conical projection, the appendage rather stout, the palm oblique, undefined by a tooth; rami of uropod 3 longer than peduncle; ventrum of peraeon without distinct teeth, a remnant of one being present on peraeon segment 2.

FEMALE: Coxa 1 quadrate in front; gnathopod 1 as large as that of male, the palm quite oblique, not excavated, guarded by a large spine; palm of gnathopod 2 nearly perfectly transverse.

MATERIAL: 6 specimens from 4 stations.

RELATIONSHIP: This species is closely related to *Lembos aequimanus* Schellenberg (1938), but differs by the female first gnathopod having a

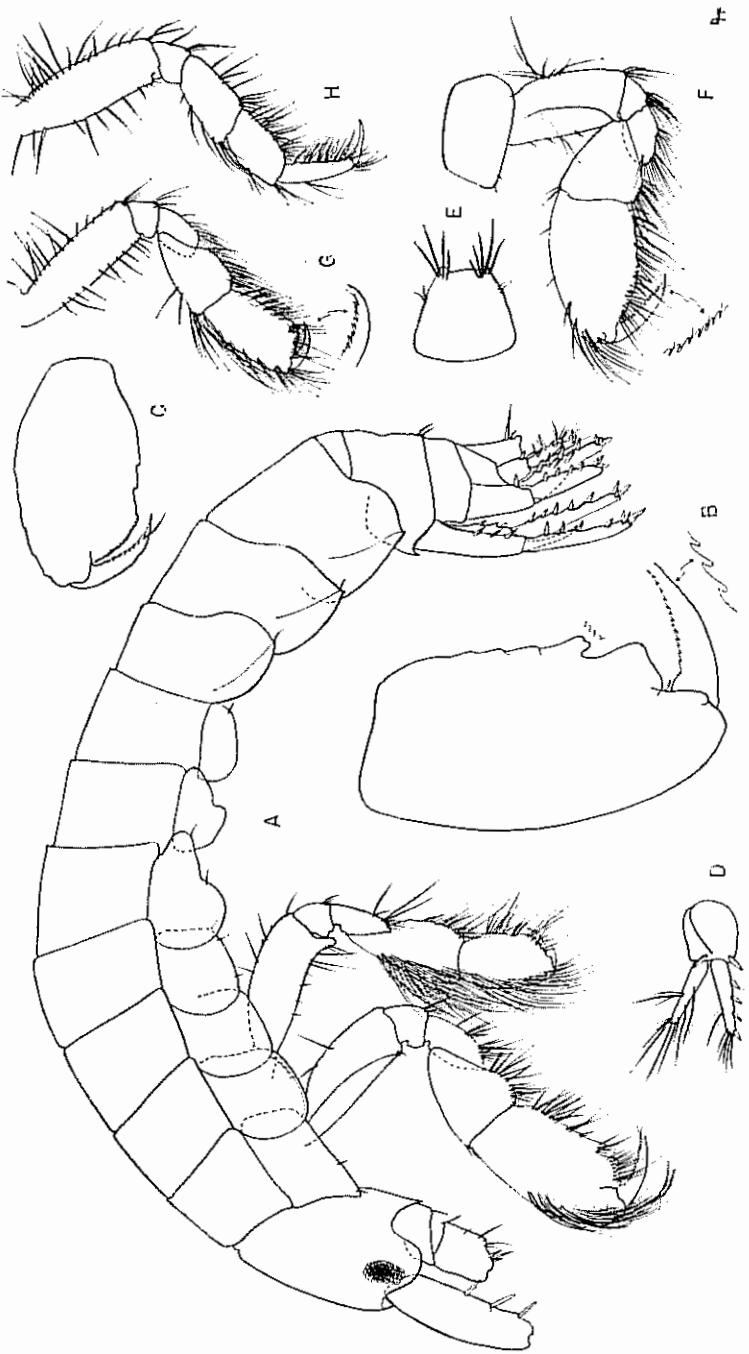

Fig. 2. *Lembos concavus* Stout. Male, 6.0 mm, sta. 5562: A, lateral view, minus antennae and peraeopods; B, enlargement of gnathopod 1, palmar tooth broken; C, gnathopod 2; D, uropod 3; E, telson. Female, F,G, gnathopods 1, 2; H, peraeopod 1.

uniformly convex palm, whereas *L. aequimanus* has a concave palm with a medial process. *Lembos concavus* differs from *L. smithi* Holmes (1905) by the more linear sixth article of gnathopod 1, the more transverse palm, and the anteriorly acute first coxa. It differs from *L. leptocheirus* Walker (1909) by the much stouter second gnathopod of the male and stouter first gnathopod of the female.

Lembos concavus bears close relationship to *L. intermedius* Schellenberg (1938) and *L. processifer* Pirlot (1938), two species indistinguishable from each other except by the acute first coxa of *L. intermedius*. *Lembos concavus* differs from both by the nearly parallel edges of article 6 of gnathopod 1; the other two species have a rather convex anterior edge.

Only a single male is present in the collections, and the first gnathopod is partially broken where marked in the figures.

ECOLOGY: The occurrence of this species on the coastal shelf below a depth of 5 fms is negligible. Apparently it is a species living on algal bottoms shallower than that depth. Females of this species are easily confused with those of *Aoroides columbiae* and the writer suspects that a number of specimens of this species lie undetected with the samples of *Aoroides columbiae* in the collections of the Hancock Foundation.

Lembos macromanus (Shoemaker)

Fig. 3

Bemlos macromanus Shoemaker 1925: 36-41, figs. 10-13.

MATERIAL: Estero de Punta Banda, near Ensenada, Baja California, March 23, 1951, coll. Dr. J. L. Mohr (20 specimens).

REMARKS: Growth stages of male first gnathopods are drawn for comparison with the other species of *Lembos* described herein.

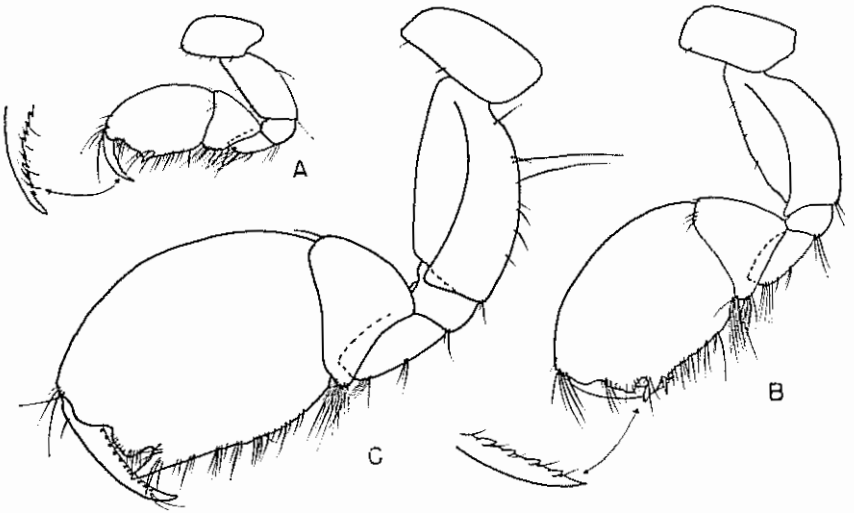

Fig. 3. *Lembos macromanus* (Shoemaker). Estero de Punta Banda. Gnathopod 1: A, male, 3.8 mm; B, male, 6.0 mm; C, male 7.0 mm.

Neomegamphopus roosevelti Shoemaker 1942: 36-38, fig. 13.

MATERIAL: Sta. 5605, off the Mexican Border, 32-33-10 N, 117-13-15 W, 23 fms, February 18, 1958, bottom of coarse, rust-colored sand.

The single specimen at hand represents the most northern record of the species described from Magdalena Bay and Cape San Lucas, Baja California; its absence from the remainder of southern California indicates its northern limit is at the Mexican border.

Family PHOTIDAE

A revision of the Photidae is required because so many species described since Stebbing's (1906) monograph represent intergradations among the genera then existing.

In my 1961a paper I pointed out the problems regarding *Podoceropsis* and *Bonnierella*. With the description herein of a presumed species of *Eurystheus* which previously would be recognized as a *Podoceropsis* I have seen that the genera *Eurystheus* and *Megamphopus* are also tied into this confusion. The accompanying key to the Photidae is the best way to explain the relationships of the genera.

The characters which have been used in past definitions of photid genera represent mostly those subject to quantitative variation, either in number of segments on the accessory flagellum, in the degree of simpleness or subchelation of gnathopods, or in the relative length and expansion of gnathopodal articles.

In Stebbing's (1906) time these criteria were easy to use in separating the few known genera, but today many more species of intergrading character are known. Now we find that species of *Cheiriphotis* progressively lose one ramus of uropod 3 with age. Previously we had been able to separate genera by the presence or absence of accessory flagella on antenna 1, but now we find variations ranging from no accessory flagellum, to a single scale, to one, two, three and more (up to 8 or 9) articles on the accessory flagellum.

I consider that the loss of the accessory flagellum in amphipods is a mark of specialization and that generally in any phylogenetic sequence the possession of an accessory flagellum marks the more primitive or ancestral condition.

We may envision that the very diverse and widespread genus *Eurystheus* bearing a well-developed accessory flagellum of three or more articles, represents a concept of the root stock. The progressive loss of articles, below 3, forms a strange sequence in that it passes through the genera *Bonnierella* and *Megamphopus* as previously recognized. These genera contain species now to be assigned to *Megamphopus* (3 species of deep-sea blind amphipods plus a number of shallow water species previously assigned to the genus *Podoceropsis*); all of these organisms bear an accessory flagellum of one long article tipped with a small one. The next stage is represented by a new genus to be described, based on *Podoceropsis kermadeci*, which bears only a scale in place of an accessory flagellum.

The final stage is the revised genus *Podoceropsis*, composed of shallow water species lacking any vestige of an accessory flagellum.

To separate genera at a point in the middle of serial gradation is artificial and can be justified only by the fact that a group of species to be assigned to *Megamphopus* is clearly marked with a 2-articulate flagellum composed of one long article and one short. Such an accessory flagellum is quite distinct and marks a commonly repeated stage in the progressive loss of flagellar articles. That such loss is probably polyphyletic in origin attests to the artificiality of orthodox Linnean systematics in this case. Hence generic separation is useful only as a means of identification.

The close relationship of some species of *Eurystheus* to *Megamphopus* is seen in *E. monodi* Schellenberg (1931) and a new species of *Eurystheus* to be described herein, both having an accessory flagellum composed of two long articles and one short.

The arrangement of these genera according to the condition of the accessory flagellum does not reflect their direct phylogenetic relationships, but marks several artificial assemblages of animals, probably having reached the same morphological condition from several independent sources. The writer envisions that species of *Megamphopus* represent independent origins from ancestors like *Eurystheus* in which the previously long accessory flagellum has become reduced to its present condition. The diversity in *Megamphopus* is remarkable, the genus being composed of such animals as the following: *Eurystheus palmata* (see *E. nana*, Sars 1895, pl. 199, fig. 2) with long coxae, male gnathopods having short fifth articles and well developed palms; *Megamphopus cornutus* (see Sars 1895, pl. 200) with intermediate sized coxae, male gnathopods having elongated fifth articles and poorly developed palms; and *Podoceropsis dubia* Shoemaker (1942) with short coxae, male gnathopods having short fifth articles and poorly developed palms.

Nevertheless, it is not justifiable to segregate species into genera based on different assortments of these criteria, for there are too many possibilities and too many intergradations. We have to remember that we are attempting to simplify the taxonomic arrangement for clarity at the expense of a systematic arrangement. I do not believe it is possible to treat these genera in a Linnaean sense, unless one were to fuse all of the mentioned genera into one. A true systematic arrangement would have to be made on a family tree basis, by placing species of a single genus on different branches and showing their distinct origins.

A reduction or modification of coxae occurs frequently with the reduction in accessory flagella; many species assigned now to *Megamphopus* and *Podoceropsis* show this, but it is far from universal, and our attention is again directed to the several evolutionary stages that these animals have reached and which do not lend themselves readily to Linnean distinction.

The third uropod is another criterion subject to diversity and is

particularly marked in the new species of *Eurystheus* to be described. This modification of third uropods, with shortened rami, coupled with an accessory flagellum that forms the practical boundary between *Eurystheus* and *Megamphopus*, suggests again the difficulty in designating genera, but it does not necessarily indicate the fusion of genera, for it is permissible to have a small percentage of intergrading species and continue to segregate genera. The short third uropodal rami of the new species of *Eurystheus* suggest identification with the monotypic genus *Bathyphotis*, but the new species can be distinguished from *Bathyphotis* by its first maxillae having the normal 9 spines of the outer plate. The presence of only 4 blunt, non-bifurcate spines on the first maxilla of *Bathyphotis* is the only criterion useful for the distinction of *Bathyphotis* from *Eurystheus*. Until the discovery of the new species to follow the short rami of the third uropod would have been useful. I feel it necessary to keep genera distinct wherever possible for ecological reasons, and *Bathyphotis* is a bathyal species with a related morphological difference, minor as it is.

Although the above paragraph is applicable as long as *Bathyphotis* and the new species of *Eurystheus* to be described remain in the family Photidae, it should be considered that both probably belong in the Ischyroceridae, as will be discussed under that family below.

The elongation of article 5 in male gnathopod 1 is not useful for generic separation since it appears both in *Eurystheus* (e.g. *E. hirsutimanus* Reid 1951) and in *Megamphopus* (e.g. *M. cornutus*). A similar elongated fifth article on male gnathopod 2 was used in defining the genus *Pseudeurystheus*.

If permitted to stand, *Pseudeurystheus* weakens the workability of the arrangements proposed herein. The type species, *P. litoralis* Schellenberg (1931), enjoins a 3-articulate accessory flagellum with a greatly elongated fifth article on the second male gnathopod, a combination not present in the other genera mentioned above. *Megamphopus blaisus* K. H. Barnard (1932) also bears a second male gnathopod similar to *Pseudeurystheus* but has only a bi-articulated accessory flagellum, like *Megamphopus*. Thus, we have the conflict of opinions: apparently K. H. Barnard was willing to broaden the definition of *Megamphopus* to include animals with such gnathopods, yet Schellenberg was not willing to broaden the genus *Eurystheus* for other animals with such gnathopods. We have to make a choice, (1) to broaden the limits of existing genera to admit these two species, perhaps by establishing them as subgenera in their respective places; (2) to bring them together into the same genus, by so doing putting two animals together, one with a bi-and one with a tri-articulate flagellum; (3) to erect a new genus for *M. blaisus*, in which case one could choose to assign it as a subgenus of *Pseudeurystheus*. Here we have to weigh the importance of accessory flagella against proportions of gnathopodal articles; unfortunately, neither is of more than minor significance, qualitatively.

Since there are other species of *Eurystheus* with gnathopods tending to have elongated fifth articles such as *E. dimorphus* K. H. Barnard (1932), *E. thompsoni* (Walker 1898), and *E. maculatus* (Johnston, see Sars 1895: pl. 198), it would seem more logical to assign *Pseudeurystheus* as a subgenus to *Eurystheus* and assign *Megamphopus blaisus* to a new subgenus in *Megamphopus*. Although this course is herein consummated, I believe that *P. litoralis* and *M. blaisus* are more closely related to each other as a pair of species than to their respective mega-genera and may have had a common origin, since both live in the southern hemisphere. In this case I choose to facilitate ease of identification from a taxonomist's standpoint in contrast to the interests of systematists. If after most photids have been described, strong intergradation of species has not been discovered, then I believe that *P. litoralis* and *M. blaisus* can be returned to a segregated genus *Pseudeurystheus* to point out their common origin.

Although Shoemaker (1942) assigned his genus *Neomegamphopus* to the Photidae because its mouthparts were similar to *Megamphopus*, already in that family, I find it necessary to remove the genus to the family Aoridae; indeed the mouthparts are not different from those of *Aora*, the type genus of *Aoridae*. If *Neomegamphopus* were to be admitted to the Photidae it would require fusion of the Aoridae and Photidae. No doubt parallel evolution has provided many similarities in mouthparts and other criteria among various aorids and photids, but enlarged first gnathopods of Aoridae still remain easily recognized characters and probably indicate some basic difference in axial gradients between the two groups.

In a forthcoming paper on amphipods of atolls in Micronesia the writer will consider that the genus *Audulla* Chevreux should be fused to *Eurystheus* Bate.

Before presenting descriptions of southern California photids it is necessary to offer the rearrangement and diagnoses of photid genera discussed above.

Genus Eurystheus Bate

DIAGNOSIS: Uropod 3 biramous, the rami biequal, usually longer than or subequal to peduncle; article 3 of antenna 1 as long as or longer than article 1, the accessory flagellum composed of 3 or more articles.

TYPE SPECIES: *Eurystheus tridentatus* Bate (= *Gammarus maculatus* Johnston) known as *Eurystheus maculatus* (Johnston).

KEY TO SUBGENERA OF EURYSTHEUS

1. Article 5 of male gnathopod 2 at least 1.6 times as long as article 6 ..... *Pseudeurystheus*

1. Article 5 of male gnathopod 2 subequal to or shorter than article 6 ..... *Eurystheus*

Subgenus **Eurystheus** Bate

DIAGNOSIS: *Eurystheus* with fifth article of male gnathopod 2 subequal to or shorter than article 6.

TYPE SPECIES: *Gammarus maculatus* Johnston.

LIST OF SPECIES: List remains the same as in Barnard (1958) except for the following removals, all to be transferred to the genus *Megamphopus*, s.s.

Eurystheus ctenurus Schellenberg
Eurystheus georgianus Schellenberg
Eurystheus kergueleni Schellenberg
Eurystheus longicornis Walker
Eurystheus palmatus (Stebbing and Robertson)

Subgenus **Pseudeurystheus** Schellenberg

DIAGNOSIS: *Eurystheus* with fifth article of male gnathopod 2 at least 1.6 times as long as article 6.

TYPE SPECIES: *Pseudeurystheus litoralis* Schellenberg.

LIST OF SPECIES: Unique.

Genus **Kermystheus**, new genus

DIAGNOSIS: Similar to *Eurystheus* but with accessory flagellum composed of a short, scale-like article.

TYPE SPECIES: *Podoceropsis kermadeci* Stebbing.

LIST OF SPECIES: The type species and a new species to follow.

Genus **Megamphopus** Norman, new synonymy

Megamphopus Norman, Stebbing 1906: 621.
Bonnierella Chevreux 1900: 97.

DIAGNOSIS: Like *Eurystheus* but the accessory flagellum composed of one or two articles only: usually a long article tipped with a small one.

TYPE SPECIES: *Megamphopus cornutus* Norman.

KEY TO SUBGENERA OF MEGAMPHOPUS

1. Second articles of peraeopods 3-5 with parallel edges .... *Bonnierella*
1. Second articles of peraeopods 3-5 with biconvex edges 2
   2. Article 5 of male gnathopod 2 at least 1.6 times as long as article 6 ..... *Segamphopus*, n. subg.
   2. Article 5 of male gnathopod 2 shorter than article 6 ..... *Megamphopus*

Subgenus **Bonnierella** Chevreux

DIAGNOSIS: *Megamphopus* with article 5 of male gnathopod 2 subequal to or shorter than article 6; second articles of peraeopods 3-5 with edges parallel.

TYPE SPECIES: *Podoceropsis abyssi* Chevreux.

LIST OF SPECIES:
Bonnierella abyssi (Chevreux)
Bonnierella abyssorum (Bonnier)
Bonnierella angoliae J. L. Barnard (1961a)

Subgenus **Megamphopus**, sensu stricto

DIAGNOSIS: *Megamphopus* with article 5 of male gnathopod 2 subequal to or shorter than article 6; second articles of peraeopods 3-5 with edges biconvex.

TYPE SPECIES: *Megamphopus cornutus* Norman.

Note: That *Podoceropsis lapisi* J. L. Barnard (1961a) is aberrant in its short rami of uropod 3 and is like the genus *Bathyphotis* in this respect.

LIST OF SPECIES:

Megamphopus cornutus Norman
Eurystheus ctenurus Schellenberg
Podoceropsis dubia Shoemaker
Podoceropsis elephantis K. H. Barnard
Eurystheus georgianus Schellenberg
Podoceropsis insignis Chilton
Eurystheus kergueleni Schellenberg
Podoceropsis lapisi J. L. Barnard (1961a)
Eurystheus longicornis (Walker)
Megamphopus longicornis Chevreux
Megamphopus longidactylus Chevreux
Megamphopus pachypus Schellenberg
Eurystheus palmatus (Stebbing and Robertson)

Subgenus **Segamphopus**, new subgenus

DIAGNOSIS: *Megamphopus* with article 5 of male gnathopod 2 at least 1.6 times as long as article 5; second articles of peraeopods 3-5 with edges biconvex.

TYPE SPECIES: *Megamphopus blaisus* K. H. Barnard (1932).

LIST OF SPECIES: Unique.

Genus **Podoceropsis** Boeck

DIAGNOSIS: Similar to *Eurystheus* but lacking an accessory flagellum.

TYPE SPECIES: *Podoceropsis sophiae* Boeck.

LIST OF SPECIES:

Podoceropsis angulosa Chevreux
Podoceropsis lindahli Hansen
Podoceropsis nitida (Stimpson)
Podoceropsis pusilla Chevreux
Podoceropsis similis Schellenberg
Podoceropsis sophiae Boeck
Podoceropsis inaequistylis Shoemaker (with missing first antenna)

KEY TO WORLD PHOTIDAE

1. Uropod 3 uniramous 2
1. Uropod 3 biramous 6
   2. Lateral head lobes and article 6 of peraeopods 1-2 elongated ..... *Ampelisciphotis*

2. Lateral head lobes and article 6 of peraeopods 1-2 not elongated 3
3. Gnathopod 1 simple ..... *Kuphocheira*
3. Gnathopod 1 subchelate 4
4. Antenna 1 with accessory flagellum 5
4. Antenna 1 lacking accessory flagellum ..... *Microphotis*
5. First four coxae similar in size and shape ..... *Microprotopus*
5. First four coxae of varying shapes and sizes ..... *Cheiriphotis* (in part)
6. Uropod 3 with one distinctly shortened ramus 7
6. Uropod 3 with subequal rami 10
7. Gnathopods simple ..... *Haplocheira*
7. Gnathopods subchelate 8
8. Antenna 1 lacking accessory flagellum ..... *Photis*
8. Antenna 1 with accessory flagellum 9
9. Uropod 3 scale-like, the peduncle plate-like ..... *Cheiriphotis* (in part)
9. Uropod 3 cylindrical ..... *Cheirimedeia*, n. subgenus
10. Gnathopod 1 complexly subchelate with chela projecting from article 5; gnathopod 2 with well developed palm ..... *Amphideutopus*[3]
10. These characters not combined 11
11. Article 3 of antenna 1 as long as article 1 or longer 12
11. Article 3 of antenna 1 shorter than article 1 17
12. Spines of outer plate of first maxilla reduced to 4 ..... *Bathyphotis*
12. Spines of outer plate of first maxilla 9 or more 13
13. Flagellum of antenna 2 stout ..... (*Audulla*)[4]
13. Flagellum of antenna 2 slender 14
14. Accessory flagellum of antenna 1 absent ..... *Podoceropsis*
14. Accessory flagellum of antenna 1 present 15
15. Accessory flagellum composed of a scale ..... *Kermystheus*, n.g.
15. Accessory flagellum composed of 1 or more long articles 16
16. Accessory flagellum composed of 1-2 articles ..... *Megamphopus* and *Bonnierella*
16. Accessory flagellum composed of 3 or more articles ..... *Eurystheus* and *Pseudeurystheus*
17. Accessory flagellum absent ..... *Goesia*
17. Accessory flagellum present 18
18. Gnathopod 2 subchelate 19
18. Gnathopod 2 simple ..... *Leptocheirus*

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[3] *Amphideutopus* J. L. Barnard (1959).
[4] *Audulla*, to be considered a synonym of *Eurystheus* in a forthcoming paper on Micronesian atolls.

19. Pleon segments 4-5 separated ..... *Protomedeia*
19. Pleon segments 4 and 5 coalesced ..... *Chevalia*

Genus Cheiriphotis Walker

Cheiriphotis megacheles (Giles)

Fig. 4

Walker 1904: 284-285, pl. 6, fig. 42; Stebbing 1910: 461; Schellenberg 1926: 383; K. H. Barnard 1937: 167-169, fig. 14; Pirlot 1938: 345; K. H. Barnard 1940: 480; Ruffo 1956: 215; Pillai 1957: 57-58, fig. 15.
Eurystheus monuropus Walker 1909: 340-341, pl. 43, fig. 8.
Cheiriphotis durbanensis K. H. Barnard 1916: 247-249.
Cheiriphotis walkeri Stebbing 1918: 68-69, pl. 12.
Cheiriphotis Delloyei Pirlot 1934: 231-235, fig. 100.

REMARKS: This is a polymorphic species and transcends its generic limits to overlap those of *Microprotopus*, as defined in the key to the Photidae. In young specimens the third uropod has a moderately well-developed inner ramus half as long as the outer ramus, but in fully developed adults the inner ramus disappears. It is now necessary to distinguish *Microprotopus*, lacking an inner ramus, by the similarity of its first four coxae, which in *Cheiriphotis* are of varying sizes and shapes.

Both male and female second gnathopods are diverse, as seen in the literature; with age the male gnathopod changes from an oblique palm bearing 3 large teeth to a transverse palm bearing 4 or 5 small irregular teeth. The figures of the female second gnathopod in the literature are so variable as to prevent any analysis of a growth trend. These factors indicate that the species has developed local races or ecophenotypes.

In southern California no fully developed males have been found.

MATERIAL: 18 specimens from 5 stations.

ECOLOGY: The species has not been recovered in any of the samples assigned to the statistical program. It has been taken at stations on the extreme inner edge of the sampling program in depths of 9 fathoms between Pt. Conception and Santa Monica, but it is a tropical species known through the Indian Ocean from South Africa to Indonesia. This is its first record from the eastern Pacific Ocean and its rarity in southern California suggests that it is near its northern range limit.

Genus Chevalia Walker

Chevalia aviculae Walker, new synonymy

Fig. 5

Chevalia aviculae Walker 1904: 288-290, pl. 7, fig. 50, pl. 8, fig. 50; Walker 1909: 341; K. H. Barnard 1916: 252; Shoemaker 1921: 101; K. H. Barnard 1937: 169, fig. 15; Shoemaker 1941: 187; Shoemaker 1942: 39.
Chevalia mexicana Pearse 1912: 374-376, fig. 5.
Neophotis inaequalis Stout 1913: 653-654.

REMARKS: This fascinating animal apparently is circumtropical, having been collected in the Indian Ocean, South Africa, Caribbean Sea, and eastern Pacific Ocean. As it has not been adequately figured before, I have redrawn it. The most remarkable feature of the genus is the fusion of pleon segments 4 and 5.

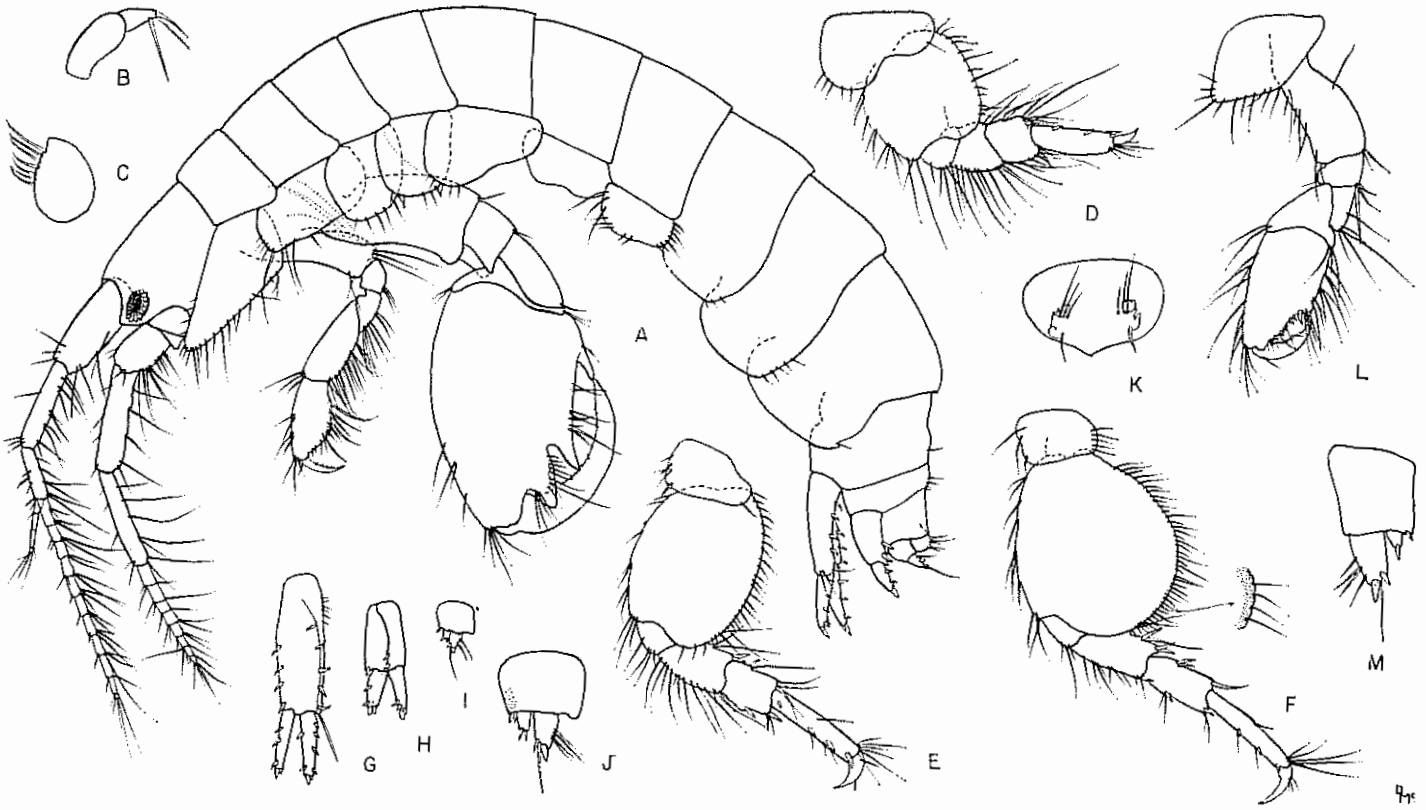

Fig. 4. *Cheiriphotis megacheles* (Giles). Male, 4.5 mm, sta. 5164: A, lateral view; B, articles 3-4 of maxillipedal palp; C, inner plate of maxilla 1; G,H,I,J, uropods 1, 2, 3, 3; K, telson. Male, 5.0 mm: D,E,F, peraeopods 3, 4, 5. Female, 4.0 mm: L, gnathopod 2. Male, 5.0 mm, sta. 5557: M, uropod 3.

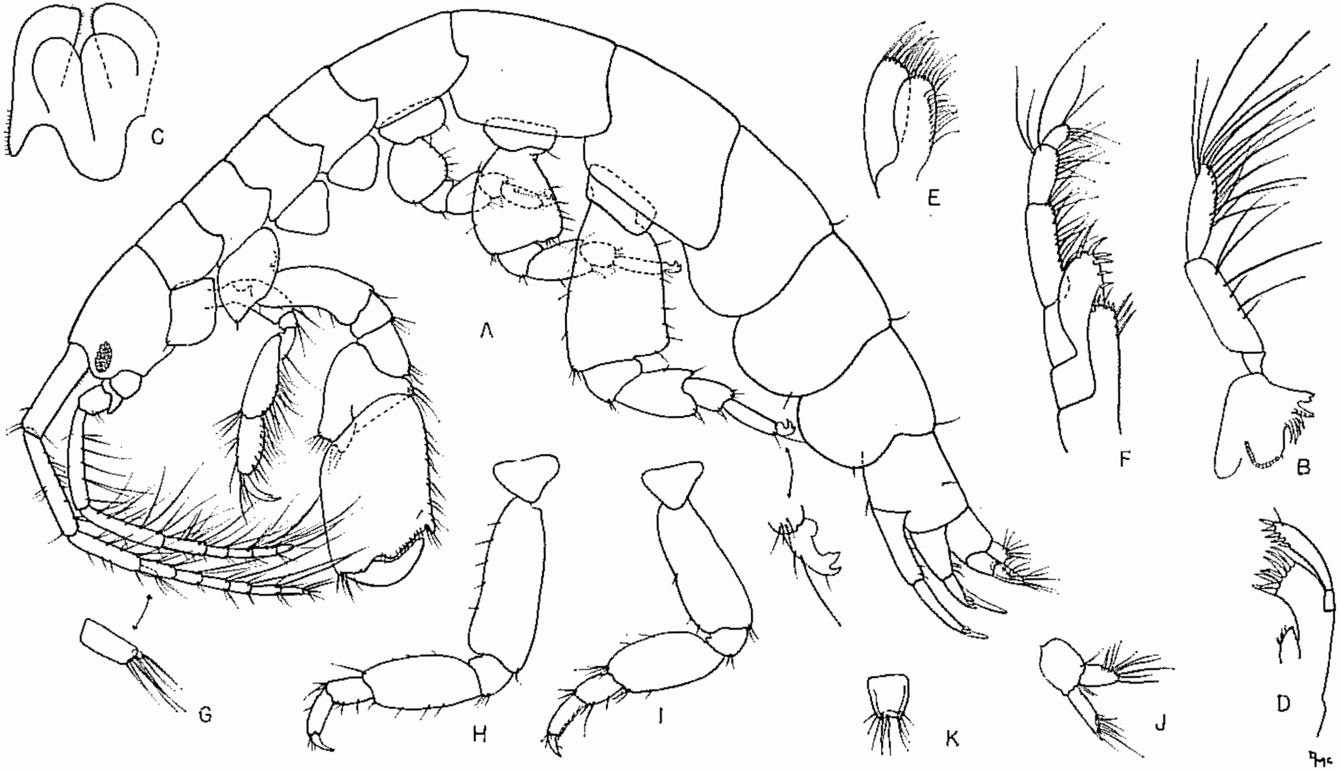

Fig. 5. *Chevalia aviculae* Walker. Female, 5.0 mm, sta. 5164: A, lateral view; B, mandible; C, lower lip; D,E, maxillae 1, 2; F, maxilliped; G, accessory flagellum; H,I, peraeopods 1, 2; J, uropod 3; K, telson.

Pearse gave no reason for the erection of his *C. mexicana* and there appears to be no distinction from *C. aviculae*. Probably he described it for geographic reasons.

MATERIAL: 19 specimens from 4 stations.

ECOLOGY: This species is rare on bottoms deeper than 5 fms. The 4 stations here range from 9 to 19 fms.

Genus Eurystheus Bate

See Barnard (1959 and 1961) for a recent review of the other southern California species, *Eurystheus thompsoni* (Walker).

Eurystheus ventosa, new species

Figs. 6, 7

DIAGNOSIS: Accessory flagellum composed of 2 long articles tipped with a minute third; coxae intermediate in length, not as short as in most species of *Megamphopus* but shorter than those of most species of *Eurystheus*; article 5 of first gnathopod 1.3 times longer than article 6, the palm slightly oblique, the defining corner broadly rounded and bearing one slender spine; gnathopod 2 with long anterior distal lobe; article 5 short, with distinct protrusion on proximal end; palm slightly oblique, defined by a cusp supporting a spine (the cusp smaller in juveniles), bearing a larger, shallow, but sub-acute process near finger hinge, the middle of palm bearing a smaller protrusion and a large spine (males and females identical); distal articles of peraeopods 3-5 not greatly expanded, not strongly spinose; outer ramus of uropod 3 bearing 3 marginal setae in adults, 2 in subadults and 1 in juveniles, plus a terminal spine; inner ramus of uropod 3 with terminal spine only; epistome conically produced; segments lacking dorsal teeth.

HOLOTYPE: AHF No. 555, female, 4 mm.

TYPE LOCALITY: Barnard Station no. 2, Corona del Mar, intertidal formalin wash of holdfasts of the alga *Egregia* sp., Feb. 6, 1955.

MATERIAL: Barnard Stations 2 (9), 16 (3).

RELATIONSHIP: The reduction of the accessory flagellum to two long articles and a short one brings this species close to *Megamphopus*, and the shortened coxae are correlated with that reduction in the accessory flagellum. On Pacific American shores this species closely resembles *Eurystheus spinosus* Shoemaker (1942) but differs by the short coxae and the slender fourth article of the third peraeopod which has only two sets of posterior spines in contrast with the 8 sets in *E. spinosus*. The latter species has a 3-articulate accessory flagellum, but all articles are long.

Eurystheus ventosa bears remarkable resemblance to *Parajassa angularis* in the Ischyroceridae. Eventually, I believe it feasible to transfer *E. ventosa* to the family Ischyroceridae, based on the condition of the third uropod. Unfortunately the evidence is not clear-cut as seen in the

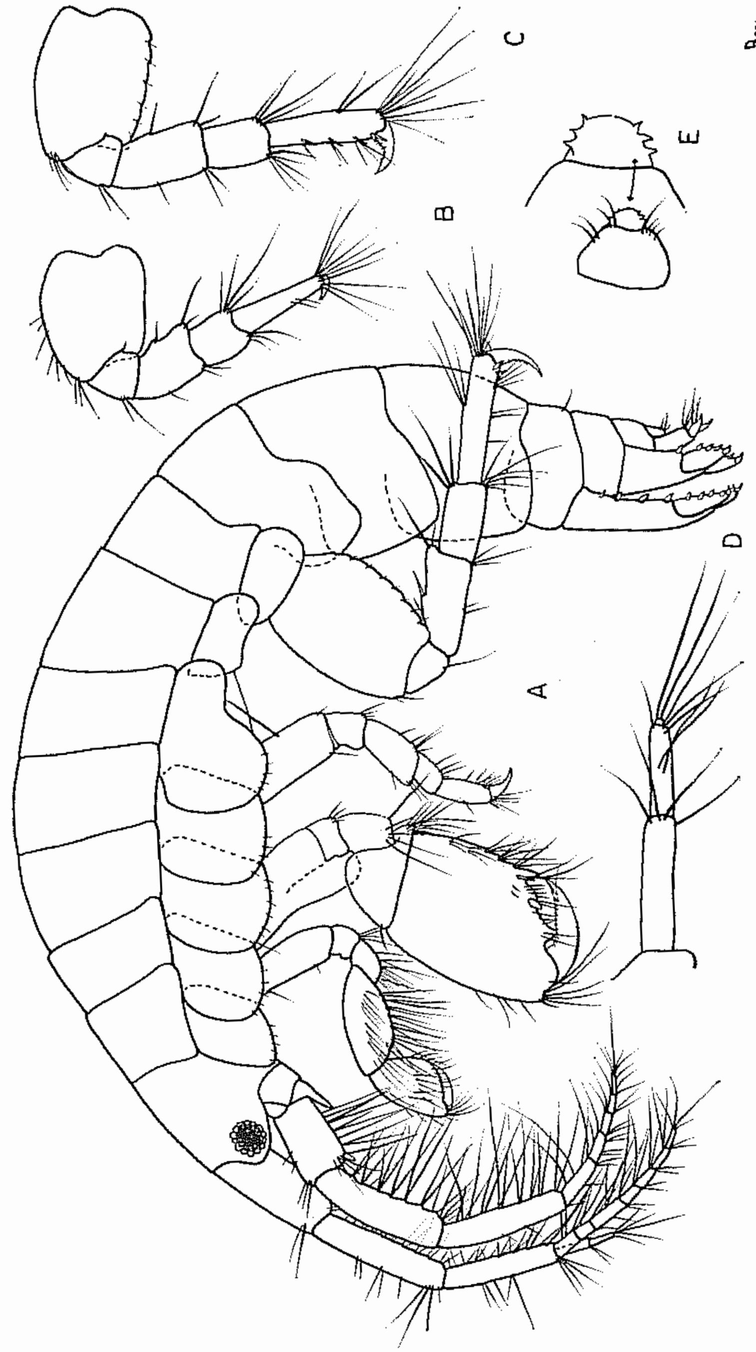

Fig. 6. *Eurystheus ventosa*, n. sp. Female, holotype, 4.0 mm, Barnard sta. 2: A, lateral view; B,C, peraeopods 3, 4; D, accessory flagellum; E, telson.

following discussion; a point of reference is the discussion under the title Family Ischyroceridae.

Most species of Photidae, including the genus *Eurystheus* have the rami of the third uropods equal to or longer than the peduncle. In the genus *Eurystheus*, as now composed, one may see a progression of shortening of these rami in this sequence: *E. maculatus*, *E. abyssalis*, *E. spinosus*, *E. ventosa*, n. sp. Several species of *Eurystheus* (e.g. *abyssalis*) have a crown of apical peduncular spines on the third uropod, similar to many species of the Ischyroceridae. Indeed, but for the slight difference in size of rami, it is difficult to distinguish *E. abyssalis* and *Ischyrocerus megacheir* at the family level, and much less so *E. ventosa*, from various ischyrocerids. Essentially, ischyrocerids are photids with shortened third uropodal rami, on most of which have become developed various kinds of terminal uncinae. Numerous cases of this progression may be seen in photids and ischyrocerids and qualitative familial distinctions are most unclear. To emphasize the need for further study into such relationships, *E. ventosa* is being placed provisionally in the genus *Eurystheus*.

ECOLOGY: An intertidal species in southern California, at Corona del Mar and Laguna Beach, washed from algae and sponges.

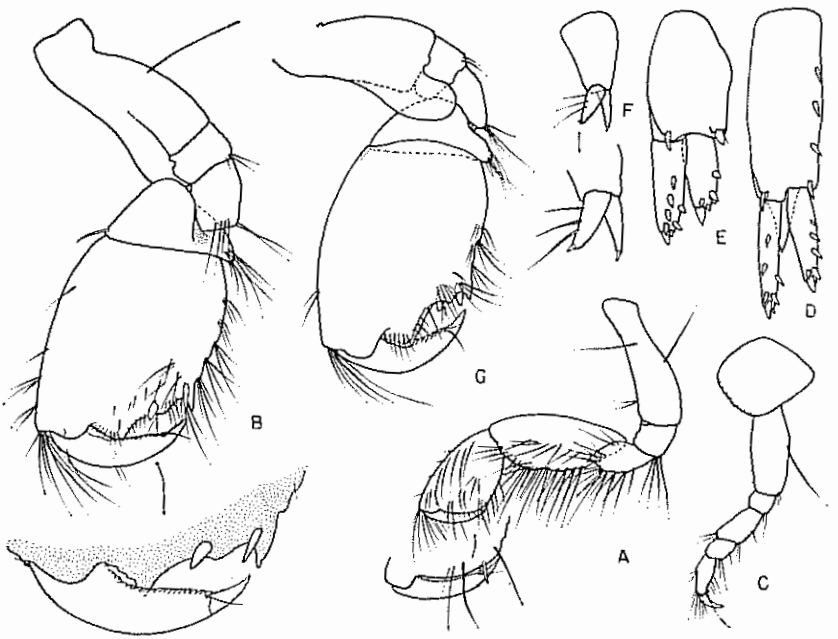

Fig. 7. *Eurystheus ventosa*, n. sp. Female, holotype, 4.0 mm, Barnard sta. 2: A,B, gnathopods 1, 2; C, peraeopod 1; D,E,F, uropods 1, 2, 3. Male, 3.1 mm, Barnard sta. 2: G, gnathopod 2.

Genus **Kermystheus** new genus (above)

Kermystheus ociosa, new species

Fig. 8

DIAGNOSIS OF MALE: Accessory flagellum of antenna 1 composed of a small conical scale; palm of gnathopod 2 indistinct from hind margin, distally produced to a large tooth, in front of which is a deep incision and a smaller setose process; article 5 of gnathopod 1 longer than article 6; peraeopod 3 with a large posterior proboscoid process on article 2, with article 4 also bearing a posterior process; epistome formed into a long conical cusp.

FEMALE: Palm of gnathopod 2 distinct from hind margin, sharply invaginated.

HOLOTYPE: AHF No. 593, male, 5.2 mm.

TYPE LOCALITY: Station 6474, Monterey Bay, California, 36-41-56 N, 121-58-42 W, 63 fms, October 2, 1959, bottom of glauconitic sand, rock, gravel.

MATERIAL: 121 specimens from 17 stations.

RELATIONSHIP: This species differs from members of *Podoceropsis* by the scale-like accessory flagellum and is distinct from *Kermystheus kermadeci* (Stebbing 1888) which is a blind species with a transverse palm on male gnathopod 2. From other species, except *P. angulosa* Chevreux (1927), *K. ociosa* differs by the peculiar process of peraeopod 3. From *P. angulosa* it differs by the lack of a defined palm on gnathopod 2 and by the much shorter coxae.

ECOLOGY: This species has an overall coastal shelf density of 0.9 animals per square meter. The species ranges in depth from 15 to 90 fms but is mostly concentrated between the depths of 50 and 90 fms where its density is 4.7 animals per square meter.

Genus **Megamphopus** Norman

Megamphopus mamolus, new species

Fig. 9

DIAGNOSIS OF MALE: Gnathopods nearly equal in size, in both pairs article 5 longer than 6; palm of gnathopod 2 oblique, slightly excavate, with a slight bump and large spine at defining corner; coxa 1 not acute anteriorly; coxa 2 produced behind into a large lobe; article 2 of peraeopod 1 inflated, much stouter than that of peraeopod 2.

FEMALE: Gnathopods small; palm of gnathopod 2 oblique, with article 6 ovate, not linear; coxa 2 not lobate.

DESCRIPTIVE FEATURES: Antennae missing in all but one of the 114 specimens at hand; in that juvenile female, antenna 1 is similar to that of *Megamphopus cornutus* Norman (Sars 1895: pl. 200) but the accessory flagellum is 2-articulate, not uniarticulate; mouthparts like Sars' figures of *M. cornutus*.

HOLOTYPE: AHF No. 592, male, 5.3 mm.

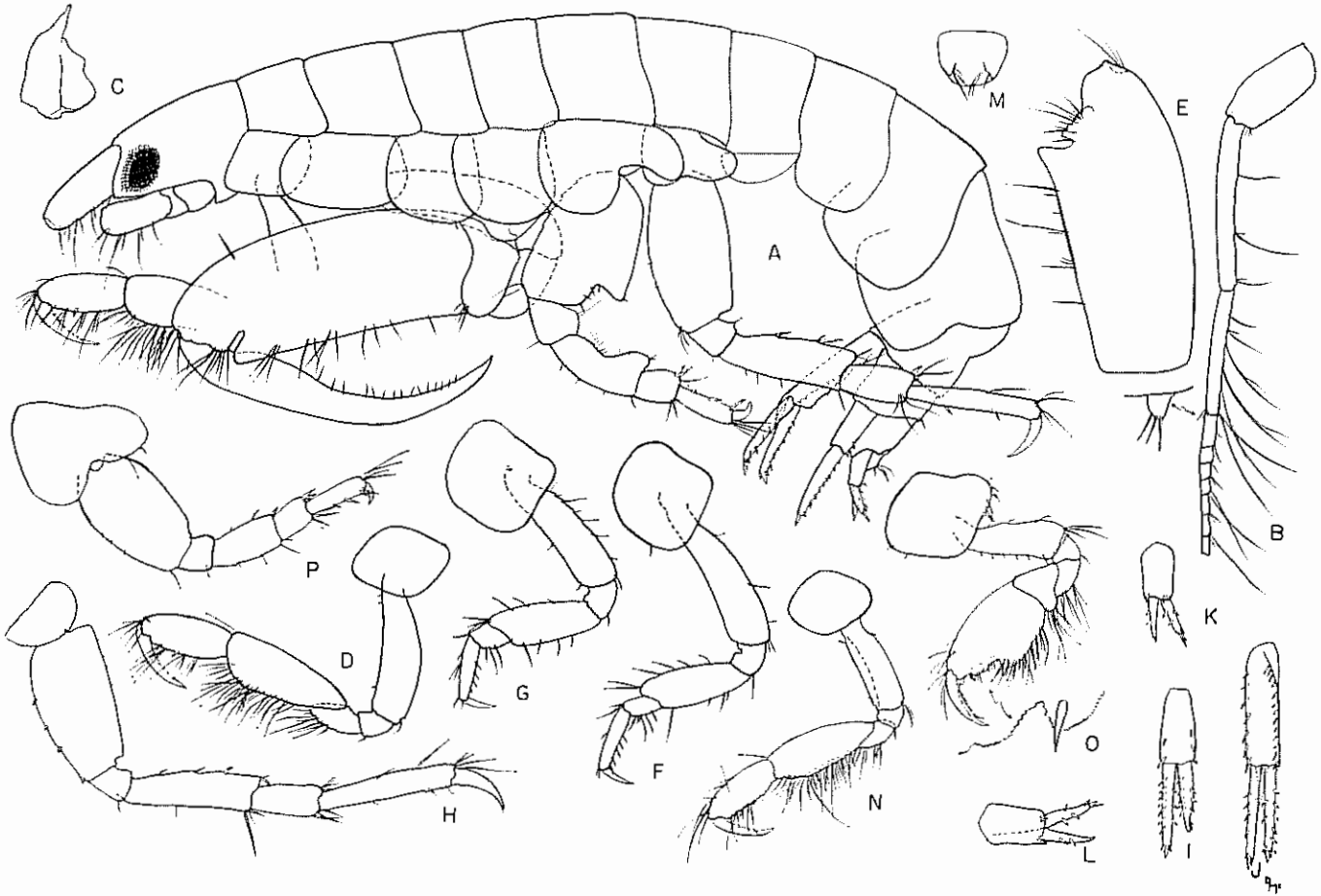

Fig. 8. *Kermystheus ociosa*, n. sp. Male, holotype, 5.2 mm, sta. 6474: A, lateral view; C, epistome, conical process at top; D, gnathopod 1; F,G, peraeopods 1, 2; I,J,K,L, uropods 2, 1, 3, 3; M, telson. Another male, 4.5mm: B, antenna 1; E, article 6 of gnathopod 2, showing palm; H, peraeopod 5. Female, 4.5 mm: N,O, gnathopods 1, 2; P, peraeopod 3.

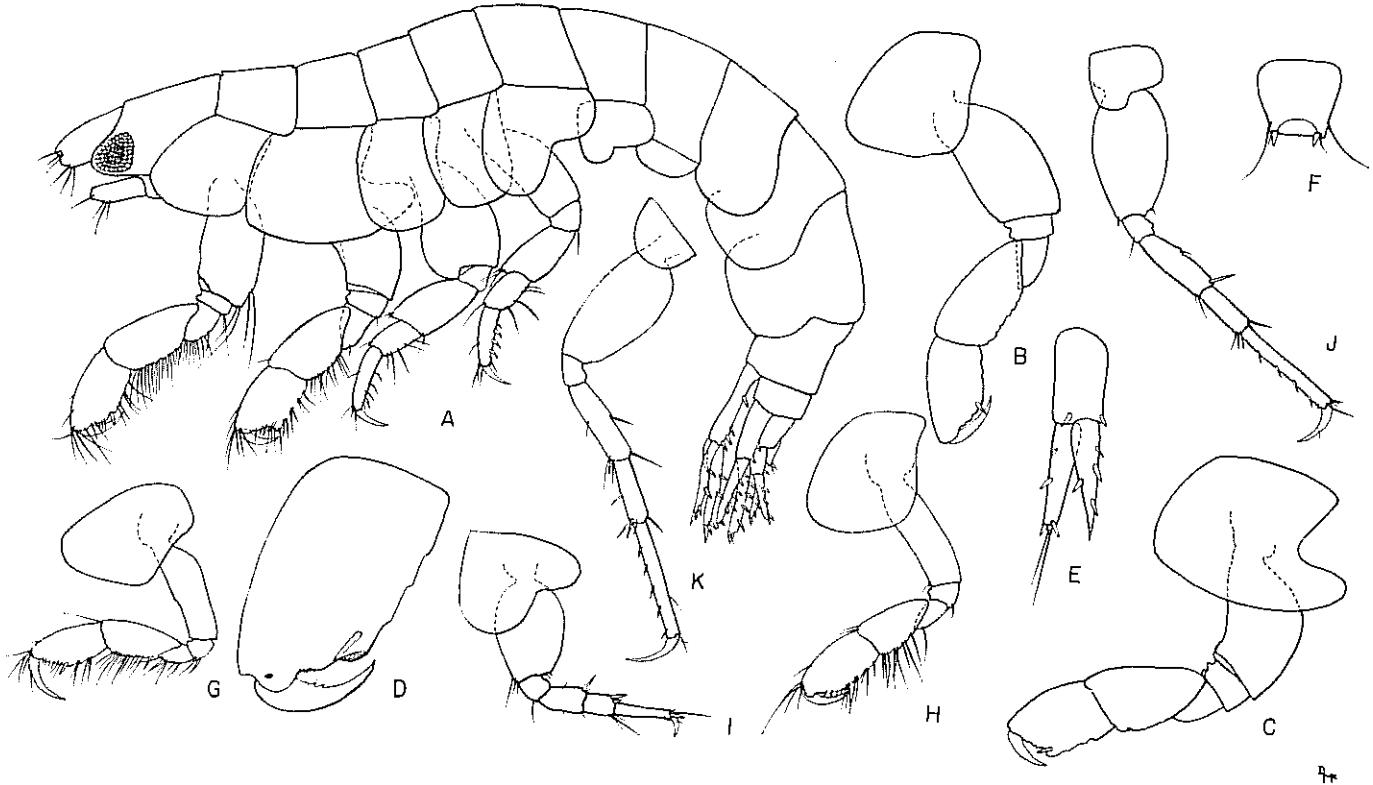

Fig. 9. *Megamphopus mamolus*, n. sp. Male, holotype, 5.3 mm, sta. 6425: A, lateral view; B,C, gnathopods 1, 2; D, gnathopod 2, enlarged; E, uropod 3; F, telson. Female, 3.5 mm: G,H, gnathopods 1, 2. Juvenile female, 3.2 mm, sta. 4822: I,J, J', peraeopods 3, 4, 5.

TYPE LOCALITY: Station 6425, Monterey Bay, California, 36-36-54 N, 121-52-28 W, 13.5 fathoms, September 29, 1959, rock bottom.

MATERIAL: Stations 4822 (50), 6425 (64).

RELATIONSHIP: This peculiar species may require separate generic designation in the future, primarily because of the lobate second coxa, possibly unique among tube-dwelling amphipods. Nevertheless, other species of *Megamphopus* show peculiarities of the male second coxa; in *M. cornutus* and *M. longidactylus* Chevreux (1926) it is longer than any of the other coxae; in *M. longicornis* Chevreux (Chevreux and Fage 1925: 318) it is quite prolonged; and apparently it is longer than the other coxae in *M. blaisus* K. H. Barnard (1932). The male of *M. pachypus* Schellenberg (1925) is unknown.

DISTRIBUTION: Pt. Conception, California, 9 fms depth, in rich red algal - *Diopatra* bed; Monterey Bay.

Genus Photis Krøyer

Taxonomy in this genus is especially difficult because of the lack of life history studies. Males, particularly, are polymorphic, passing through several stages of development, the early phases of which are indistinguishable in a number of species. To separate mixed populations collected in the same sample is difficult because terminally developed males are rare, and differences among young males, females and juveniles have not been worked out. Young of *Photis californica* are so similar to presumed young of *P. lacia* as to defy proper identification. Some samples contain as many as four species and the ecologist desiring population ratios is beset with severe difficulties.

Several species now described probably are young stages of others and some species may be polymorphic in terminal states, such as the pair of species *P. californica* and *P. brevipes*, described herein. These should be subjected to the kind of study so well exemplified by Sexton and Reid's (1951) analysis of *Jassa falcata* where polymorphic adults were shown to develop from the same clutch of eggs.

The recognition of species of *Photis* on the basis of shortening of the first 2 male coxae is not satisfactory because it appears to have some relationship to the adult size of the species. All of the species in southern California appear to show a tendency for this coxal shortening, but it reaches its fullest extent only in the two largest species, *P. californica* and *P. brevipes*, and in an intermediate sized species, *P. conchicola*.

The shapes of the second articles on the second male gnathopods are characteristic in the several southern California species and are not fully described in my diagnoses since other characters are just as useful, but each condition is figured and may be of some use to other taxonomists.

Photis nana Walker (1904) is not included in the following key, for it should be removed to a new genus as Walker suggested originally.

KEY TO WORLD PHOTIS (ADULT MALES)

1. Articles 4-5 of peraeopod 4 grossly enlarged ..... *elephantis*, n. sp.
1. Articles 4-5 of peraeopod 4 slender 2
2. Article 6 of gnathopod 2 slender, scarcely broader than article 2 3
2. Article 6 of gnathopod 2 twice as broad as article 2 4
3. Article 5 of gnathopod 2 bearing posterior lobe ..... *digitata*
3. Article 5 of gnathopod 2 lacking posterior lobe ..... *obesa*
4. Article 5 of first gnathopod 1.75 times longer than article 6 5
4. Article 5 of first gnathopod less than 1.25 times as long as article 6 6
5. Article 6 of gnathopod 2 very broad, the palm bearing 2 bumps and without deep excavation, its article 7 lacking an apical setal bundle ..... *geniculata*
5. Article 6 of gnathopod 2 narrow, the palm bearing one tooth, and a deep excavation, its article 7 bearing an apical setal bundle ..... *longicarpa*
6. Palm of gnathopod 1 very strongly excavate with article 7 not quite closing on defining bump 7
6. Palm of gnathopod 1 not strongly excavate, with article 7 closing on defining bump 9
7. Palm of gnathopod 2 lacking process near finger hinge ..... *vinogradovi*
7. Palm of gnathopod 2 bearing a process near finger hinge 8
8. Coxa 1 not excavate below ..... *macrocoxa*
8. Coxa 1 excavate below ..... *nataliae*
9. Article 7 of gnathopod 2 shorter than palm 10
9. Article 7 of gnathopod 2 as long as or longer than palm 11
10. Palm of gnathopod 1 excavate ..... *tenuicornis*
10. Palm of gnathopod 1 not excavate ..... sp. Pirlot (1938)
11. Article 7 of gnathopod 2 bearing a bump or notch on posterior margin, or the margin very sinuous 12
11. Article 7 of gnathopod 2 lacking a bump or sinuous margin 22
12. Palm of gnathopod 2 bearing 2 teeth besides defining one, one tooth being accessory ..... *baeckmannae*
12. Palm of gnathopod 2 excavate, bearing one tooth besides defining one, the former tooth often slightly divided 13
13. Both palmer teeth of gnathopod 2 mounted on a process separate from rest of hand ..... *bifurcata*, n. sp.
13. Palmer teeth of gnathopod 2 attached directly to hand 14
14. Coxa 2 shorter than broad 15
14. Coxa 2 longer than broad 17

15. Article 7 of gnathopod 2 with large inner medial bump .... *brevipes*
15. Article 7 of gnathopod 2 lacking a large medial bump, (sometimes with a low distal bump) 16
16. Palmer invagination of gnathopod 2 conical; third coxa 1.2 times as broad as coxa 4 ..... *conchicola*
16. Palmer invagination of gnathopod 2 round or quadrate; third coxa 1.6 times as broad as coxa 4 ..... *californica*
17. Palm of gnathopod 2 lacking sinus bounded on 2 sides ..... *distinguenda*
17. Palm of gnathopod 2 bearing sinus bounded on 2 sides 18
18. Article 7 of gnathopod 2 bearing both a proximal bump and a distal constriction 19
18. Article 7 of gnathopod 2 bearing only a distal bump formed by a distal constriction 21
19. Palmar defining tooth of gnathopod 2 reaching a line perpendicular to finger hinge (palm transverse) 20
19. Palmar defining tooth of gnathopod 2 not reaching a line perpendicular to finger hinge (palm slightly oblique) ..... *macrotica*, n. sp.
20. Gnathopod 2 with hind tooth of palm gaping ..... *pugnator*
20. Gnathopod 2 with hind tooth not gaping ..... *goreensis*
21. Palm of gnathopod 2 transverse ..... *reinhardi*
21. Palm of gnathopod 2 oblique ..... *lacia*, n. sp. (in part)
22. Article 7 of gnathopod 2 as long as palm, the palm oblique and not diverging from hind margin, with article 2 bearing a large distal stridulating process ..... *hawaiensis*
22. These characters not combined 23
23. Palm of gnathopod 2 lacking distal bump or bumps 24
23. Palm of gnathopod 2 bearing 1-2 distal bumps 27
24. Article 5 of gnathopod 1 bearing large anterior spines ..... *spinicarpa*
24. Article 5 of gnathopod 1 lacking anterior spines 25
25. Article 2 of first antenna twice as long as article 1 ..... *antennata*
25. Article 2 of first antenna 1.5 times as long as article 1, or less 26
26. Article 2 of gnathopod 2 lacking distal process ..... *brevicaudata*
26. Article 2 of gnathopod 2 bearing distal process ..... *fischmanni*
27. Palm of gnathopod 2 bearing an accessory defining tooth ..... *dentata*
27. Palm of gnathopod 2 lacking an accessory defining tooth 28

28. Article 7 of gnathopod 2 not serrate 29
28. Article 7 of gnathopod 2 serrate 31
29. Palm of gnathopod 2 bifid near finger hinge ..... *spasskii*
29. Palm of gnathopod 2 not bifid near finger hinge 30
30. Palm of gnathopod 2 with medial tooth ..... *lacia*, n. sp. (in part)
30. Palm of gnathopod 2 lacking medial tooth ..... *viuda*, n. sp.
31. Palm of gnathopod 2 castellate ..... *uncinata*
31. Palm of gnathopod 2 not castellate 32
32. Eyes absent 33
32. Eyes present 34
33. Palm of gnathopod 2 distinct, nearly transverse; uropods 1-2 very spinose ..... *kurilica*
33. Palm of gnathopod 2 indistinct, oblique; uropods 1-2 sparsely spinose ..... *coecus* J. L. Barnard (1961a)
34. Eyes on extremely long peduncles 35
34. Eyes on short or not on peduncles 36
35. Article 5 of gnathopod 1 as long as article 6 ..... *dolichommata*
35. Article 5 of gnathopod 1 half as long as article 6 ..... *lamellifera*
36. Article 6 of gnathopod 2 with hind margin very short ..... *longimanus*
36. Article 6 of gnathopod 2 with hind margin long 37
37. Article 6 of gnathopod 2 broader than long ..... *strelkovi*
37. Article 6 of gnathopod 2 longer than broad 38
38. Animal lacking stridulating organs ..... *africana*
38. Animal bearing stridulating organs ..... *longicaudata*

Not included in this key:
P. aequimanus = female
P. macrocarpa, male not well defined.

KEY TO ADULT MALES OF PHOTIS FROM CALIFORNIA

1. Articles 4-5 of peraeopod 4 grossly enlarged ..... *elephantis*, n. sp.
1. Articles 4-5 of peraeopod 4 slender 2
2. Male gnathopod 2 bearing a bifurcate, cryptically separated process at the palm ..... *bifurcata*, n. sp.
2. Male gnathopod 2 with a single tooth defining the palm 3
3. Tooth of male gnathopod 2 reaching a line perpendicular to hinge point (palm transverse) 4
3. Tooth of male gnathopod 2 not reaching a line perpendicular to hinge point (palm oblique) 6
4. Inner edge of article 7 on male gnathopod 2 bearing a large bump ..... *brevipes*
4. Inner edge of article 7 on male gnathopod 2 sinuous but lacking distinct bump 5

5. Palm of male gnathopod 2 with large, shallow hemispherical excavation; article 7 scarcely overlapping palm; third coxa 1.6 times as wide as coxa 4 ..... *californica*
5. Palm of male gnathopod 2 with narrow, slit-like deep excavation; article 7 greatly overlapping palm; third coxa 1.2 times as wide as coxa 4 ..... *conchicola*
6. Middle of palm on male gnathopod 2 bearing a tooth ..... *viuda*, n. sp.
6. Middle of palm on male gnathopod 2 lacking a tooth 7
7. Palmar process near finger hinge on male gnathopod 2 blunt, not produced; eyes small ..... *lacia*, n. sp.
7. Palmar process near finger hinge on male gnathopod 2 acutely produced; eyes large ..... *macrotica*, n. sp.

Photis bifurcata, new species

Fig. 10

DIAGNOSIS OF MALE: Coxae 1 and 2 not shorter than 3-5; coxa 2 longer than wide; palm of gnathopod 1 excavate, well defined by a spine; gnathopod 2 bearing a bifid process at lower corner of palm projecting slightly beyond the theoretical limit of a transverse palm, this process separated from the rest of the hand by an invagination in the middle of the palm, but the surfaces of the process and the hand apposed so closely that the invagination is not normally visible; however, the bifid process can be pulled down and away from the hand, thus revealing the break between the two parts of the hand; article 7 overlapping palm slightly, its inner margin with a proximal bump and slight distal bump and constriction; article 2 of gnathopod 2 produced strongly anterodistally, its lateral face with stridulation ridges, and the lower edge of coxa 2 also with such ridges.

FEMALE: Palm of gnathopod 2 slightly excavate, defined by a spine, the hind edge of article 6 relatively long, parallel with anterior edge, similar to *P. californica* (young females and juveniles of *P. bifurcata* are thus difficult to distinguish from *P. californica*).

JUVENILES: Young males with bifurcate process of gnathopod 2 not so strongly separated from rest of hand, the teeth less well developed.

HOLOTYPE: AHF No. 5718, male, 2.75 mm.

TYPE LOCALITY: Station 5164, SE of Pt. Conception, 34-26-40 N, 120-21-45 W, 11 fms, July 2, 1957, bottom of rock with the polychaete *Diopatra ornata*.

MATERIAL: 557 specimens from 51 stations.

RELATIONSHIP: The adult males of this species show no particular relationship to any other species because of the unusual palmar configuration of gnathopod 2, but young males are easily confused with *P. californica* and *P. lacia* and are related to many other species of *Photis*.

ECOLOGY: This species has an overall density of 4.5 animals per square

meter on the coastal shelf and is distributed by depth according to the following scheme:

Depth, fms	10	20	30	40	50	100
Specimens per square meter	12	3.1	3.6	3.4	0.1	0

The species is found mainly in the *Diopatra* community, where its density is 27 animals per square meter.

Photis brevipes Shoemaker 1942: 25-27, fig. 9
Fig. 11

Photis californica, J. L. Barnard 1954a: 26-27, pls. 23-24 (not Stout 1913).

DIAGNOSIS OF MALE: Coxae 1 and 2 much shorter than coxae 2-5, coxa 2 shorter than broad; third coxa 1.4 times as wide as coxa 4; gnathopod 1 with palm slightly excavate, distinctly defined by a bump armed with a stout spine; palm of gnathopod 2 transverse, with a large hemispherical palmar invagination, the defining tooth large, tapering evenly, reaching a line perpendicular to finger hinge, the process near finger hinge stout, slightly upturned; posterior edge of article 7 produced into a large bump, followed distally by a serration (in young males this is a spine becoming fused in adults); tip of article 7 not overlapping palmar defining process; article 2 of gnathopod 2 poorly produced

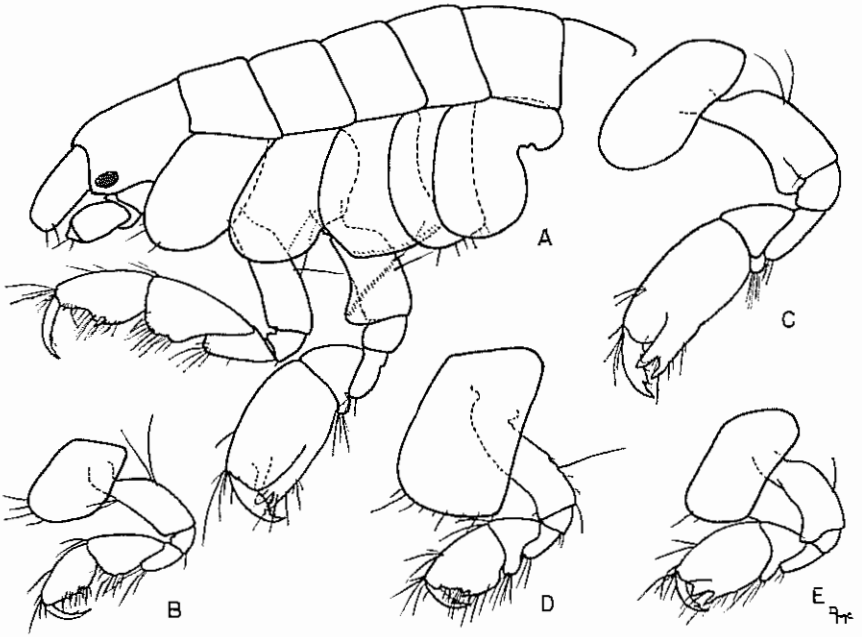

Fig. 10. *Photis bifurcata*, n. sp. Male, 2.75 mm, sta. 5164: A, lateral view, front part of body. Male, 2.0 mm, sta. 5042: B,E, gnathopods 1, 2. Male, 3.0 mm, sta. 5164: C, gnathopod 2. Female, 2.0 mm, sta. 5042: D, gnathopod 2.

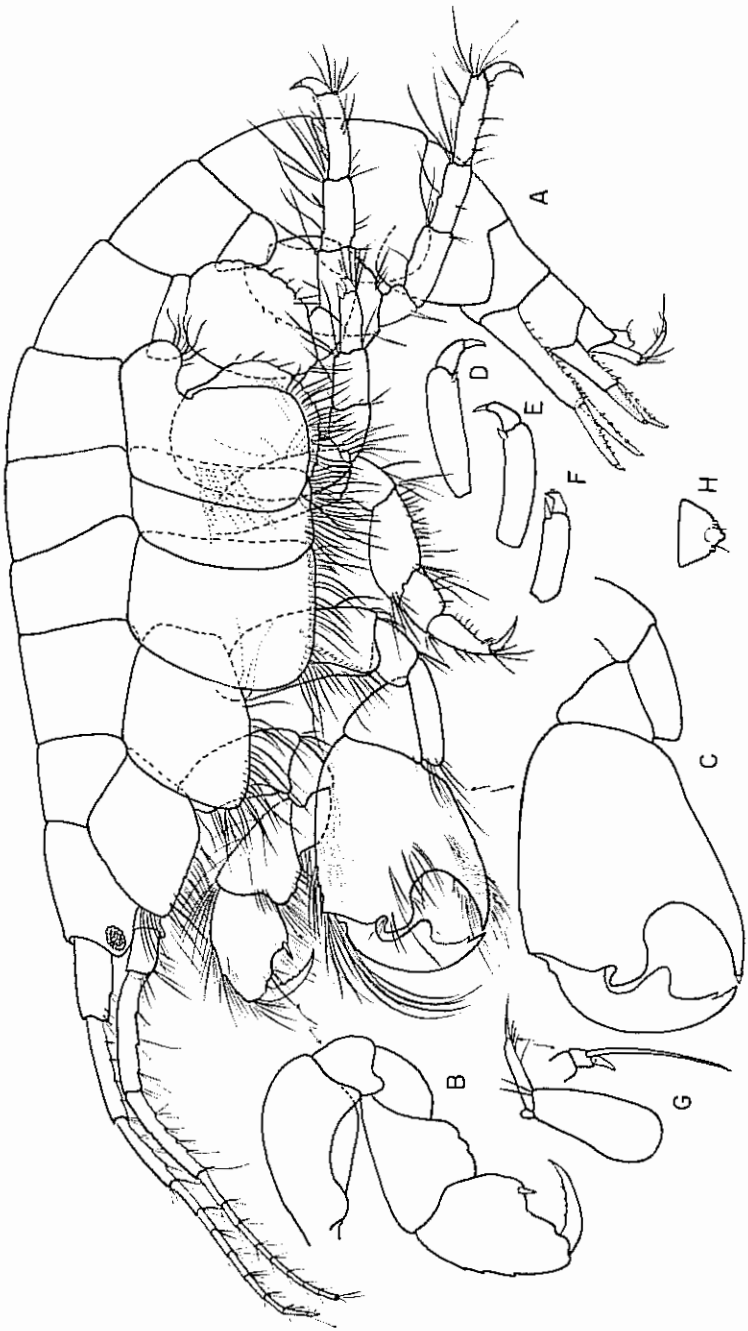

Fig. 11. *Photis brevipes* Shoemaker. Male, 5.3 mm, sta. 4869: A, lateral view; B,C, gnathopods 1, 2, minus setae; D,E,F, ends of peraeopods 5, 4, 3; G, uropod 3; H, telson.

anterodistally, its lateral face with stridulation ridges, and lower edge of coxa 3 also with such ridges.

FEMALE: Palm of gnathopod 2 slightly excavate, its article 7 in very large females just failing to reach end of palm; coxae 1-5 subequal in length.

JUVENILES: The young of this species and *P. californica* apparently undergo the same developmental stages where the inner edge of article 7 on gnathopod 2 is slightly bulbous distally. In *P. brevipes* the bulge increases in size to become a large process; in *P. californica* the bulge decreases and the article becomes more slender.

MATERIAL: 2034 specimens at 110 stations. In addition, 798 specimens from 194 stations were examined but no positive identification could be made. From the ratio between positive identifications of *P. brevipes* and *P. californica*, it is assumed that 80% of these unknown specimens are juveniles of *P. brevipes*, and the other 20% of *P. californica*.

REMARKS: The adults of *P. brevipes* on southern California coastal bottoms are much larger than adults of *P. californica*, those of *P. brevipes* being 8 mm and those of *P. californica* being 4-5 mm. In *P. californica* the hind tooth of the palm on gnathopod 2 starts to gape in terminal adulthood so that if the dactyl lacks the inner bump the specimen may be identified as *P. californica*, even though it may have the size of a young *P. brevipes*.

Shoemaker described no stridulation ridges for this species and his figured specimen was a young male, but I have no hesitation in identifying the present material with his species.

ECOLOGY: This species has an overall density of 34 animals per square meter on the coastal shelf, based on positively identified specimens. Adding 80% of the unknown specimens, as stated above, would increase the overall density of *P. brevipes* to 39 animals per square meter. The following additional statistics are based on the combination of these data as explained above. *Photis brevipes* is distributed by depth according to the following scheme:

Depth, fms	10	20	30	40	50	100
Specimens per square meter	48	51	72	24	12	6

This species is most heavily concentrated in the *Diopatra* community where its frequency is 232 per square meter, followed by the *Listriolobus* community where its abundance is 97 animals per square meter, the *Nothria* community where its abundance is 26 per square meter, and the *Amphiodia* communities where it averages 19 animals per square meter.

Photis californica Stout 1913: 654-656

Figs. 12, 13

DIAGNOSIS OF MALE: Coxae 1 and 2 much shorter than coxae 3-5; coxa 2 shorter than broad; third coxa 1.6 times wider than coxa 4; palm

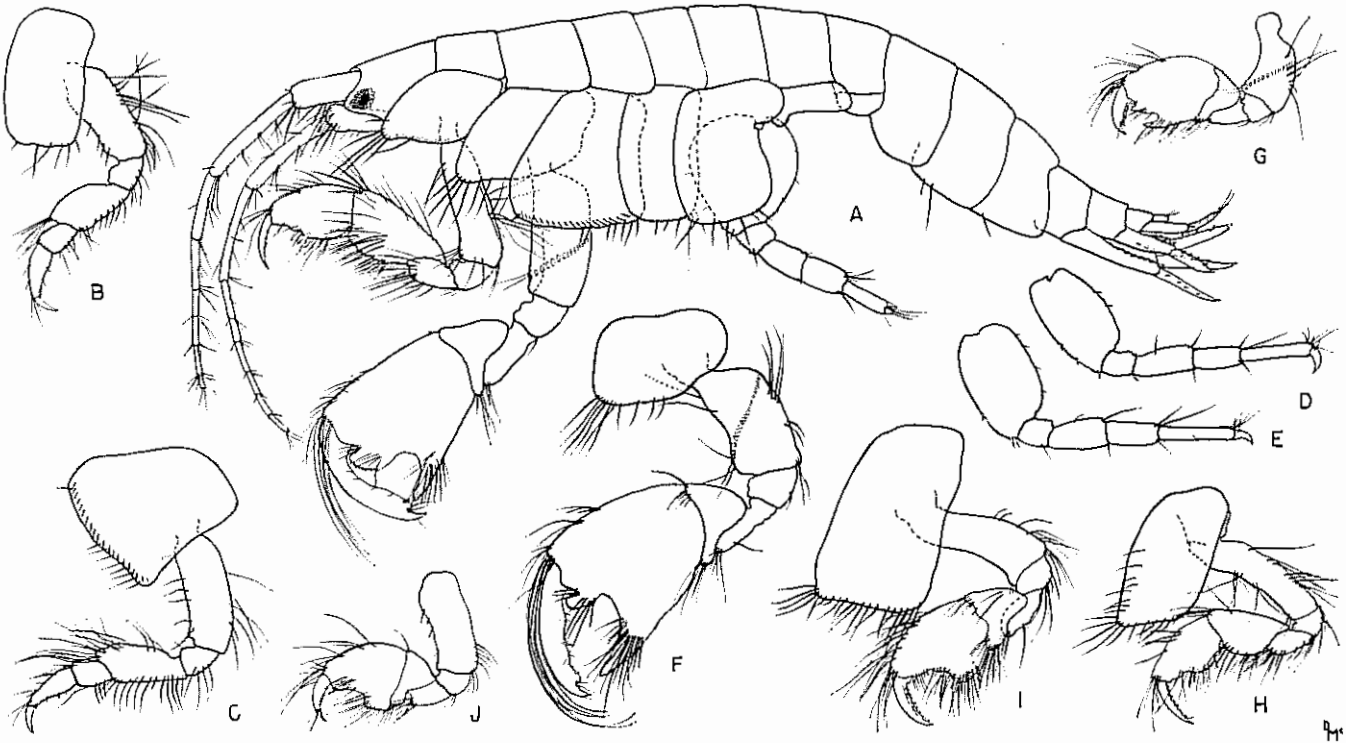

Fig. 12. *Photis californica* Stout. Male, 4.3 mm. sta. 4743. A, lateral view; B,C,D,E, peraeopods 1, 2, 4, 5. Male, 4.0 mm, sta. 4743: G, gnathopod 2. Female, 5.3 mm, sta. 4743: H,I, gnathopods 1, 2. Female, 3.0 mm, sta. 4743: J, gnathopod 2.

of gnathopod 1 slightly excavate, distinctly defined by a bump armed with a stout spine; palm of gnathopod 2 transverse, with a large hemispherical or quadrate palmar invagination, the defining tooth large, tapering evenly, reaching a line perpendicular to finger hinge, the process near the finger hinge stout, slightly upturned; inner distal edge of article 7 with broad but low bump, followed by a setose serration (in young males this is a strong spine becoming fused in adults); tip of article 7 overlapping palmar defining process; article 2 of gnathopod 2 poorly produced anterodistally, lateral face with stridulation ridges and lower edge of coxa 3 with such ridges.

Very large males have the hind palmar tooth gaping slightly and the posterodistal bump of article 7 is obsolescent; a poorly developed proximal inner tooth on article 7 is seen in some specimens, but article 7 is generally quite slender in comparison with *P. brevipes.*

FEMALE: Gnathopod 2 with palm broadly excavate, its article 7 just reaching end of palm; coxae 1-5 subequal in length.

JUVENILES: The juvenile male has a coxal configuration similar to the male of *P. lacia* n. sp. shown herein, with the first two coxae longer than

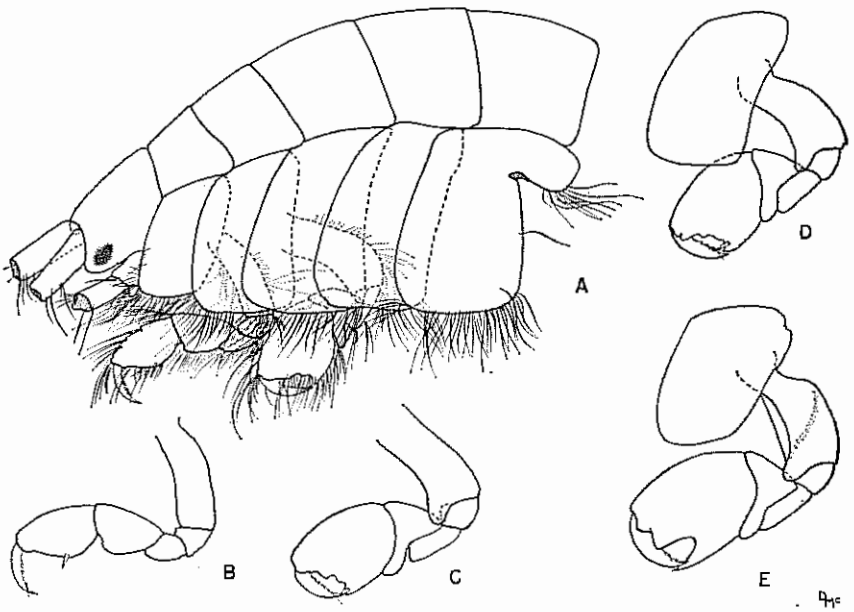

Fig. 13. *Photis californica* Stout. Female, 6.0 mm, sta. 4869: A, lateral view of front part of body; B,C, gnathopods 1, 2, minus setae. Juvenile female, 3.0 mm: D, gnathopod 2, minus setae. Juvenile male, 3.0 mm: E, gnathopod 2.

in the adult. Young *P. californica* are distinguishable from some medium-sized *P. lacia* only by the transverse (not oblique) line running from the finger hinge to the defining tooth of the palm. Young *P. californica* and *P. brevipes* are indistinguishable since both pass through the same developmental stages.

MATERIAL: 465 specimens from 34 stations.

REMARKS: Two other species of *Photis* have been described from Pacific America prior to this time and both bear close resemblance to *P. californica*. The first, *P. conchicola* Alderman (1936) apparently is distinct, differing by the fact that the finger of male gnathopod 2 strongly overlaps the palm, but the distinction made by Alderman that *P. conchicola* differs from *P. californica* by the short first two male coxae is not true. It was based on an error by Stout in the original description of *P. californica*. The second *Photis* from the Pacific is *P. brevipes* Shoemaker (1942) which is indistingnishable from juvenile males of *P. californica*.

This species is closely related to *P. pugnator* Shoemaker (1945) from the Atlantic coast of North America but differs by the broader, less attenuated second coxa, the larger hinge process of the palm on gnathopod 2, and the less excavate first gnathopodal palm.

ECOLOGY: This species has an overall density of 4.7 animals per square meter on the coastal shelf, based on positively identified specimens. Of the total unidentified specimens of *Photis*, split between *P. californica* and *P. brevipes*, it is estimated that about 20% are *P. californica*, based on the ratio between positive identifications of both species. This would increase the density of *P. californica* to 6.0 animals per square meter. The following additional statistics are based on the combination of these data as explained above. *Photis californica* is distributed by depth according to the following scheme:

Depth, fms	10	20	30	40	50	100
Specimens per square meter	1.8	6.2	6.7	12	11	1.1

Most specimens of this species were recovered from the *Amphiodia* community and none was found in the *Diopatra* community where the dominant species was *P. brevipes*.

Photis conchicola Alderman 1936: 66-67, figs. 39-43
Figs. 14, 15

DIAGNOSIS OF MALE: Coxae 1 and 2 much shorter than coxae 3-5; coxa 2 shorter than broad; third coxa 1.2 times as wide as coxa 4; gnathopod 1 with palm very slightly excavate, defined by a spine; palm of gnathopod 2 transverse, with a large conical palmar invagination forming a long tooth which tapers evenly, the tooth reaching a line perpendicular to the finger hinge, the palmar process near the finger hinge rather slender; article 7 of gnathopod 2 bearing on its inner distal edge a broad bump, followed by a setose serration, this in young males represented by a strong spine becoming fused in adults; tip of article 7 strongly

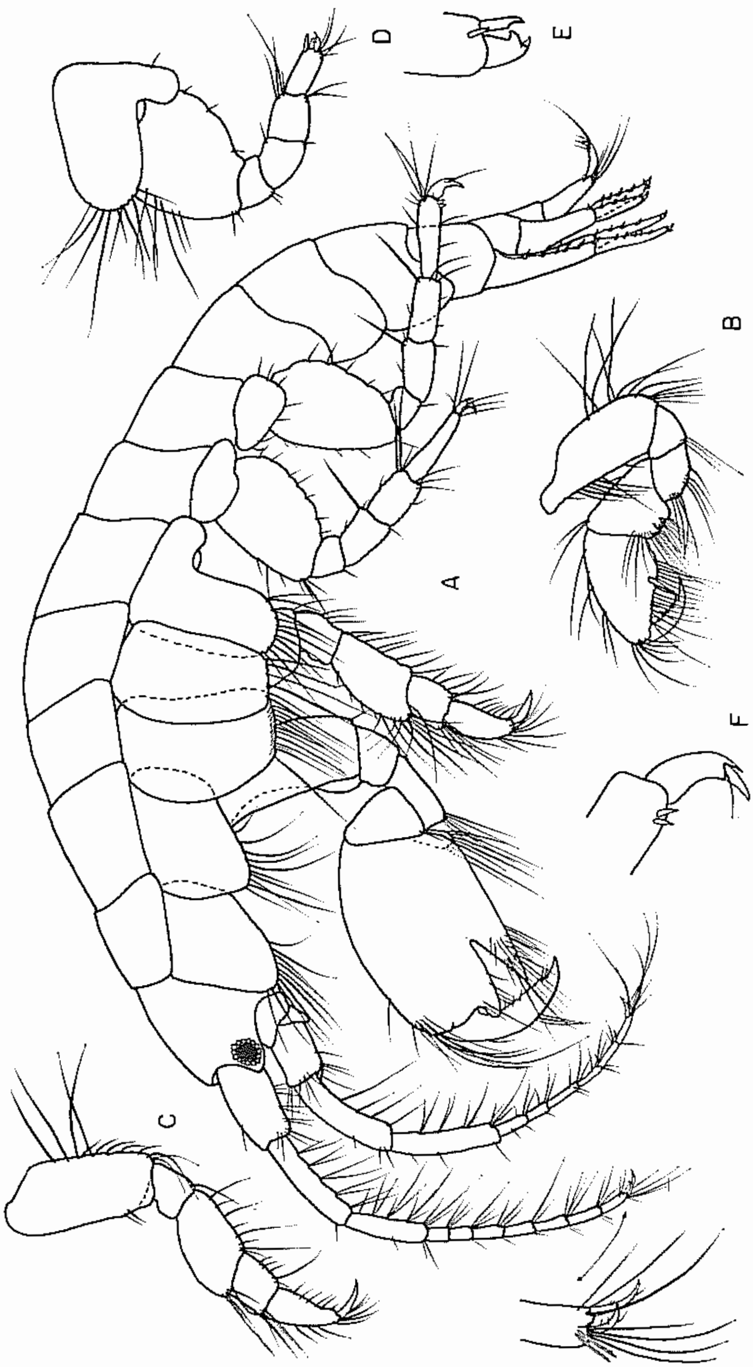

Fig. 14. *Photis conchicola* Alderman. Male, 3.7 mm, Barnard sta. 3: A, lateral view; B, gnathopod 1; C,D, peraeopods 2, 3; E,F, ends of peraeopods 3, 5.

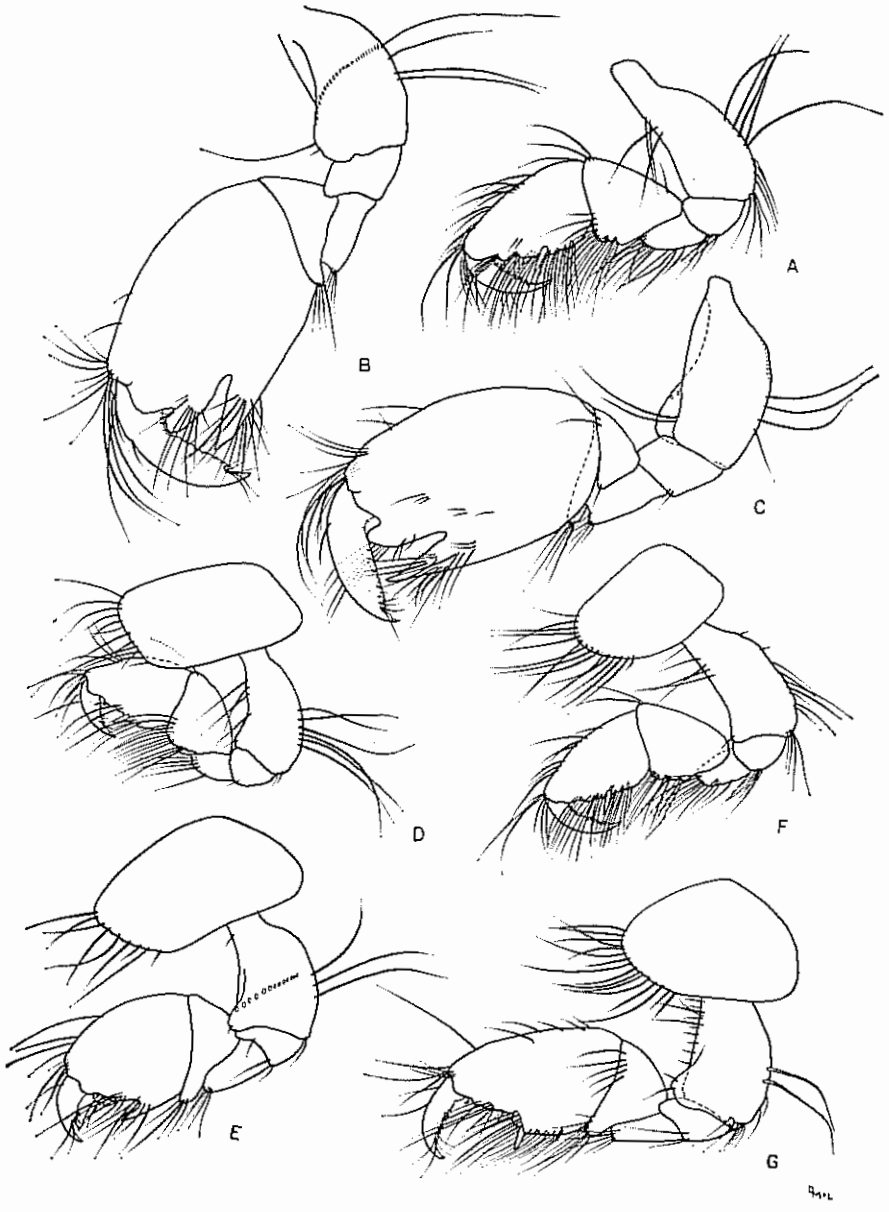

Fig. 15. *Photis conchicola* Alderman. Male, 3.7 mm, Barnard sta. 3: A, gnathopod 1; B,C, gnathopod 2, lateral and medial views. Young male, 2.0 mm: D,E, gnathopods 1, 2. Female, 3.2 mm; F,G, gnathopods 1, 2.

overlapping palm; article 2 of gnathopod 2 poorly produced anterodistally, its lateral face with stridulation ridges, and the lower edge of coxa 3 also with such ridges.

FEMALE: Gnathopod 2 with palm excavate, its article 7 just reaching end of palm; coxae 1-5 subequal in length.

MATERIAL: This is a common intertidal species in southern California. In the examination of 25 washings of algae and rocks in the intertidal of Pt. Fermin, Corona del Mar and La Jolla, only this species of *Photis* and its apparent juveniles have been found along with the aberrant form, *Photis elephantis*, n. sp. *Photis conchicola* is rare subtidally, being found in only one *Velero* sample, 4928, San Diego Shelf, 7 fms, 4 specimens.

RELATIONSHIP: This species has its closest relationship to *Photis californica* Stout, and there is some doubt that the two species are distinct. Most certainly it appears impossible to separate the juveniles of these species. At present, with sampling limited to intertidal regions and to depths greater than 5 fms, the problem is simplified since all intertidal specimens of *Photis* appear to be *P. conchicola* and it has been found only once in depths greater than 30 feet; when samples from mean low water to 30 feet are collected it may prove difficult to separate the species if they meet. They may prove to be different populations of the same species, the intertidal form responding to the different environment by its smaller adult size.

Young *P. californica* resemble *P. conchicola* to a certain extent (see fig. 12 G). Compare other figures of young *P. californica* second gnathopods (fig. 13 E) with *P. conchicola* (fig. 15 E) to see differences in palmar configuration. Nevertheless, adult male *P. conchicola* differs from adult male *P. californica* by the size and shape of the first 4 coxae as seen in the accompanying illustrations. The difference is seen particularly in the third coxa which in *P. californica* is quite broad and expanded anteriorly, whereas in *P. conchicola* it is scarcely wider than coxa 4, and its lower edge is quite narrow and not expanded forward. The large palmar excavation in *P. californica* is hemispherical and broad, whereas in *P. conchicola* it is conical and narrow.

See "Remarks" of *Photis elephantis*, n. sp.

Photis elephantis, new species

Figs. 16, 17

DIAGNOSIS: Coxae 1 and 2 not shortened; coxa 3 not much wider than coxa 4; gnathopod 1 simple, lacking distinct palm; gnathopod 2 nearly simple; peraeopod 4 grossly enlarged, especially articles 4 and 5, its article 2 with a large posterior cusp; article 4 of peraeopod 5 formed into a cone-shaped posterior process.

HOLOTYPE: AHF No. 4919, sex?, 2.3 mm.

TYPE LOCALITY: Barnard Sta. 21, Corona del Mar, intertidal, formalin wash of the surf-grass, *Phyllospadix* sp., Dec. 20, 1949.

MATERIAL: Barnard Sta. 21 (19).

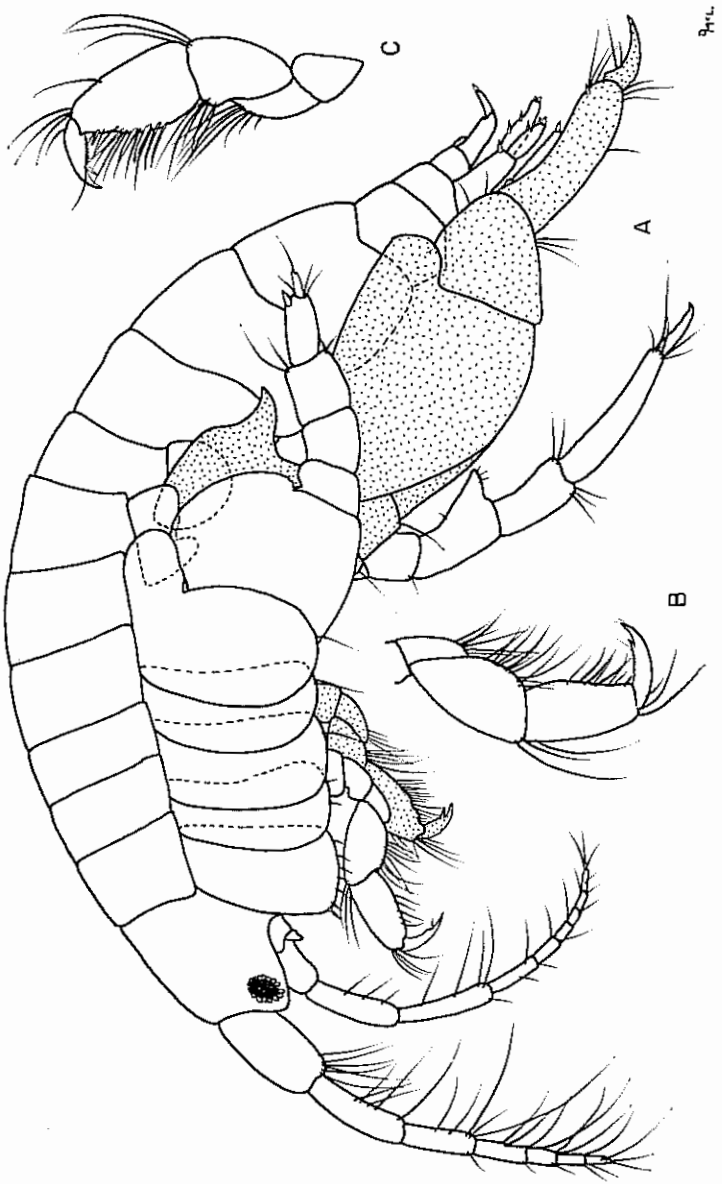

Fig. 16. *Photis elephantis*, n. sp. ?Sex, 2.4 mm, Barnard sta. 21: A, lateral view; B,C, gnathopods 1, 2.

REMARKS: All specimens of this odd "species" appear to be neuters, lacking either female brood plates or penial projections on the ventrum of peraeonal segment 7. The type collection of 19 specimens was mixed with many specimens of *Photis conchicola*. Adults of both are of the same size. In many species of *Photis* the peraeopods are fragile and break off readily, but in preserved animals of this species they remain attached unless carelessly manipulated. Young specimens (fig. 17 I, J) have the fourth and fifth peraeopods considerably less modified so that very young animals could not be segregated from young of *P. conchicola*.

The gnathopods of young *P. conchicola* are like those of adult *P. elephantis*.

The simplicity of the gnathopods in "adult" specimens of this species represents a stage connecting the more distinctly simple gnathopods of *Photis nana* Walker (1904) which should be made the type of a new genus. The intermediary of the gnathopods in *P. elephantis* would provide a link to *P. nana* and perhaps require its retention in *Photis* but there may be other factors to consider.

The peculiar situation of finding only neuters of *P. elephantis* suggests the possibility that the species represents a population of *P. conchicola* which has been parasitized or diseased in some way, affecting the gonads.

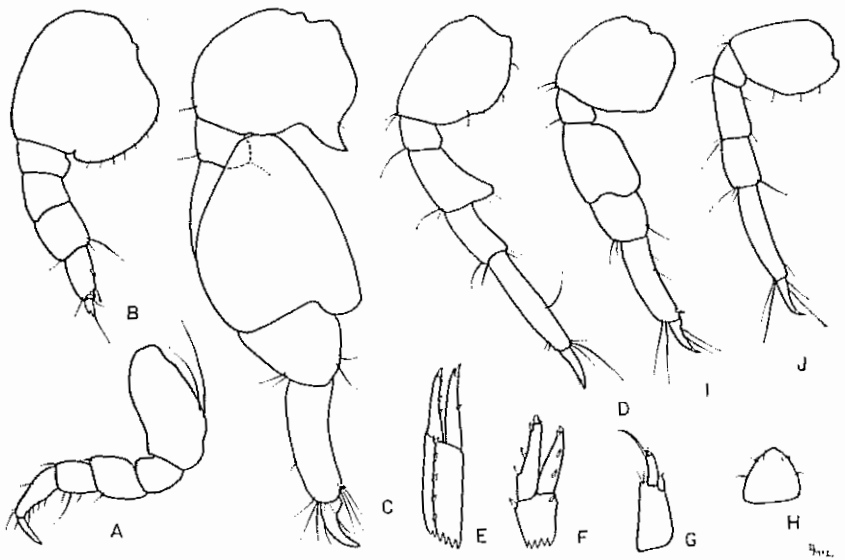

Fig. 17. *Photis elephantis*, n. sp. ?Sex, 2.4 mm, Barnard sta. 21: A,B,C,D, peraeopods 2, 3, 4, 5; E,F,G, uropods 1, 2, 3; H, telson. Juvenile, 1.8 mm: I, J, peraeopods 4, 5.

and that the great enlargement of the fourth peraeopod, the juvenile condition of the gnathopods and the juvenile-female condition of the coxae are results of a change in production of sexual hormones. If so, it would continue to be a logical course to split off *P. nana* into another genus, providing it is sexually normal.

Photis lacia, new species

Fig. 18

DIAGNOSIS OF MALE: Coxae 1 and 2 slightly shorter than coxae 3-5; coxa 2 intermediate in length between 1 and 3, longer than broad; palm of gnathopod 1 not excavate, poorly defined; palm of gnathopod 2 oblique, with subconical palmar excavation, the process defining it failing to reach a line perpendicular to the finger hinge, the palmar margin near the finger hinge formed of a very broad, flat process; article 7 of gnathopod 2 lacking bumps along inner edge, slightly notched near apex, its tip scarcely overlapping palmar process; article 2 of gnathopod 2 broadly and slightly produced anterodistally on the lateral face and medially on the inner face, its lateral face with stridulation ridges, and the lower edge of coxa 3 also with such ridges.

FEMALE: Palm of gnathopod 2 long, quite oblique, not excavated, poorly defined, conjoining without interruption the short hind margin of article 6. At the theoretical point of the merger between the hind edge and the palmer edge the sixth article is broad and bulbous, contrary to the condition in *P. californica*, so that females and juveniles of *P. lacia* are easily distinguished from that species.

JUVENILES: Young males differ from males of *P. californica* only by the oblique (not transverse) orientation of the palm and processes on gnathopod 2.

HOLOTYPE: AHF No. 5719, male, 3 mm.

TYPE LOCALITY: Station 5164. SE of Pt. Conception, 34-26-40N, 120-21-45W, 11 fms, July 2, 1957, bottom of rock with polychaete *Diopatra ornata*.

MATERIAL: 1357 specimens from 109 stations.

RELATIONSHIP: This species is related especially to *P. pugnator* Shoemaker (1945) but differs as follows: the oblique (not transverse) palm of male gnathopod 2; the hind tooth not gaping as much as in *P. pugnator*; the palm of the first gnathopod not excavate as in P. *pugnator*; the finger of gnathopod 2 lacking the proximal inner bump. The species differs from *P. californica* by the oblique palm of male gnathopod 2, but the young stages of *P. californica* are easily confused with subadults of *P. lacia* and are distinguishable only by the special points mentioned in the descriptions of both species concerning females and young.

The new species is closely related to *P. spasskii* Gurjanova (1951),

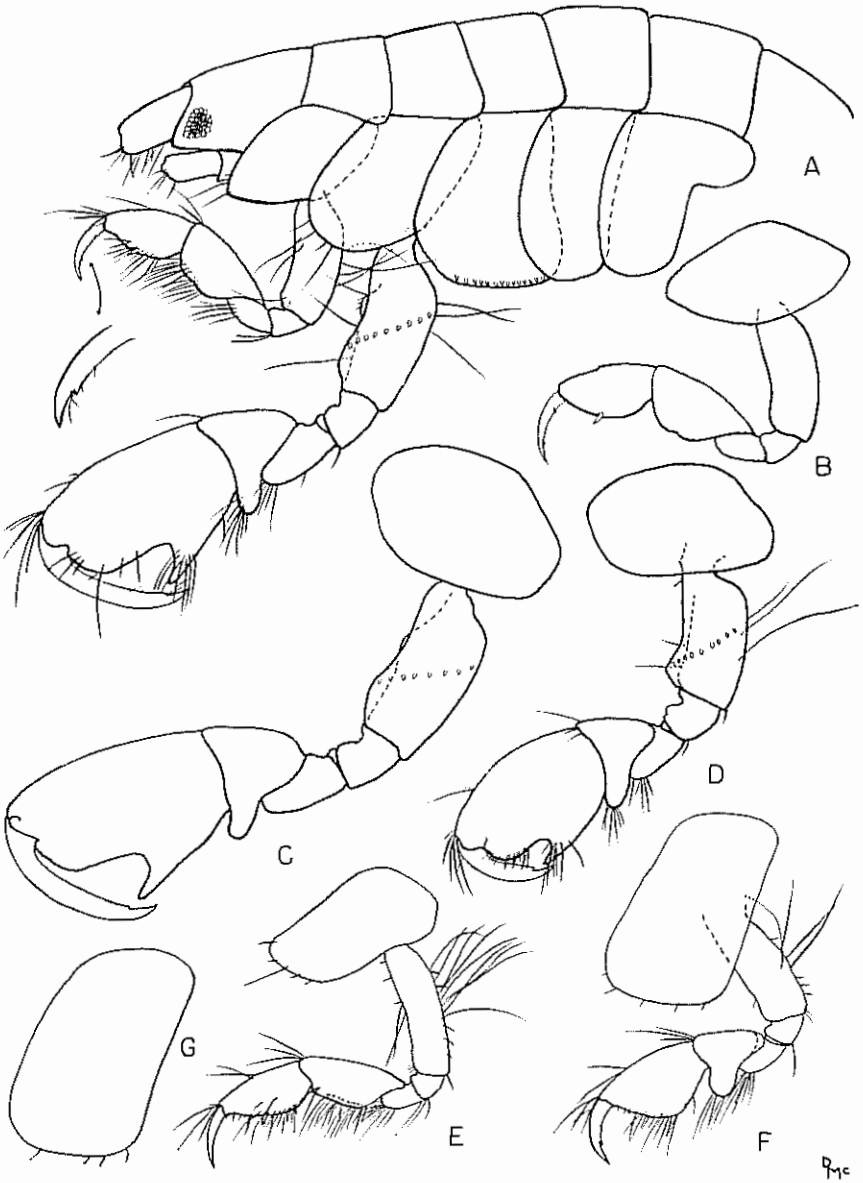

Fig. 18. *Photis lacia*, n. sp. Male, 3.0 mm, sta. 5164: A, front part of animal: B,C, gnathopods 1, 2, minus setae. Young male, 2.75 mm, sta. 5164: D, gnathopod 2. Female, 2.5 mm, sta. 5164: E,F, gnathopods 1, 2; G, coxa 3.

but differs by the plain (not bifid) palmar process near the finger hinge on male gnathopod 2, and in the non-excavate palm of the female second gnathopod. The finger of male gnathopod 1 is relatively short in *P. spasskii* as compared with *P. lacia*.

ECOLOGY: This species has an overall density of 13 animals per square meter on the coastal shelf. It is distributed by depth according to the following scheme:

Depth, fms.	10	20	30	40	50	100
Specimens per square meter	1.3	0.6	26	14	38	15

The species is found mainly in the *Amphiodia* community with a density of 24 animals per square meter and in the *Amphiodia-Onuphis* assemblage with 39 animals per square meter.

Photis macrotica, new species

Fig. 19

DIAGNOSIS OF MALE: Coxa 1 slightly shorter than 3-5; coxa 2 slightly longer than wide; gnathopod 1 with the palm scarcely excavate, its article 6 rather inflated for the genus, its article 7 considerably overlapping the palmar defining spine; gnathopod 2 with the palm oblique, bearing a strong, conically projecting tooth near the finger hinge, followed by a large excavation defined by a long slender tooth which fails to reach a line perpendicular to the hinge point, its article 7 overlapping palm considerably, relatively slender, with a distinct bump on the inner edge quite close to the hinge point and fitting into the excavation between the anterior palmar tooth and the hinge, the rest of inner edge of article 7 smooth except for 3-5 small spines; gnathopod 2 with the anterodistal end of article 2 slightly attenuated, its lateral face with stridulation ridges and lower edge of coxa 3 with such ridges; eyes quite large.

FEMALE: Palm of gnathopod 2 nearly transverse, slightly excavate, the defining angle bulging slightly.

HOLOTYPE: AHF No. 5720, male, 3.3 mm.

TYPE LOCALITY: Station 4939, SE of Pt. Conception, 34-23-20 N, 120-24-30 W, 74 fms, April 9, 1957, bottom of coarse sand and gravel.

MATERIAL: 24 specimens from 11 stations.

RELATIONSHIP: This species and its females are easily distinguishable from other species of *Photis* in southern California by the large eyes. On this basis, females of the species were first noticed, mixed with otherwise unrecognizable females of other species of *Photis*, but only a single adult male has been recovered in the samples. In southern California the new species bears closest relationship to *Photis lacia*, n. sp. from which it differs by the conically produced palmar tooth near the finger hinge of gnathopod 2 and by the small proximal bump of article 7.

Its relationship to other species is shown in the master key to the genus, preceding.

ECOLOGY: This rare species has an overall density of 0.2 animals per square meter on the coastal shelf. It occurs between 31 and 100 fms.

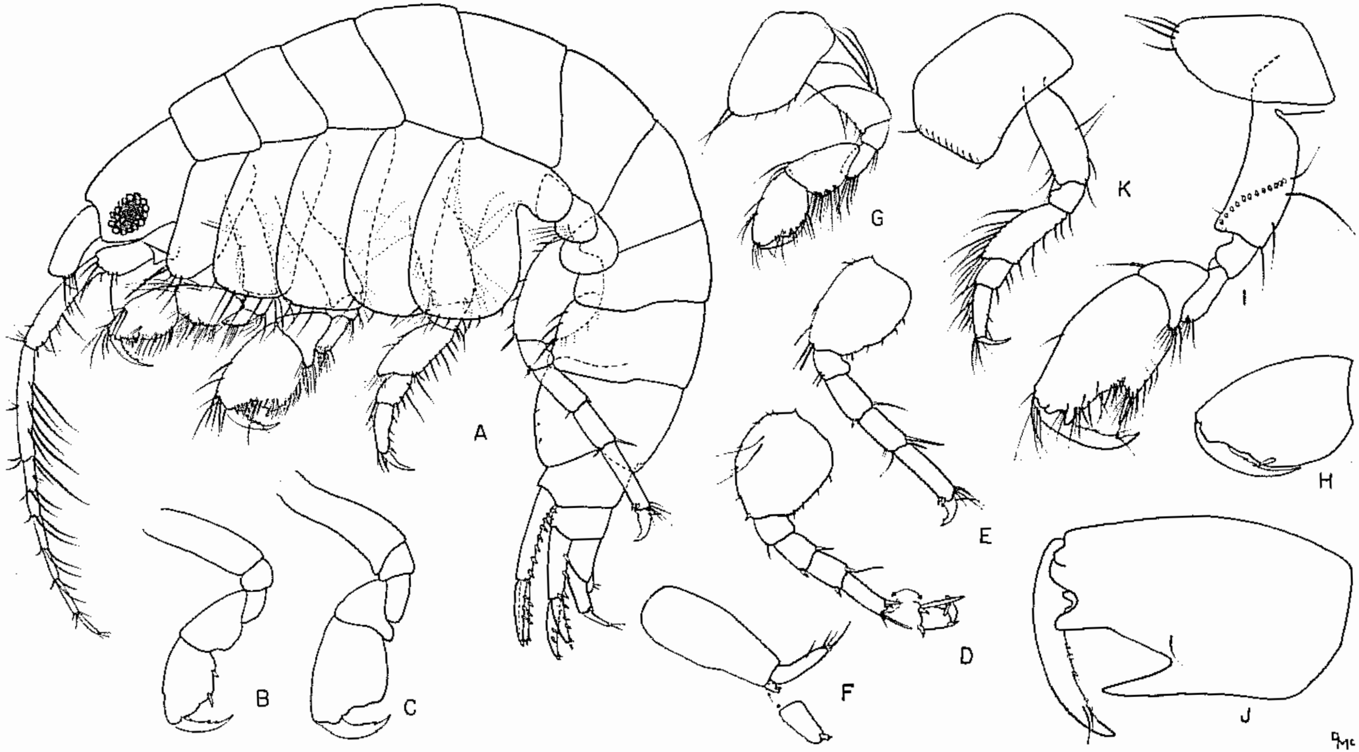

Fig. 19. *Photis macrotica*, n. sp. Female, 3.0 mm, sta. 4939: A, lateral view; B,C, gnathopods 1, 2, minus setae; D,E, peraeopods 3, 4: F, uropod 3. Male, holotype, sta. 4939: G,H, gnathopod 1; I,J, gnathopod 2; K, peraeopod 1.

Photis viuda, new species

Fig. 20

DIAGNOSIS OF MALE: Coxa 1 shorter than 2, longer than broad; palm of gnathopod 1 oblique, straight, defined by a spine; palm of gnathopod 2 oblique, long, defined by a large tooth near the finger hinge and bearing a medial palmar tooth; article 7 of gnathopod 2 simple, curved, reaching end of palm, lacking bumps, in younger males with a small group of stiff setae distally; article 2 of gnathopod 2 with its anterodistal end slightly produced, its lateral face with stridulation ridges, and the lower edge of coxa 3 also with such ridges.

FEMALE: Palm of gnathopod 2 slightly excavate, the defining angle bulging.

HOLOTYPE: AHF No. 602, male, 5 mm.

TYPE LOCALITY: Station 6804, Santa Cruz Island canyon, California, 33-56-25 N, 119-50-32 W, 218 fathoms, December 22, 1959, bottom of coarse brown shelly sand and pebbles.

MATERIAL: Station 6804 (91).

RELATIONSHIP: This species differs from other California species of *Photis* by the medial palmar tooth of male gnathopod 2. In other respects the species stands close to *P. lacia*, n. sp.

Genus Protomedeia Krøyer

KEY TO MALE PROTOMEDEIA OF THE WORLD

1.	Article 2 of gnathopod 1 with posterodistal bump ..... *P. fasciata*	
1.	Article 2 of gnathopod 1 smooth posterodistally	2
2.	Palm of gnathopod 2 with large projecting defining tooth or a spine acting as a false tooth[5]	3
2.	Palm of gnathopod 2 lacking large spine or tooth	8
3.	Article 7 of gnathopod 1 overlapping palm by 75% of its length	4
3.	Article 7 of gnathopod 1 overlapping palm by 40% of its length or less	7
4.	Palm of gnathopod 2 defined by an articulated spine	5
4.	Palm of gnathopod 2 defined by a fixed tooth	6
5.	Inner ramus of uropod 3 more than two thirds as long as outer ramus ..... *articulata*, n. sp. (in part)*	
5.	Inner ramus of uropod 3 less than one half as long as outer ramus ..... *zotea*, n. sp. (in part)*	
6.	Palm of gnathopod 2 with a small medial process ..... *fasciatoides*	
6.	Palm of gnathopod 2 lacking a medial process ..... *popovi*	
7.	Hind tooth of gnathopod 2 gaping ..... *palmata*	
7.	Hind tooth of gnathopod 2 not gaping ..... *dulkeiti*	

[5]Species with a palmar defining spine on gnathopod 2 are entered twice in the key (*) because the spine may be broken off in some specimens.

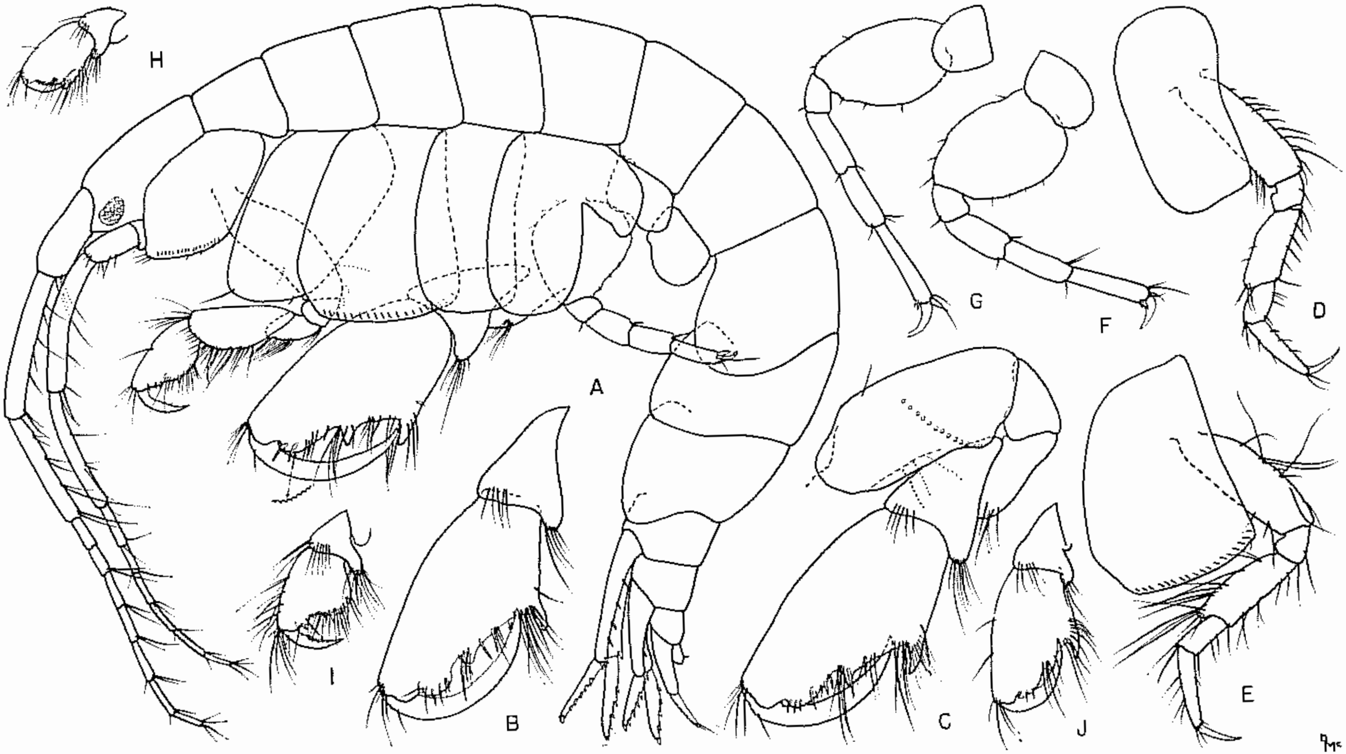

Fig. 20. *Photis viuda*, n. sp. Male, holotype, 5.0 mm. sta. 6804: A, lateral view; B,C, medial and lateral views of gnathopod 2; D,E,F,G, pereopods 1, 2, 4, 5. Female, 3.8 mm: H,I, gnathopods 1, 2. Male, 4.2 mm: J, gnathopod 2.

8. Article 7 of gnathopod 2 strongly hooked, blunt .... *grandimana*
8. Article 7 of gnathopod 2 curved, evenly tapering 9
9. Article 7 of gnathopod 2 not overlapping palm 10
9. Article 7 of gnathopod 2 overlapping palm by more than 25% of its length 11
10. Article 7 of gnathopod 2 reaching end of palm ..... *epimerata*
10. Article 7 of gnathopod 2 failing to reach end of palm ..... *microdactyla*
11. Article 5 of gnathopod 2 proximally expanded 12
11. Article 5 of gnathopod 2 not expanded 13
12. Article 6 of gnathopod 2 broad distally ..... *macrocarpa*
12. Article 6 of gnathopod 2 tapering distally ..... *zotea*, n. sp. (in part)*
13. Rami of uropod 3 short, the inner reaching only half way along the outer ..... *gurjanovae*
13. Rami of uropod 3 long, the inner reaching three fourths along the outer 14
14. Palm of gnathopod 1 transverse ..... *coeca* and *stephenseni*
14. Palm of gnathopod 1 oblique, poorly developed ..... *articulata*, n. sp. (in part)*

Protomedeia articulata, new species

Fig. 21

DIAGNOSIS OF MALE: Gnathopod 1 with article 2 lacking posterodistal bump, its article 7 (claw) overlapping the short palm by 75% of its length; gnathopod 2 with the palm defined by a large, articulated spine, the middle of palm with a blunt projection, its article 7 overlapping the palm by nearly half its length; article 3 of first antenna 70% as long as article 1.

HOLOTYPE: AHF no. 5615 male, 4 mm.

TYPE LOCALITY: Station 4785, off Gaviota, 34-27-00 N, 120-08-30 W, 31 fms, December 18, 1956, bottom of green silt.

MATERIAL: 363 specimens from 81 stations.

RELATIONSHIP: This species is remarkable for a *Protomedeia* in the rather long third article of antenna 1 which is 70% as long as article 1, but it cannot be assigned to *Eurystheus*, for in that genus article 3 is supposed to be at least as long as article 1. The new species bears close relationship to *Protomedeia popovi* Gurjanova (1951) from which it differs by the defining process of the palm on gnathopod 2 being an articulated spine, not a tooth, and by the strongly overlapping seventh article. The species differs from *P. fasciatoides* Bulycheva (1952) by the strongly overlapping claw of gnathopod 2. The very close similarity of the two species in second gnathopods is seen in my fig. 21F when the articulation line of the defining palmer spine is eliminated. One might speculate that the defining tooth in *P. fasciatoides* is actually an articulated spine

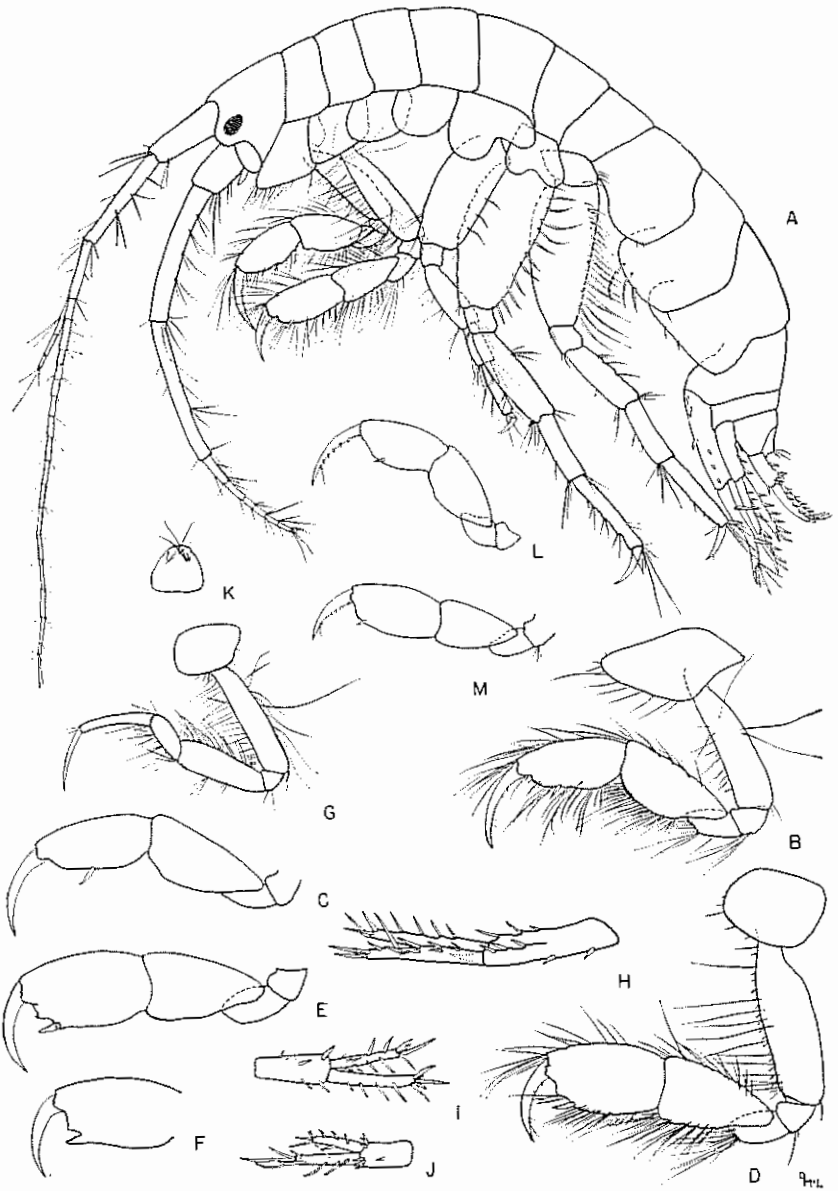

Fig. 21. *Protomedeia articulata*, n. sp. Female, 4.0 mm, sta. 4785: A, lateral view; G, peraeopod 1; H,I,J, uropods 1, 2, 3; K, telson; L,M, gnathopods 1, 2, minus setae. Male, holotype, 4.0 mm: B,C, gnathopod 1; D,E, gnathopod 2; F, gnathopod 2, showing spine as if fused to palm for comparison with other species.

and that species should be rechecked for verification of this character.

The species reaches a length of 8 mm.

ECOLOGY: On the coastal shelf, 5 to 100 fms, this species has a density of 4.5 animals per square meter. It is distributed by depth as follows:

Depth, fms.	10	20	30	40	50	60	100
No. of animals per square meter	0	2.5	5.0	13	5.0	4.7	0.5

The center of distribution of the species is along the 40 fathom depth-contour.

Protomedeia articulata is almost exclusively limited to three benthic communities, those of *Amphiodia*, *Amphiodia-Cardita* and *Listriolobus*. In the *Amphiodia* and *Cardita* communities the species has a density of 16 animals per square meter and in the *Listriolobus* community it has a density of 14 animals per square meter.

Cheirimedeia, new subgenus

DIAGNOSIS: *Protomedeia* with inner ramus of uropod 3 less than half as long as outer ramus, the peduncle slender, not plate-like; antenna 1 with 3 or more articles in accessory flagellum; gnathopods subchelate.

TYPE SPECIES: *Protomedeia* (*Cheirimedeia*) *zotea*, new species.

OTHER SPECIES: *Protomedeia macrocarpa* Bulycheva (1952); *Protomedeia palmata* Bulycheva (1952); *Protomedeia dulkeiti* Gurjanova (1951).

REMARKS: This subgenus is erected on the basis of the shortened inner ramus of uropod 3. Its members bridge the small gap between the genera *Protomedeia* and *Cheiriphotis* and indeed, point to the small qualitative differences (if any) between the two genera. Even *Cheirimedeia* is not qualitatively different from *Protomedeia* because other species such as *P. gurjanovae* Bulycheva show a partially shortened inner ramus of uropod 3. Thus, members of *Cheirimedeia* are recognized only as expressions of intermediacy between two extremes and their limits, because of evolution, are indefinable.

Protomedeia (Cheirimedeia) zotea, new species

Fig. 22

DIAGNOSIS OF MALE: Gnathopod 1 with article 2 smooth, lacking a bump, its articles 5 and 6 slender, linear, the palm obsolete, its article 7 greatly overlapping the theoretical palm; gnathopod 2 with article 5 expanded proximally, its article 6 tapering distally, the palm oblique, short, bearing a medial bump, defined by a large spine forming a false tooth, its article 7 greatly overlapping the palm; inner ramus of uropod 3 less than half as long as outer ramus.

FEMALE: Gnathopod 2 slightly stouter than gnathopod 1, but article 6 remaining nearly linear, the palm very short, transverse, and article 7 overlapping palm. (If one considered that the palm were defined by the posterior spine of article 6, then the palm is considered to be quite oblique

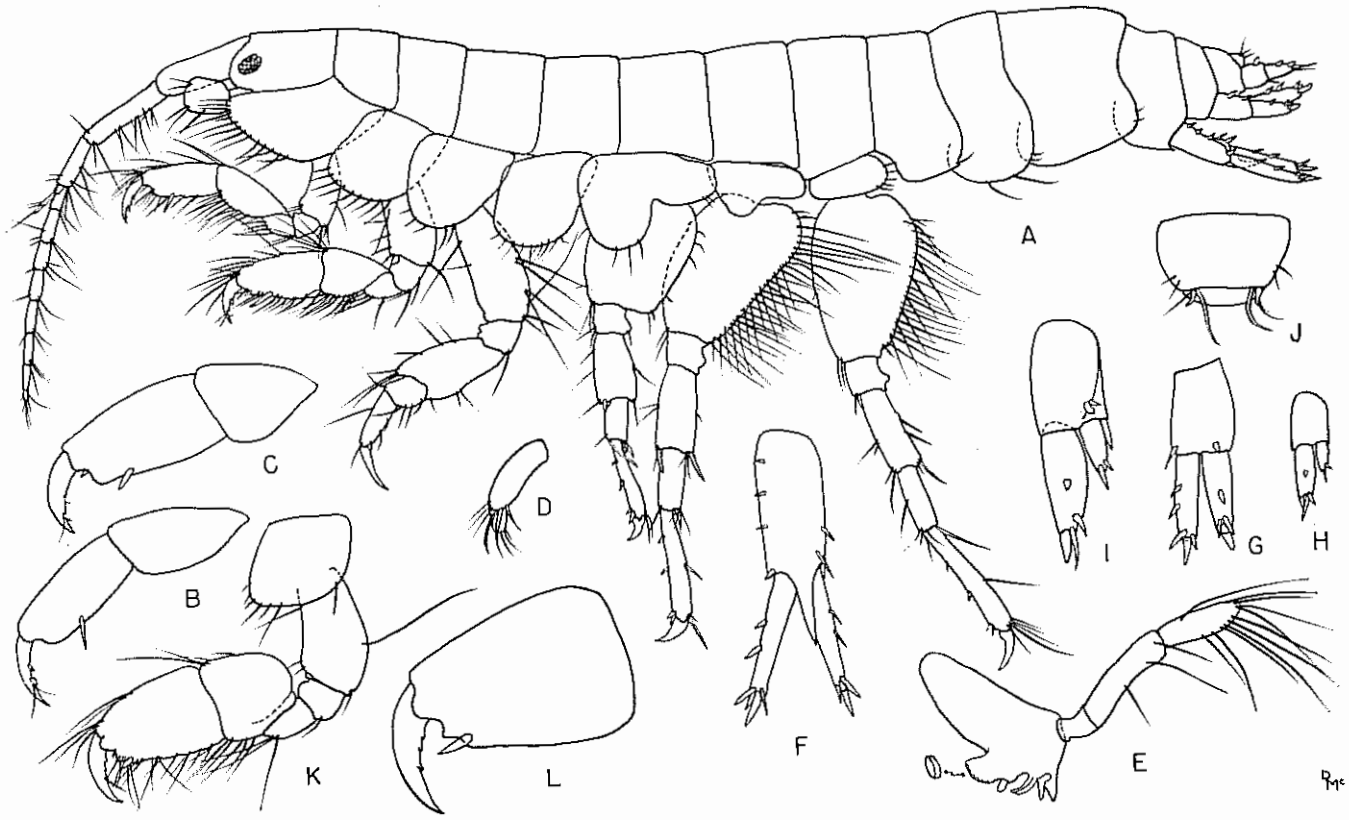

Fig. 22. *Protomedeia* (*Cheirimedeia*) *zotea*, n. sp. Female, holotype, sta. 6445: A, lateral view; B,C, gnathopods 1, 2, minus setae; D, articles 3-4 of maxillipedal palp; E, mandible; F,G,H,I, uropods 1, 2, 3, 3; J, telson. Male, 2.4 mm: K,L, gnathopod 2.

and to bear a strong medial bump; the same condition is true of gnathopod 1 in both sexes.)

HOLOTYPE: AHF no. 594, female, 3.5 mm.

TYPE LOCALITY: Station 6445, Monterey Bay, California, 36-39-57 N, 121-51-00 W, 15.5 fathoms, October 1, 1959, bottom of medium gray sand.

MATERIAL: The type and 8 other specimens from the type locality.

RELATIONSHIP: This species is easily distinguished from its faunistic relative *P. articulata* by the shortened inner ramus of uropod 3, but also by the paler eyes and pigmentation in alcohol, as well as the much stouter first two peraeopods.

The species is also related to *P. macrocarpa* Bulycheva (1952) resembling it in the expanded carpus of the male second gnathopod, but differing by the tapering sixth article. From *P. gurjanovae* Bulycheva (see Gurjanova 1951) this species differs by the nearly simple first gnathopod, which in *P. gurjanovae* is stouter and transversely palmate.

Family ISCHYROCERIDAE

This family has been considered distinct from the Photidae by the uncinate outer ramus of the third uropod. Such uncination is not as clear in the Ischyroceridae as it is in the Ampithoidae (separated from Ischyroceridae by notched outer lobes of lower lip). The tip of the outer ramus of uropod 3 is either slightly hooked or has a spine that is hooked, but if one looks at the figures of the following species assigned to the Ischyroceridae the uncination is scarcely evident, and indeed it often is completely overlooked on mounted uropods which have been turned to dorsal view or otherwise altered during mounting. Even in the Ampithoidae it is cause for confusion, for *Paragrubia vorax* scarcely can be considered to have an uncinate third uropod.

I believe that a firmer basis for recognition of ischyrocerids is the relationship between lengths of rami and peduncle on the third uropod.

In almost all species described before 1906 of the classic genera *Ischyrocerus*, *Jassa*, *Microjassa* and *Parajassa*, the peduncle of the third uropod is elongated, at least as long as the outer ramus of the second uropod, and the rami of the third uropod are about half as long as the peduncle. In the Photidae, by contrast, the third uropod varies from this condition in the following ways: the peduncle often is short, with rami considerably longer than the peduncle (at least the outer ramus) or if the peduncle is elongated as in the Ischyroceridae, the rami are at least as long as the peduncle.

When the third uropodal rami are longer than half of the peduncle as in *Pseudischyrocerus denticauda* Schellenberg (1931) the outer ramus clearly has apical hooks or is uncinate. Another feature of recognition is that most ischyrocerids have a crown of blunt spines at the apex of the peduncle on the third uropod, but this is also common to many photids.

I believe, on the basis of third uropods as so described above, that

the genus *Bathyphotis* Stephensen (1944) should be removed from the Photidae and placed in the Ischyroceridae where it bears close relationship to *Microjassa*, differing by the multiarticulate accessory flagellum and the reduced spines of the outer plate on the first maxilla.

The genus *Bogenfelsia*, to be described by Barnard (1961a) also should be assigned to the Ischyroceridae.

One should also consult *Eurystheus ventosa*, n. sp. in this paper, a species which eventually should be assigned to the Ischyroceridae.

Genus Ischyrocerus Krøyer

In southern California, Stout (1913) described *Ischyrocerus parvus* which I believe to be a synonym of the *I. minutus* phase of *I. anguipes* Krøyer, a common European species known also from Oregon (J. L. Barnard 1954a). Specimens from Dillon Beach in northern California identified as *I. parvus* by Mr. C. R. Shoemaker in the U.S. National Museum (courtesy of Dr. T. E. Bowman) are in reality *I. anguipes*. Nevertheless, I have not found *I. anguipes* or any species inhabiting *Phyllospadix* in the Laguna Beach area (type-locality) fitting Stout's description; neither of the following species fits the description in terms of setosity of the gnathopods.

Ischyrocerus litotes (J. L. Barnard), new combination
Figs. 23, 24

Microjassa litotes J. L. Barnard 1954b: 127-130, pls. 35, 36.

DIAGNOSIS OF MALE: Eyes large, occupying roughly a third of the head length, uniformly and lightly pigmented, not divided into zones as in *I. pelagops*, n. sp. to follow; body dorsally smooth; rami of uropod 3 less than half as long as peduncle, the outer ramus with 10-13 minute distal serrations, the end of the peduncle sparsely spinose; second gnathopods highly variable, indicating perhaps a multiform species; young stages with palm distinct and only slightly longer than hind edge of article 6, a small protuberance developing near finger hinge; article 7 fitting the palm which is defined by a protuberance; fully adult males with indistinct palm not separated from hind edge, although excavated near finger hinge; protuberance near finger hinge now well defined and acute; article 7 as long as article 6, the hand (article 6) being much stouter than in juveniles and bearing an anterior keeled process; coxa 1 scarcely half as long as coxa 2 and in large males mostly hidden by coxa 2 as in fig. 24A; coxa 5 half as long as coxa 4.

FEMALE: Gnathopods 1 and 2 small, subequal in size.

MATERIAL: 92 specimens from 32 stations.

RELATIONSHIP: This unusual species of multiform character is easily distinguished from *I. pelagops* to follow, the other southern Californian benthic ischyrocerid, by the uniformly pigmented eyes as they appear in alcohol. Occasionally a few large specimens of *I. pelagops* exhibit the same eye character as *I. litotes* but the gnathopods are those of *I. pelagops*.

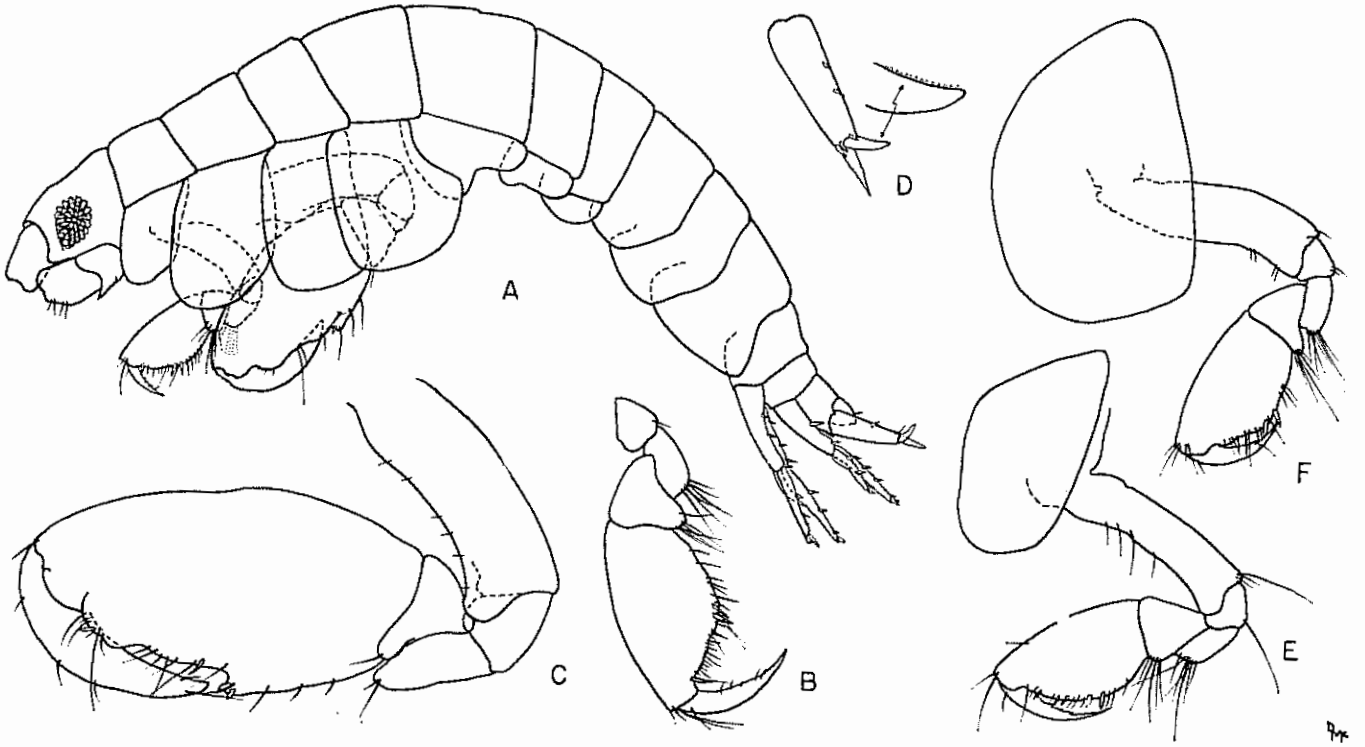

Fig. 23. *Ischyrocerus litotes* (Barnard) Male, 2.3 mm. sta. 4910. A, lateral view; B,C, gnathopods 1, 2; D, uropod 3. Female, 2.5 mm, sta. 4850: E,F, gnathopods 1, 2.

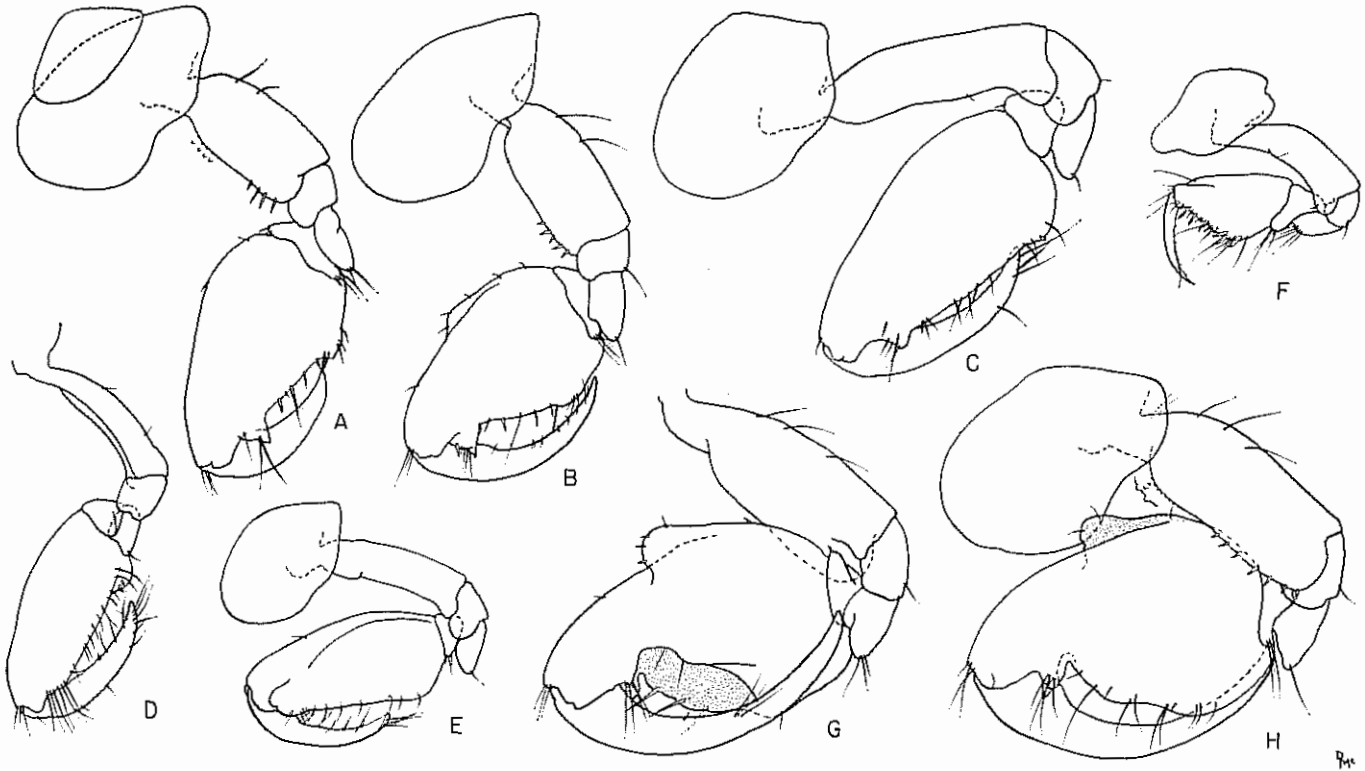

Fig. 24. *Ischyrocerus litotes* (Barnard). A, coxae 1-2, gnathopod 2 of male, 2.3 mm, sta. 4844. Second gnathopods in remaining figures: B, male, 2.5 mm, sta. 5030; C, male, 2.2 mm. sta. 5189; D,E, both gnathopods, male, 2.0 mm, sta. 4785. F,G,H, gnathopods 1, 2, 2, of male, 3.5 mm, sta. 5030.

The gnathopods of young males might be those of any number of other species of *Ischyrocerus* and the rarity of the terminal adult makes identification of the majority of specimens dependent on the younger stages. In southern California the species is easily separated by its eyes and short coxa 5. According to Gurjanova's (1951) key to the genus this species comes closest to *I. megalops* Sars (1895: pl. 210, fig. 2) and *I. laptevi* Gurjanova (1951: fig. 645). Young *I. litotes* are very close to *I. megalops* but differ by the markedly short first coxa and the longer palm of gnathopod 2, as well as the more numerous small denticles of the outer ramus on the third uropod. The new species seems distinguishable from *I. laptevi* by the non-excavate palm of gnathopod 1 and by the short fifth article of that appendage.

When originally described this species was considered to belong to *Microjassa* because of the short fifth coxa, but reexamination of the relationship of the coxae shows that coxa 5 is significantly larger than coxa 6 and that the species should be transferred to *Ischyrocerus*. The male second gnathopods are highly polymorphic as recorded in the original description and seen in the additional figures presented herein. None of the specimens collected from the open-sea has had gnathopods as large as those found in Los Angeles Harbor, the type locality, although the morphology is the same.

ECOLOGY: This species has an overall density of 1.0 animals per square meter on the coastal shelf. It is rather evenly distributed between the depths of 5 and 45 fms.

Ischyrocerus pelagops, new species

Fig. 25

DIAGNOSIS OF MALE: Eyes large, occupying roughly a third of the head length, with dark centers bounded by a ring of lighter ommatidea; body dorsally smooth; rami of uropod 3 less than half as long as peduncle; the outer ramus with 8-9 distal serrations and small distal claw, the end of the peduncle sparsely, not heavily spinose; palm of gnathopod 1 slightly convex; article 6 of second gnathopod 1.5 times as long as broad, its palm oblique, straight, lacking protuberances, in large males article 7 becoming shorter than the palm; coxa 5 as long as coxa 4. The species reaches 5 mm in length.

FEMALE: Palms of gnathopods quite oblique, scarcely distinct from hind margins of sixth articles.

HOLOTYPE: AHF no. 5721, male, 3.5 mm.

TYPE LOCALITY: Station 4870, off Laguna Beach, 33-30-33 N, 117-45-17 W, 6 fms, February 21, 1957, bottom of fine gray sand.

MATERIAL: 381 specimens from 37 stations.

RELATIONSHIP: In the key to this genus of 28 species found in Gurjanova (1951: 913) *I. pelagops* appears closest to *I. megalops* (see Sars 1895: pl. 210, fig. 2) and *I. laptevi* (in Gurjanova 1951). It resembles

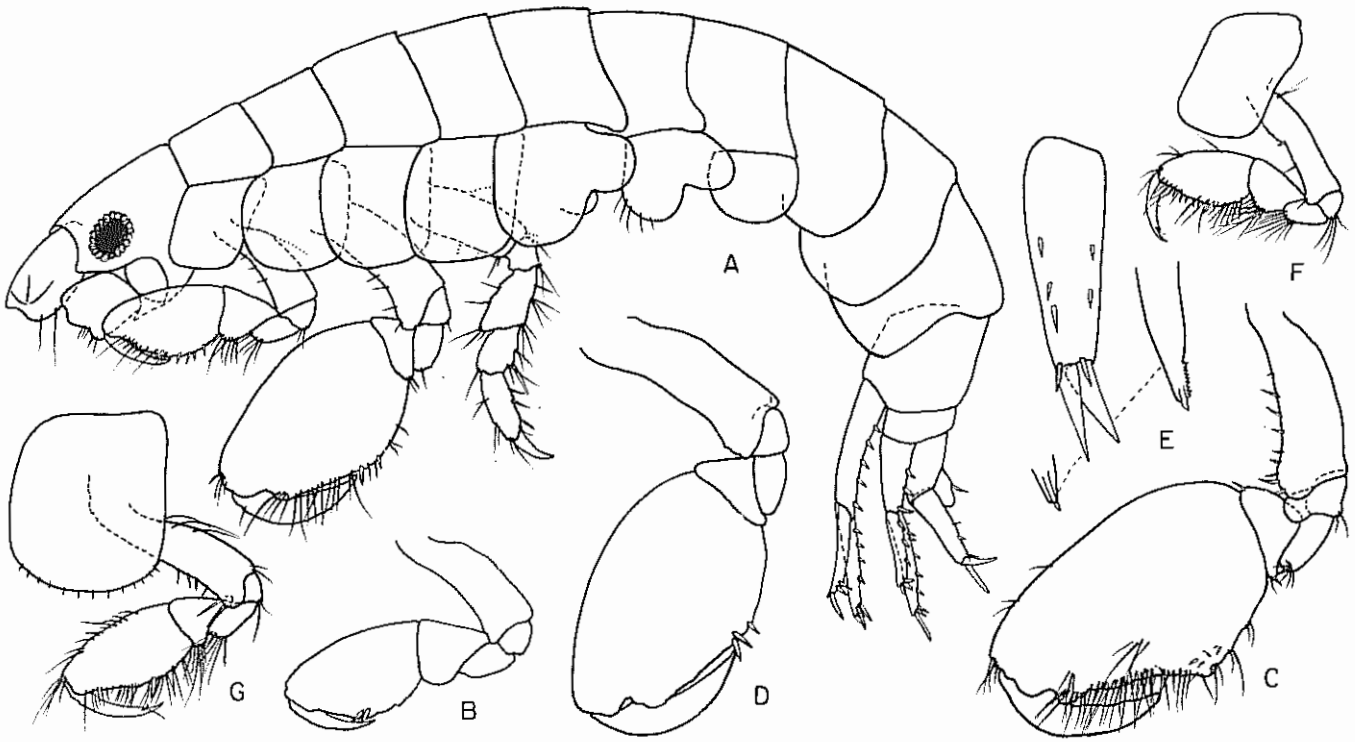

Fig. 25. *Ischyrocerus pelagops*, n. sp. Male, holotype, 3.5 mm, sta. 4870: A, lateral view; B,D, gnathopods 1, 2, minus setae; E, uropod 3. Female, 4.2 mm: F,G, gnathopods 1, 2. Male, 4.5 mm, sta. 4869: C, gnathopod 2.

I. megalops in all details except the long fifth coxa which in *I. megalops* is quite short. From *I. laptevi* the species differs by the non-excavate palm of the first gnathopod and the stouter sixth article of gnathopod 2, the palm of which is distinct from the hind margin of article 6.

ECOLOGY: This species has an overall density of 3.9 animals per square meter on the coastal shelf. It is confined to depths of less than 20 fms. In the 10 fathom depth class it has a frequency of 12 animals per square meter and in the 20 fathom class its frequency is 5.5 animals per square meter.

Genus **Parajassa** Stebbing

Parajassa angularis Shoemaker 1942: 41-44, figs. 14,15

Figs. 26, 27

MATERIAL: 62 specimens from 5 stations.

ECOLOGY: This species has a negligible overall density on the coastal shelf although it was collected abundantly in several stations not included in the grid system used to calculate abundance of animals on the coastal shelf. Four of these stations are shallow, ranging from 9 to 11 fms along the Pt. Conception to Dana Pt. shelves and the fifth station was located off the north end of Santa Rosa Island at a depth of 19 fms. These stations were characterized by being rocky or gravelly and dominated by the polychaete *Diopatra* sp.

Family COROPHIIDAE

It has become increasingly more difficult to classify by family various members of Photidae and Corophiidae, because the differences involve quantitative aspects of depression or compression of the pleon, especially the urosome. There is really little cause to retain these discrete families since so many intergrades are present, and it is almost impossible in many cases to decide between two alternatives. While not officially fusing these families herein, I recommend that identification of genera in these families should be based on consideration of the species of both families. Attention should be called to comments under Photidae concerning the relationship of Aoridae to Photidae.

The Ischyroceridae, also, are scarcely distinct from the photid-corophiid complex. According to Stebbing (1906) the Ischyroceridae are like Photidae, except that the third uropods are supposed to be uncinate. This is no longer recognized of several species classified as Ischyroceridae, but the genera of that family still may be recognized by means of the biramous third uropods with elongated peduncle, the rami never being more than two thirds as long as the peduncle.

J. L. Barnard (1958b) has published a key to the Corophiidae to which must be added the new genus (herewith) and the following genera erected since 1958: *Aorcho* Barnard (1961b) and *Bogenfelsia* Barnard (1961a). See Barnard (1958b, 1959, and 1961) for other species in the Corophiidae, such as *Gaviota podophthalma, Erichthonius brasiliensis* and several species of *Corophium*.

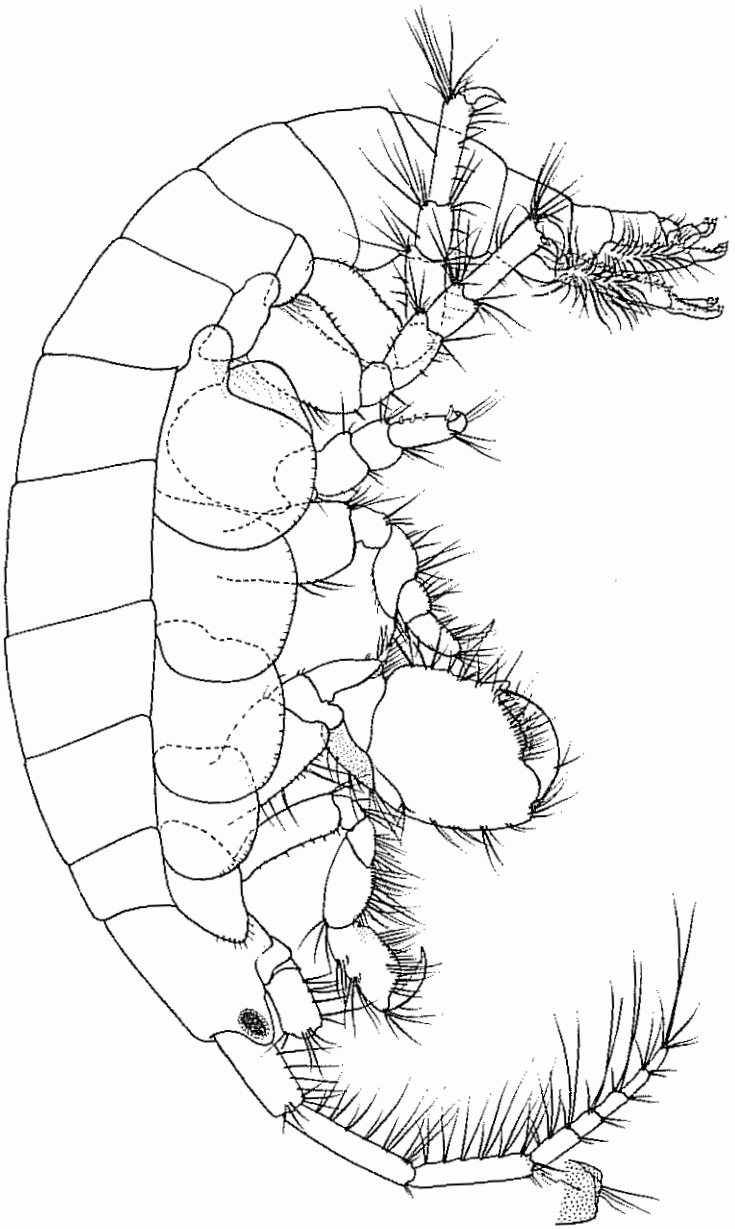

Fig. 26. *Parajassa angularis* Shoemaker. Female, 3.6 mm, sta. 4794. Lateral view.

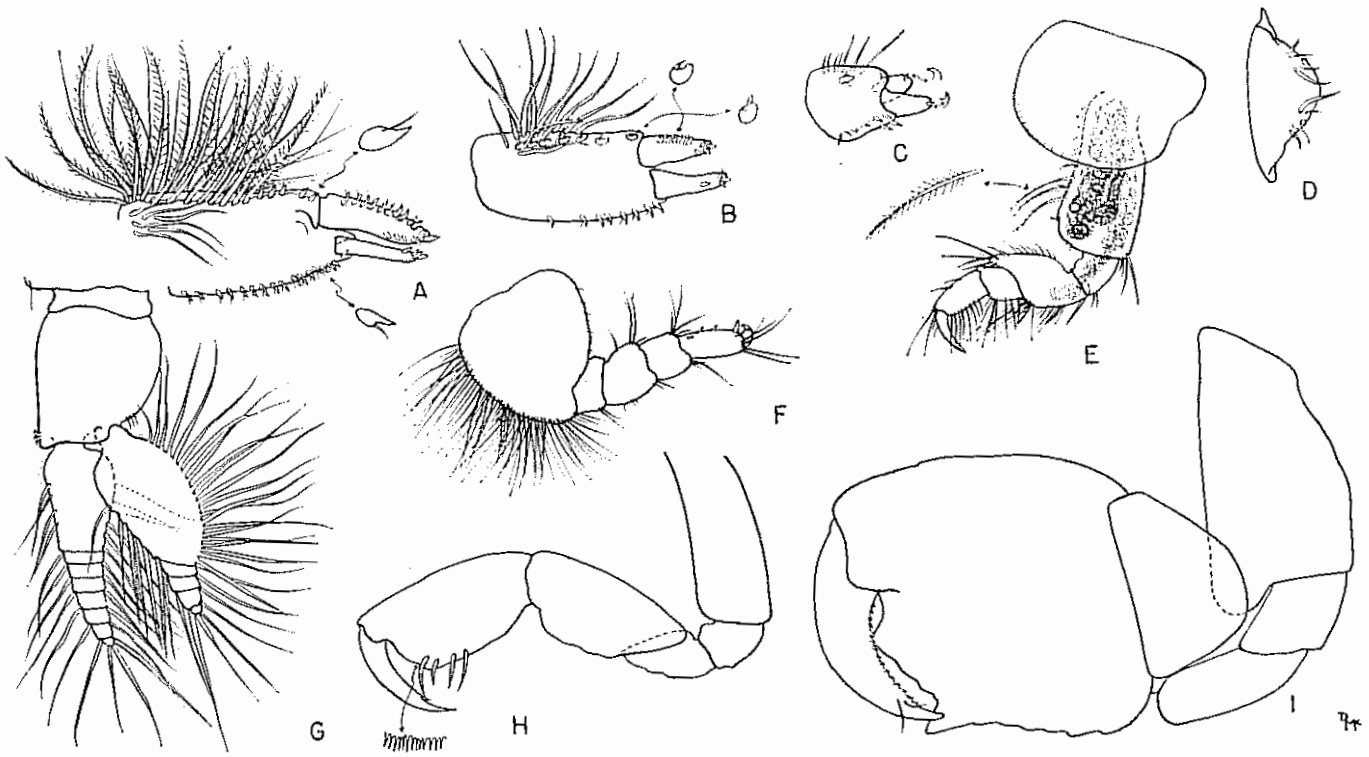

Fig. 27. *Parajassa angularis* Shoemaker. Female, 3.6 mm, sta. 4794: A,B,C, uropods 1, 2, 3; D, telson; E,F, peracopods 1, 3; G, pleopod 1; H,I, gnathopods 1, 2, minus setae.

Genus Cerapus Say

KEY TO WORLD CERAPUS

1. First article of antenna 1 distally widened and produced 2
1. First article of antenna 1 not distally widened 3
   2. Article 5 of male gnathopod 2 with large tooth on posterior edge ..... *crassicornis*
   2. Article 5 of male gnathopod 2 smooth on posterior edge ..... *sismithi* and *oppositus*
3. Article 5 of peraeopod 3 not cryptic anteriorly, not covered by article 4 ..... *polutovi*
3. Article 5 of peraeopod 3 cryptic, covered anteriorly by article 4 ..... *tubularis*, (= *abditus*, *longirostris*, *erae*)

Cerapus tubularis Say, new synonymy

Figs. 28, 29

Cerapus tubularis Say, Stebbing 1906: 667-668; Holmes 1905: 517, fig.; Kunkel 1918: 160-161, fig. 48; Pearse 1912: 377; Monod 1939: 568; Shoemaker 1942: 48.

?*Cerapus abditus* Templeton, Stebbing 1906: 668-669; Stebbing 1910: 616-618, pl. 55A; Pirlot 1938: 349-352, figs. 157-158.

?*Cerapus longirostris* Shen 1936: 265-272, figs. 1-5.

?*Cerapus erae* Bulycheva 1952: 248-249, fig. 39.

REMARKS: Most certainly *C. longirostris* is a synonym of *C. abditus* and *C. abditus* simply represents terminal adults of what has come to be known as *C. tubularis* and which represents younger stages. Actually the figures of Holmes (1905) and Kunkel (1918) are not representative of *C. tubularis* as described by Stebbing 1906, whose concept presumably was based on Say's original description in 1817 and Smith's redescription in 1880, neither reference having been seen by me. If Stebbing's description and Bate's (1862) figures of *C. tubularis* are representative, then the male second gnathopod of *C. tubularis* in terminal adulthood is like that of *C.*

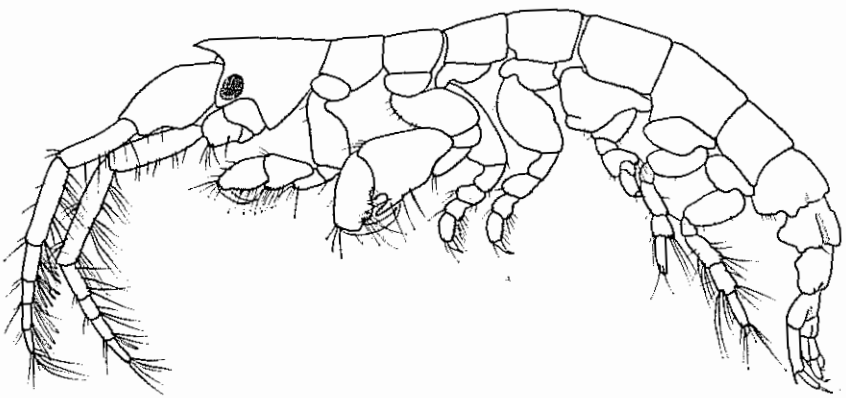

Fig. 28. *Cerapus tubularis* Say. Male, 2.8 mm, sta. 5975. Lateral view.

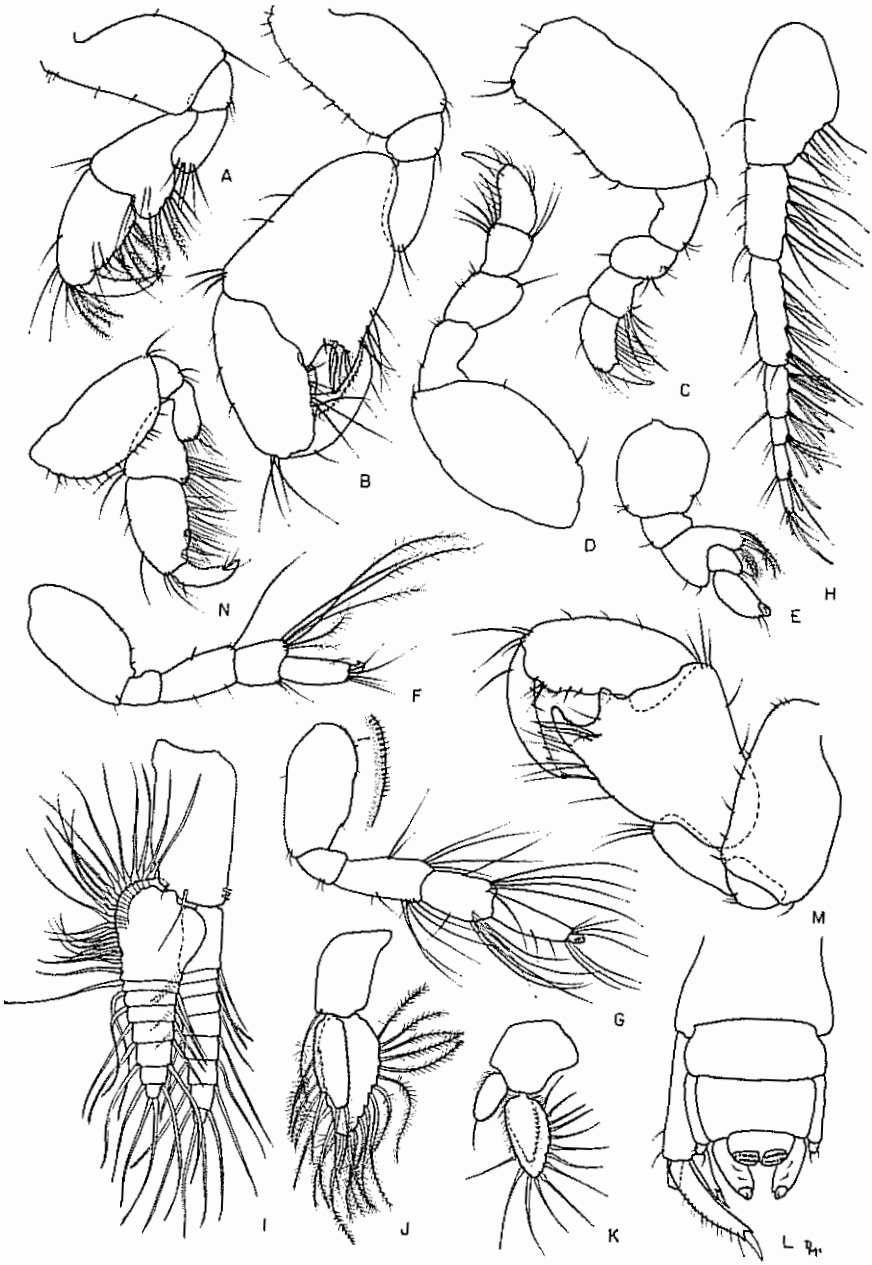

Fig. 29. *Cerapus tubularis* Say. Male, 2.75 mm, sta. 5975: A,B, gnathopods 1, 2; C,D,E,F,G, peraeopods 1, 2, 3, 4, 5; H, antenna 1; I,J,K, pleopods 1, 2, 3; L, dorsal view of urosome. Male, 3.0 mm: M, gnathopod 2. Female, 3.2 mm: N, gnathopod 2.

abditus as redescribed by Stebbing (1910). The specimens at hand fit *C. abditus* as described by Pirlot (1938) and *C. flindersi* Stebbing (1888), another synonym of *C. abditus*.

One of the difficulties seems to have been that Stebbing (1906) in his key to *Cerapus* restricted *C. tubularis* to specimens with only 3 flagellar articles on antenna 1. In the present material these vary between 2 and 5, and on antenna 2 the flagellar articles vary from 3 to 5.

In *Cerapus erae* no distinctions from *C. tubularis* are seen except that the "female" second gnathopod has the hind lobe of article 4 strongly produced distally. Probably this is a young male. If so, perhaps it is gerontic and tending to develop male characteristics, a common occurrence in terminal amphipod females. Of course, peraeopod 1 in *C. erae* shows a bump on the posterior margin of article 5 but probably this is only of varietal value.

None of the specimens at hand has the fully developed conditions seen in Stebbing's (1910) drawings, but the writer has little hesitation in forming this new synonymy. It may be, that as an optimally tropical species, *C. tubularis* has its terminal post-maturational stages retarded in colder waters as is known in other species of amphipods, so that the terminal adults are rare in warm-temperate and cold-temperate waters.

MATERIAL: 64 specimens from 7 stations.

RECORDS: Along the coast of southern California, in depths of 5 to 30 fms where its density is 1.6 animals per square meter. Probably a species more widely represented in the intertidal. Circumtropical and temperate.

Ericthonius hunteri (Bate)

Sars 1895: 605, pl. 216, fig. 2; Stebbing 1906: 673; Holmes 1908: 543; Chevreux and Fage 1925: 254-256, fig. 363; Enequist 1950: 344-345, fig. 62; Gurjanova 1951: 951, fig. 662; Shoemaker 1955: 68.

MATERIAL: 19 specimens from 5 stations.

RECORDS: Recorded for the first time from southern California. Of rare occurrence, with a density of 0.2 animals per square meter on the coastal shelf, all records occurring between the depths of 40 and 100 fathoms, where the density is about 0.6 animals per square meter. A species of the subarctic and boreal regions perhaps reaching its southern limit as a submergent in southern California.

Family PODOCERIDAE

Genus Dulichia Krøyer

Dulichia monacantha Metzger

Sars 1895: 638-639, pl. 230, fig. 1; Stebbing 1906: 710; Gurjanova 1951: 993-994, fig. 690.

MATERIAL: 4 specimens from 2 samples near Pt. Conception, California, 50 fms depth.

DISTRIBUTION: These records must be near the southern limit of this arctic, subarctic and cold-temperate species.

Genus Podocerus Leach

Regardless of the fact that the species of this genus bear numerous characters for identification, apparently each criterion is quite variable. This may be seen, for example, in the extremes of carination on the body segments as represented by Pirlot (1938), K. H. Barnard (1937), Chilton (1926), and in the developmental changes in structure of the male second gnathopods, in some cases (K. H. Barnard 1937), ranging from a palm distinctly defined to a palm confluent with the hind margin of article 6. The animals shed most of their appendages in preservative so that noncomparable descriptions of characters have resulted, some species having all their appendages described and others not. Often, early species were poorly described. Redescriptions of these have occasionally been based on presumptions that new materials were identical to sketchy original descriptions.

The following key reflects the serious difficulties in identifying species of *Podocerus*. I have questioned practically every redescription and identification, subsequent to the original, having found in almost all cases some conspicuous error or oversight. The key is based only on the literature and shows the need to have the genus revised by one with all available types and collections.

The key should be used only by the specialist as an indicator of the problems and not for identification; it points out where one must continue to compare materials and descriptions which have not been previously compared. For instance, one should note that *P. brasiliensis*, *P. laevis* Haswell (1885) and *P. variegatus* cannot be distinctly separated; *P. zeylanicus* and *P. mangarevae* appear identical; *P. lobatus* Haswell (1885) and *P. palinuri* are not separable as based on the literature; *P. laeve* of Walker (1904) is seemingly distinct from *P. laevis* of Haswell (1885). *Podocerus palinuri* K. H. Barnard (1916) has been fused with *P. inconspicuus* by K. H. Barnard (1940) and Pirlot (1938), but may be kept separate within the confines of the key.

KEY TO WORLD PODOCERUS

1. Body with dorsal carinae or processes 2
1. Body lacking dorsal carinae or processes 10
   2. Peraeon segments each with 5 dorsal processes ..... *septemcarinatus*
   2. Peraeon segments each with 1 or 2 dorsal processes 3
3. Conspicuous dorsal processes start on peraeon segments 1 or 2 4
3. Conspicuous dorsal processes start on peraeon segments 5, 6, or 7 7
   4. Palm of male gnathopod 2 with defining tooth 5
   4. Palm of male gnathopod 2 lacking defining tooth 6
5. Head with elevated process, dorsal processes of body well developed ..... *hystrix*
5. Head lacking elevated process, dorsal processes of body feeble ..... *lobatus* Haswell (1885) and *palinuri*

6. Head with elevated process, dorsal processes of body well developed ..... *danae*
6. Head lacking elevated process, dorsal processes of body feeble ..... *cristatus rotundatus* Schellenberg (1931)

7. Palm of male gnathopod 2 with 3 processes at finger hinge ..... *cristatus* of Haswell (1926)
7. Palm of male gnathopod 2 with 2 processes at finger hinge 8
7. Palm of male gnathopod 2 with one process at finger hinge ..... *fulanus*, n. sp.
7. Palm of male gnathopod 2 with no process at finger hinge ..... *laeve* of Walker (1904)

8. Palm of female gnathopod 2 lacking defining tooth ..... *cristatus*
8. Palm of female gnathopod 2 with defining tooth 9

9. Article 4 of female gnathopod 2 with small process ..... *inconspicuus* of Pirlot (1938)
9. Article 4 of female gnathopod 2 with huge process ..... *lobatus* of Pirlot (1938) (in part)

10. Article 2 of peraeopods 1-2 inflated 11
10. Article 2 of peraeopods 1-2 not inflated 12

11. Anterior process of article 2 on peraeopod 2 subconical ..... *africanus*
11. Anterior process of article 2 on peraeopod 2 oval ..... *cheloniae*

12. Palm of female gnathopod 1 shorter than hind margin of article 6 ..... *inconspicuus*
12. Palm of female gnathopod 1 longer than hind margin of article 6 13

13. Male antenna 2 very stout ..... *chelonophilus*
13. Male antenna 2 slender 14

14. Peraeon segments with dorsal tubercles ..... *multispinis*
14. Peraeon segments lacking dorsal tubercles 15

15. Palm of male gnathopod 2 defined by large conical process (possibly part of article 5) ..... *capillimanus*
15. Palm of male gnathopod 2 not defined by large process 16

16. Palm of male gnathopod 2 lacking teeth 17
16. Palm of male gnathopod 2 bearing teeth 18

17. Article 4 of male gnathopod 2 greatly produced ..... *spongicolus*
17. Article 4 of male gnathopod 2 poorly produced ..... *variegatus*

18. Palm of male gnathopod 2 with tooth proximal to closing point of finger ..... *laevis* of Chilton (1926) and *lobatus* of Pirlot (1938) (in part)
18. Palm of male gnathopod 2 lacking tooth proximal to closing point of finger 19

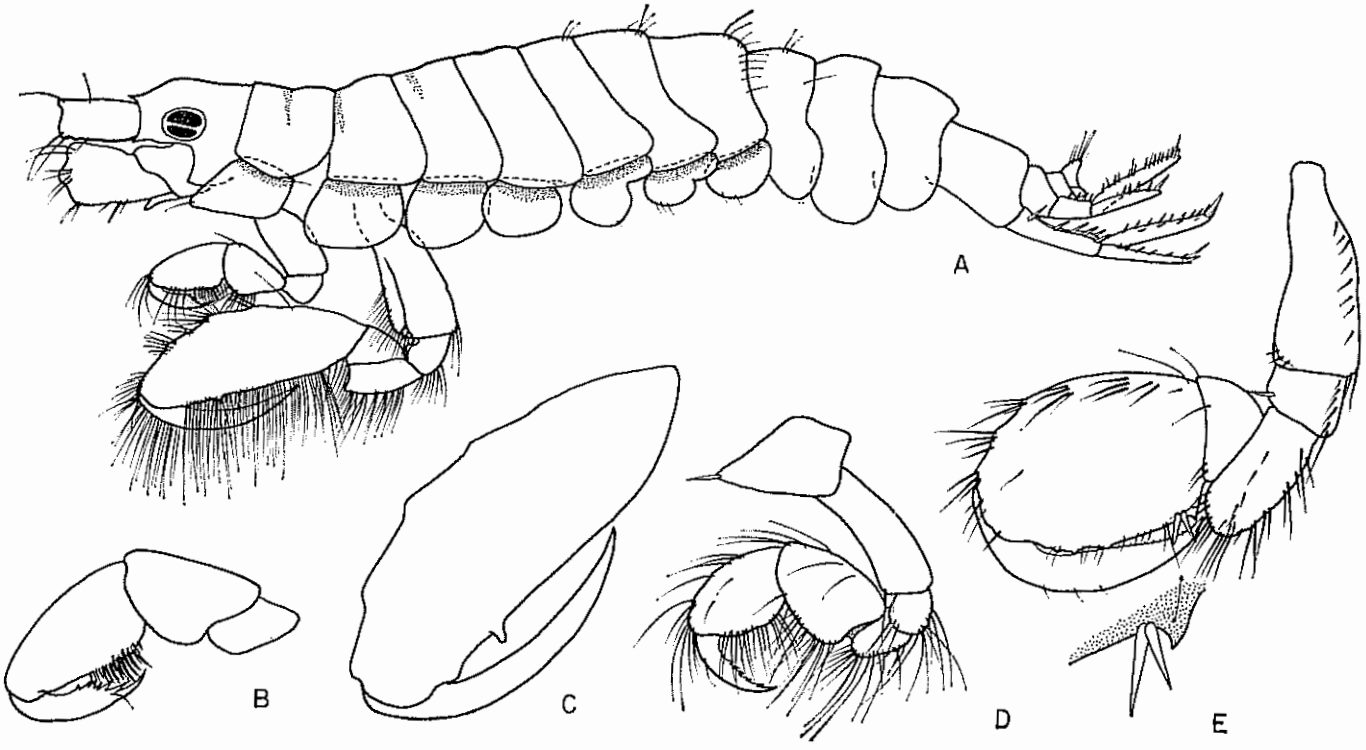

Fig. 30. *Podocerus brasiliensis* (Dana). Male, 5.0 mm, Los Angeles Harbor, 1951: A, lateral view; B,C, gnathopods 1, 2, minus setae. Female, 4.0 mm: D,E, gnathopods 1, 2.

19. Palm of male gnathopod 2 heavily setose, its article 6 quite long, the hind margin and palm straight .... *brasiliensis*, *variegatus*, and *laevis* of Haswell (1885)
19. Palm of male gnathopod 2 poorly setose, its article 6 with palm distinct from hind margin ..... *zeylanicus* and *mangarevae*

Podocerus brasiliensis (Dana)

Fig. 30

J. L. Barnard 1953: 87 (with references); J. L. Barnard 1955: 39; J. L. Barnard 1959: 39-40, pl. 13.

MATERIAL: 16 specimens from 4 stations.

RECORD: Open sea benthic of southern California, 8 to 12 fms.

Podocerus cristatus (Thomson)

Figs. 31, 32

Stebbing 1906: 706 (and literature); Stebbing 1910: 651; Thomson 1913: 245; K. H. Barnard 1916: 276-277; Schellenberg 1925: 188; ?Chilton 1926: 513-515, fig. 2; Chevreux 1935: 131; K. H. Barnard 1940: 483; Shoemaker 1942: 48-49.
?*Podocerus cristatus rotundatus* Schellenberg 1931: 260-262, fig. 135.
Not *Podocerus* sp., J. L. Barnard 1959: 40, pl. 14.

REMARKS: There is little doubt that these specimens, commonly distributed subtidally in southern California, are *P. cristatus*. Although there is wide variability in *Podocerus*, the specimens show distinctly the carinae of peraeonal segments 6-7 and pleonal segments 1-2, as well as a small one on peraeonal segment 5, and, in large specimens, the rudiments of

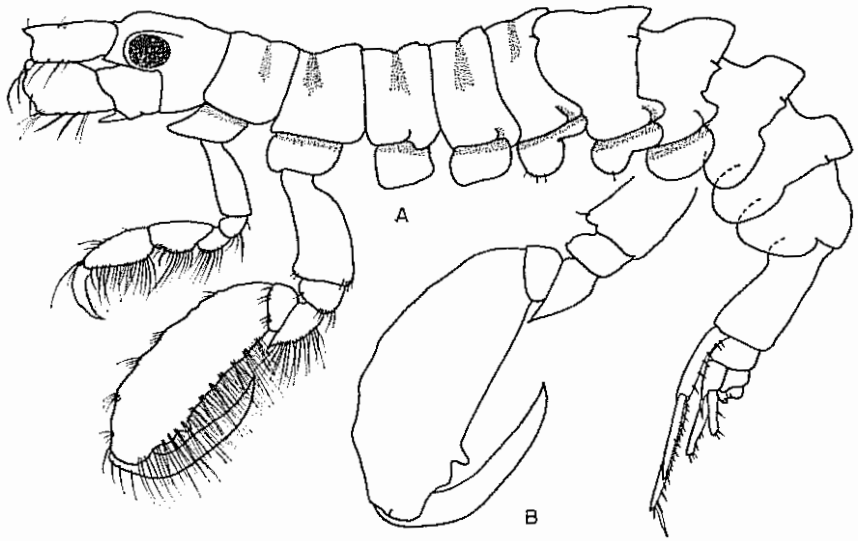

Fig. 31. *Podocerus cristatus* (Thomson). Male, 6.0 mm, sta. 4938: A, lateral view; B, gnathopod 2, minus setae.

carinae on peraeonal segments 3-4. Only very tiny juveniles fail to show distinct carinae on any segments, and so the species is clearly distinct from *P. brasiliensis* in southern California waters. Chilton's (1926) figure showed 3 palmer processes of the male second gnathopod; otherwise, there is agreement in the literature that only 2 are present.

No adult males in the present collections have the spiny finger of gnathopod 1 seen in *P. brasiliensis*.

MATERIAL: 194 specimens from 27 stations.

ECOLOGY: This species has an overall density of 2.4 specimens per square meter on the coastal shelf. Its distribution with depth is indicated in the following scheme:

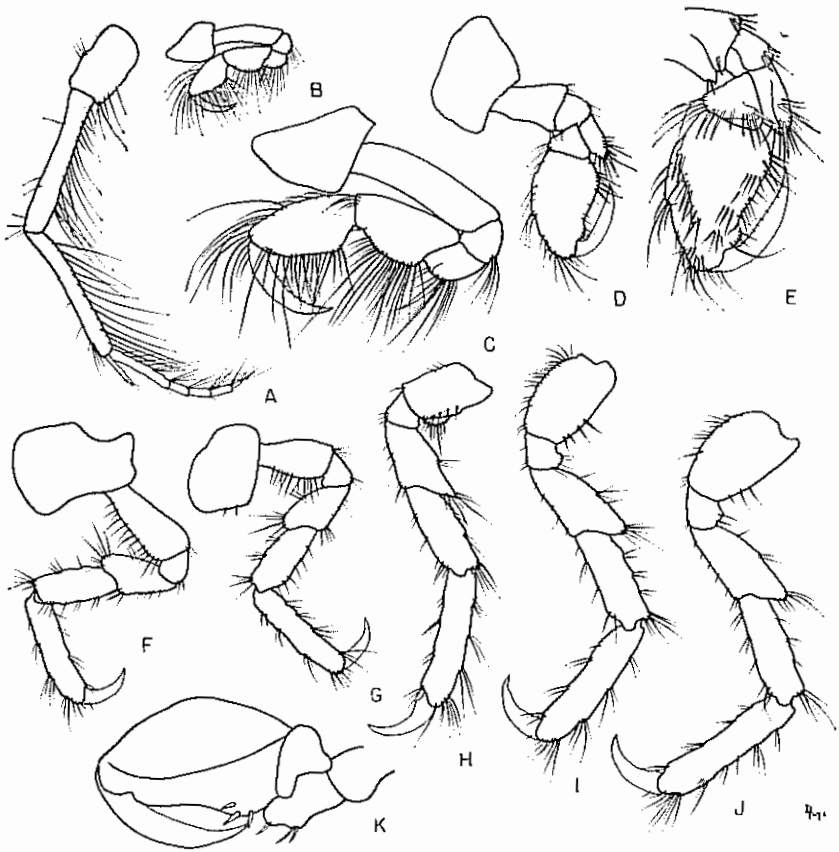

Fig. 32. *Podocerus cristatus* (Thomson). Female, 6.0 mm, sta. 4938: A, antenna 1; B,C, gnathopod 1; D,E, gnathopod 2; F,G,H,I,J, peraeopods 1, 2, 3, 4, 5. Female, 6.5 mm: K, gnathopod 2.

Depth in fathoms	10	20	30	40	50	100
Specimens per square meter	2.3	2.8	8.0	0.2	0.4	0.1

DISTRIBUTION: Probably circumtropical and circum-warm temperate.

Podocerus fulanus, new species

Podocerus sp., J. L. Barnard 1959: 40, pl. 14.

DIAGNOSIS: Body with mid-dorsal carinae on peraeonal segments 6 and 7 and pleonal segments 1 and 2; palm of gnathopod 1 much longer than hind margin of article 6; article 6 of gnathopod 2 elongated, poorly setose, the palm scarcely defined from hind margin of article 6, marked only by a group of spines, otherwise these edges nearly contiguous, the palm with a single square process near the finger hinge, the finger reaching only half way along hind edge of article 6 and bearing a bump near base of inner margin followed by a sinus; article 4 of gnathopod 2 not strongly produced (differing from *P. spongicolus* Alderman 1926); article 2 of peraeopods 1-5 not disproportionately widened.

HOLOTYPE: AHF No. 5410, male, 5 mm.

TYPE LOCALITY: Station 44, Newport Bay, California (see J. L. Barnard 1959).

RELATIONSHIP: There are three known species of *Podocerus* in southern California: *Podocerus cristatus* of the open sea, *Podocerus brasiliensis* of bays and estuaries(especially where pollution occurs), and *Podocerus fulanus*, n. sp., probably a native estuarine species which is intolerant of polluted conditions. *P. fulanus* differs from the other two species by the poorly setose palm of male gnathopod 2 and the single palmar process near the finger hinge. In the other two species the palm is heavily setose and bears two palmar processes. The new species differs also from *P. brasiliensis* by the dorsal body carinae. Its further relationship may be seen in the foregoing key to the species.

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