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

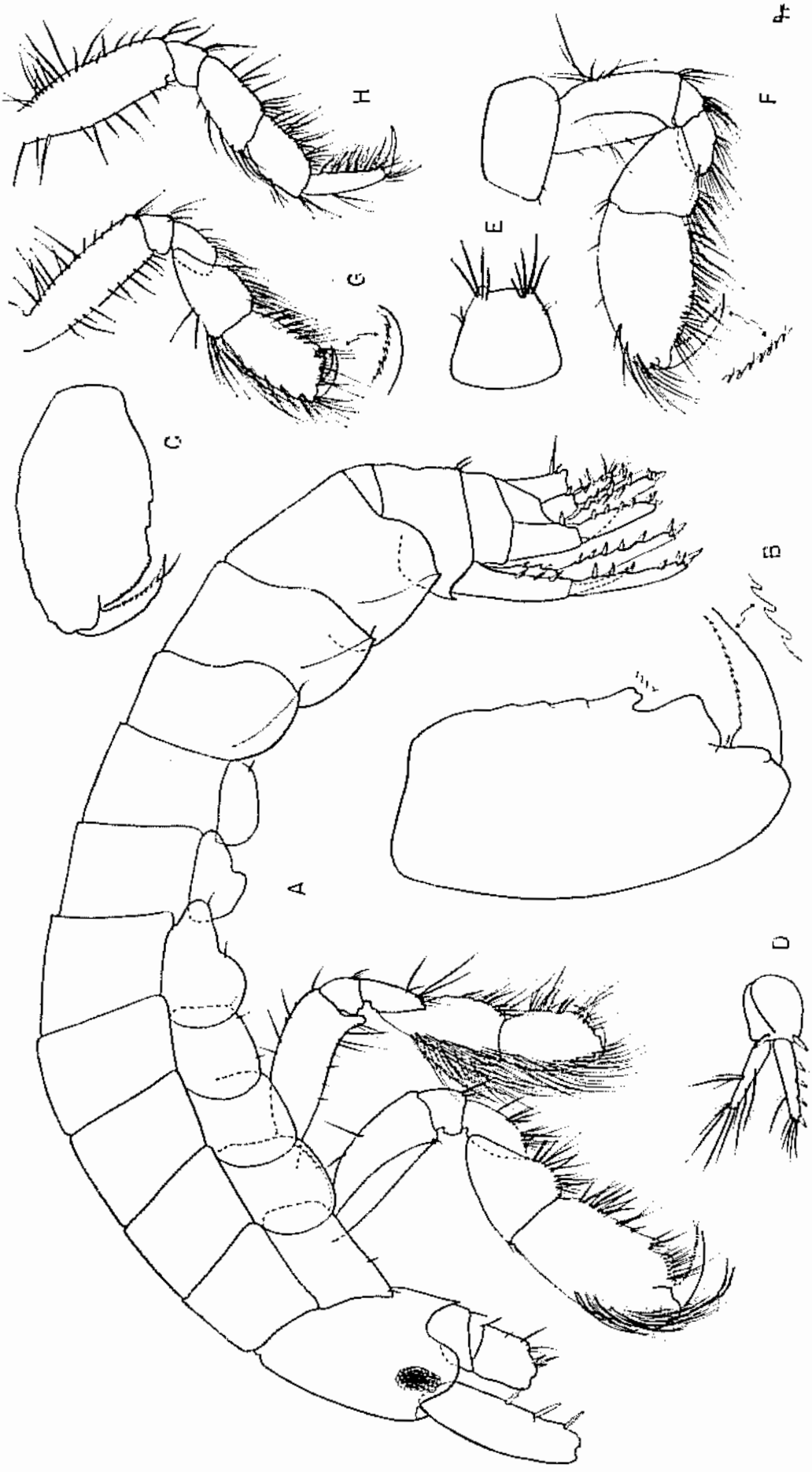

Fig. 2. *Lembos concavus* Stout. Male, 6.0 mm, sta. 5562: A, lateral view, minus antennae and peraeopods; B, enlargement of gnathopod 1, palmar tooth broken; C, gnathopod 2; D, uropod 3; E, telson. Female, F,G, gnathopods 1, 2; H, peraeopod 1.

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.

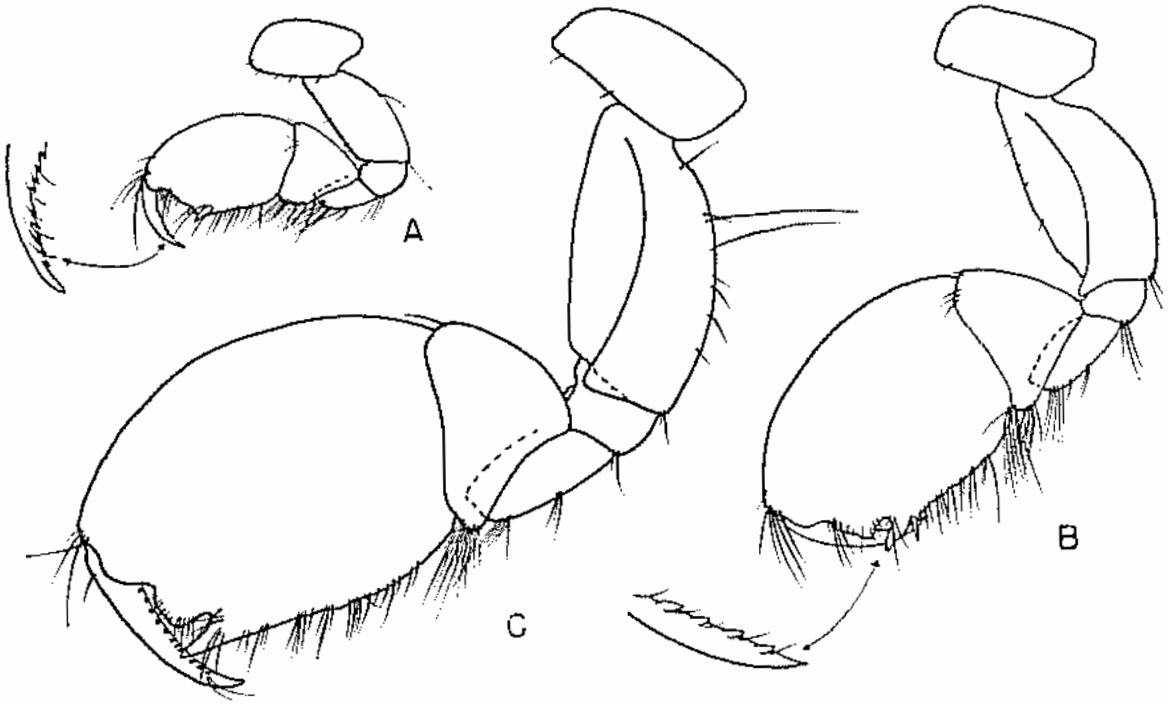

Fig. 3. *Lembos macromanus* (Shoemaker). Estero de Punta Banda. Gnathopod 1: A, male, 3.8 mm; B, male, 6.0 mm; C, male 7.0 mm.

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.

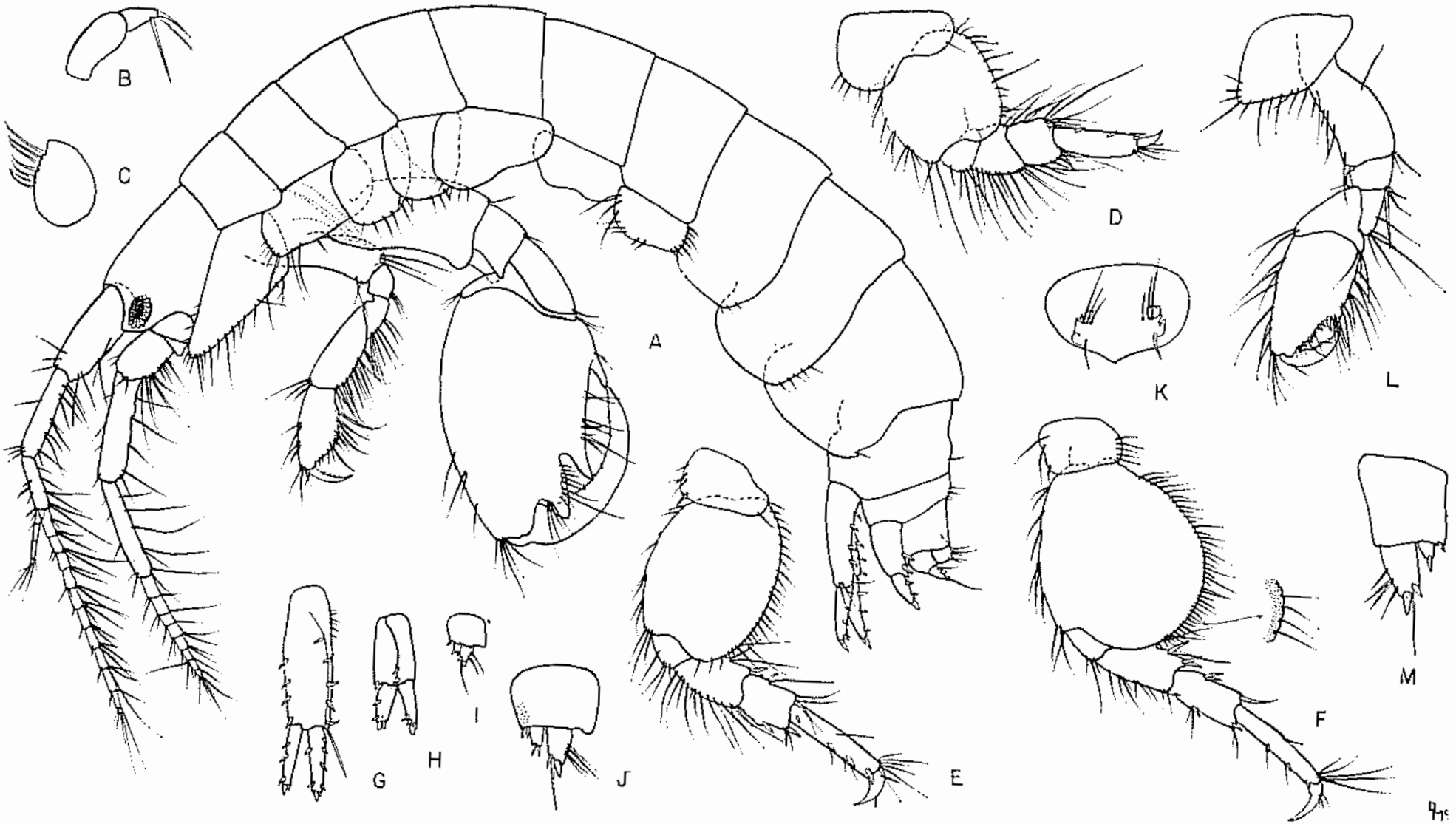

Fig. 4. *Cheiriphotis megacheles* (Giles). Male, 4.5 mm, sta. 5164: A, lateral view; B, articles 3-4 of maxillipedal palp; C, inner plate of maxilla 1; G,H,I,J, uropods 1, 2, 3, 3; K, telson. Male, 5.0 mm: D,E,F, peraeopods 3, 4, 5. Female, 4.0 mm: L, gnathopod 2. Male, 5.0 mm, sta. 5557: M, uropod 3.

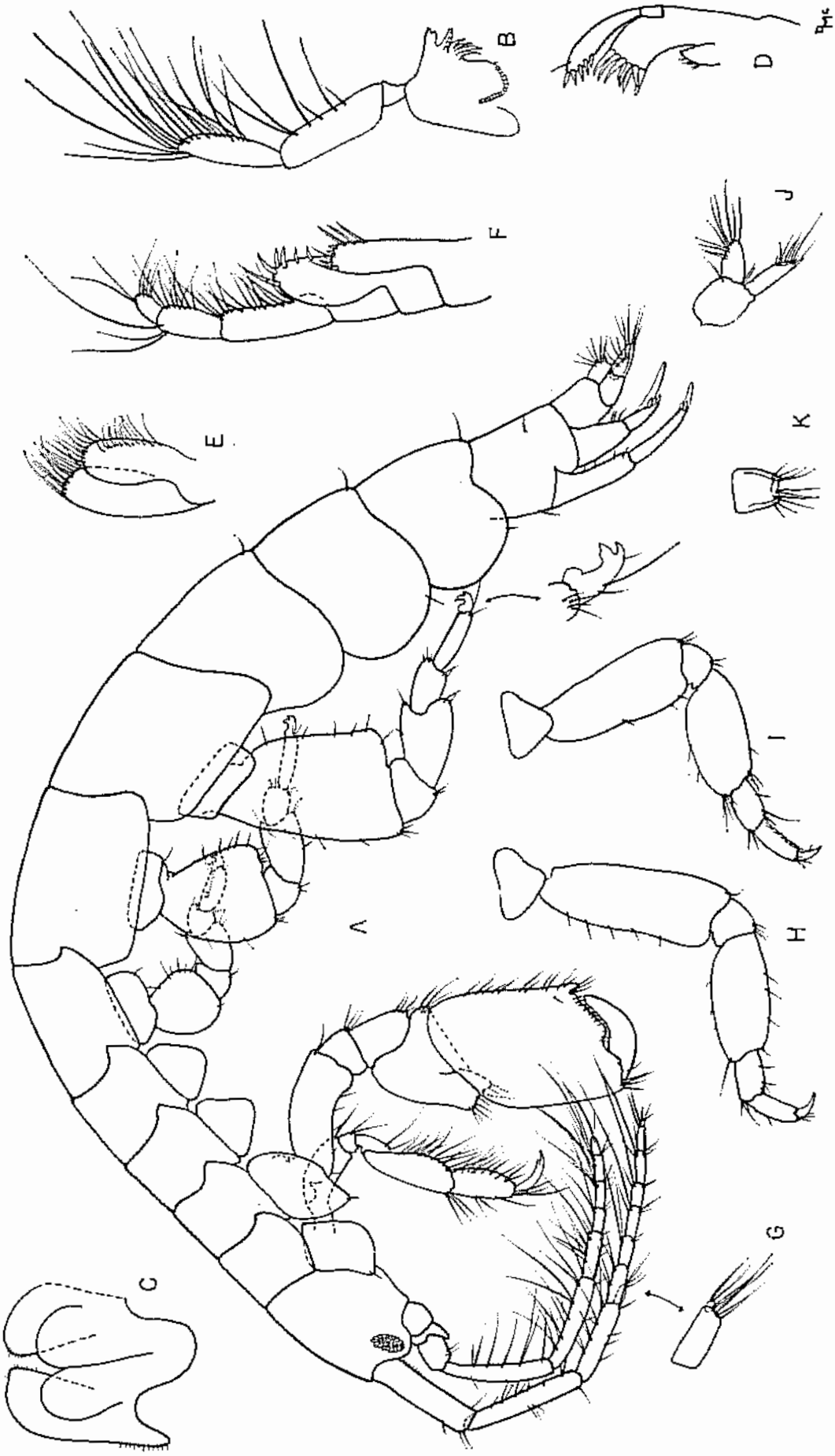

Fig. 5. *Chevalia aviculae* Walker. Female, 5.0 mm, sta. 5164: A, lateral view; B, mandible; C, lower lip; D,E, maxillae 1, 2; F, maxilliped; G, accessory flagellum; H,I, peraeopods 1, 2; J, uropod 3; K, telson.

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

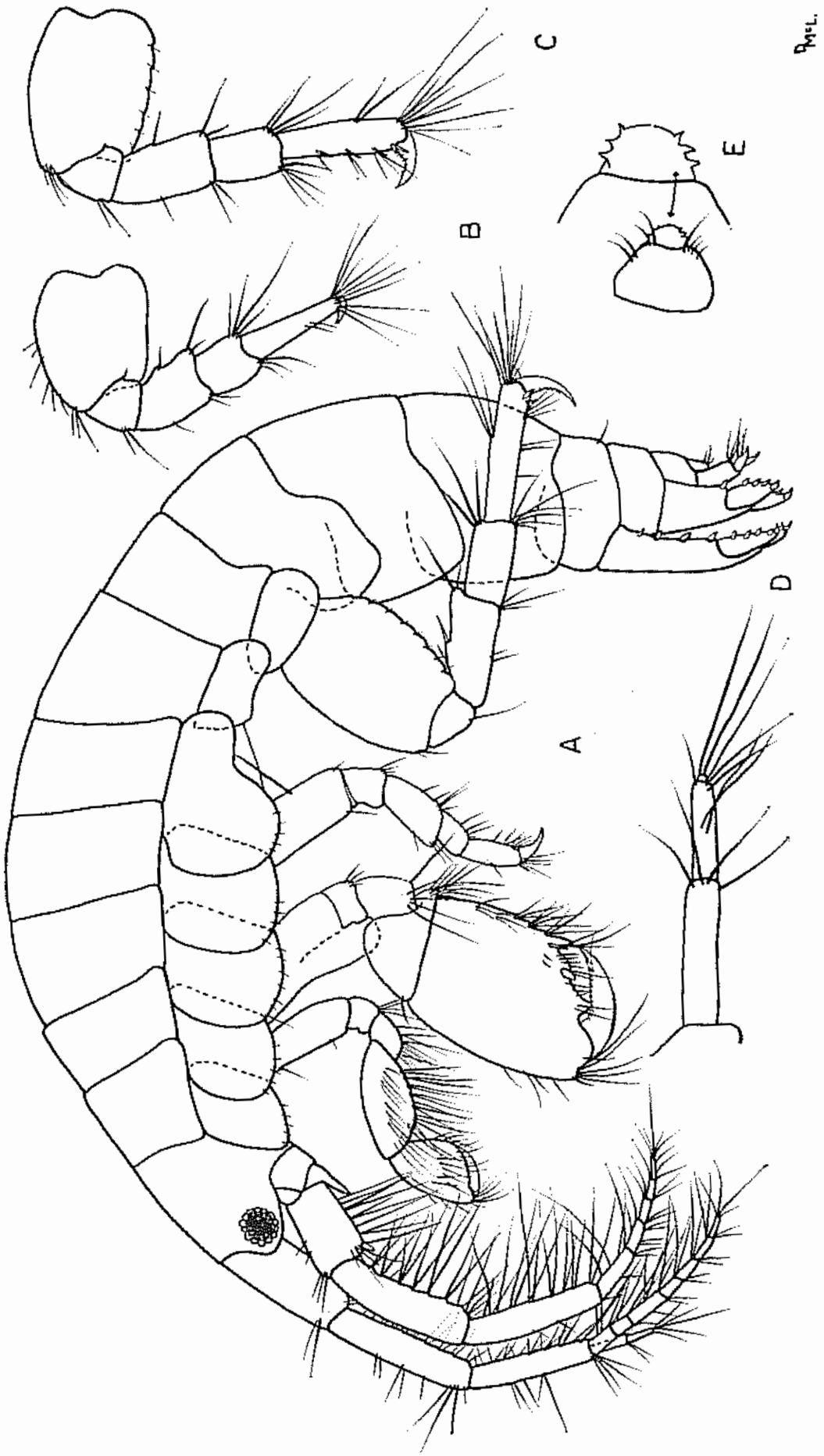

Fig. 6. *Eurystheus ventosa*, n. sp. Female, holotype, 4.0 mm, Barnard sta. 2: A, lateral view; B,C, peraeopods 3, 4; D, accessory flagellum; E, telson.

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.

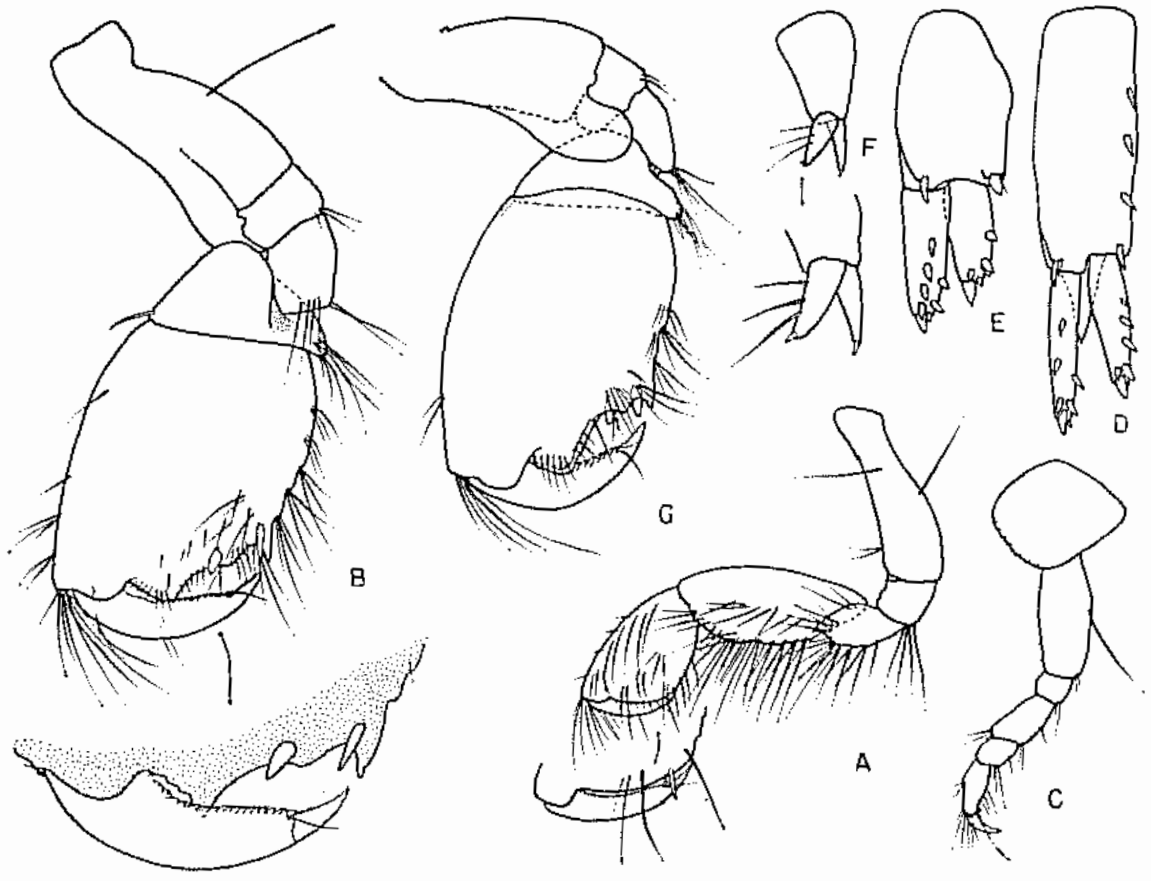

Fig. 7. *Eurystheus ventosa*, n. sp. Female, holotype, 4.0 mm, Barnard sta. 2: A,B, gnathopods 1, 2; C, peraeopod 1; D,E,F, uropods 1, 2, 3. Male, 3.1 mm, Barnard sta. 2: G, gnathopod 2.

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.

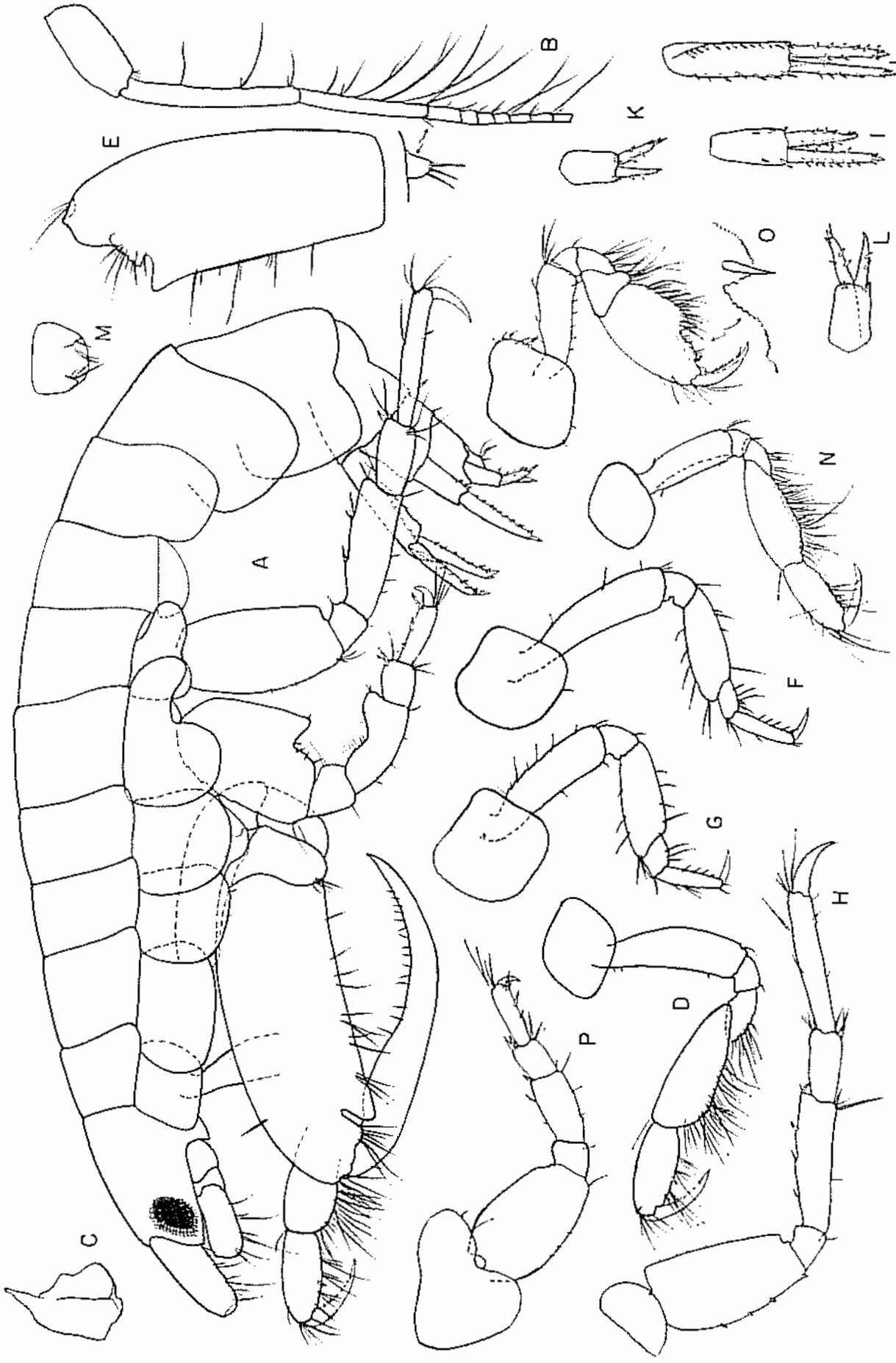

Fig. 8. *Kermystheus ociosa*, n. sp. Male, holotype, 5.2 mm, sta. 6474: A, lateral view; C, epistome, conical process at top; D, gnathopod 1; F,G, peraeopods 1, 2; I,J,K,L, uropods 2, 1, 3, 3; M, telson. Another male, 4.5mm: B, antenna 1; E, article 6 of gnathopod 2, showing palm; H, peraeopod 5. Female,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

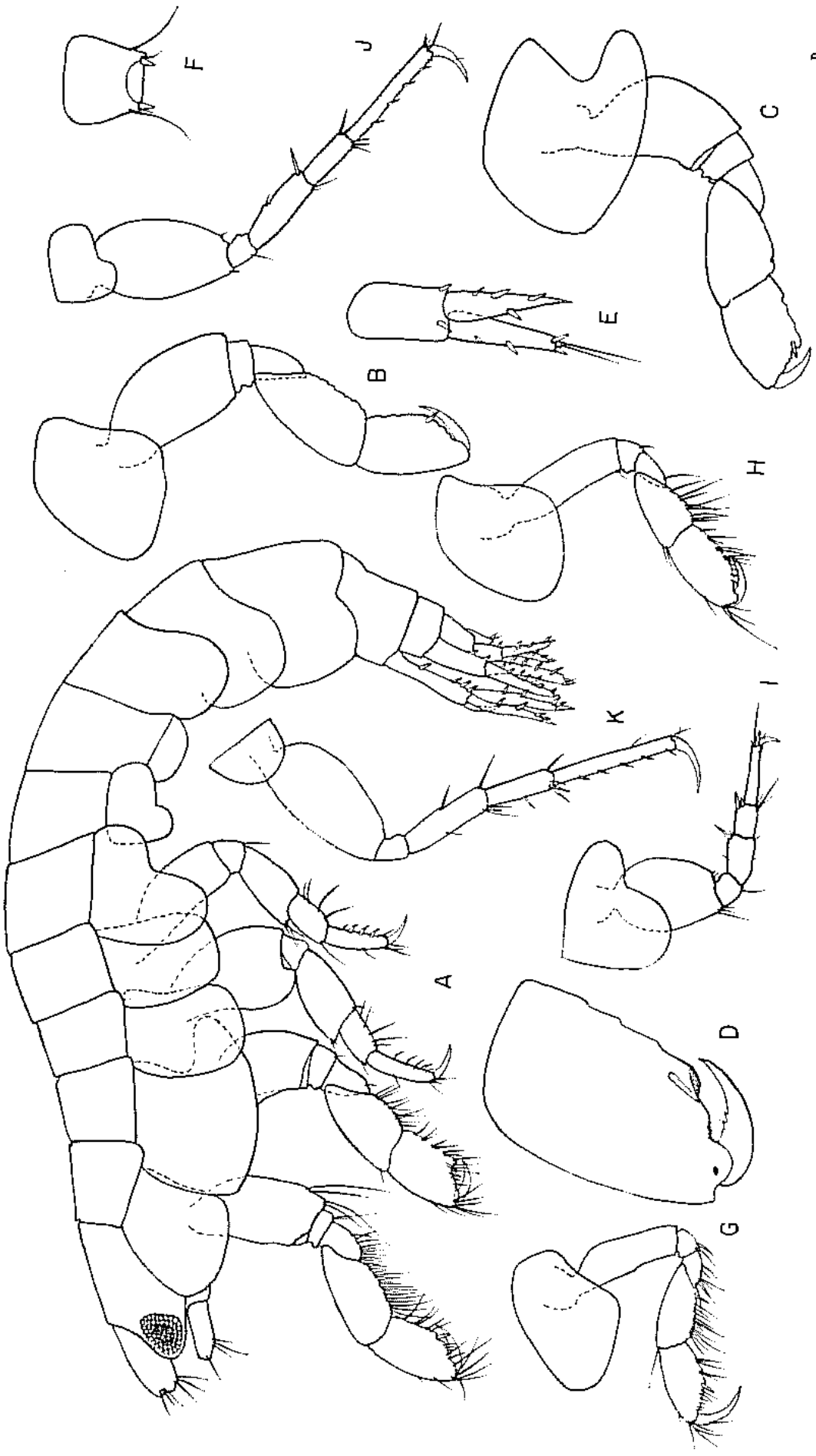

Fig. 9. *Megamphopus mamolus*, n. sp. Male, holotype, 5.3 mm, sta. 6425: A, lateral view; B,C, gnathopods 1, 2; D, gnathopod 2, enlarged; E, uropod 3; F, telson. Female, 3.5 mm: G,H, gnathopods 1, 2. Juvenile female, 3.2 mm, sta. 4822: I,J, K, peraeopods 3, 4, 5.

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

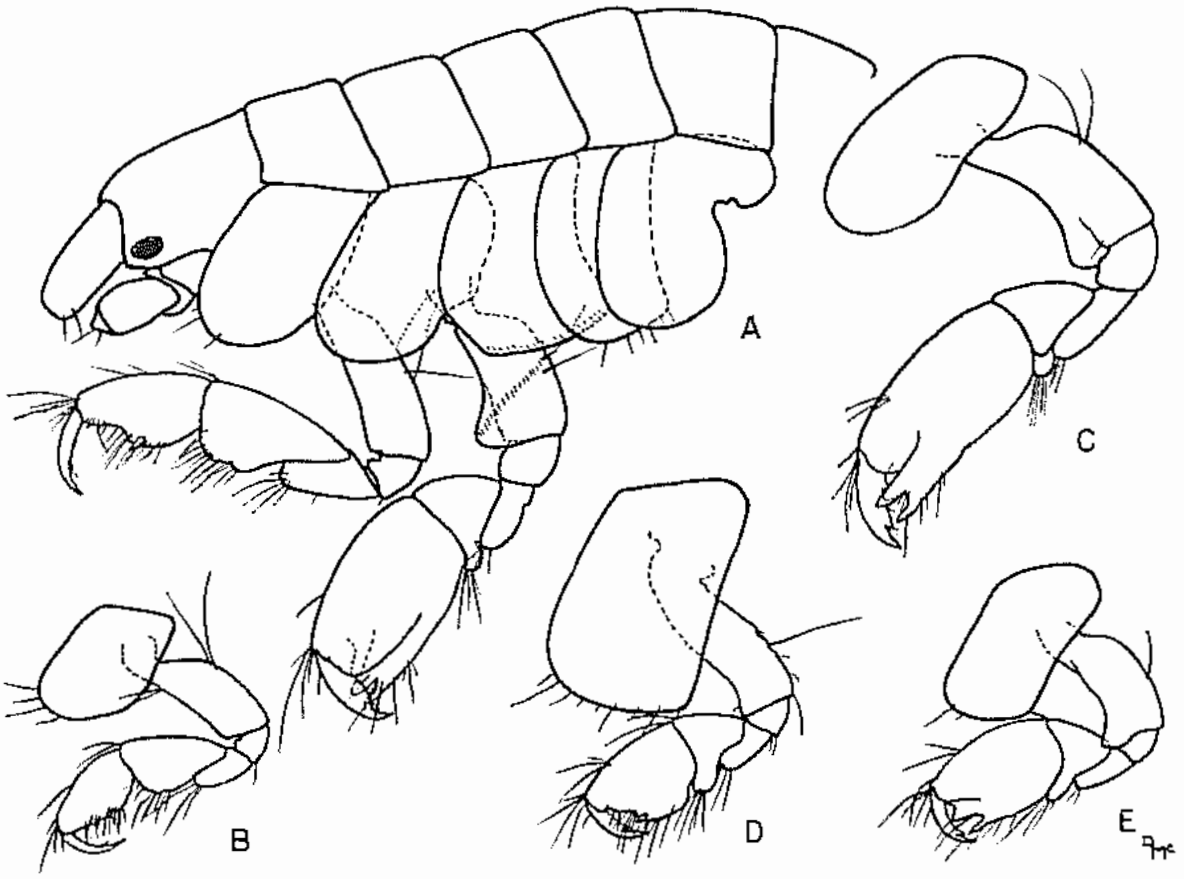

Fig. 10. *Photis bifurcata*, n. sp. Male, 2.75 mm, sta. 5164: A, lateral view, front part of body. Male, 2.0 mm, sta. 5042: B,E, gnathopods 1, 2. Male, 3.0 mm, sta. 5164: C, gnathopod 2. Female, 2.0 mm, sta. 5042: D, gnathopod 2.

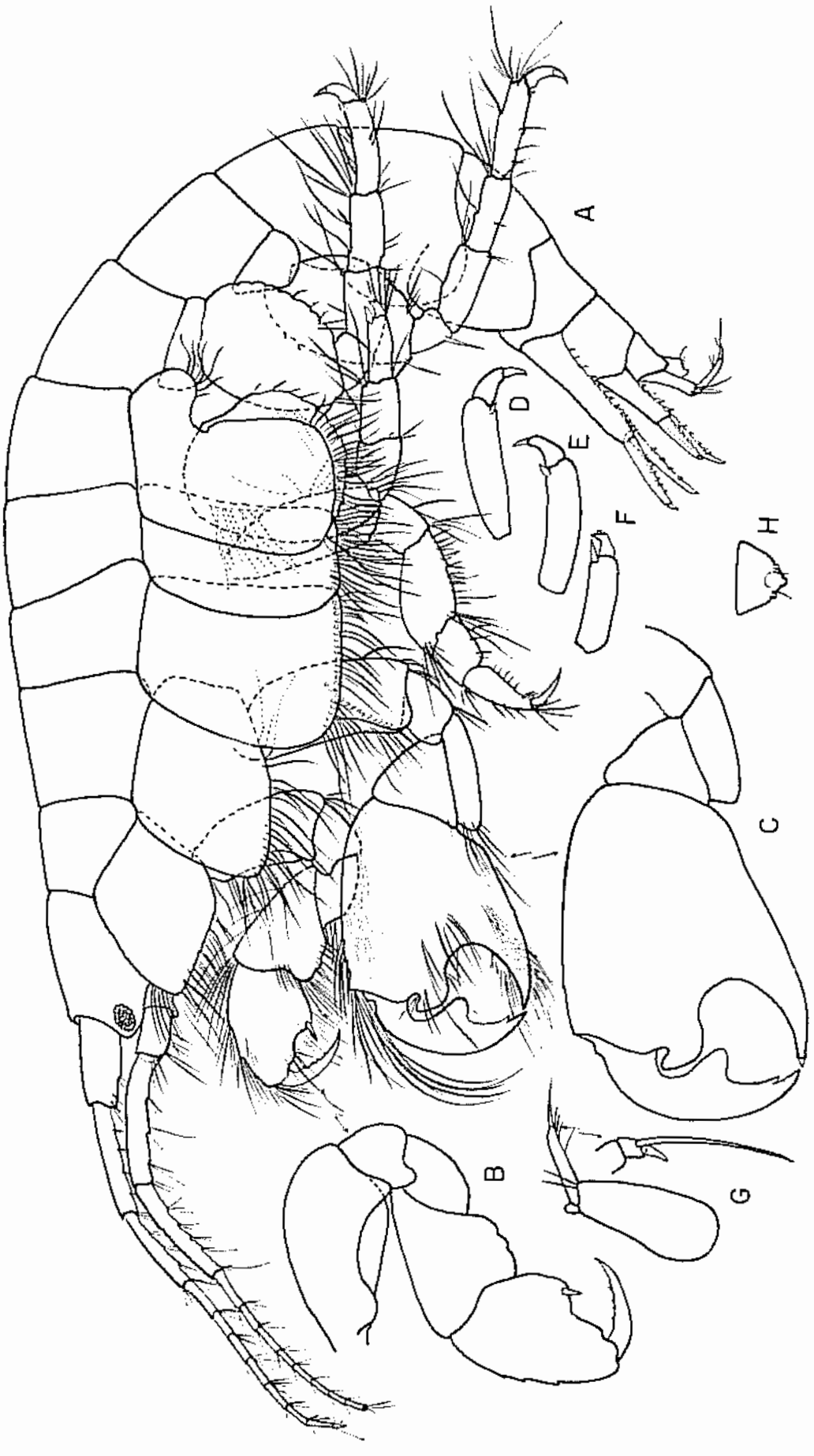

Fig. 11. *Phatis brevipes* Shoemaker. Male, 5.3 mm, sta. 4869: A, lateral view; B,C, gnathopods 1, 2, minus setae; D,E,F, ends of peraeopods 5, 4, 3; G, uropod 3; H, telson.

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

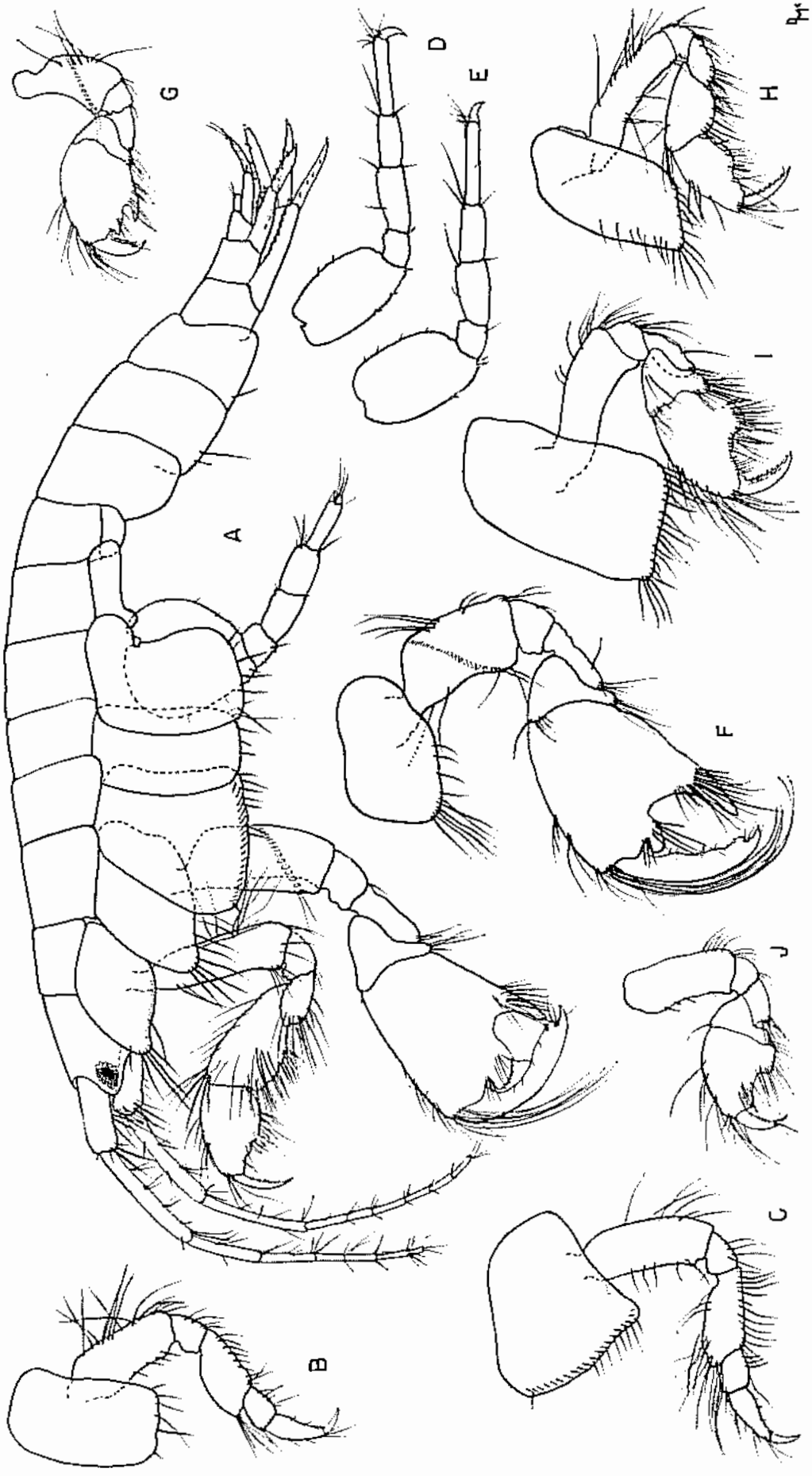

Fig. 12. *Photis californica* Stout. Male, 4.3 mm, sta. 4743. A, lateral view; B,C,D,E, peraeopods 1, 2, 4, 5. Male, 4.0 mm, sta. 4743: G, gnathopod 2. Female, 5.3 mm, sta. 4743: H,I, gnathopods 1, 2. Female, 3.0 mm, sta. 4743: J, gnathopod 2.

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

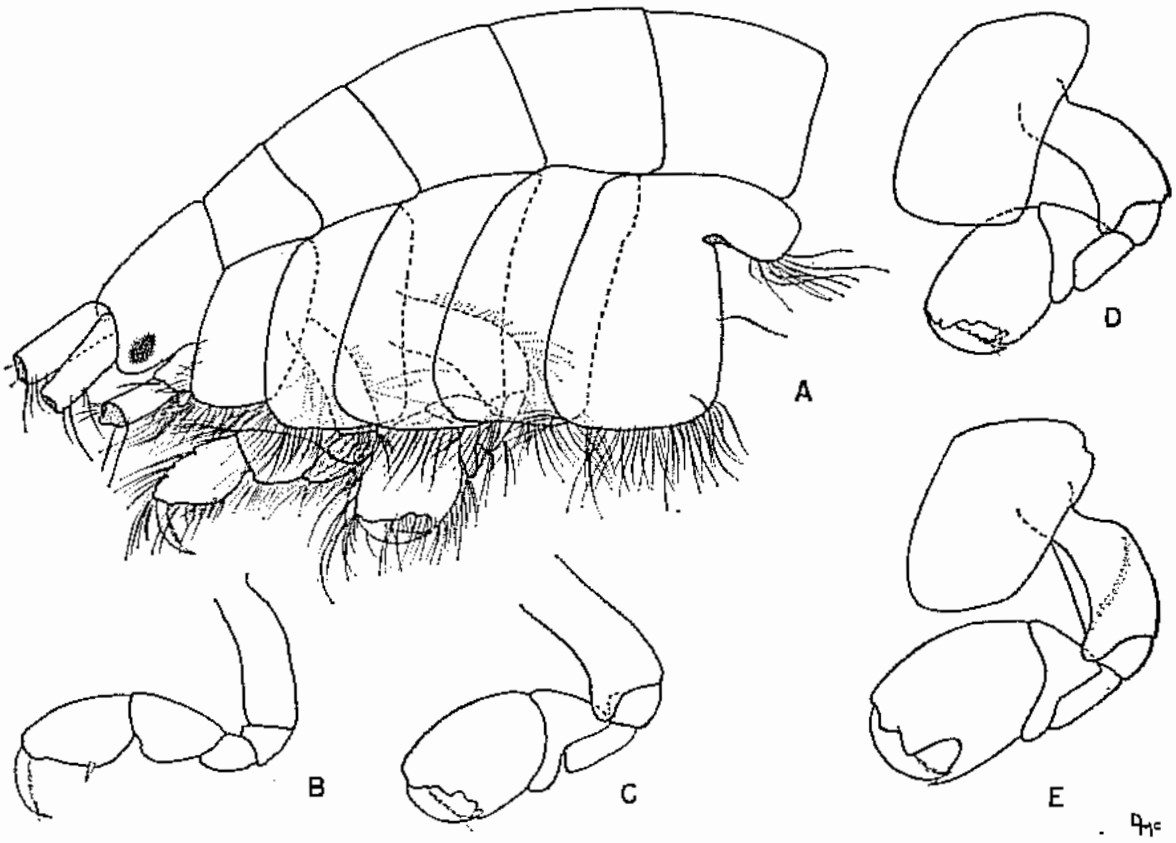

Fig. 13. *Photis californica* Stout. Female, 6.0 mm, sta. 4869: A, lateral view of front part of body; B,C, gnathopods 1, 2, minus setae. Juvenile female, 3.0 mm: D, gnathopod 2, minus setae. Juvenile male, 3.0 mm: E, gnathopod 2.

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

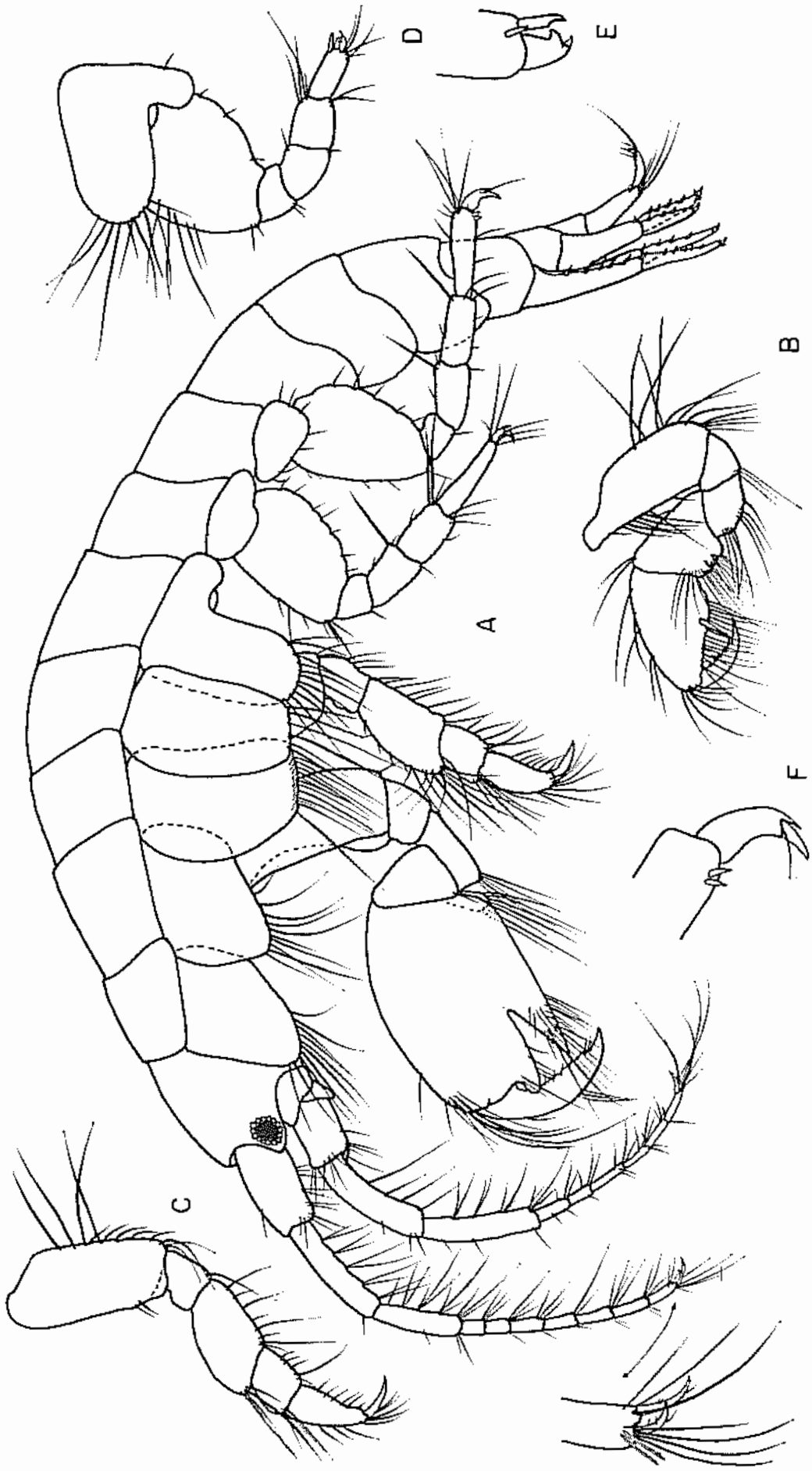

Fig. 14. *Photis conchicola* Alderman. Male, 3.7 mm, Barnard sta. 3: A, lateral view; B, gnathopod 1; C,D, pereopods 2, 3; E,F, ends of pereopods 3, 5.

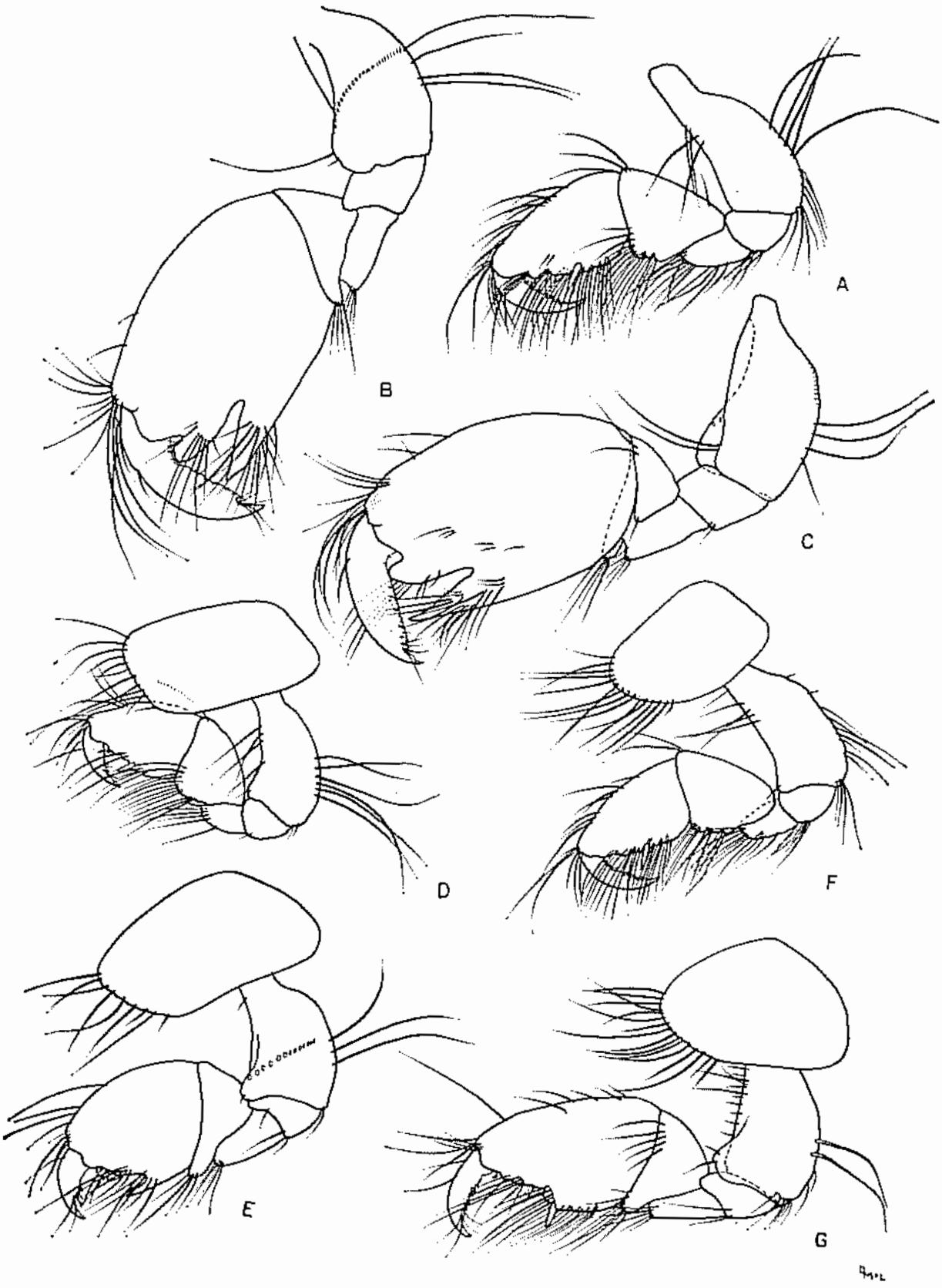

Fig. 15. *Photis conchicola* Alderman. Male, 3.7 mm, Barnard sta. 3: A, gnathopod 1; B,C, gnathopod 2, lateral and medial views. Young male, 2.0 mm: D,E, gnathopods 1, 2. Female, 3.2 mm; F,G, gnathopods 1, 2.

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).

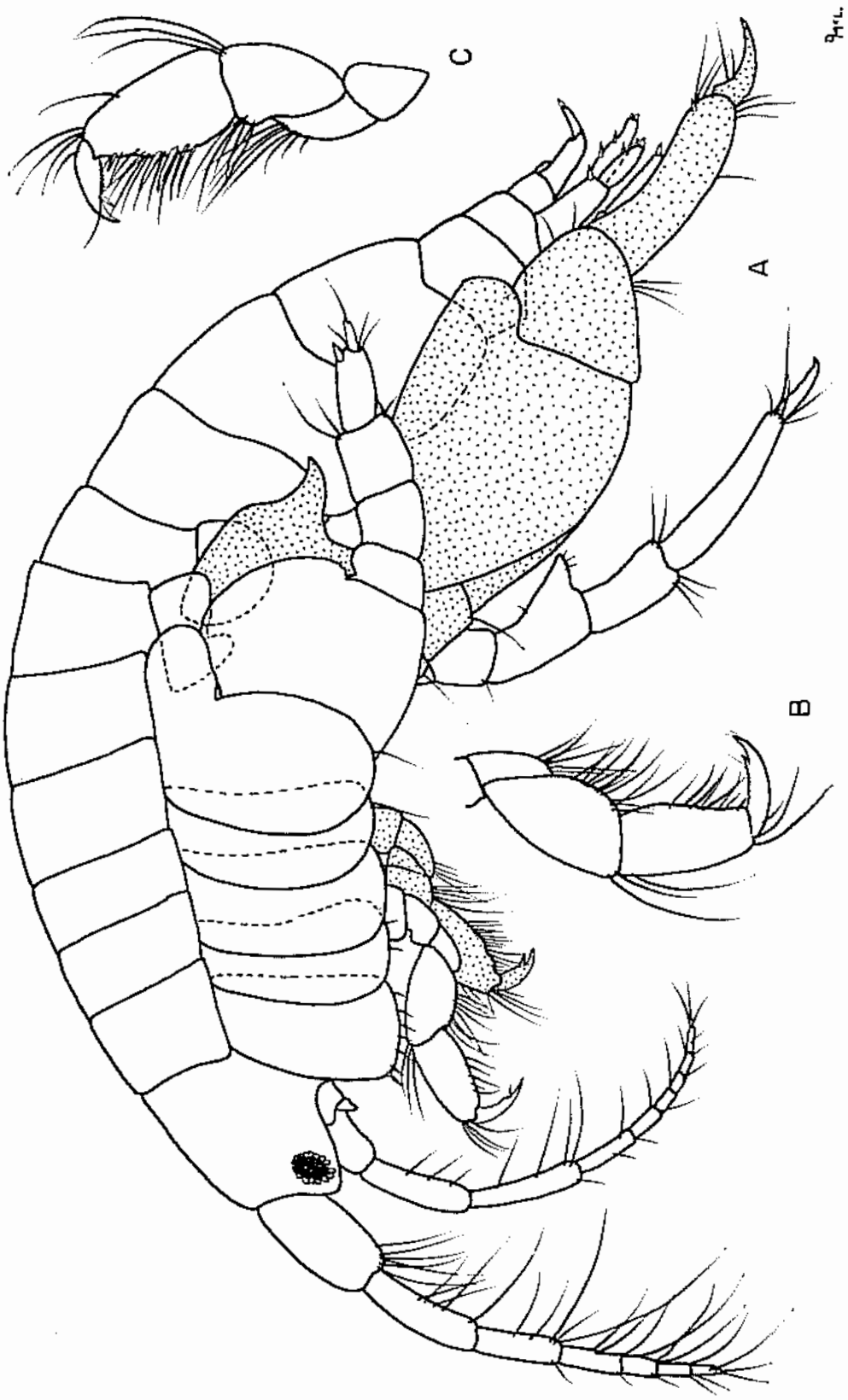

Fig. 16. *Photis elephantis*, n. sp. ?Sex, 2.4 mm, Barnard sta. 21: A, lateral view; B,C, gnathopods 1, 2.

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.

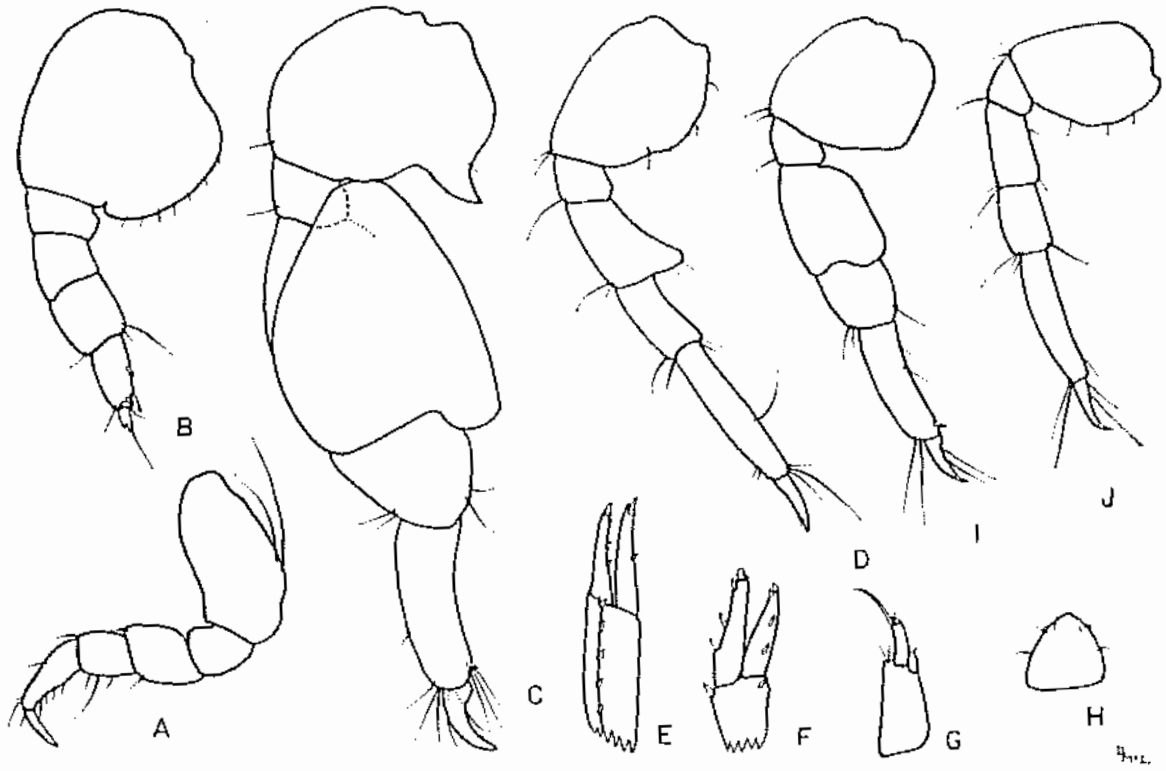

Fig. 17. *Photis elephantis*, n. sp. ?Sex, 2.4 mm, Barnard sta. 21: A,B,C,D, peraeopods 2, 3, 4, 5; E,F,G, uropods 1, 2, 3; H, telson. Juvenile, 1.8 mm: I, J, peraeopods 4, 5.

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),

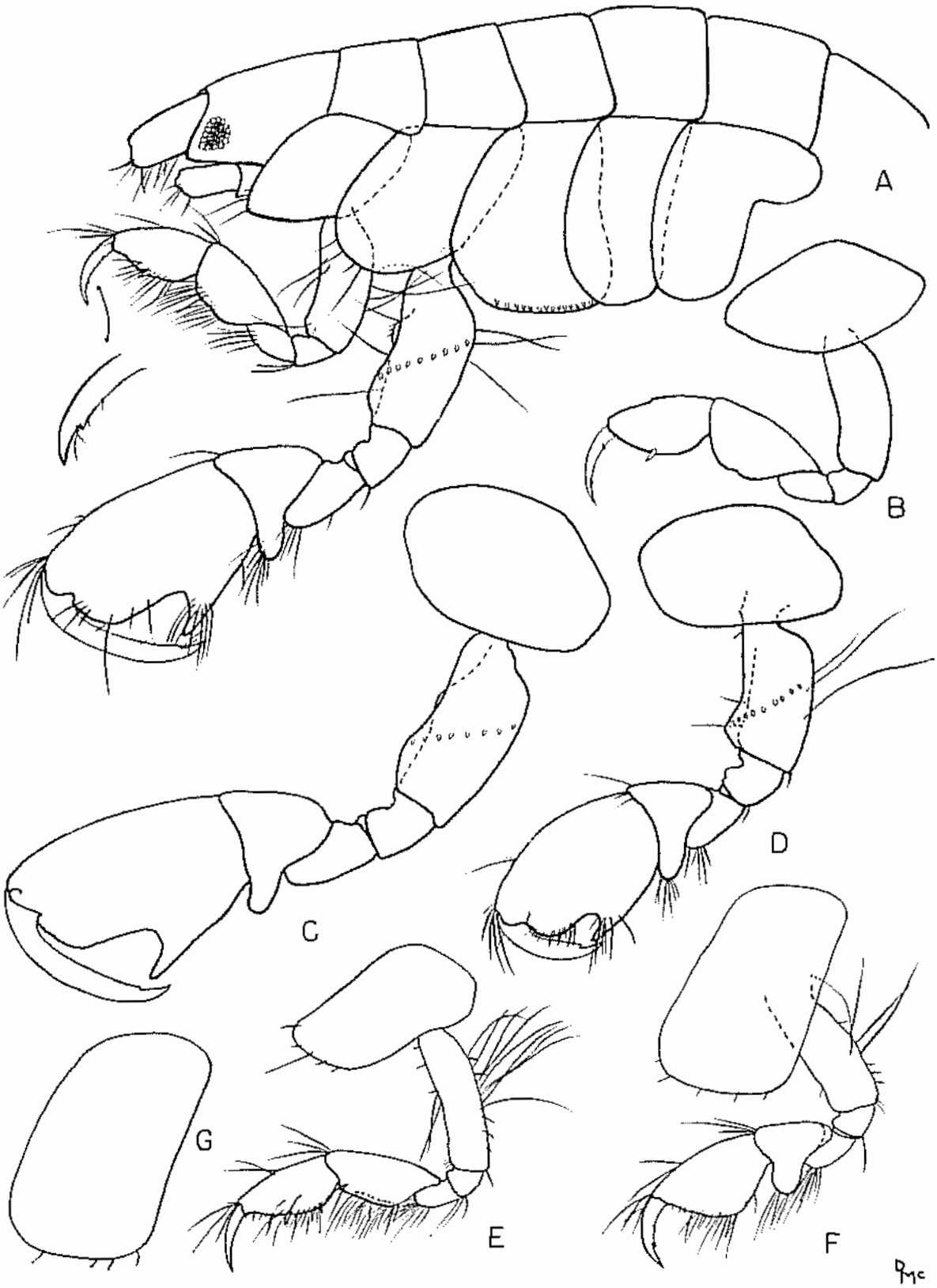

Fig. 18. *Photis lacia*, n. sp. Male, 3.0 mm, sta. 5164: A, front part of animal; B,C, gnathopods 1, 2, minus setae. Young male, 2.75 mm, sta. 5164: D, gnathopod 2. Female, 2.5 mm, sta. 5164: E,F, gnathopods 1, 2; G, coxa 3.

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.

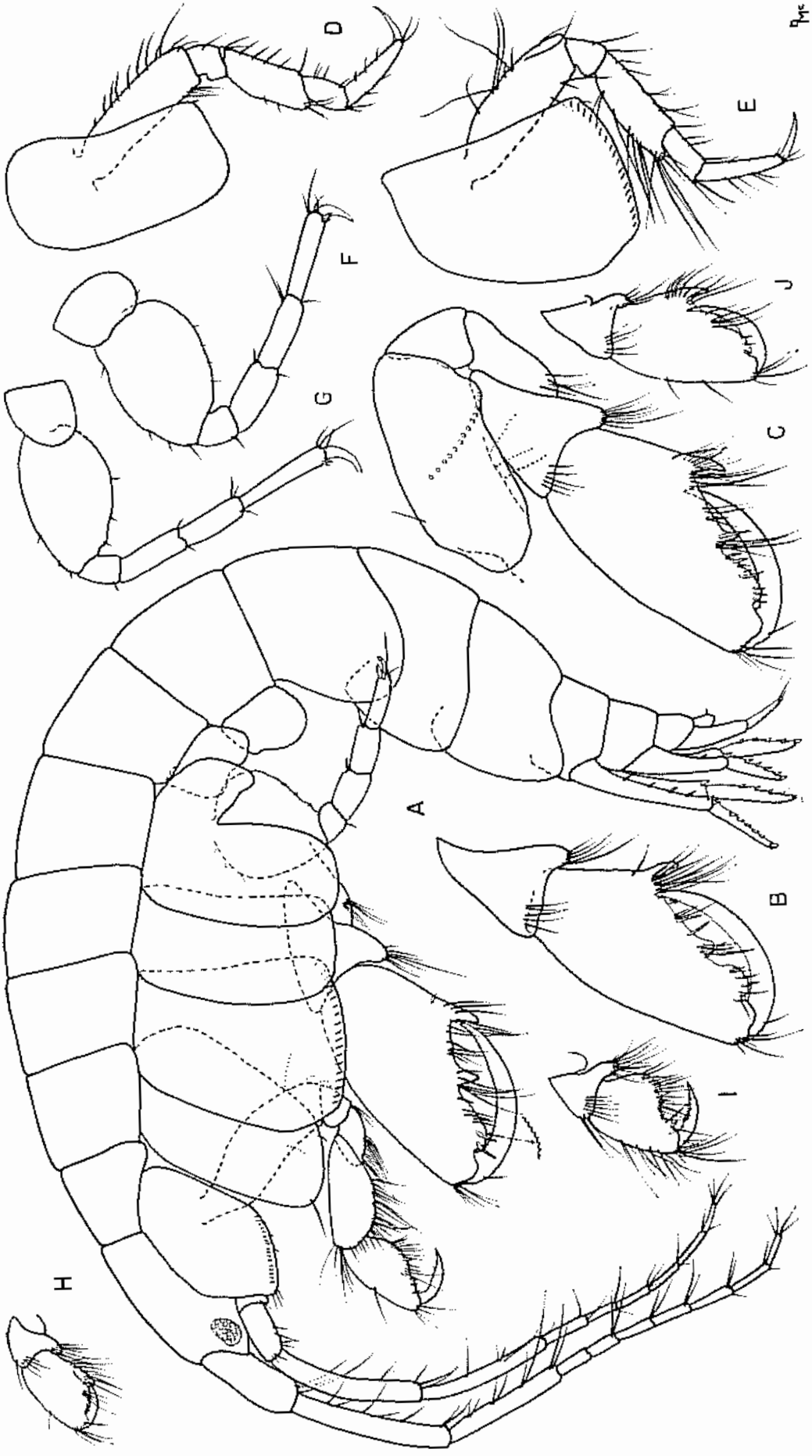

Fig. 20. *Photis viuda*, n. sp. Male, holotype, 5.0 mm. sta. 6804: A, lateral view; B,C, medial and lateral views of gnathopod 2; D,E,F,G, pereopods 1, 2, 4, 5. Female, 3.8 mm: H,I, gnathopods 1, 2. Male, 4.2 mm: J, gnathopod 2.

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

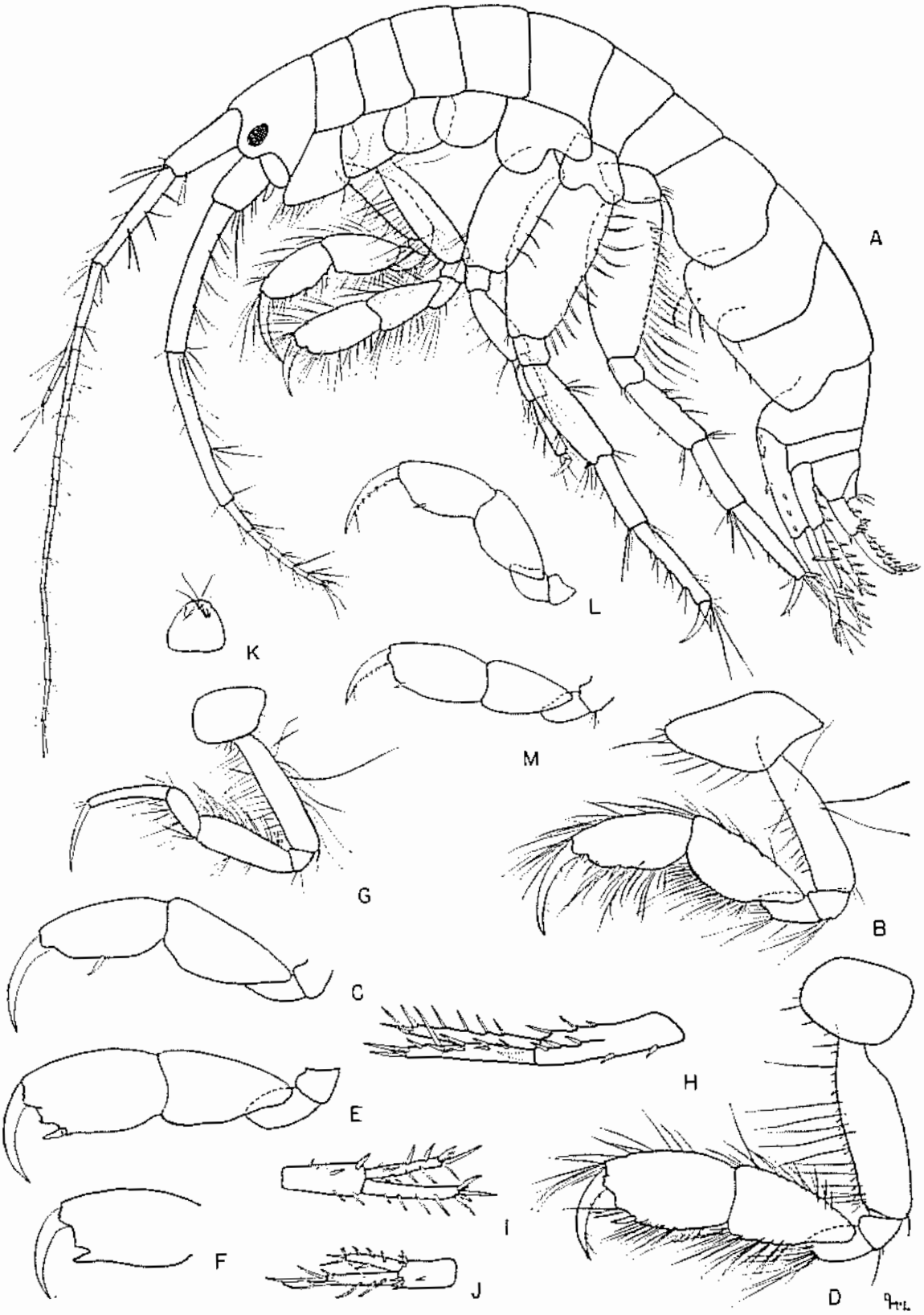

Fig. 21. *Protomedeia articulata*, n. sp. Female, 4.0 mm, sta. 4785: A, lateral view; G, peraeopod 1; H,I,J, uropods 1, 2, 3; K, telson; L,M, gnathopods 1, 2, minus setae. Male, holotype, 4.0 mm: B,C, gnathopod 1; D,E, gnathopod 2; F, gnathopod 2, showing spine as if fused to palm for comparison with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

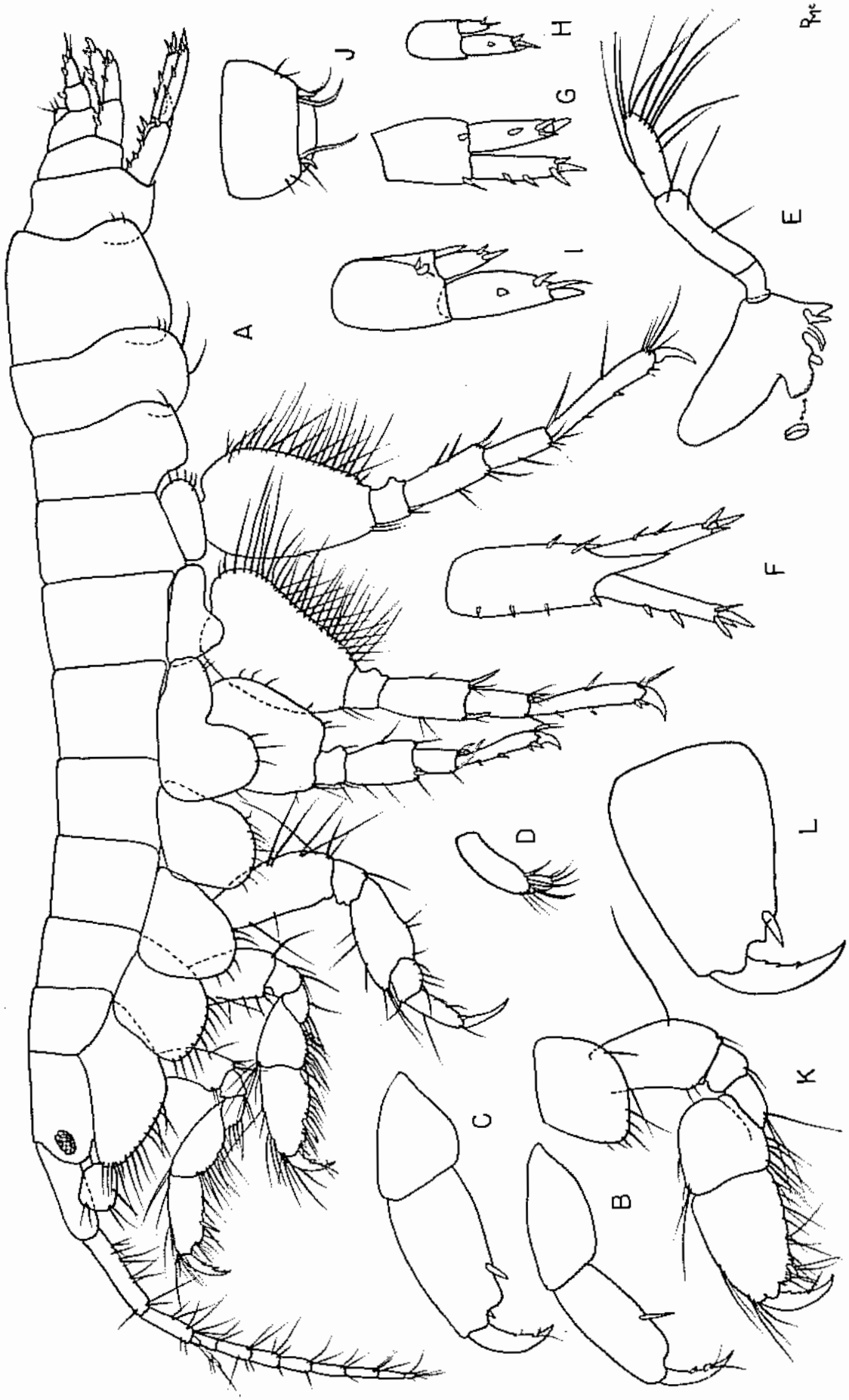

Fig. 22. *Protomedeia* (*Cheirimedeia*) *zotea*, n. sp. Female, holotype, sta. 6445: A, lateral view; B,C, gnathopods 1, 2, minus setae; D, articles 3-4 of maxillipedal palp; E, mandible; F,G,H,I, uropods 1, 2, 3, 3; J, telson. Male, 2.4 mm: K,L, gnathopod 2.

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*.

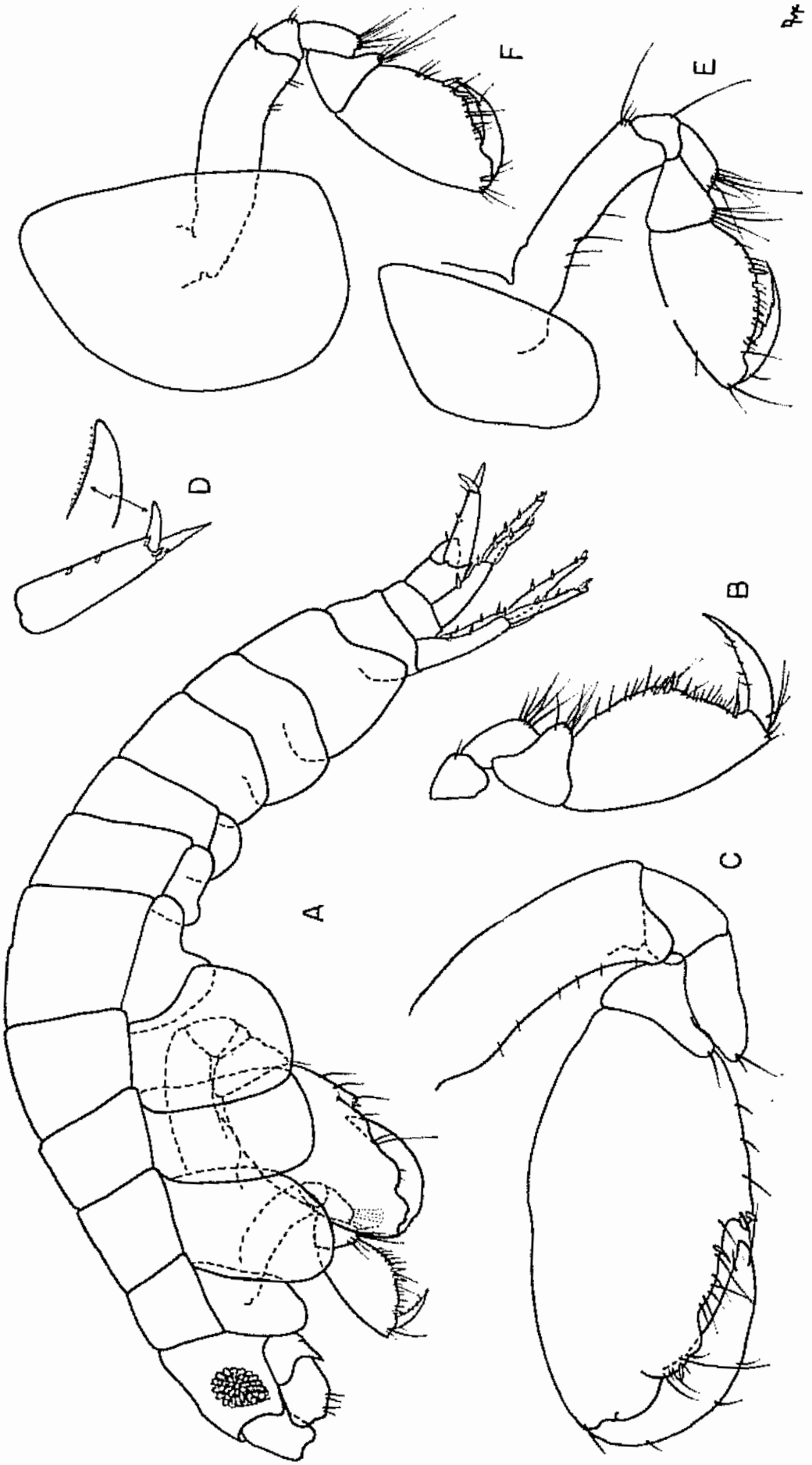

Fig. 23. *Ischyrocerus litotes* (Barnard) Male, 2.3 mm. sta. 4910. A, lateral view; B,C, gnathopods 1, 2; D, uropod 3. Female, 2.5 mm, sta. 4850: E,F, gnathopods 1, 2.

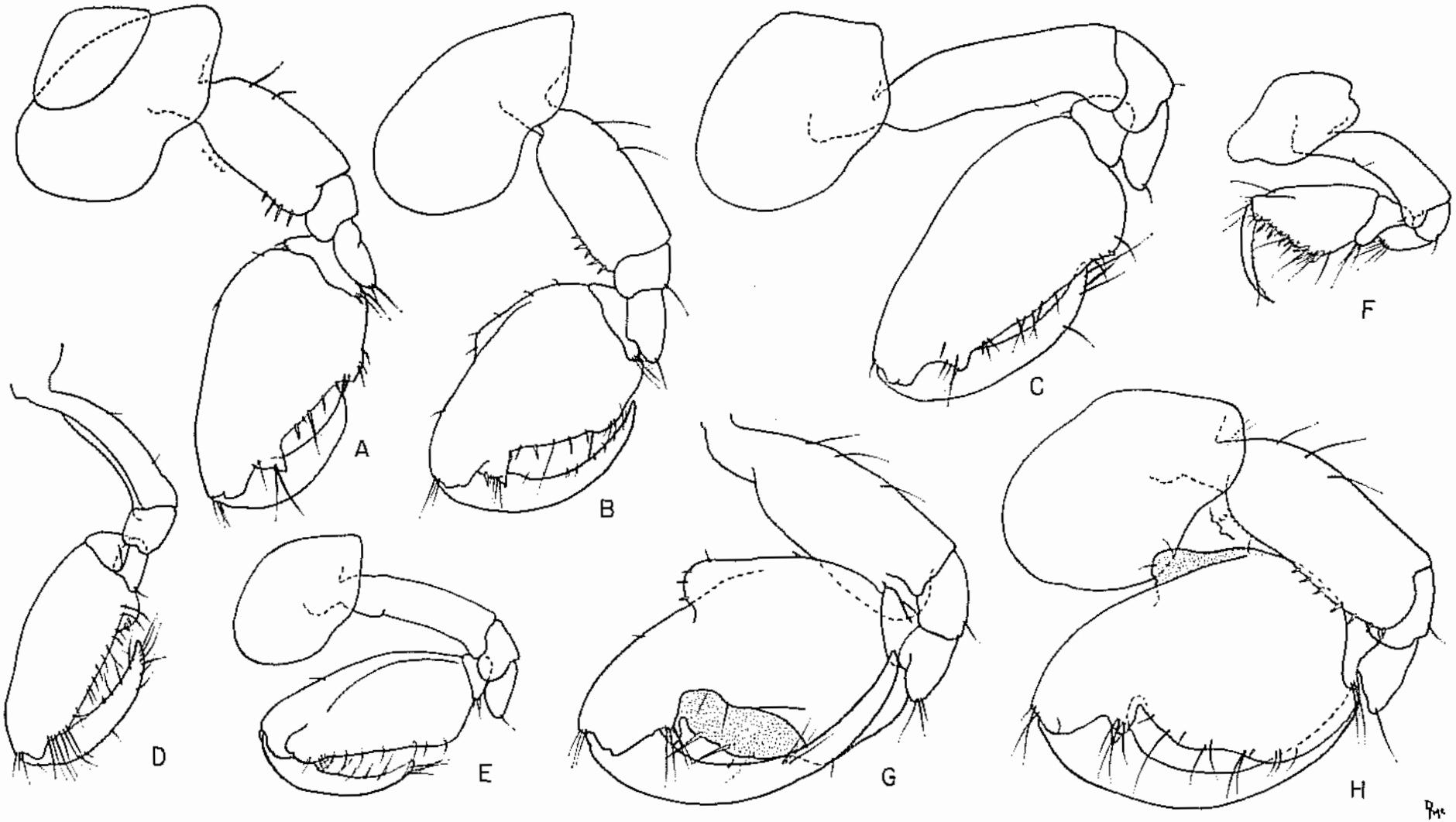

Fig. 24. *Ischyrocerus litotes* (Barnard). A, coxae 1-2, gnathopod 2 of male, 2.3 mm, sta. 4844. Second gnathopods in remaining figures: B, male, 2.5 mm, sta. 5030; C, male, 2.2 mm. sta. 5189; D,E, both gnathopods, male, 2.0 mm, sta. 4785. F,G,H, gnathopods 1, 2, 2, of male, 3.5 mm, sta. 5030.

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*.

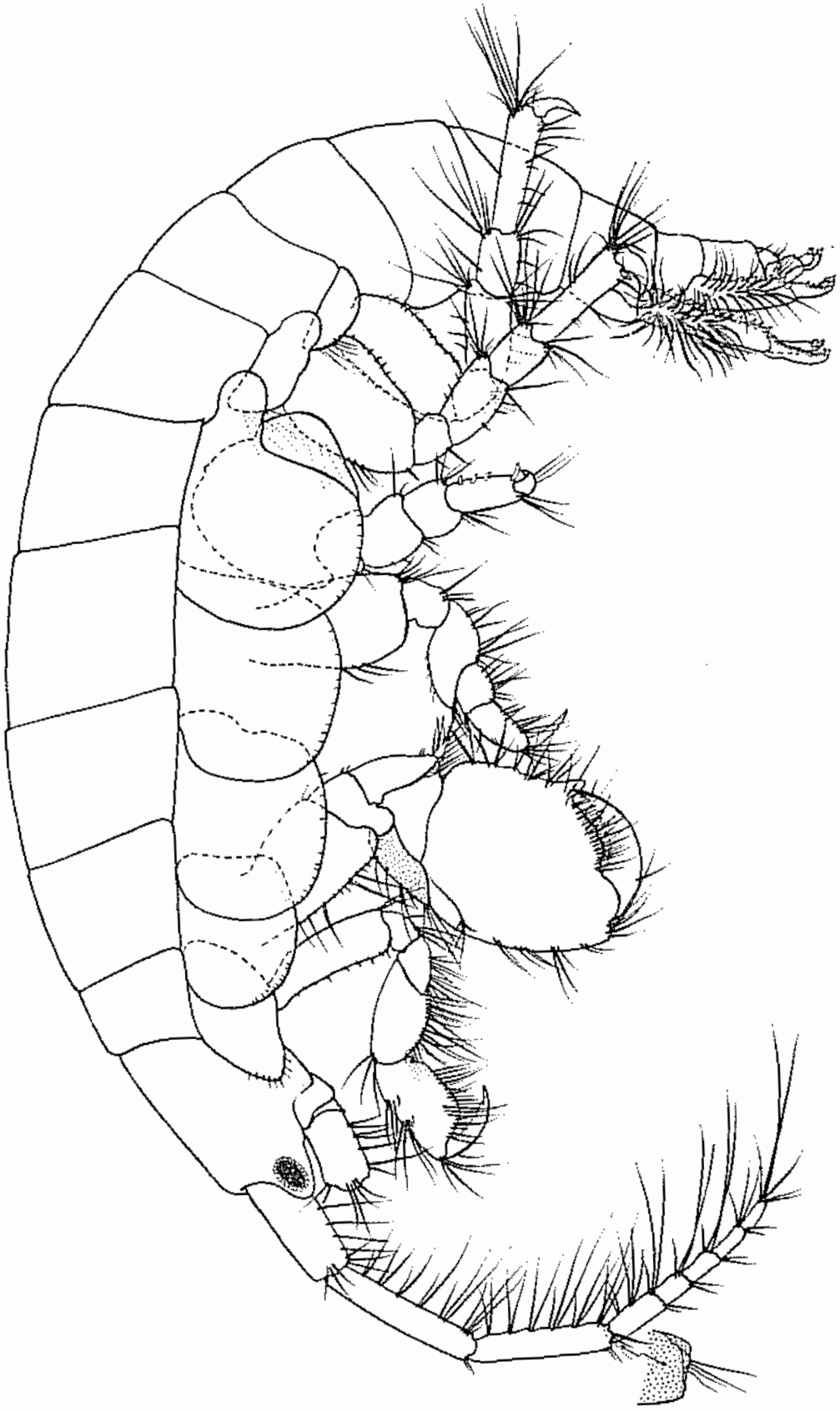

Fig. 26. *Parajassa angularis* Shoemaker. Female, 3.6 mm, sta. 4794. Lateral view.

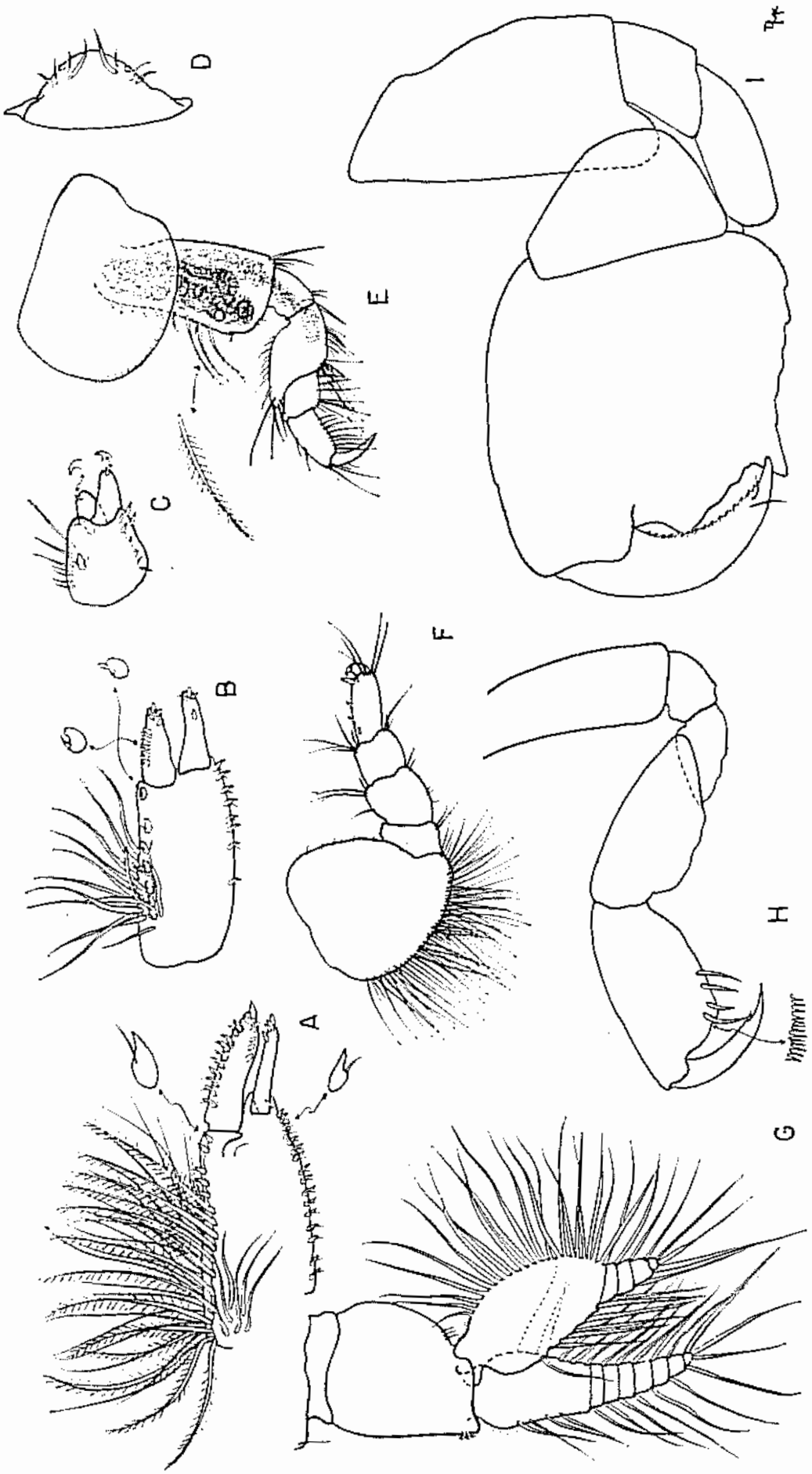

Fig. 27. *Parajassa angularis* Shoemaker. Female, 3.6 mm, sta. 4794: A,B,C, uropods 1, 2, 3; D, telson; E,F, peracopods 1, 3; G, pleopod 1; H,I, gnathopods 1, 2, minus setae.

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.*

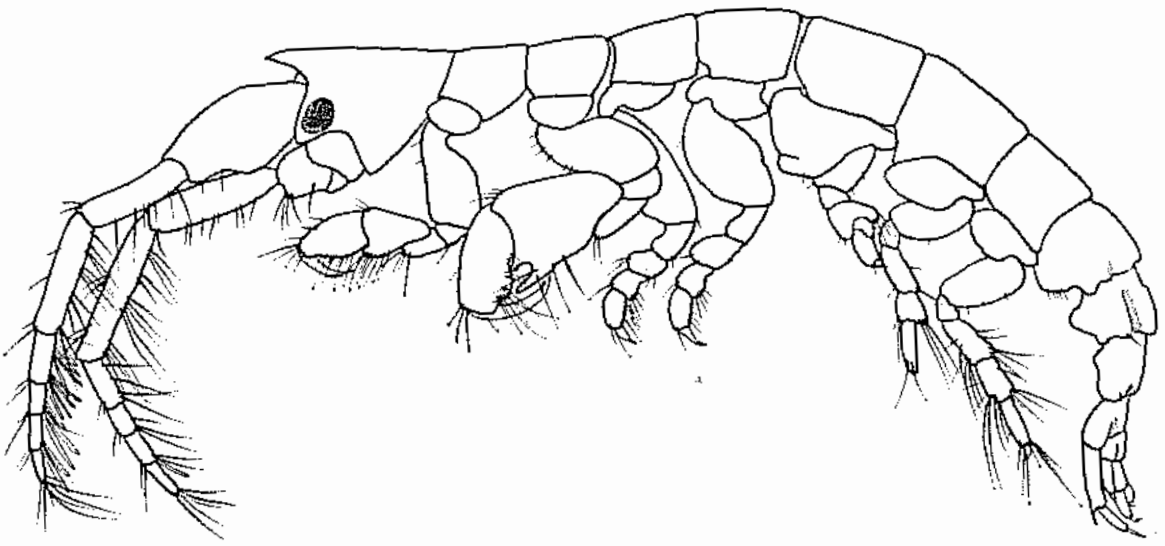

Fig. 28. *Cerapus tubularis* Say. Male, 2.8 mm, sta. 5975. Lateral view.

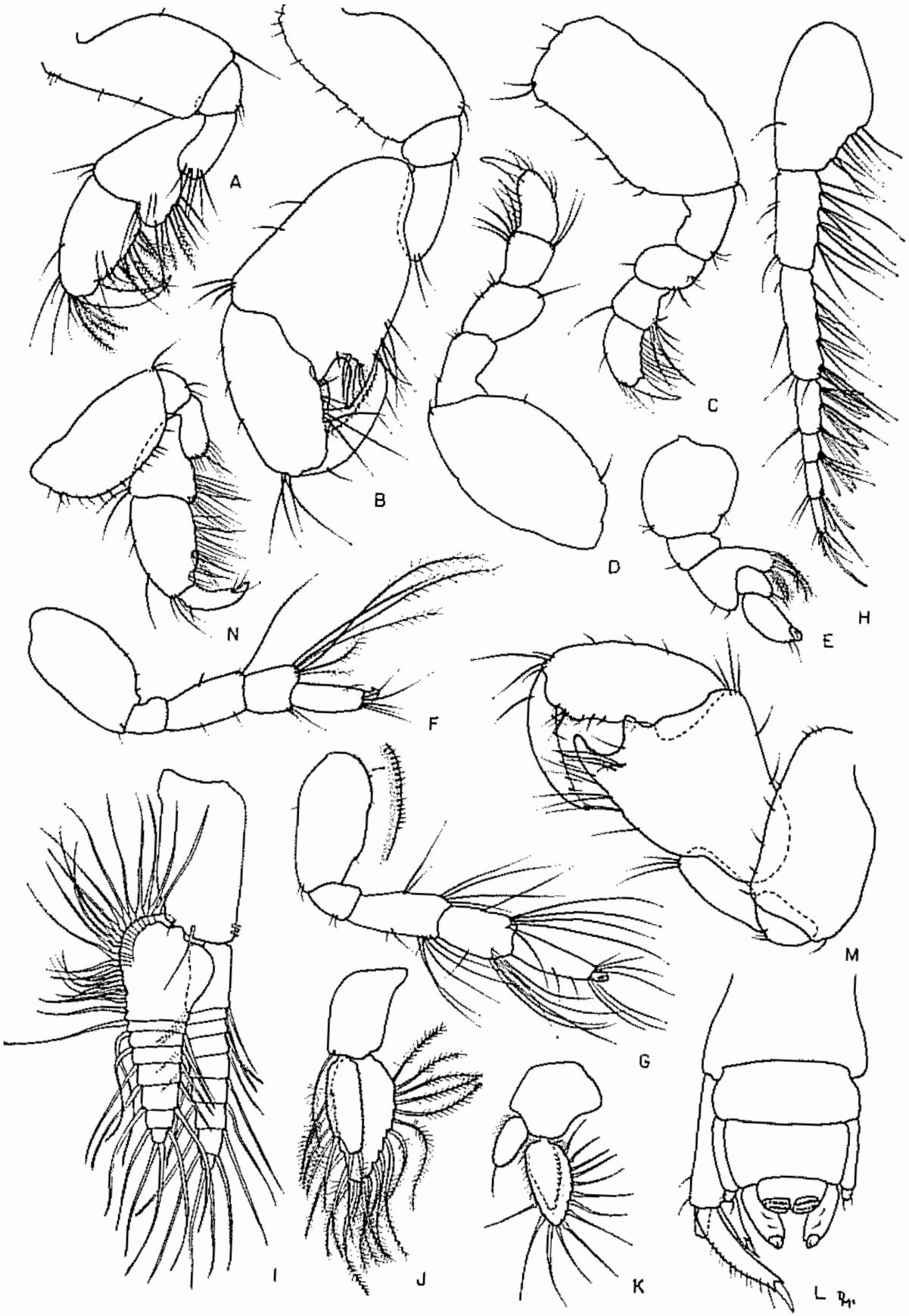

Fig. 29. *Cerapus tubularis* Say. Male, 2.75 mm, sta. 5975: A,B, gnathopods 1, 2; C,D,E,F,G, peracopods 1, 2, 3, 4, 5; H, antenna 1; I,J,K, pleopods 1, 2, 3; L, dorsal view of urosome. Male, 3.0 mm: M, gnathopod 2. Female, 3.2 mm: N, gnathopod 2.

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 descripticns 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

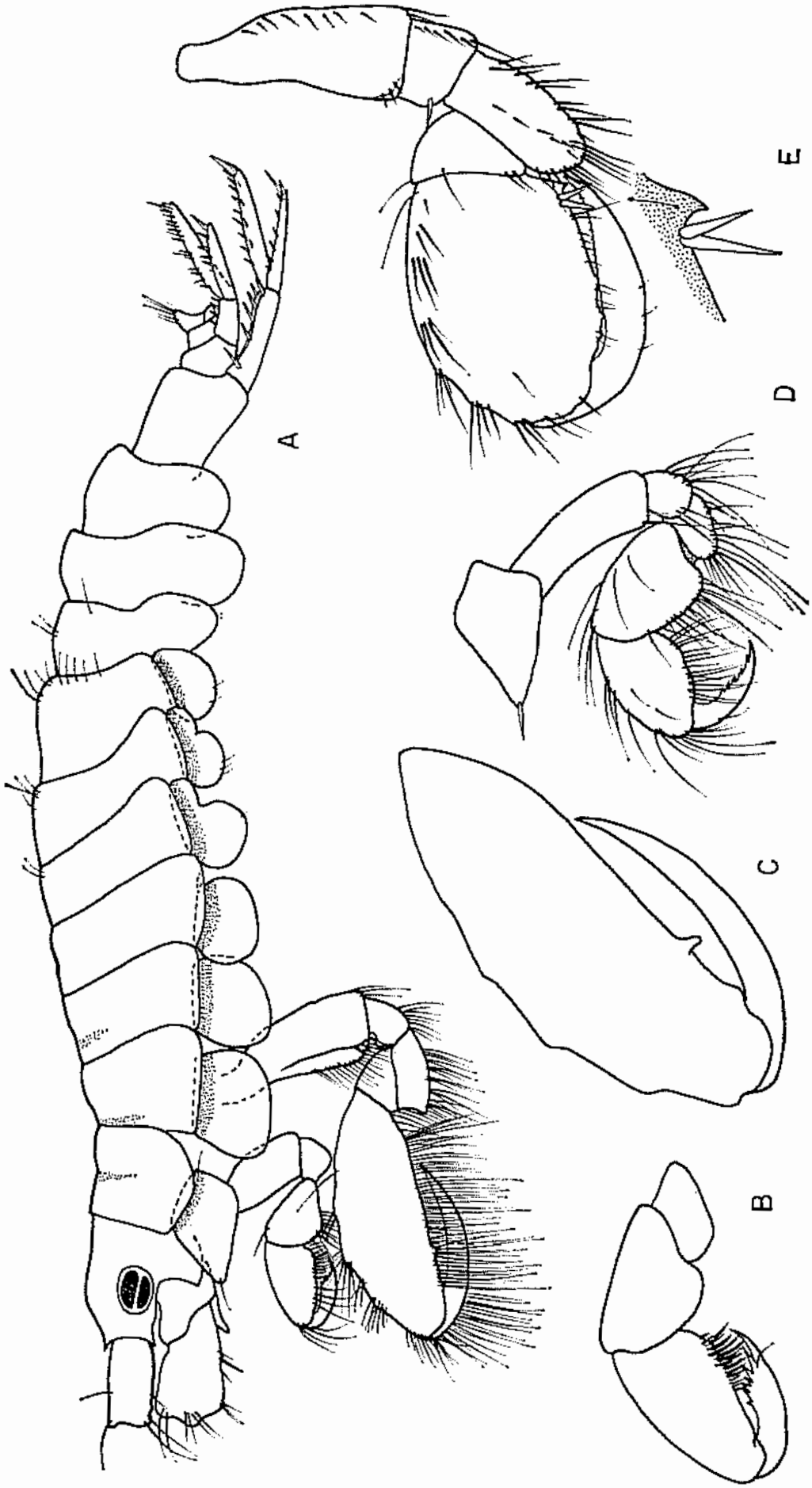

Fig. 30. *Podocerus brasiliensis* (Dana). Male, 5.0 mm, Los Angeles Harbor, 1951: A, lateral view; B,C, gnathopods 1, 2, minus setae. Female, 4.0 mm: D,E, gnathopods 1, 2.

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

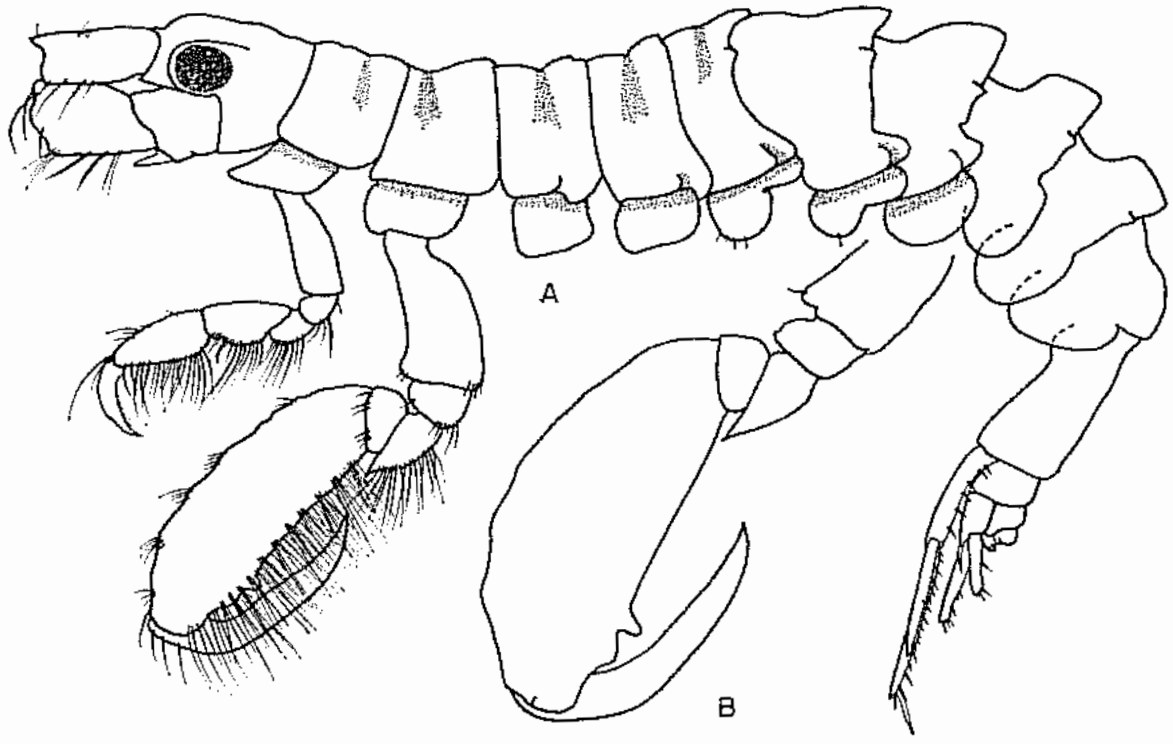

Fig. 31. *Podocerus cristatus* (Thomson). Male, 6.0 mm, sta. 4938: A, lateral view; B, gnathopod 2, minus setae.

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:

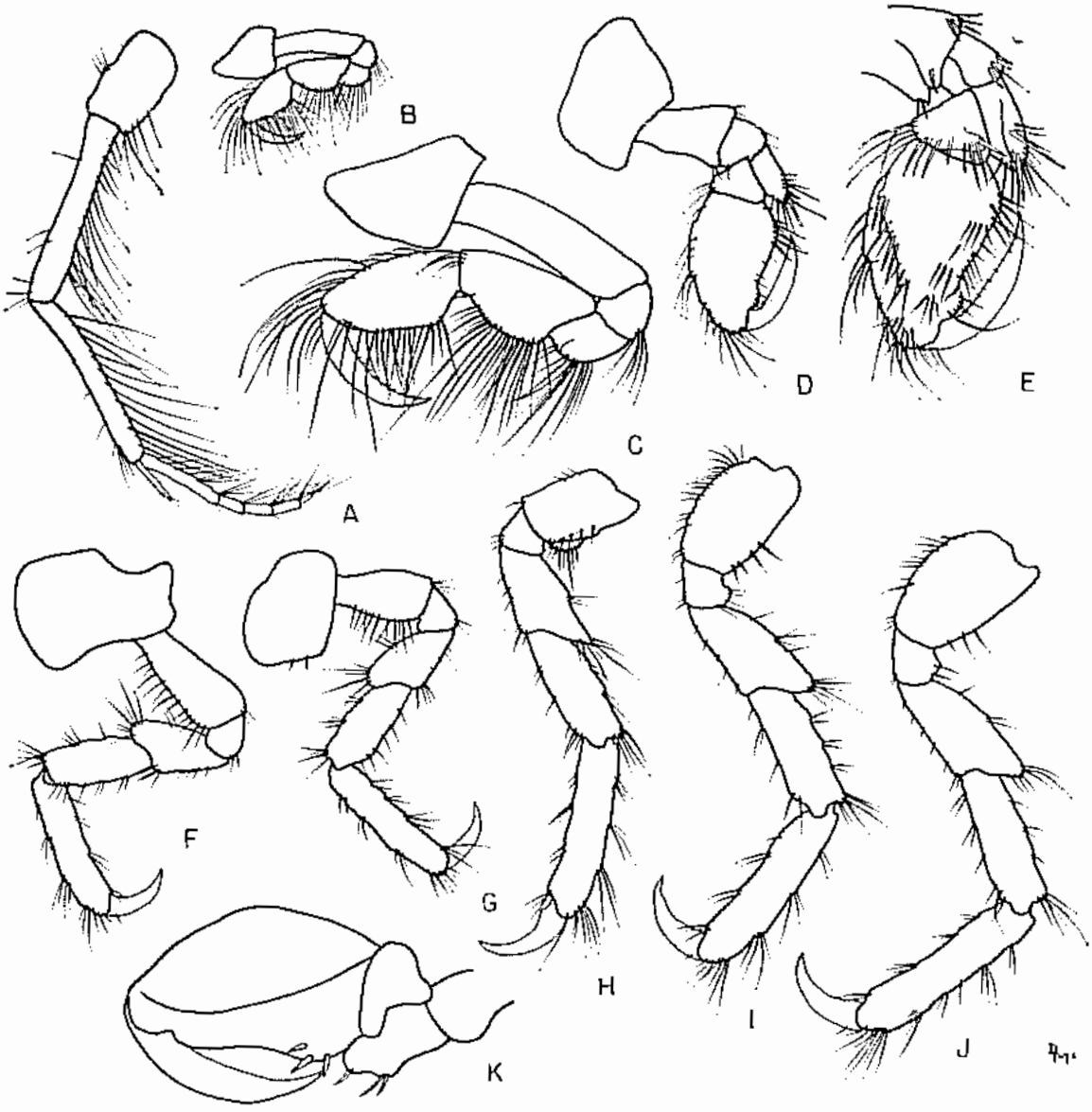

Fig. 32. *Podocerus cristatus* (Thomson). Female, 6.0 mm, sta. 4938: A, antenna 1; B,C, gnathopod 1; D,E, gnathopod 2; F,G,H,I,J, peraeopods 1, 2, 3, 4, 5. Female, 6.5 mm: K, gnathopod 2.

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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BENTHIC MARINE AMPHIPODA OF SOUTHERN CALIFORNIA: FAMILIES TIRONIDAE TO GAMMARIDAE

By J. Laurens Barnard

Introduction

Nine families of gammaridean amphipods are considered here, namely, Tironidae, Pardaliscidae, Acanthonotozomatidae, Phliantidae, Bateidae, Pontogeneiidae, Melphidippidae, Liljeborgiidae and Gammaridae. Except for the Gammaridae, all of these families are sparsely represented on soft coastal bottoms of southern California, and, indeed, the Gammaridae are inconspicuous compared with other families such as Ampeliscidae (J. L. Barnard 1954, 1960) and Phoxocephalidae (J. L. Barnard 1960a) for most of the Gammaridae reported here come from intertidal regions. The intertidal species treated were examined mainly to elaborate the genus *Elasmopus*, and further research on intertidal regions is in progress. Previous studies of Californian Amphipoda are listed in the introduction here (p. 3), where methods for collecting and for calculating distributions are explained. See that paper also for acknowledgments.

Family TIRONIDAE

Genus Bruzelia Boeck

Bruzelia tuberculata Sars

Sars 1895: 397-398, pl. 139, fig. 2; Stebbing 1906: 275; Stephensen 1931: 252; Stephensen 1938: 232; Gurjanova 1951: 589, fig. 395.

Remarks: The one specimen at hand differs from Sars' figures in the slightly produced hind edge of the third pleonal epimeron at the same place it is produced on the first and second epimera. This small kind of difference has not been used for distinguishing species in the remaining bruzeliids and may be only of subspecific or phenotypic value.

Material: AHF Station 5828 (1).

Distribution: Recorded here for the first time from California and the eastern Pacific, from Las Pitas Pt. in 86 fms. Previously known from the Arctic and North Atlantic Oceans, 82 to 309 fms. Its rarity in southern California suggests it may be at its southern limit of distribution.

Genus Syrrhoites Sars

Syrrhoites bigarra, new species

Fig. 1

Diagnosis: Head massive, turned down in front; rostrum short, broad; eyes large, fused along midline, heart-shaped from dorsal view; gnathopod 2 much more slender than gnathopod 1, the palms of both gnathopods transverse, short, each armed with a large spine forming a claw similar to article 7; a small dorsal posterior tooth produced on

peraeonal segment 7 and pleonal segments 1 and 2; dorsal posterior edge of pleonal segment 3 with a few obsolete serrations; third pleonal epimeron quadrate, rounded at lower corner, its posterior edge serrate; telson cleft three fourths of its length; mouthparts similar to *S. serratus* Sars (1895: pl. 137) but third mandibular palp article smaller, the outer lobes of

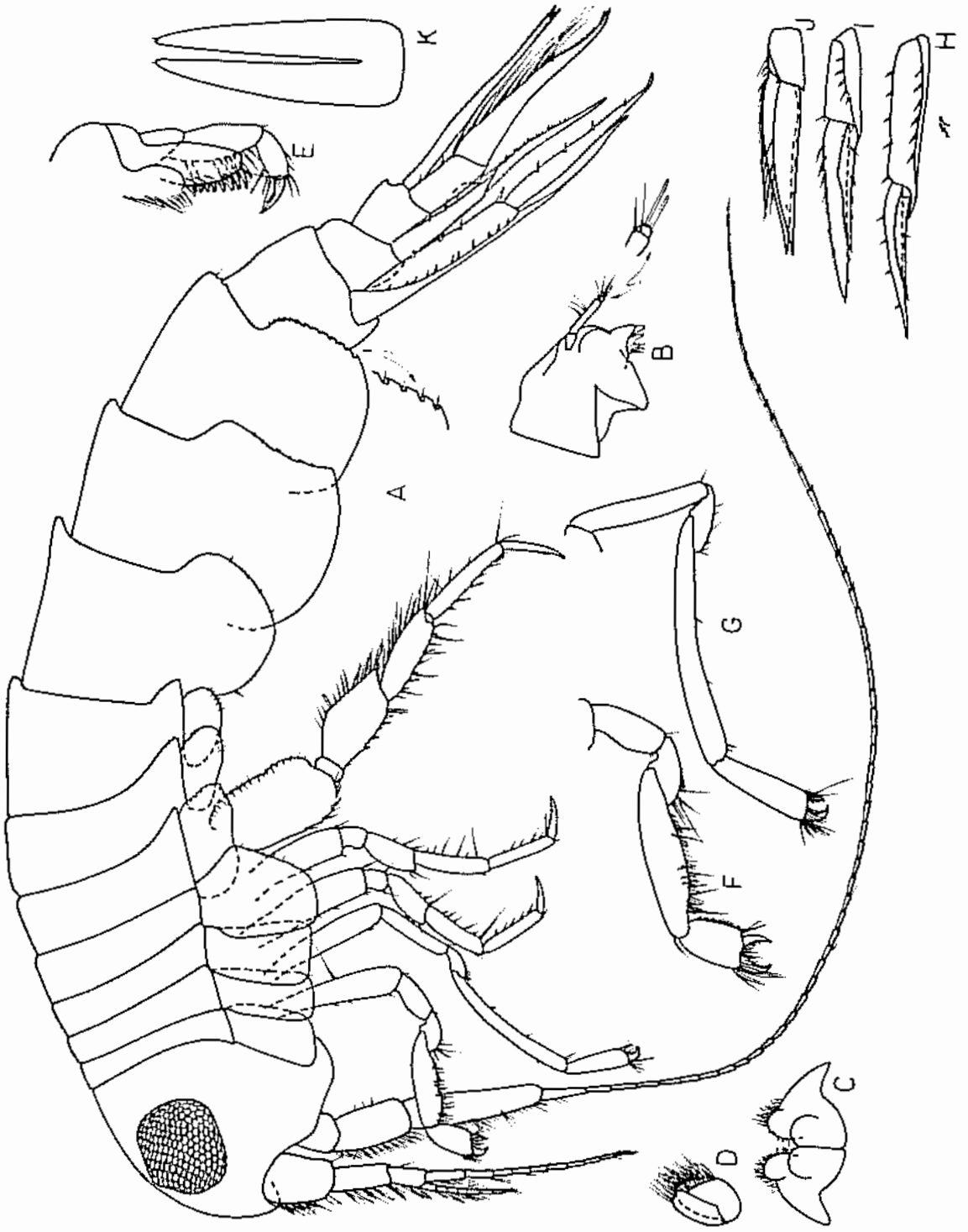

Fig. 1. *Syrrhoites bigarra*, n. sp. ?Male, holotype, 4.5 mm, sta. 5190: A, lateral view; B, mandible; C, lower lip; D, maxilla 2; E, maxilliped; F,G, gnathopods 1, 2; H,I,J, uropods 1, 2, 3; K, telson.

lower lip medially protruding, the spines on outer plates of maxilliped not as stout, and the claw of maxillipedal palp relatively longer; peraeopods 4 and 5 missing on both sides of the unique specimen.

HOLOTYPE: AHF No. 5723, ? male, 4.5 mm. Unique.

TYPE LOCALITY: Station 5190, off the Mexican border of California 32-32-45 N, 117-13-20 W, 24 fms, August 14, 1957, bottom of coarse, rust-colored sand.

RELATIONSHIP: J. L. Barnard (1961) has published a key to the previous members of this genus. The new species differs from the others by the quadrate and serrate posterior edge of the third pleonal epimeron. In the quadrate shape of this plate the species is closely related to *S. tenellus* K. H. Barnard (1925, South Africa) but differs by the more deeply cleft telson, and the epimeral serrations. The gnathopods of *S. bigarra* resemble those of *S. septentrionalis* (Stephensen 1931) because of the large palmar spines which form a chelate appearance, but the third pleonal epimeron in *S. septentrionalis* is smooth behind and turned into a tooth at the lower posterior corner.

Genus Tiron Liljeborg

Tiron biocellata, new species

Fig. 2

DIAGNOSIS OF MALE: Primary eye large, well developed; accessory eye composed of a pair of segregated ommatidea; hind edge of pleonal segments 1-3 dorsally multiserrate; pleonal segments 4, 5, and 6 each with a dorsal posterior tooth, that on segment 5 the largest; peraeopod 5 with article 2 minutely crenulate and article 4 long but not broadly expanded; coxa 4 rather small; front of head evenly convex and low; mouthparts like *Tiron spiniferum* (Stimpson) (= *T. acanthurus* in Sars 1895: pl. 140) except for maxilla 2, which has broader plates, and the outer plate of the maxilliped which has 5 stout spines on its inner edge.

FEMALE: Antenna 2 short; base of flagellum on antenna 1 segmented; rami of uropod 3 lacking long setae.

HOLOTYPE: AHF No. 5617, female 4.4 mm.

TYPE LOCALITY: Station 4787, Pt. Conception, 34-26-30 N, 120-26-00 W, 13 fms, December 18, 1956, bottom of rock and polychaetes of the genera *Diopatra* and *Nothria*.

MATERIAL: 95 specimens from 45 stations.

RELATIONSHIP: Differing from other species of *Tiron* (see list in J. L. Barnard, 1958) by the pair of segregated lateral ommatidea, which, when present in other species, are grouped into a bundle.

ECOLOGY: This species has an overall density on the coastal shelf of 1.1 animals per square meter; it ranges in depth from 5 to 90 fms, but 85% of the animals collected were from depths of 5 to 15 fms where the density of the species is 2.6 per square meter.

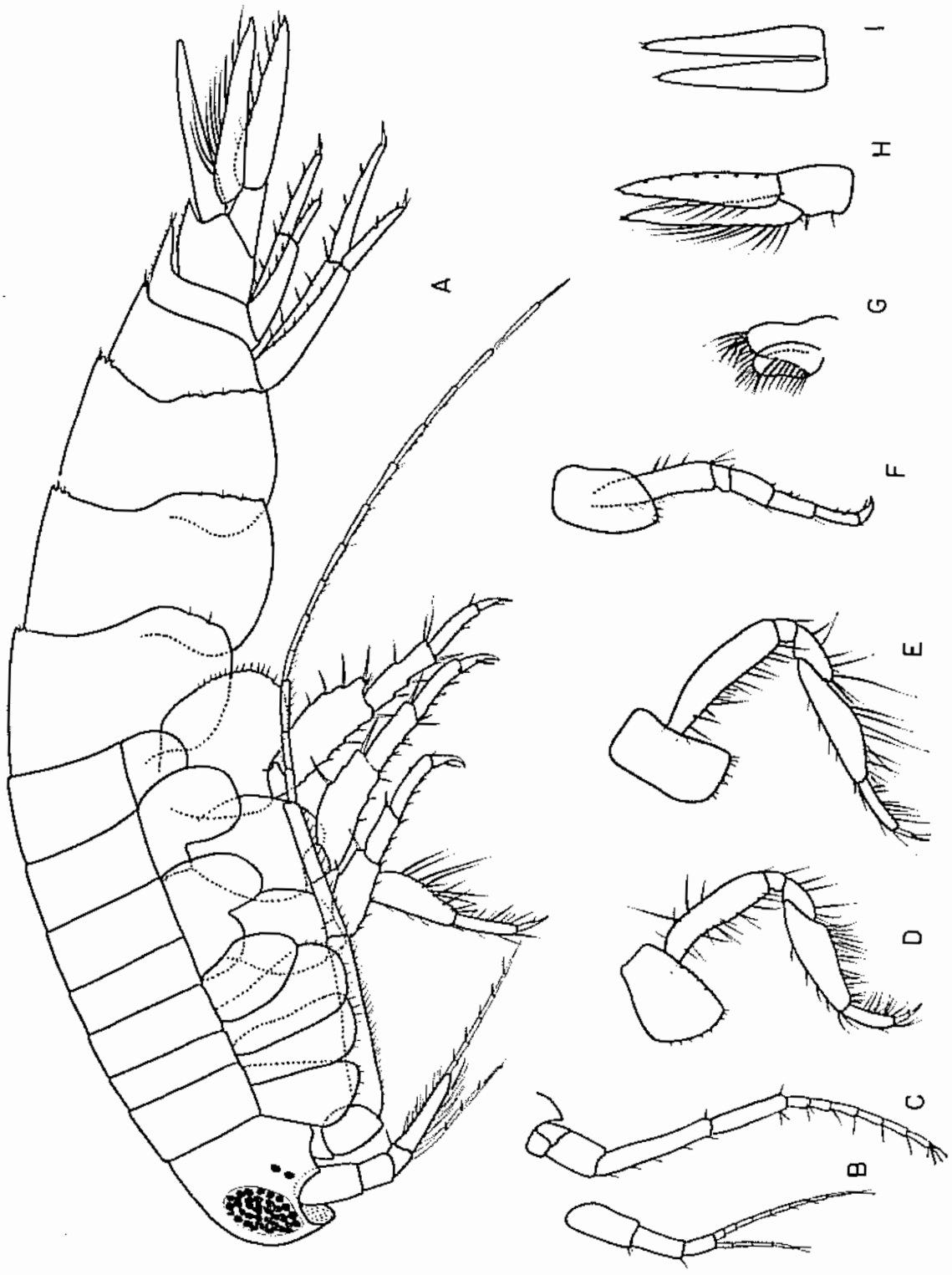

Fig. 2. *Tiron biocellata*, n. sp. Male, 3.5 mm, sta. 4843: A, lateral view; D,E, gnathopods 1, 2; F, peraeopod 2; G, maxilla 2; H, uropod 3; I, telson. Female: B,C, antennae 1, 2.

Family PARDALISCIDAE

Genus Pardalisca Kroyer

Pardalisca tenuipes Sars

Sars 1895: 404-405, pl. 142, fig. 2; Stebbing 1906: 223; Schellenberg 1925: 203; Shoemaker 1930: 54; Stephensen 1931: 213, chart 37; Stephensen 1938: 191; Gurjanova 1951: 508, fig. 331.

MATERIAL: AHF Station 6854 (1).

RECORD: San Pedro sea valley, 33-39-45 N, 118-16-28 W, 102 fms, February 13, 1960, bottom of dark gray mud.

DISTRIBUTION: Northeastern and western Atlantic Ocean; Barents Sea; California south to Los Angeles, 16 to 547 fms.

Genus Pardisynopia Barnard 1961a

Pardisynopia synopiae, new species
Figs. 3, 4

DIAGNOSIS: Article 2 of peraeopod 4 with straight hind edge, without a lobe at lower corner; third pleonal epimeron with straight posterior edge and quadrate lower corner.

HOLOTYPE: AHF No. 5724, female, 5.0 mm.

TYPE LOCALITY: Station 4873, off Laguna Beach, 33-30-36 N, 117-47-58 W, 95 fms, February 21, 1957, bottom of green mud.

MATERIAL: 170 specimens from 35 stations.

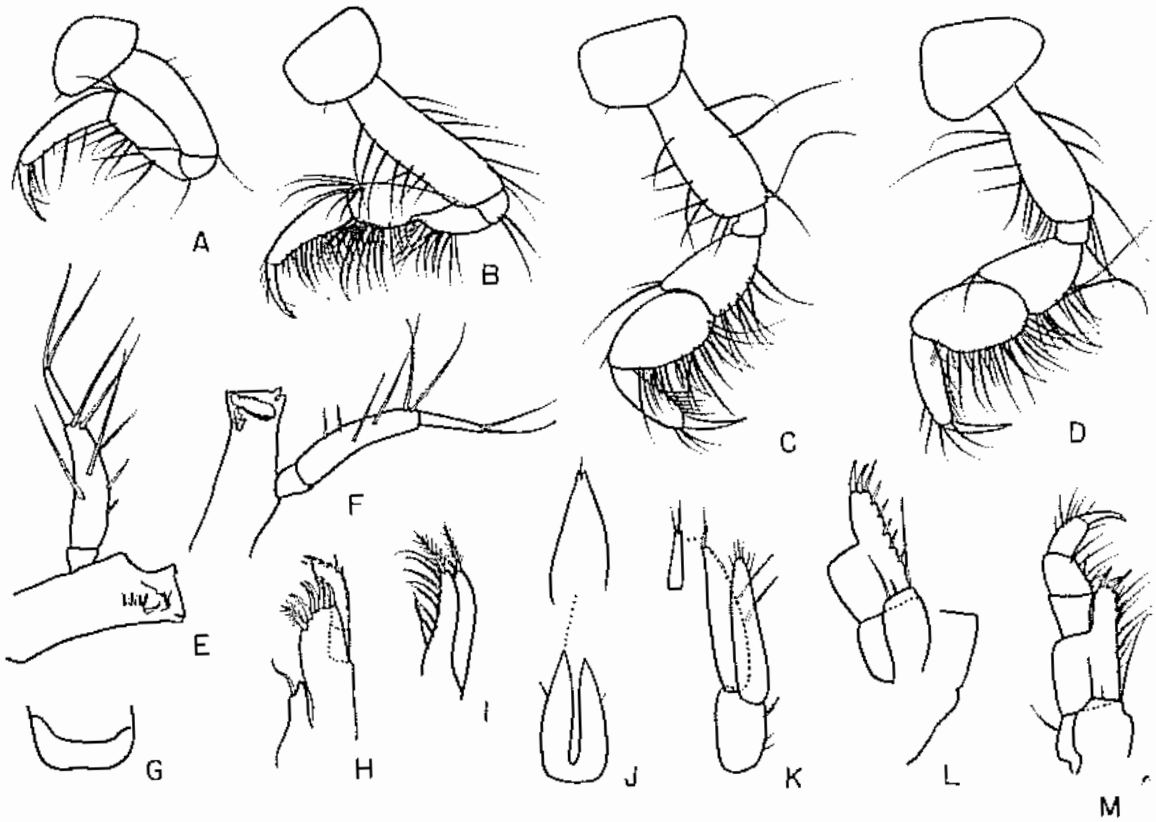

Fig. 3. *Pardisynopia synopiae*, n. g. n. sp. Female, 5.0 mm, sta. 4936: A,B, gnathopods 1, 2; C,D, peraeopods 1, 2; E,F, mandibles; G, upper lip; H,I, maxillae 1, 2; J, telson; K, uropod 3; L, inner and outer plates of maxilliped; M, maxilliped.

RELATIONSHIP: This species differs from the type species, *P. tambiella* J. L. Barnard (1961a) by just those characters indicated in the brief diagnosis above, for *P. tambiella* has a lobe at the lower posterior corner of article 2 on peraeopod 4 and a small tooth at the lower corner of the third pleonal epimeron.

ECOLOGY: This species has a density of 2.4 animals per square meter on the coastal shelf but is distributed by depth according to the following scheme:

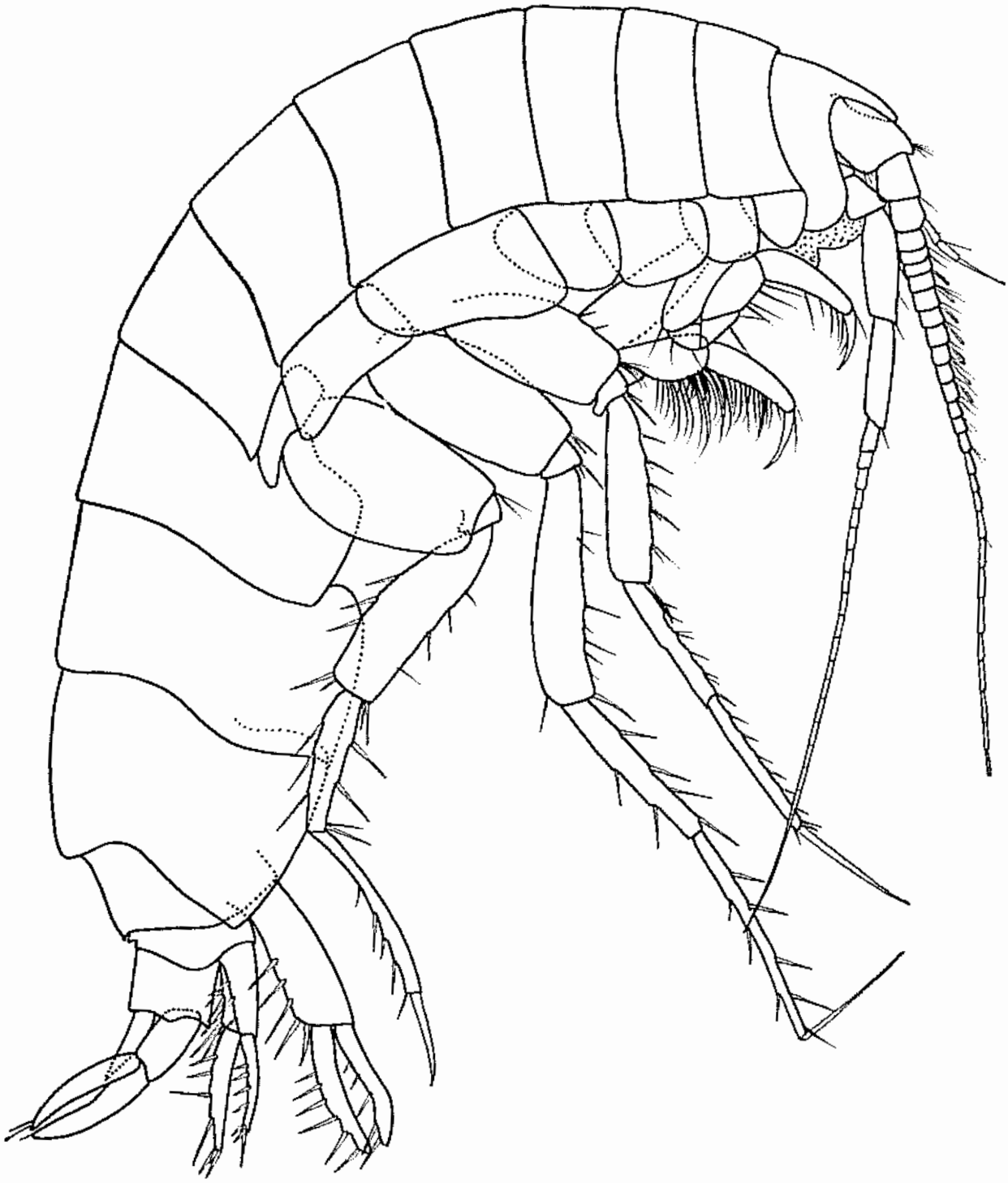

Fig. 4. *Pardisynopia synopiae*, n. g. n. sp. Female, 5.0 mm, sta. 4936: Lateral view.

Depths in fms	10	20	30	40	50	100
Specimens per square meter	0	0	0.6	1.8	8.6	7.1

Family ACANTHONOTOZOMATIDAE

Genus Panoploea Thomson

Panoploea rickettsi Shoemaker 1931: 1-5, figs. 1, 2.

MATERIAL: One specimen from 74 fms off Pt. Conception, California, on gravel bottom; one specimen from Monterey Bay.

DISTRIBUTION: Monterey Bay to Pt. Conception, California, from about 55 to 74 fms.

Family PHLIANTIDAE

Genus Heterophlias Shoemaker

Heterophlias seclusus escabrosa, new subspecies

Fig. 5

DIAGNOSIS: Like the type of the species except: basal articles of antenna 1 considerably broader and with larger processes; uropod 2 more slender and with longer inner ramus.

HOLOTYPE: AHF No. 5725, male, 3.3 mm.

TYPE LOCALITY: Station 4822, southeast of Pt. Conception, 34-27-15 N, 120-14-45 W, 9 fms, January 17, 1957, bottom of silty sand and algae.

MATERIAL: 9 specimens from 2 stations.

REMARKS: The distinguishing criteria for the new subspecies are minor and only of quantitative value. All other criteria closely approximate the excellent description of the type (Shoemaker 1933: 250-252, figs. 4, 5) except that the outer plate of the maxilliped in the present specimens lacks a fuzzy row of ornamentation along the inner edge.

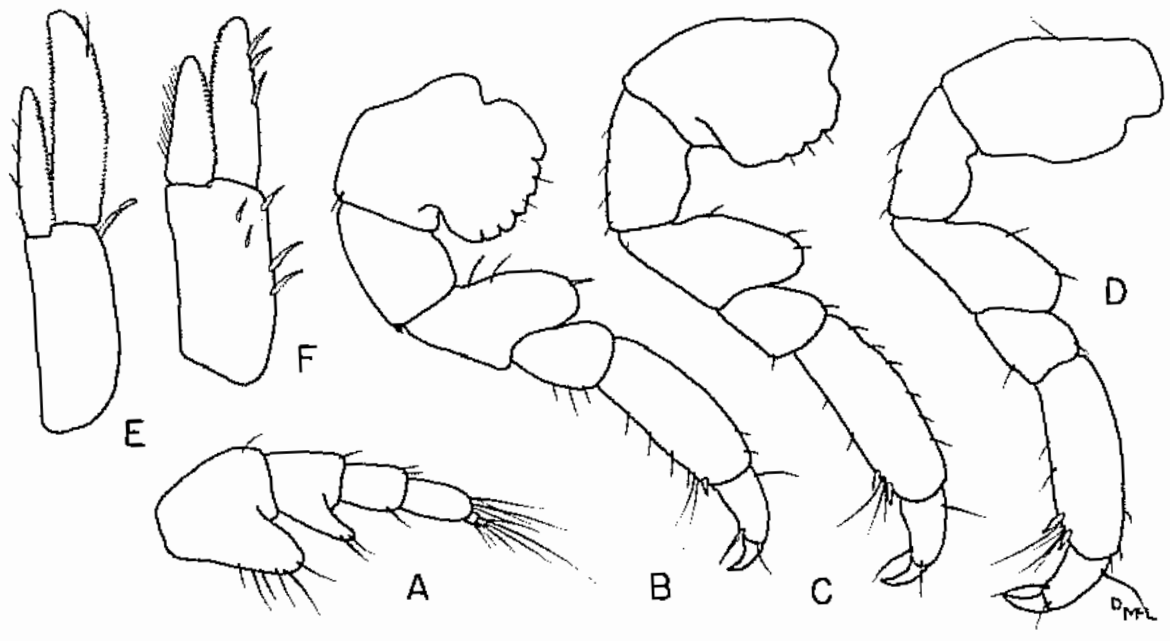

Fig. 5. *Heterophlias seclusus escabrosa*, n. ssp. Male, 3.5 mm, sta. 4822: A, antenna 1; B,C,D, peraeopods 3, 4, 5; E,F, uropods 1, 2.

RECORDS: Samples near Pt. Conception and Santa Barbara, 9 fms.

DISTRIBUTION: The type subspecies was described from the Dry Tortugas off Florida.

Family BATEIDAE

Genus Batea Muller

Batea transversa Shoemaker 1926: 13-18, figs. 8-11.
Fig. 6

MATERIAL EXAMINED: 264 specimens from 12 stations.

ECOLOGY: When this species occurs at a station it is exceedingly abundant, up to 88 specimens in a sample. Its overall coastal shelf density is 5.2 animals per square meter, but it is restricted to depths shallower than 15 fms where its frequency is 15 animals per square meter. The species is associated with algal bottoms. Known only from southern California.

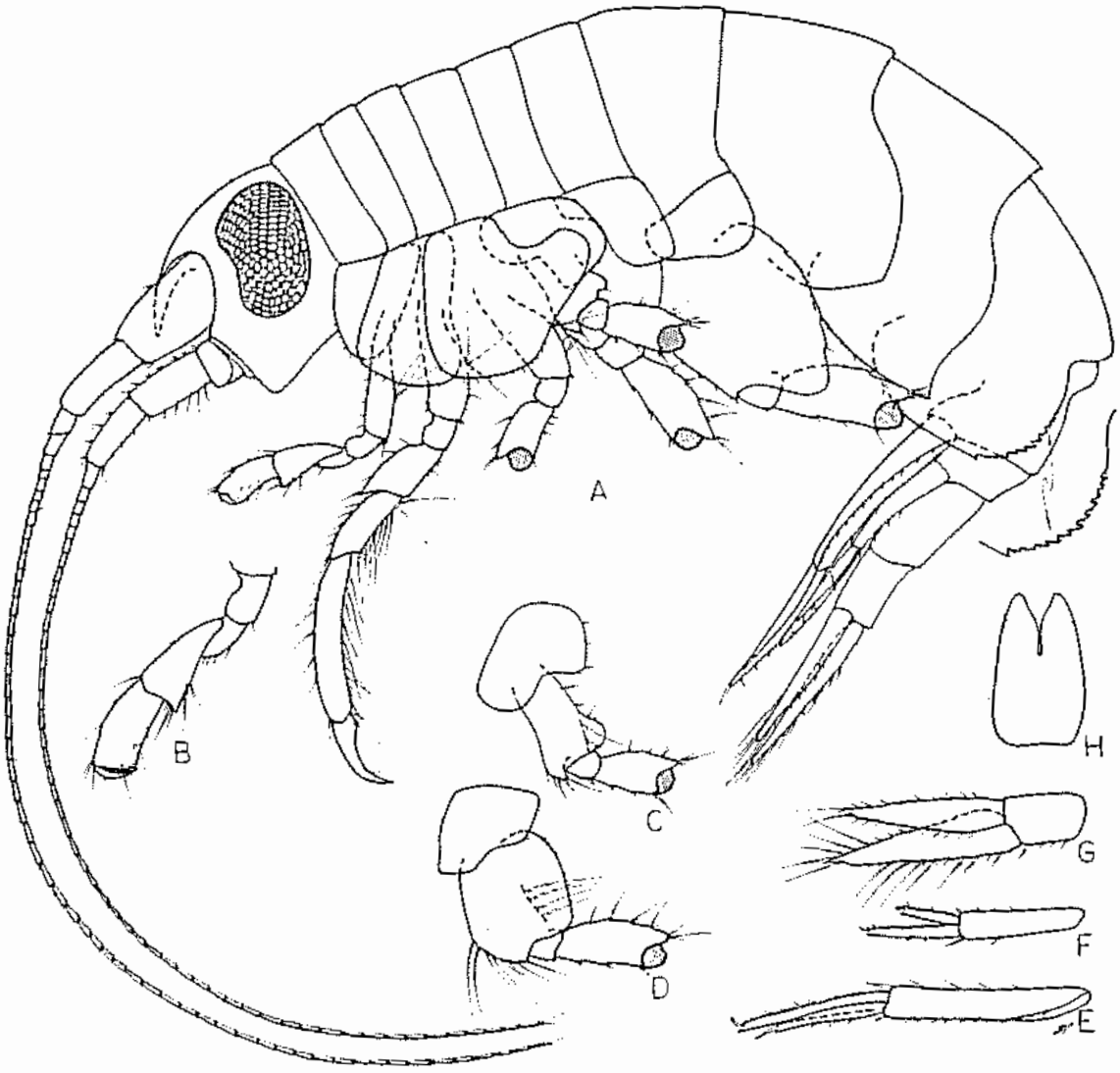

Fig. 6. *Batea transversa* Shoemaker. Male 5.0 mm, sta. 4938: A, lateral view; B, gnathopod 2; C,D, peraeopods 3, 4; E,F,G, uropods 1, 2, 3; H, telson.

Batea lobata Shoemaker 1926: 18-21, figs. 12, 13.

MATERIAL EXAMINED: Stations 6403 (1), 6415 (1).

RECORD: Found only in the inshore sand regions of southern California in depths of 2 to 5 fms. Known only from southern California.

Family PONTOGENEIIDAE

Genus Pontogeneia Boeck

Pontogeneia rostrata Gurjanova

Gurjanova 1951: 719, fig. 500.
Pontogeneia sp., Nagata 1960: 171-173, pl. 14, figs. 50-53, pl. 15, figs. 54-71.

MATERIAL EXAMINED: Stations 4818 (1), 4819 (27), 4822 (1), 5583 (1).

REMARKS: The species of *Pontogeneia* are difficult to identify because so many differ among themselves by criteria which are at best measured quantitatively, and so minor as to require dissection and mounting of each specimen. The present specimens agree with the figures of Gurjanova (1951), the main features being the head, eyes, rostrum, the small bump on the third article of the first antenna, the gnathopods and the third pleonal epimeron. Nagata's specimens also fit *P. rostrata* except for the third pleonal epimeron, which in his figures has a small tooth at the lower corner. It is probable that this is simply a variation of no specific value. Nagata believed that his materials probably belonged with *P. rostrata*, but the original references were unavailable to him.

DISTRIBUTION: These stations are at depths of 6 to 10 fms. near Pt. Conception in the northwestern section of southern California. It would appear that the species reaches its southern limit in this area. Previously known from Japan Sea, Okhotsk Sea, Bering Sea, 3-55 fms.

Family MELPHIDIPPIDAE

Melphisana, new genus

DIAGNOSIS: Accessory flagellum uniarticulate, quite small, barrel-shaped; telson emarginate, not cleft; upper lip sharply incised; fourth palp article of maxilliped short, stout, not claw-like, bearing 2 apical setae; third mandibular palp article very short.

TYPE SPECIES: *Melphisana bola*, new species.

RELATIONSHIP: Three genera of melphidippids have been described: *Melphidippa* Boeck, *Melphidippella* Sars and *Hornellia* Walker. The new genus differs from all three in the combination of the diagnostic characters, but especially in the uncleft telson. None of the other genera has a shortened third mandibular palp article,and each of the other genera has a long claw-like fourth maxillipedal palp article. Apparently the new genus is unique for the non-spinose inner edge of the outer plate of the maxilliped.

Melphisana bola, new species

Fig. 7

DIAGNOSIS: With the characters of the genus.

DESCRIPTION: Article 2 of first antenna in male longer than article 1, but subequal in female; eyes bulging, colorless but with numerous ommatidea; lower lip and maxillae like *Melphidippa goesi* (= *M. spinosa* in Sars 1895: pl. 169); gnathopods 1 and 2 similar in size and structure; pleon segments 1-5 bearing a middorsal tooth; pleon segments 2 and 3 bearing 2 and 3 small lateral teeth, respectively; posterior edges of second and third pleonal epimera serrate. The second antennae and third uropods are missing on all of the specimens in the collections.

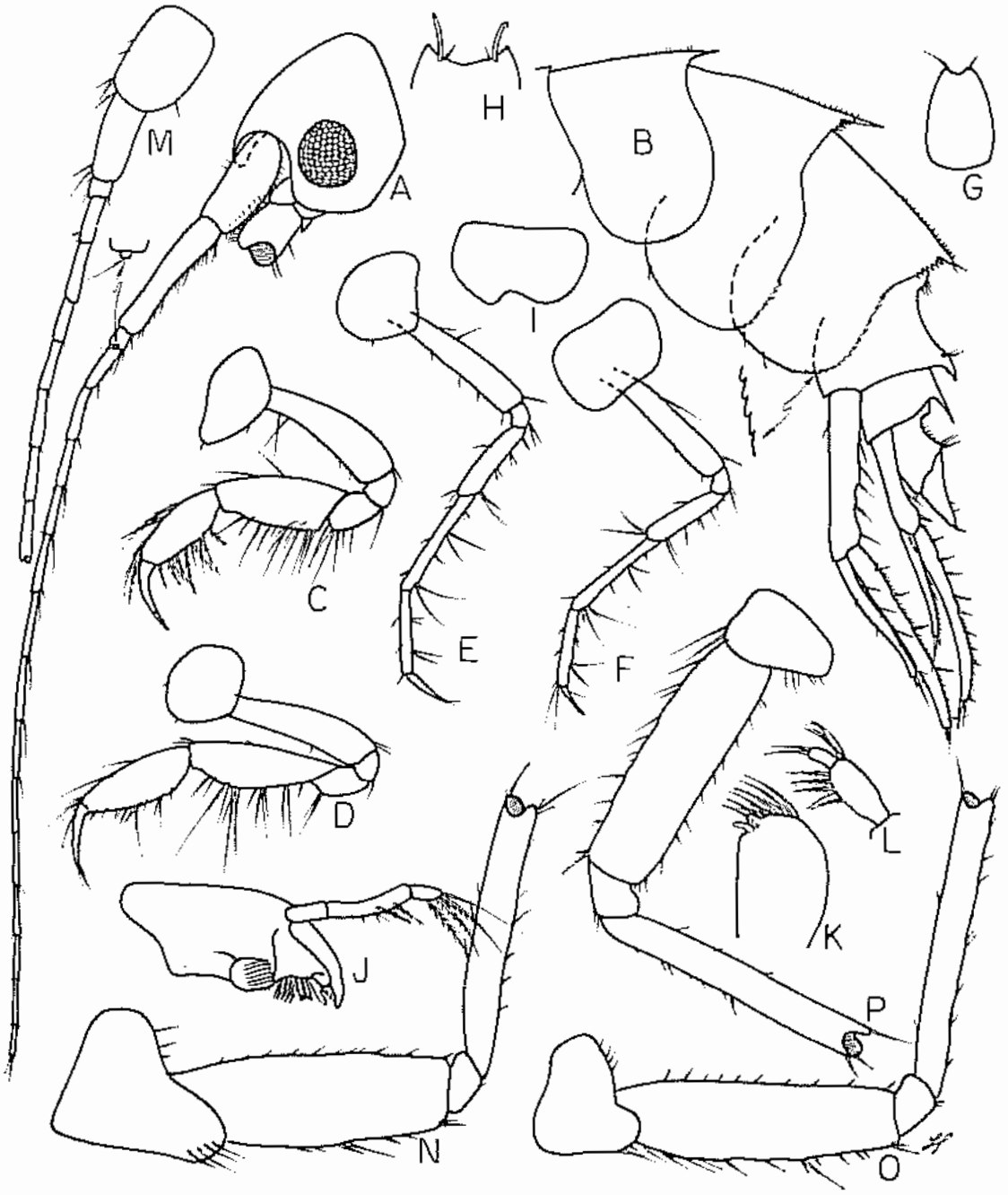

Fig. 7. *Melphisana bola*, n. g. n. sp. Male, 3.0 mm, sta. 6155: A, head; B, pleon; C,D, gnathopods 1, 2; E,F, peraeopods 1, 2; G,H, telson. Female, 3.0 mm, sta. 4769: I, upper lip; J, mandible; K,L, outer plate and palp articles 3-4 of maxilliped; M, antenna 1; N,O,P, peraeopods 3, 4, 5.

HOLOTYPE: AHF No. 582, male, 2.4 mm.

TYPE LOCALITY: Station 5628, northwest of Oceanside, 33-18-30 N, 117-32-30 W, 20 fms, February 22, 1958, bottom of fine gray sand.

MATERIAL: 55 specimens from 27 stations.

ECOLOGY: This species is limited to depths of 6 to 40 fms. on the southern California coastal shelf where its density is 0.7 animals per square meter.

Family LILJEBORGIIDAE

Genus Liljeborgia Bate

Liljeborgia brevicornis (Bruzelius)

Lilljeborgia pallida, Sars 1895: 530-532, pl. 187.
Liljeborgia brevicornis. Stebbing 1906: 231; Holmes 1908: 526; Chevreux and Fage 1925: 155-156, fig. 155; Chevreux 1925: 301; Stephensen 1931: 221-222; Stephensen 1938: 195-196; Gurjanova 1951: 515-516, fig. 337; Reid 1951: 232.

REMARKS: The specimens at hand differ from Sars' figures in the lack of a tooth on pleon segment 2. Two of the specimens have evanescent teeth on pleon segments 1 and 2. The rarity of the species in southern California suggests it to be near its southern limit of distribution. This marginal position of the population might account for its aberrancies.

MATERIAL: Stations 4822 (3), 5562 (1).

RECORDS: Near Pt. Conception, 10 fms, on algal bottoms.

DISTRIBUTION: Norway, Britain, France, Senegal, California; 10-308 fms.

Liljeborgia kinahani (Bate)

Stebbing 1906: 233; K. H. Barnard 1932: 142-143, fig. 81; Stephensen 1938: 197-198.
Lilljeborgia kinahani, Sars 1895: 532-533, pl. 188, fig. 1; Chevreux and Fage 1925: 157, fig. 157.

MATERIAL: Stations 4794 (3), 6425 (5).

RECORDS: Monterey Bay, 14 fms; Santa Rosa Island, 19 fms.

DISTRIBUTION: This is the first record from the eastern Pacific; known from Norway, Britain, France, 6-11 fms; South Africa; Falklands; South Georgia.

Liljeborgia cota, new species

Figs. 8, 9

DIAGNOSIS: Eyes absent; lateral head lobe strongly produced, rounded; epistome produced and rounded in front; coxae 1-3 each with a small lower posterior notch; coxa 4 with 2 notches on posterior edge and one at lower corner; gnathopods 1 and 2 with simple palms, the fingers with 4 and 7 notches, respectively; telson split about a third of its length; inner edge of peduncle on uropod 1 with 2-3 large spines; posterior edge of third pleonal epimeron with a slight sinuation above a small lower tooth; dorsal tooth formula of pleon quite variable as seen in the figures, each of the first 5 pleonal segments generally with a small tooth, but the tooth of pleonal segment 1 and, occasionally, that of pleonal segment 2 not developed, in other cases the tooth of pleonal segment 2 quite large; teeth of

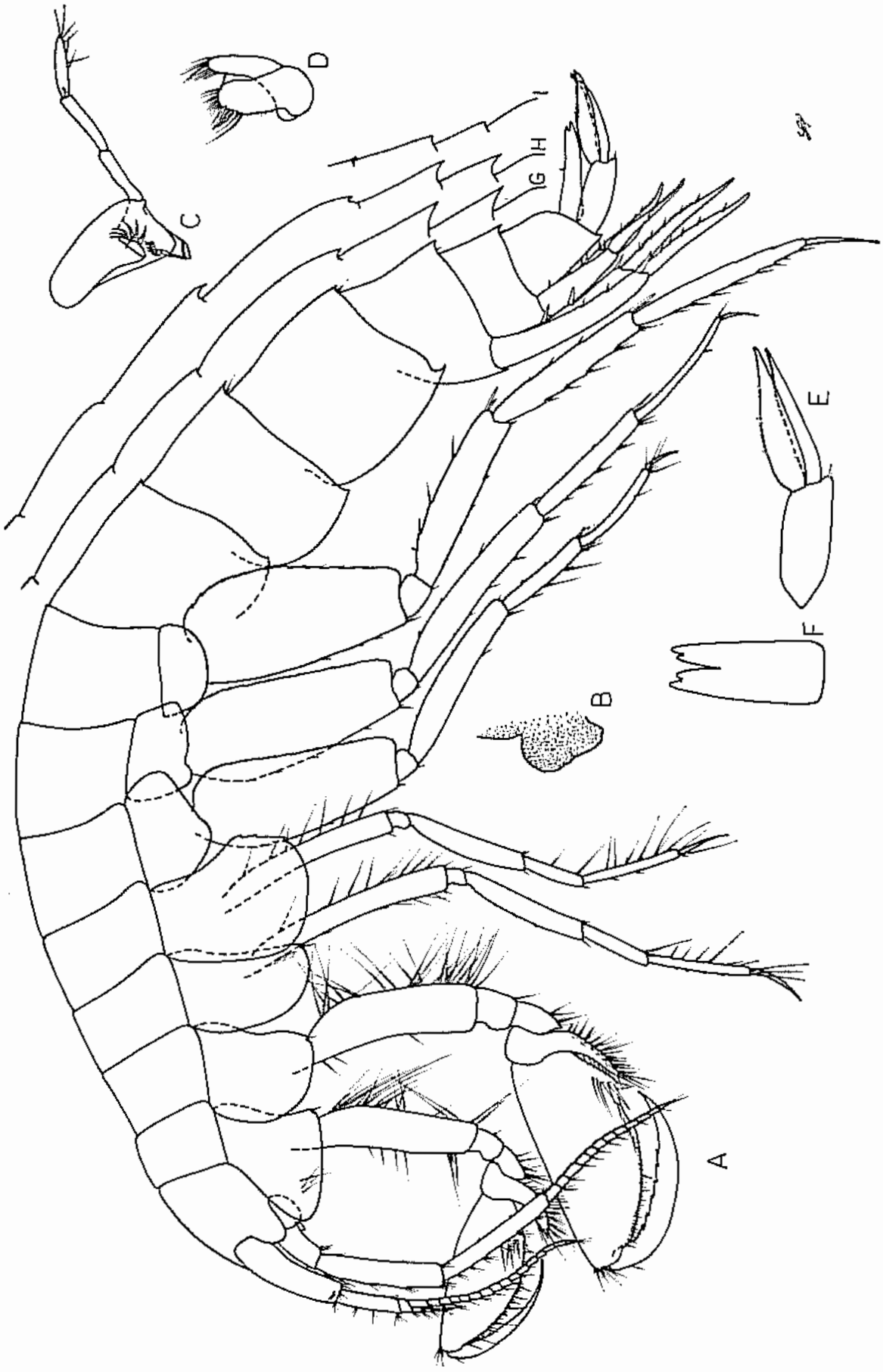

Fig. 8. *Liljeborgia cota*, n. sp. Female, holotype, sta. 6338: A, lateral view; B, upper lip and epistome, lateral view; C, mandible; D, maxilla 2; E, uropod 3; F, telson. Additional pleonal configurations: G, male, sta. 6348; H, female, 6347; I, male, sta. 6347.

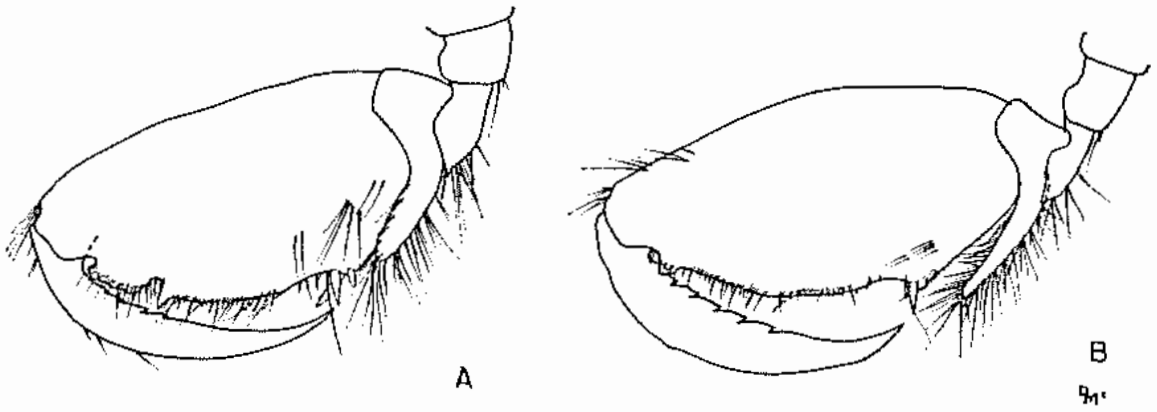

Fig. 9. *Liljeborgia cota*, n. sp. Second gnathopods: A, male, sta. 6351: B, male, sta. 6347.

pleonal segments 4 and 5 variable, from nearly obsolete to very strongly developed; lower corners of second articles on peraeopods 3-5 rounded, not produced downward, the articles rectangular, not oval.

HOLOTYPE: AHF No. 595, female, 12 mm.

TYPE LOCALITY: Station 6338, San Nicolas Basin, 33-06-18 N, 119-12-30 W, 948 fms, August 14, 1959, green clay.

MATERIAL: Stations 2335 (1), 5933 (5 mm juv.), 6338 (holotype) 6339 (male, 7 mm), 6347 (male, 10 mm; female, 6 mm), 6348 (male, 6 mm), ?6351 (?male, 7 mm, aberrant).

RELATIONSHIP: This species is closely related to *L. consanguinea* Stebbing (1888: pl. 91) but differs by the rectangular (not oval) second articles on peraeopods 3-5 and by the less well-developed serrations on their posterior edges; the telson is less deeply cleft. The new species also is related to *L. fissicornis* (in Sars 1895: pl. 189) but differs by the smaller size of the dorsal pleonal teeth, the rounded (not conical) lateral head lobe and the less deeply cleft telson. Some specimens of the new species bear resemblance to *L. macronyx* Sars (1895: pl. 188, fig. 2), but differ again by the poorly cleft telson and the rounded head lobe. The species resembles *L. caeca* Birstein and Vinogradova (1960), but differs by the small cleft of the telson and the presence of teeth on the inner edge of article 7 of gnathopod 1.

Specimens of *Liljeborgia cota* vary in the dorsal armature of the pleon. The writer believes that the variants do not represent distinct species, but a demonstration such as this casts doubt on the usefulness of tooth formulas for specific identity of other species in the genus. A summary of these formulas is included in table 1 for comparison with the new species.

The supposed male of station 6351 is aberrant in having a notch and a tooth on the palm of gnathopod 2; probably this is not the normal male condition because several other older males (with genital papillae) have the smooth palm of gnathopod 2.

RECORDS: Basins in borderland off southern California: San Nicolas Basin, 1608 m, 1735 m, 1749 m; Tanner Basin, 1292 m, 1414 m; Long

Basin, 1821 m; San Pedro Basin, 769 m. Records are quoted in meters because deep-sea species have international interest.

Family GAMMARIDAE

Genus Ceradocus Costa

Ceradocus spinicauda (Holmes)

Figs. 10, 11

Maera spinicauda Holmes 1908: 539-541, fig. 45.
Ceradocus spinicauda, J. L. Barnard 1954: 18-19.

DIAGNOSIS: Pleonal segments 1-5 each with a single dorsal tooth; third pleonal epimeron serrate both below and behind; second gnathopods asymmetrical, at least one in either sex with an oblique palm armed with 2 blunt processes near the finger hinge and defined by a cusp behind; proximal inner edge of article 7 of gnathopod 2 with a bump; each apex of telson with 3 long spines, 2 small spines and a setule; coxae not serrate below; eyes present.

MATERIAL: 14 specimens from 3 stations.

RECORDS: From depths of 11 fms near Pt. Conception, California. Apparently this species reaches its southern limit on the coastal shelf, at or near Pt. Conception, since it has not been found south of that point in

Table 1

Pleonal tooth formulas of species in the genus *Liljeborgia*. Numbers refer to dorsal teeth on the posterior dorsal edge of the numbered segment. (+) = large tooth; m = male; f = female.

	Pleon Segment				
Species	1	2	3	4	5
inermis	0	0	0	0	0
epistomata	0	1	0	1+	1
quinquedentata	0	3	0	1	1
barhami	1	0	0	1	1
brevicornis	1	1	0	1	0
macronyx	1	1	0	1	0
pallida	1	1	0	1	0
proxima	1	1	0	1	0
georgiana	1	1	0	1+	1+
mojada	1	1	0	1+	1+
quadridentata	1	1	0	1	1
consanguinea	1	1	1	1	1
zarica	1	1	1	1	1
fissicornis	1	1	1	1+	1+
caeca	1	1	1	1+	1+
hansoni	1	3	0	1+	1+
aequabalis	3	3	0	1	1

	Pleon Segment				
Species	1	2	3	4	5
akaroica	3	3	0	1	1
kinahani	3	3	0	1	1
longicornis	3	3	0	1+	1+
macrodon	3	3	0	1	1
mixta	3	3	0	1	1
octodentata	3	3	0	1	1
dellavallei	3	3	1	2	1
dubia	5(3)	5(3)	1	1+	1+
*cota** 6348	0	0	1	1+	1+
*cota** 6347f	0	1+	1	1+	1+
*cota** 2335	0	1+	1	1+	1+
*cota** 6339	0	1+	1	1+	1+
*cota** 6351	0	1	1	1	1
*cota** 6338	1	1	1	1	1
*cota** 6347m	1	1+	1	1	1
*cota** 5933	1	1+	1	1+	1+

See J. L. Barnard (1958) for references to the species except for the following: *L. caeca* Birstein & Vinogradova (1960); *L. mojada* Barnard (1961a); *L. zarica* Barnard (1961).
*new species

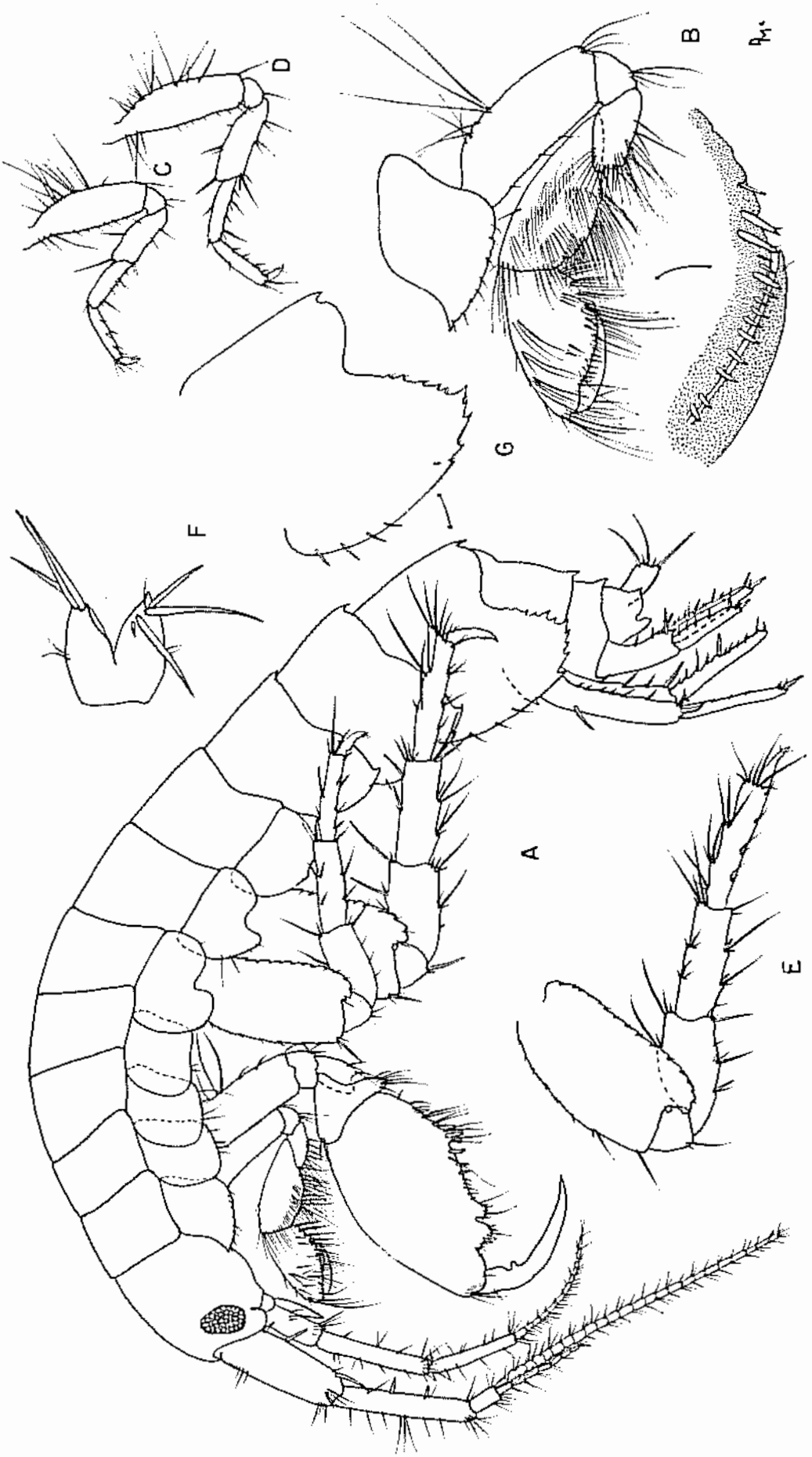

Fig. 10. *Ceradocus spinicauda* (Holmes). Female, 9.0 mm, sta. 5557: A, lateral view; B, gnathopod 1; C,D,E, peraeopods 1, 2, 5; F, telson; G, third pleonal epimeron.

hundreds of samples. Also known intertidally from Oregon and at depths of 29 to 45 fms in the channel islands off southern California, at Santa Rosa Island, San Nicolas Island and Santa Barbara Island.

Genus Elasmopus Costa

Elasmopus antennatus (Stout)

Figs. 12, 13

Neogammaropsis antennatus Stout 1913: 645-646.
Elasmopus antennatus, Shoemaker 1941: 187.

DIAGNOSIS OF MALE: No body segments dorsally dentate; gnathopod 2 with the palm quite oblique, heavily setose, not defined, with poorly developed process near finger hinge, its article 7 overlapping hind margin

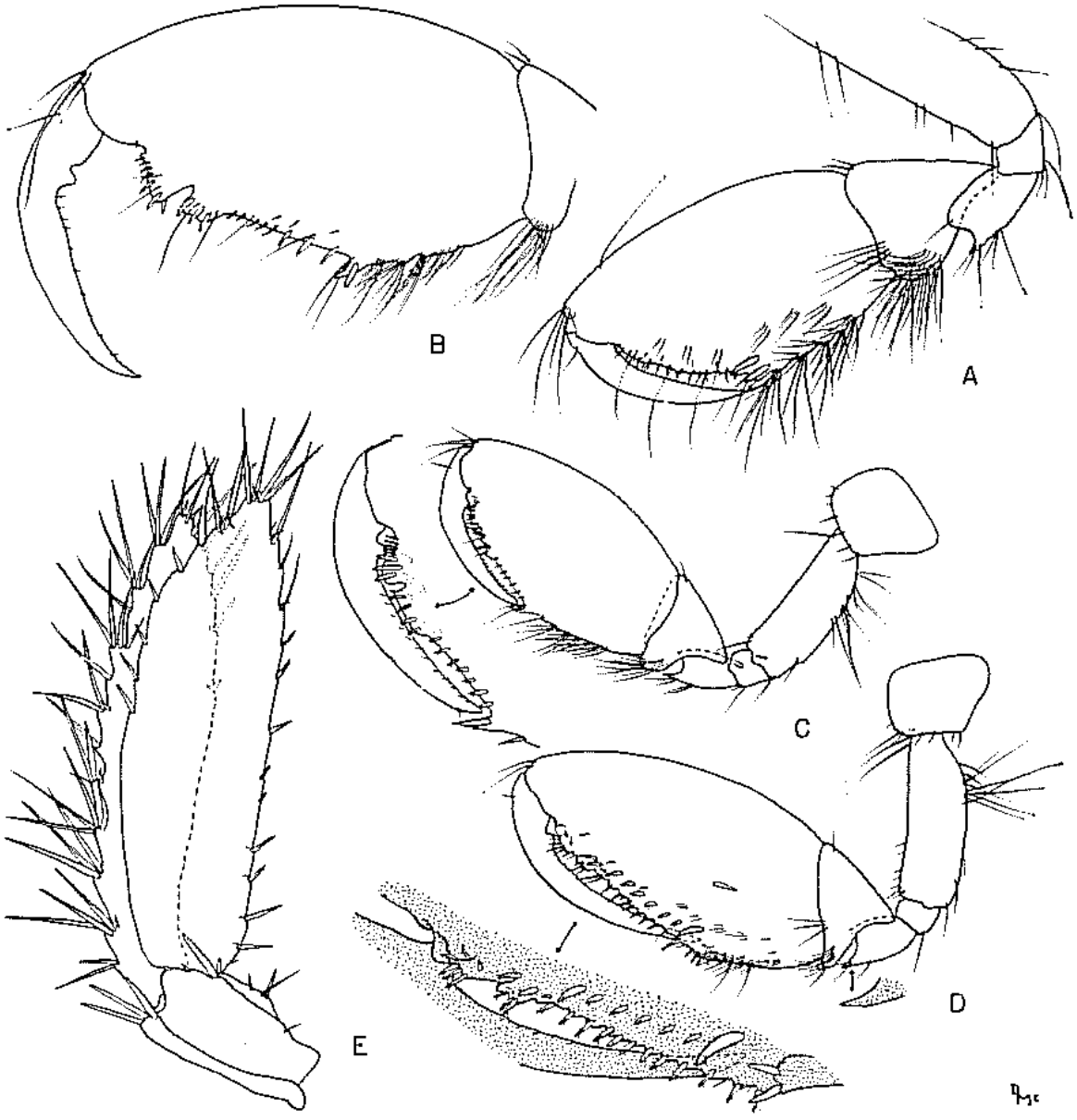

Fig. 11. *Ceradocus spinicauda* (Holmes). Female, 9.0 mm, sta. 5557: A,B, same magnification of medial view of right gnathopod and lateral view of left gnathopod 2; E, uropod 3. Male, 10.0 mm, sta. 5557: C,D, same magnification of lateral view of left gnathopod 2 and medial view of right gnathopod 2.

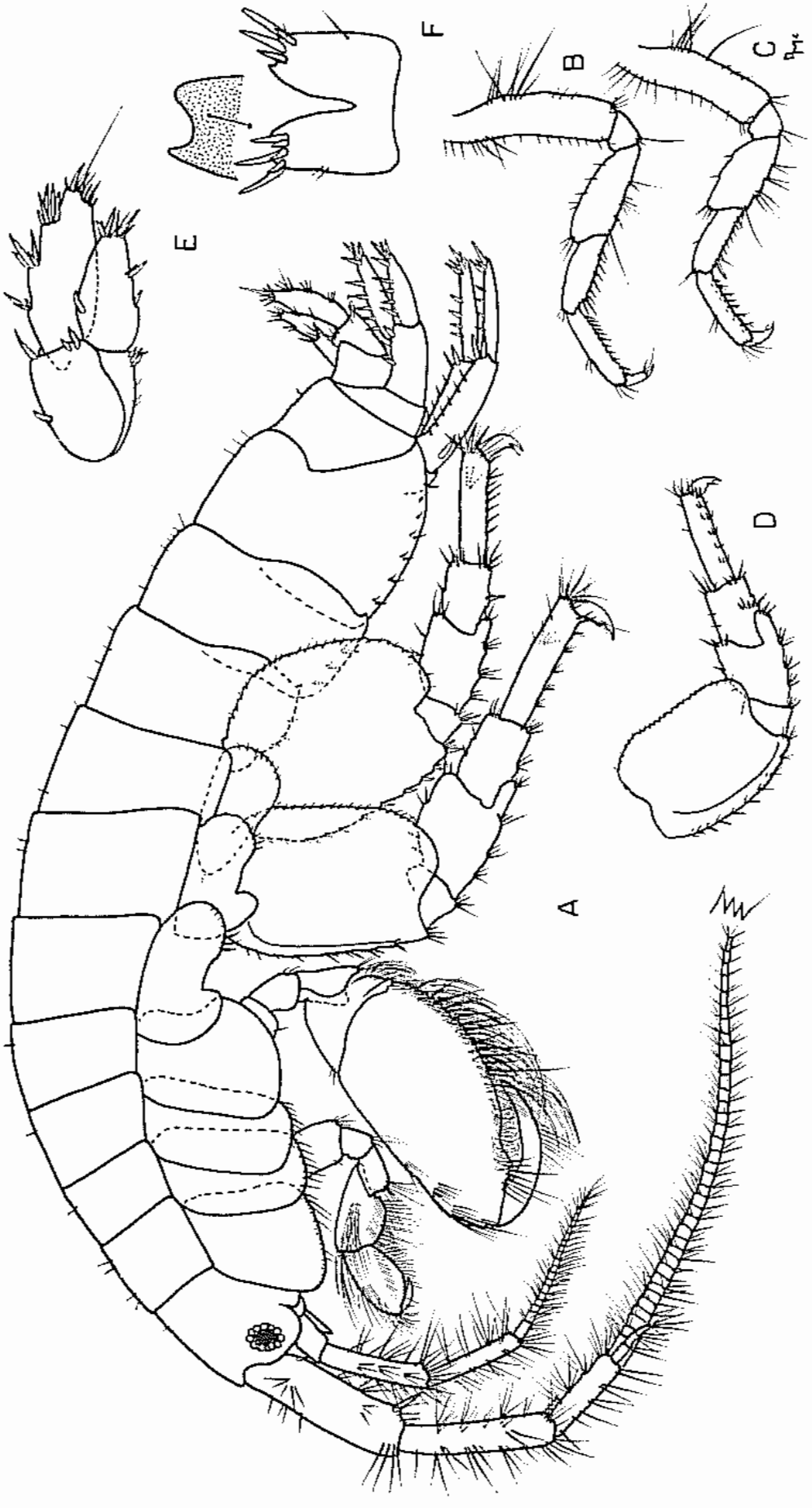

Fig. 12. *Elasmopus antennatus* (Stout). Male, 9.0 mm, sta. 4822: A, lateral view; B,C,D, peraeopods 1, 2, 3; E, uropod 3; F, telson.

of article 6, about half as long as article 6, the medial face of article 6 with a ridge and a slight bilobation; right and left gnathopods alike, peraeopods 3-5 with their second articles normally ovate, article 4 produced into a lobe covering the front of article 5; third pleonal epimeron with a small posterodistal tooth, the hind edge straight; uropod 3 short, the rami obtuse, the inner shorter than the outer; apices of telson deeply notched, spinose.

FEMALE: Second gnathopods very small, thin, the palm quite oblique, scarcely defined, less than half as long as hind margin of article 6, bearing 3-4 spines at defining angle.

MATERIAL: 118 specimens from 7 subtidal stations and 38 specimens

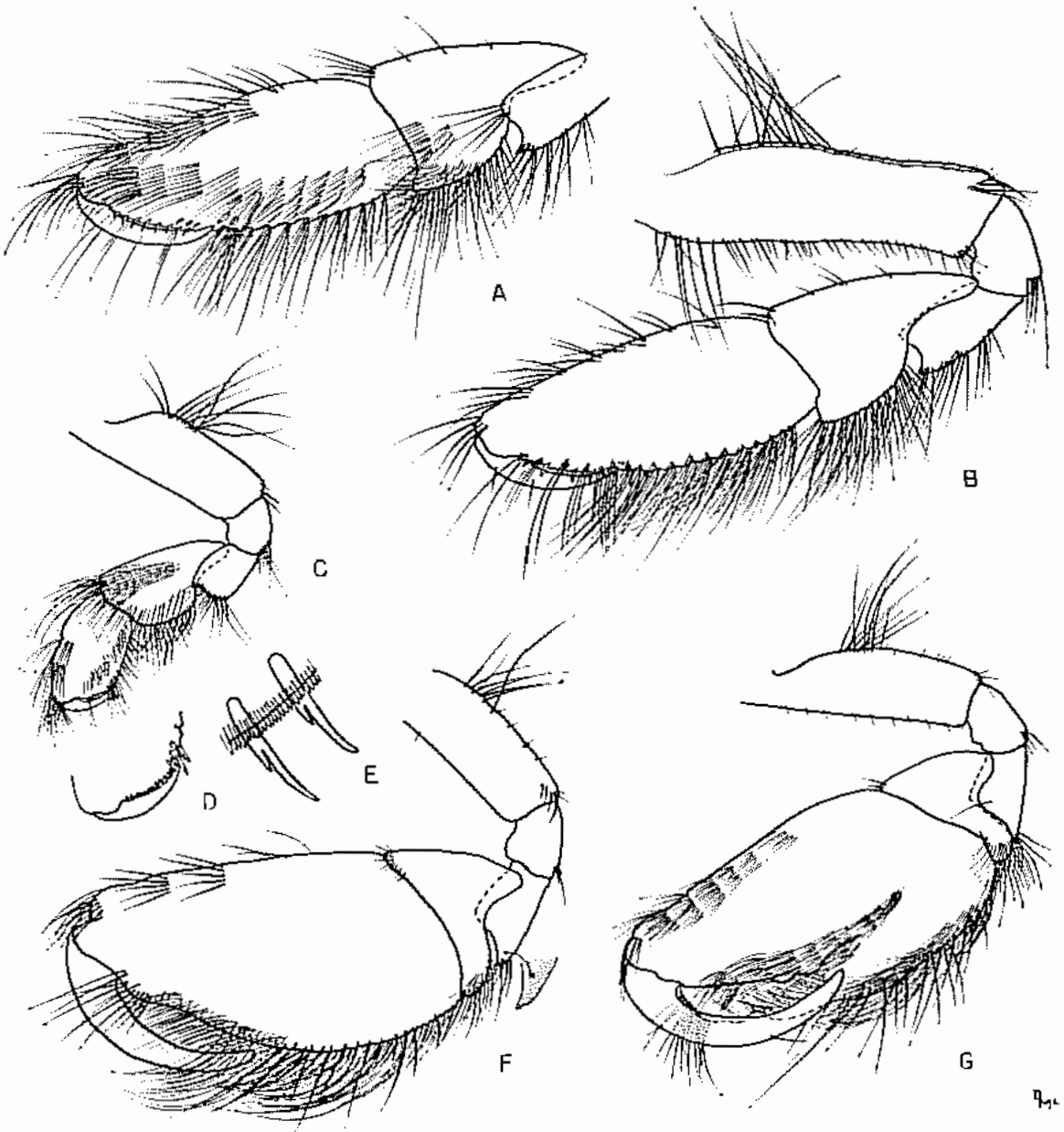

Fig. 13. *Elasmopus antennatus* (Stout). Female, 9.0 mm, Sta. 4822: A,B, gnathopods 1, 2. Male, 9.0 mm: C,D, gnathopod 1; E, ornamentation of palm on gnathopod 1; F,G, same magnification of lateral view of left gnathopod 2, and medial view of right gnathopod 2.

from two intertidal stations, one at Whites Pt., Los Angeles County, in algae, Oct. 12, 1947, the other at Laguna Beach, Orange County, north reefs, Jan. 24, 1948, both coll. by Dr. J. L. Mohr.

ECOLOGY: A shallow water species, frequent in intertidal zones amongst algae and surf-grass and on algal bottoms down to 5 fms. On the shelf the animal is confined to depths of 6-10 fms where its density is 7.5 animals per square meter. Nothing is known of its occurrence on algal bottoms shallower than 5 fms or deeper than 1 fm, but the species is absent on sandy and silty bottoms in those depths.

Elasmopus holgurus, new species

Figs. 14, 15

DIAGNOSIS OF MALE: No body segments dorsally dentate; palm of male gnathopod 2 oblique, heavily setose, bearing a spinose cusp near hinge, an asymmetrically, deflected, conical tooth in the middle and a small tooth defining the palm; second articles of peraeopods 3-5 closely serrate behind, poorly setose, the fourth articles produced into distally projecting forward lobes; third pleonal epimeron with a small tooth; apices of telson broadly truncate and heavily spinose.

FEMALE: See figures of gnathopods, not significantly distinct from other species of *Elasmopus*.

HOLOTYPE: AHF No. 5011, male, 8 mm.

TYPE LOCALITY: Barnard Sta. 16, North Laguna Beach, intertidal, August 31, 1950, formalin wash of sponge, *Leucetta losangelensis*.

MATERIAL: Barnard Stations 6 (63), 16 (9).

RELATIONSHIP: This species is difficult to separate in a key of *Elasmopus* because of its close relationship to *Elasmopus rapax*. *Elasmopus holgurus*, as it exists in southern California, is easily distinguished from *E. rapax* as it exists in southern California, but the differences are not easily described in a few words nor are they qualitatively uniform when adults of *E. holgurus* are compared with young animals of *E. rapax*.

The shape of the middle tooth of the male second gnathopodal palm of *E. holgurus*, when compared with that of *E. rapax*, is the most distinctive criterion immediately seen because the middle tooth of *E. holgurus* is quite broad, asymmetrically conical and appears to be a massive deflection of the palm. The species has only 3 palmar teeth, one armed with spines at the hinge, a middle conical tooth and a small defining tooth. *Elasmopus rapax* usually has two hinge teeth, one medial and one lateral, the lateral tooth projecting strongly, the medial tooth armed with spines and ranging from strongly projecting to short and broad; in young *E. rapax* and its cold-water populations only the spinose medial hinge process is developed, so that technically both species have only 3 palmar teeth in some cases that might be compared.

Another criterion of importance locally in southern California, but not necessarily useful elsewhere, is the strongly setose condition of the

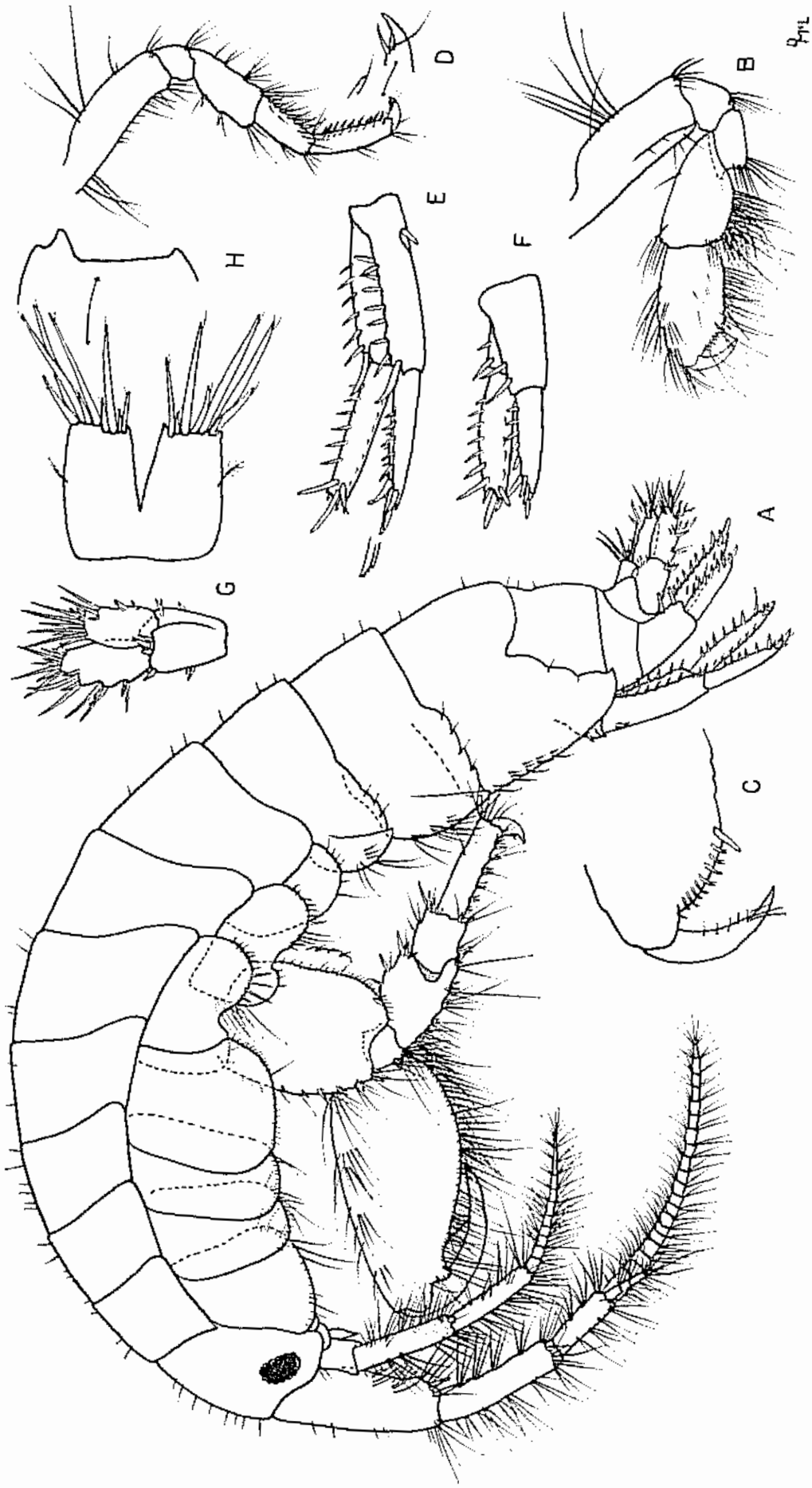

Fig. 14. *Elasmopus holgurus*, n. sp. Holotype, male, 8.0 mm, Barnard sta. 16: A, lateral view; B,C, gnathopod 1; D, peraeopod 2; E,F,G, uropods 1, 2, 3; H, telson.

posterior edges of article 2 on peraeopods 3-5 of *E. rapax*, a character typical only of large tropical and subtropical adults, but distinct from *E. holgurus* adults which are poorly setose on these appendages. A third character is the truncate apices of the telson in *E. holgurus* compared with the variable telson of *E. rapax*, which is usually apically convex in

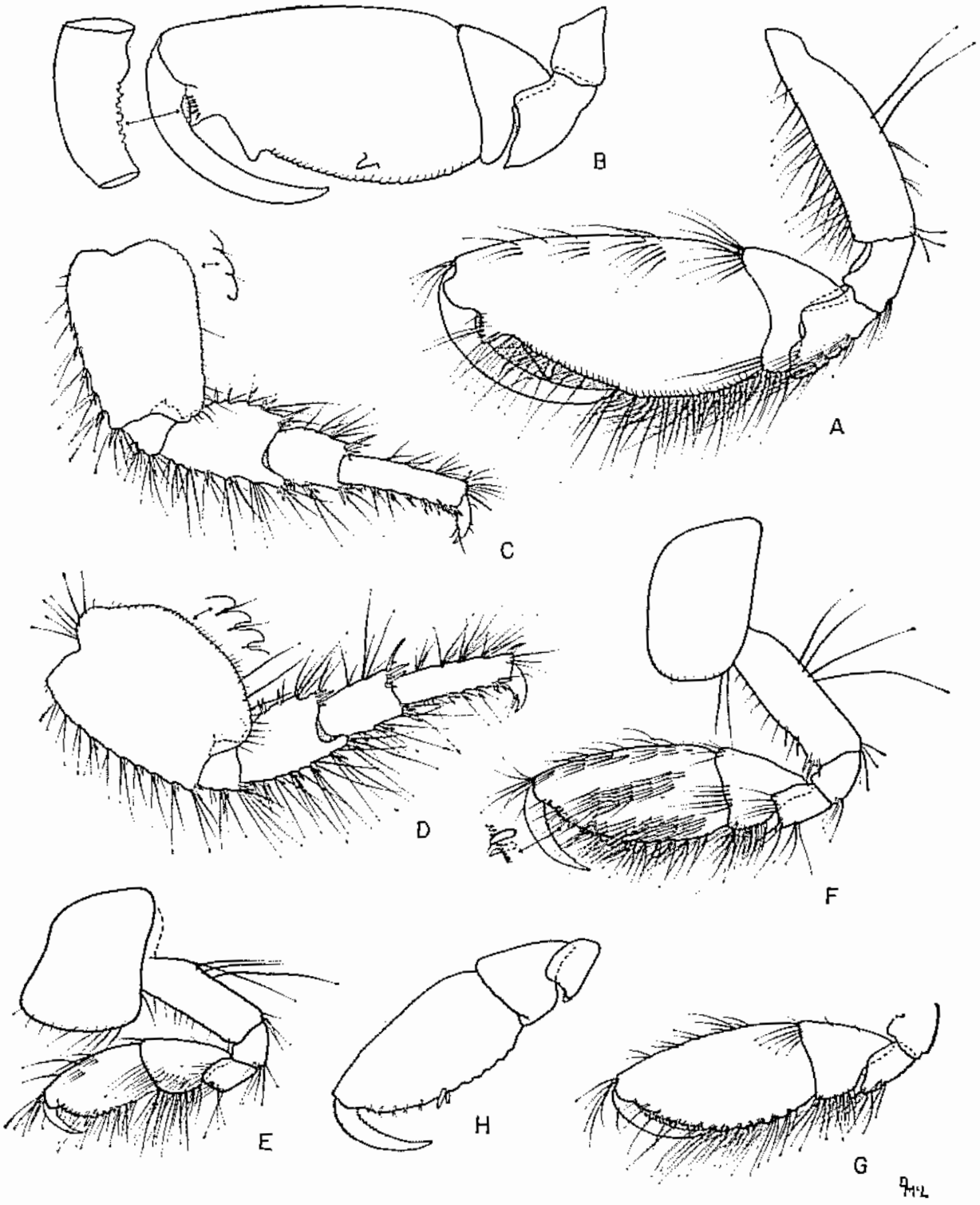

Fig. 15. *Elasmopus holgurus*, n. sp. Holotype, male, 8.0 mm, Barnard sta. 16: A,B, gnathopod 2; C,D, peraeopods 4, 5. Female, 5.5 mm: E, gnathopod 1; F,G,H, gnathopod 2.

small specimens, grading into a lateral displacement of the spines and an apical notch in large adults (see figures for *E. rapax* herein). Locally this is useful but elsewhere it may not be of value since *E. rapax* is so variable, and so widely distributed.

In southern California, *E. rapax* and *E. holgurus* are separated ecologically, *E. rapax* being confined to enclosed bays and *E. holgurus* having been found only on the wave-dashed open coast. An open-sea subspecies of *E. rapax* is described below.

ECOLOGY: An intertidal species on sponge and in beds of the reef-building polychaete, *Phragmatopoma* sp.

Elasmopus rapax Costa
Figs. 16, 17

J. L. Barnard 1955: 10-12, fig. 5 (with references).

REMARKS: In southern California this species apparently is restricted to enclosed bays such as Newport (see J. L. Barnard 1959), Alamitos Bay and San Diego Bay. It has not been found in the open-sea shelf survey below depths of 30 feet, nor has it been found in 35 samples of intertidal materials from localities in southern California such as Pt. Fermin, Corona del Mar and La Jolla. It has been found in Bahía de Los Angeles (Gulf of California) in intertidal materials of that large semi-enclosed bay and presumably will be found along the open coasts of the Panamic province where waters are much warmer than along the coast of southern California. Thus, it probably is restricted in southern California to warm, enclosed bays.

Still more figures of this species are required for it occurs in many forms, most of which appear to represent stages in its life history. The male specimens from Bahía de Los Angeles are figured here to show the bifid and trifid gnathopodal processes of these large adults (11-13 mm). The lateral process of the palm, instead of being a simple conical process, is either bifid or trifid; young males of 6-9 mm show the simple condition and males smaller than 6 mm lack the lateral process as is the case for Norwegian specimens figured by Sars (1895). This is another instance of warm water populations of a species developed to the full morphological condition, with temperate populations retaining juvenile conditions in adulthood.

Specimens in bays from southern California have the third pleonal epimeron produced into a small posterior tooth with serrations on the posterior edge, as figured herein from Alamitos Bay.

The telson of this species is quite variable, ranging from (1) the condition seen in Hawaiian specimens (J. L. Barnard 1955) of broadly excavate apices with both limbs of the excavation projecting equally (and varying from strongly to weakly projecting as in Norwegian specimens), to (2) specimens figured here from Alamitos Bay having the medial limb thickened and the lateral limb shortened so that the apices appear beveled, to (3) the large specimens of the Gulf of California having the notches

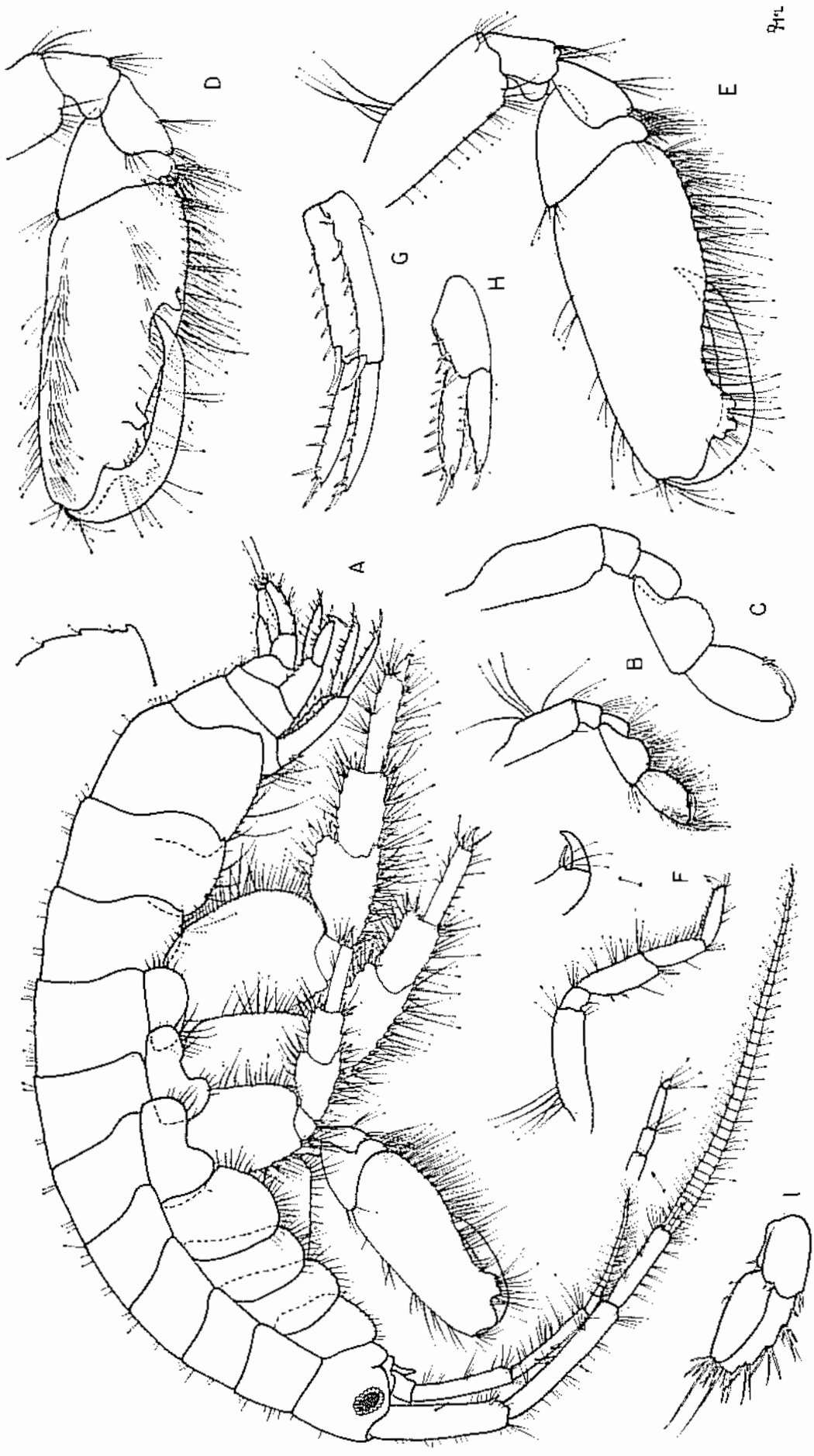

Fig. 16. *Elasmopus rapax* Costa. Male, 11 mm, Bahia de Los Angeles, Baja California: A, lateral view; B,C, gnathopod 1; D,E, gnathopod 2; F, peraeopod 1; G,H,I, uropods 1, 2, 3.

and spines displaced laterally and proximally, with the medial limb forming a broadly rounded apex that occupies most of the width of the lobe.

NEW MATERIAL: Alamitos Bay, near Long Beach, California, coll. Dr. D. J. Reish, June 10, 1960, 1.5 fms (20); Bahía de Los Angeles, Gulf of California, both in washes of intertidal rocks and in sand under large boulders at mean high water, March 10, 1961, coll. P. T. Beaudette and J. L. Barnard (150).

Elasmopus rapax mutatus, new subspecies

Fig. 18

DIAGNOSIS OF MALE: No body segments dorsally dentate; palm of male gnathopod 2 oblique, poorly setose, bearing a spinose cusp near the hinge, a small middle tooth and a pair of minute projections defining the palm; second articles of peraeopods 3-5 closely serrate behind, poorly setose, the fourth articles produced into distally projecting forward lobes;

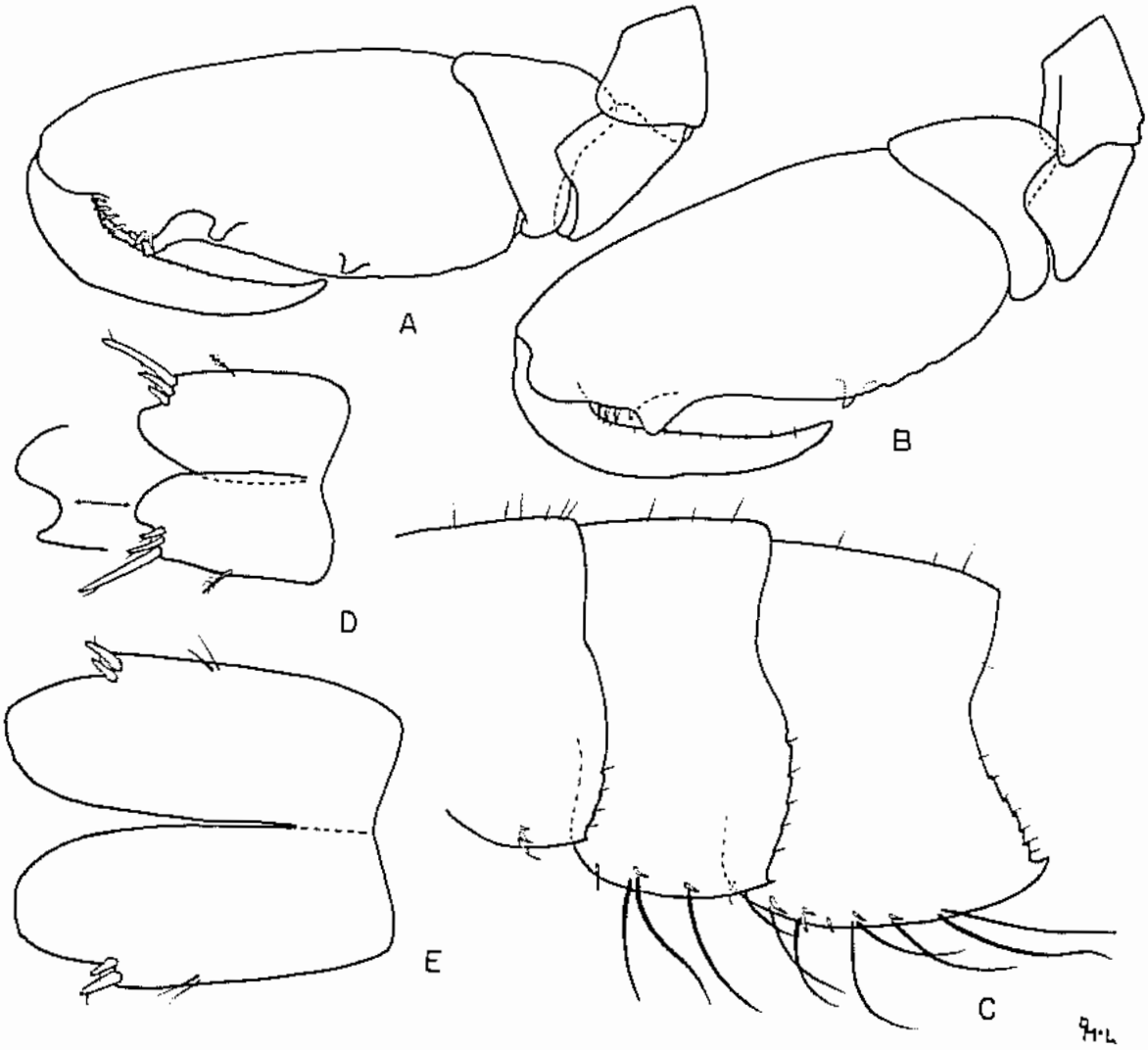

Fig. 17. *Elasmpous rapax* Costa. Male, 9.0 mm, Alamitos Bay, California: A,B, gnathopod 2; C, pleonal segments 1-3; D,E, telsons of males, 8 and 11 mm.

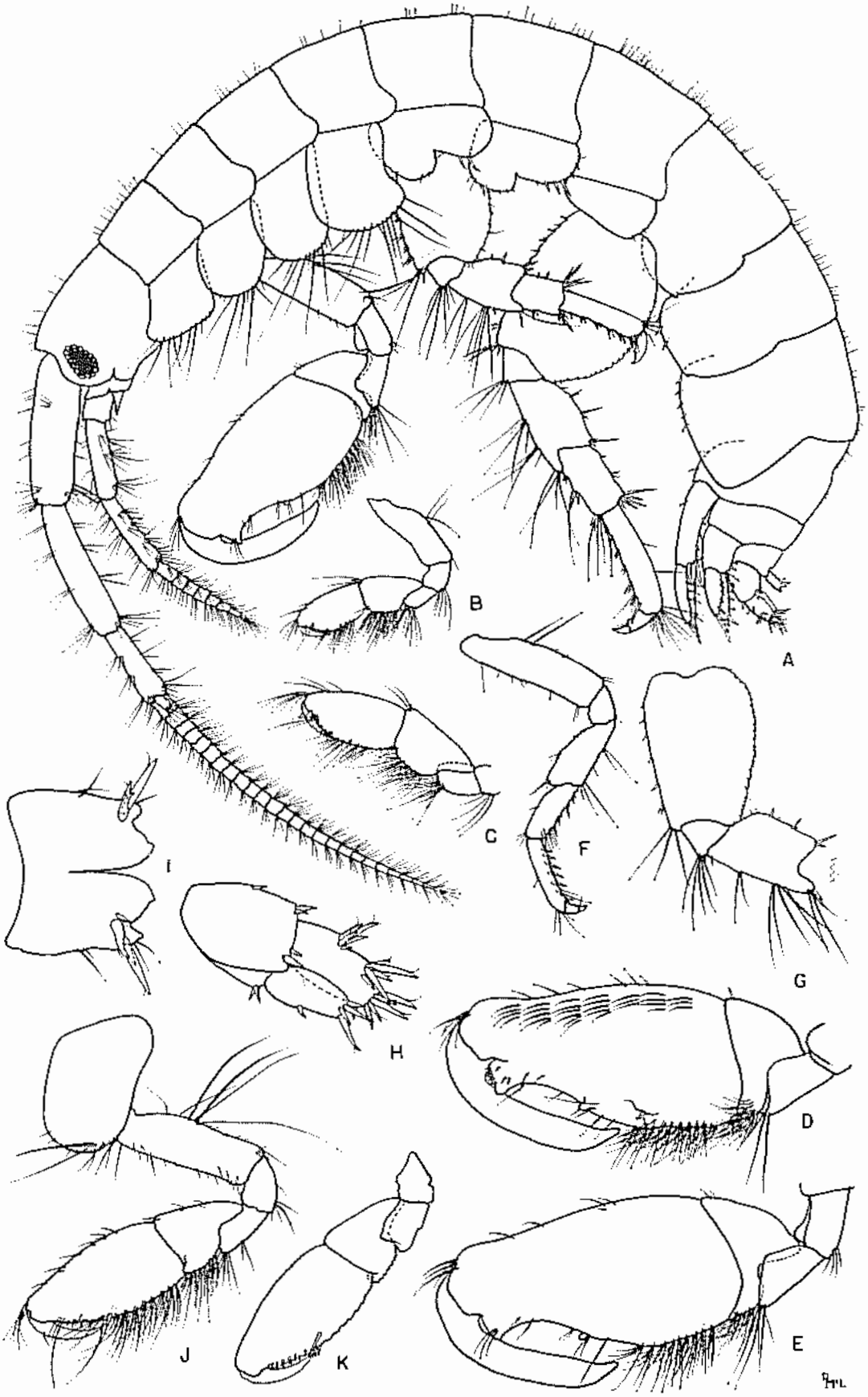

Fig. 18. *Elasmopus rapax mutatus*, n. subsp. Male, holotype, 7.5 mm, Barnard sta. 18: A, lateral view; B,C, gnathopod 1; D,E, gnathopod 2; F,G, peraeopods 2, 4; H, uropod 3; I, telson. Female, 8.0 mm: J,K, gnathopod 2.

third pleonal epimeron quadrate behind, with a very slight notch at lower corner; apices of telson slightly notched and weakly spinose.

FEMALE: see figures of gnathopods.

HOLOTYPE: AHF No. 5012, male, 7.5 mm.

TYPE LOCALITY: Barnard sta. 18, Flat Rock Pt., Palos Verdes Headland (south of Redondo Beach), August 17, 1950, wash of intertidal algae.

MATERIAL: Barnard Stas. 17 (7) and 18 (89).

RELATIONSHIP: This subspecies is difficult to define because of the variability of *E. rapax* throughout its cosmopolitan distribution. It is possible to recognize *E. r. mutatus* as distinct only within southern California. Possibly, *E. r. mutatus* is an ecological variety of *E. rapax*, for the animal is morphologically recognizable and separated ecologically in southern California from populations of *E. r. rapax* which live only in bays and harbors. The new subspecies inhabits the wave-dashed open sea intertidal. Notice the same comments for *E. holgurus*, new species.

Adults of *Elasmopus rapax mutatus* differ from *E. r. rapax* as follows: by the lack of long setae on the hind edges of the second articles on peraeopods 3-5; by the presence of only a single palmar hinge process (whereas in *E. rapax* two are present, only the inner one bearing stout spines, as if it were detached from the single juvenile process to form a medial process during maturity); by the smaller and more proximally located medial tooth and the poorly represented pair of cusps defining the palm, where in *E. rapax* a single large one is present; by the poorly setose palm of gnathopod 2; by the much stouter flagellum of antenna 2; by the rather shortened inner ramus of uropod 3; by the uniarticulate, not biarticulate, accessory flagellum.

Adults of this subspecies are measurably distinct from *E. rapax*, but it is unlikely that separation can be made in juvenile conditions since *E. r. mutatus* carries into the adult features of young *E. r. rapax* such as poor setosity of the limbs. This subspecies, usually 7 mm or less in length, does not reach the 10 mm size of adult *E. r. rapax* in neighboring enclosed bays. It is noticed that some 7.5 mm females in the bays lack the setosity of the peraeopods, but all bay specimens have the slender second antennal flagella and the two hinge processes on the adult male palm of the second gnathopod.

One male of Barnard sta. 17 has a biarticulate accessory flagellum, but all the other specimens from the open coast show a uniarticulate flagellum.

DISTRIBUTION: The type locality and La Jolla, intertidal algal wash, Nov. 1, 1949.

Genus Maera Leach

KEY TO MALE MAERA

Couplet 10 separates a species known only for females.

1. Some segments dorsally dentate 2
1. No segments dorsally dentate 5

2. First pleonal segment dentate ..... *westwoodi*
2. First pleonal segment not dentate, only the fourth dentate 3

3. Articles 4-5 of peraeopod 5 inflated, wider than article 2, but not in juveniles; palm of gnathopod 2 indistinct from hind margin of article 6 and strongly toothed ..... *insignis*
3. These characters not combined 4

4. Palm of gnathopod 2 not defined from hind margin and not heavily setose ..... *latibrachium* (= *odontoplax*)
4. Palm of gnathopod 2 usually defined from hind margin; if not, then the palm heavily setose .... *subcarinatus* (= *sokotrae*)

5. Posterior edge of third pleonal epimeron serrate 6
5. Posterior edge of third pleonal epimeron not serrate 15

6. Lower edge of third pleonal epimeron serrate 7
6. Lower edge of third pleonal epimeron not serrate 8

7. Palm straight, not sculptured ..... *othonis*
7. Palm of gnathopod 2 concave and with notch near finger hinge ..... sp. (*othonides* of Chilton 1921)

8. Uropod 3 extending much beyond uropods 1-2 9
8. Uropod 3 not extending much beyond uropods 1-2 13

9. Palm of gnathopod 2 not distinct from hind margin of article 6 10
9. Palm of gnathopod 2 distinct from hind margin of article 6 11

10. Male, palm of gnathopod 2 lined with large spines ..... sp. (*othonides* of K. H. Barnard 1937)
10. Male, palm of gnathopod 2 not lined with large spines ..... *eugeniae*
10. Female, palm of gnathopod 2 not lined with large spines ..... (female) *othonopsis*

11. Apices of telson truncate, the telson short ..... (male) *othonopsis*
11. Apices of telson notched 12

12. Article 7 of gnathopod 2 stout, the base strongly curved ..... *hamigera*
12. Article 7 of gnathopod 2 slender, not strongly curved ..... *micronyx*, *othonides* and *mastersi*

13. Palm of gnathopod 2 oblique ..... *bruzelii*
13. Palm of gnathopod 2 transverse 14

14. Palm of gnathopod 2 with 2 sinuses ..... *inaequipes serrata*
14. Palm of gnathopod 2 with one sinus ..... *rathbunae*

15. Palm of gnathopod 2 transverse 16
15. Palm of gnathopod 2 oblique 19

16. Palm of gnathopod 2 with 3 principal sinuses .... *quadrimana*
16. Palm of gnathopod 2 with 2 principal sinuses 17
16. Palm of gnathopod 2 with one principal sinus 18

17. Apices of telson notched ..... *inaequipes*
17. Apices of telson truncate ..... *schellenbergi*
18. Peraeopods with accessory claw ..... *pacifica*
18. Peraeopods lacking accessory claw ..... *rathbunae*
19. Some distal articles of peraeopods 3-5 greatly broadened 20
19. Distal articles of peraeopods 3-5 not broadened 21
20. Articles 4-5 of peraeopods 3-5 greatly broadened .... *carnleyi*
20. Only article 4 of peraeopod 3 greatly broadened ..... *ascensionis*
21. Uropod 3 extending much beyond uropods 1-2 22
21. Uropod 3 not extending much beyond uropods 1-2 30
22. Palm of gnathopod 2 not distinct from hind margin of article 6 23
22. Palm of gnathopod 2 distinct from hind margin of article 6 24
23. Article 7 of gnathopod 2 longer than article 6 ..... *knudseni*
23. Article 7 of gnathopod 2 half as long as article 6 ..... *simplex*
24. Palm of gnathopod 2 with a large notch near finger hinge 25
24. Palm of gnathopod 2 crenulate but with no distinct notch 26
25. Rami of uropod 3 huge, almost 4 times as long as peduncle ..... *pfefferi*
25. Rami of uropod 3 intermediate, less than twice as long as peduncle ..... *hirondellei*
26. Defining tooth of palm with articulated spine; second articles of peraeopods 3-5 slender 27
26. Defining tooth of palm lacking articulated spine; second articles of peraeopods 3-5 stouter than in *M. loveni* 29
27. Article 6 of gnathopod 2 with edges diverging, the palm longer than hind margin ..... *tinkerensis*
27. Article 6 of gnathopod 2 with parallel edges, the palm shorter than hind margin 28
28. Eyes absent; gnathopod 2 slender ..... *loveni*
28. Eyes present; gnathopod 2 stout ..... sp. (*inaequipes* of Chilton 1916)
29. Gnathopod 2 with article 6 nearly square; gnathopod 1 large ..... *prionochira*
29. Gnathopod 2 with article 6 rectangular; gnathopod 1 small ..... *danae*
30. Palm of gnathopod 2 concave ..... *boecki*
30. Palm of gnathopod 2 straight or convex 31
31. Coxa 1 serrate below 32
31. Coxa 1 not serrate below 33

32. Coxa 2 serrate below ..... *schmidti*
32. Coxa 2 not serrate below ..... *vagans* (= *levis*)
33. Palm of gnathopod 2 strongly toothed 34
33. Palm of gnathopod 2 scarcely toothed 35
34. Palmar teeth of gnathopod 2 slender, long ..... sp. (*boeckii* of K. H. Barnard 1916)
34. Palmar teeth of gnathopod 2 blunt ..... *simile*
35. Gnathopod 2, sixth article twice as long as broad ..... *grossimana*
35. Gnathopod 2, sixth article 1.5 times as long as broad 36
36. Eyes absent; basal articles of peraeopods 3-5 very slender ..... *tenera*
36. Eyes present; basal articles of peraeopods 3-5 very stout ..... *smirnovi*

NOTES ON THE KEY:

The writer places little reliance on the shapes of the first coxae, telsons and third pleonal epimera as taxonomic characters. There is evidence that considerable variation is present in these criteria. Wherever they have been used to separate species, a weakness in specific differentiations is indicated.

Maera furcicornis (Dana) and *Maera tenella* (Dana) may be females and are not recognizable as discrete entities.

Maera simile (Stout) as redescribed by J. L. Barnard (1959) is remarkably similar to *M. hirondellei* Chevreux (Chevreux and Fage 1925) but differs from the latter by the third uropods not extending farther than the first 2 pairs and in having shorter rami.

Maera hamigera as originally described by Haswell (1879a) is distinctive in the stout finger of gnathopod 2 by contrast to the slender finger of *M. mastersii* as described by Haswell (1879), and this use is followed by Walker (1909) (*M. hamigera*), Sheard (1936) (*M. mastersi*), and Chilton (1916) (*M. mastersi*) (although Sheard's and Chilton's concepts are not quite the same); but K. H. Barnard's (1916) portrayal of *M. hamigera* combines characters of both *M. mastersi* and *M. hamigera* and may have to be reevaluated as a potentially distinct species. The problems are complicated by changes in characters with growth and age.

Maera rathbunae Pearse (1908) is entered twice in the key because the third pleonal epimeron is only indistinctly serrate. Pearse and Kunkel (1910) disagree on whether the first coxa is acutely pointed or rounded in front. Such disagreement is common among students of this genus.

Maera viridis (Haswell, 1879 and see Chilton, 1916) should be transferred to *M. inaequipes*.

Maera prionochira Brüggen (see Stephensen 1940) is quite aberrant. Its first gnathopod is like the second gnathopod of *M. danae* or *M. loveni*, and its second gnathopod has articles 5-6 stout and shortened. Possibly it is a mutant of either *M. loveni* or *M. danae*.

Elasmopus sokotrae Walker and Scott (1903) belongs to *Maera* because of its mandibular palp; it fits one form of *E. subcarinatus* as redescribed by Chilton (1915), and the writer believes it should be made a junior synonym of that species originally described in 1879.

Maera mastersi, as refigured by Sheard (1936), has somewhat thinner second gnathopods than figured originally by Haswell (1879). Nevertheless, Sheard's redescription comes from material close to the type area. His description and that of Pirlot (1936) for *Maera othonides* Walker (1904) appear identical so that one must consider *M. othonides* a possible synonym of *M. mastersi*.

Maera othonopsis is entered twice in the key. It is based on a female and is cited first as such. Secondly, its theoretical male may be separated from males of other species by the telson and so is entered the second time.

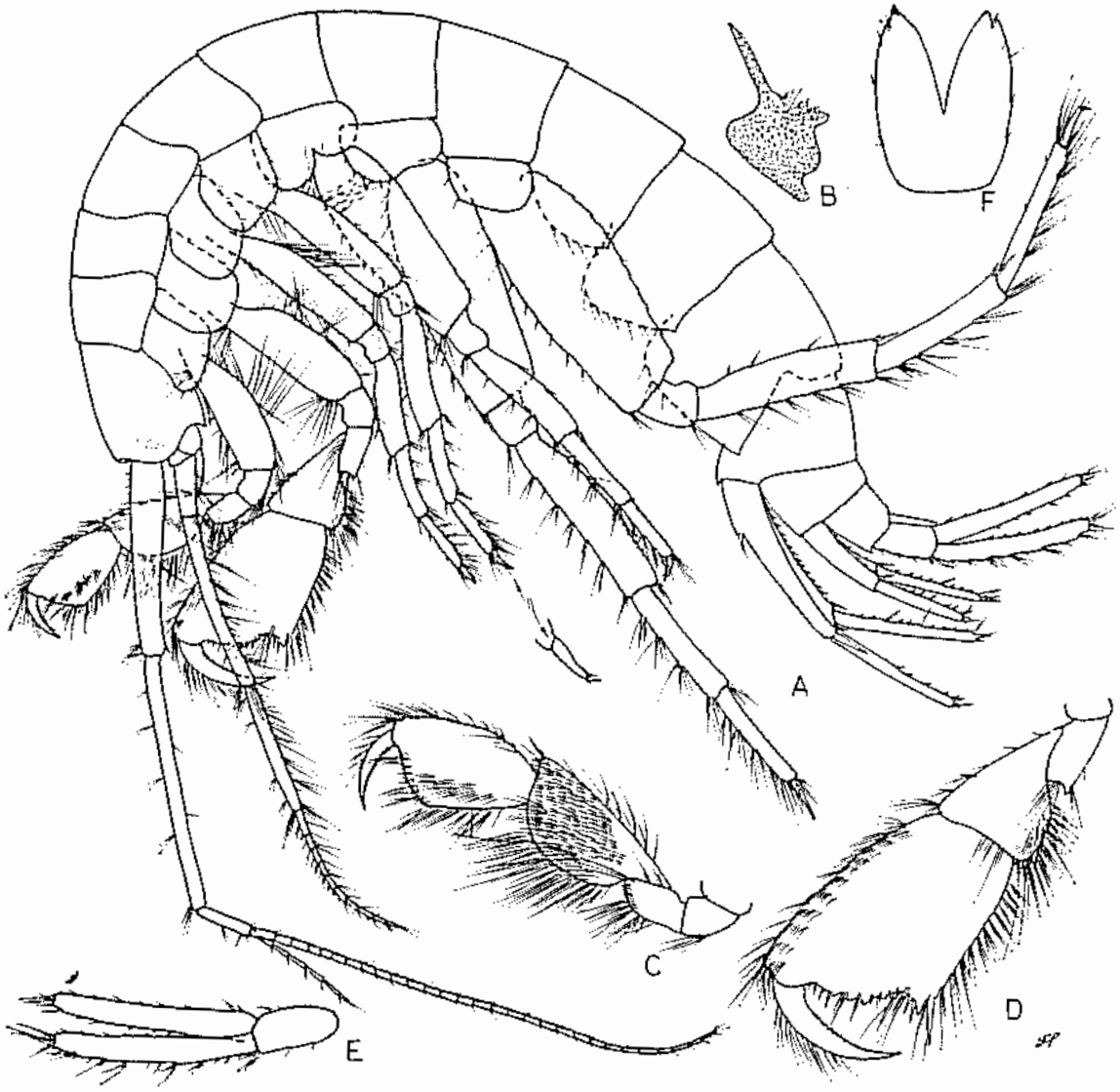

Fig. 19. *Maera loveni* (Bruzelius). Male, 15 mm, sta. 4851: A, lateral view; B, epistome and upper lip, lateral; C,D, gnathopods 1, 2; E, uropod 3; F, telson.

Maera loveni (Bruzelius)
Fig. 19

Sars 1895: 519-520, pl. 182, fig. 2; Stebbing 1906: 438; Shoemaker 1930: 116; Stephensen 1940: 311; Gurjanova 1951: 757-758, fig. 526.

MATERIAL: Station 4851 (32).

RECORD: Mugu Submarine Canyon, 34-03-30 N, 119-05-55 W, 105 fms, February 7, 1957, bottom of fine green sand.

REMARKS: Most of the specimens at hand have asymmetrical telsonic apices, one being notched, the other entire, as figured.

DISTRIBUTION: Subarctic and cold temperate of the northern Atlantic Ocean, Okhotsk Sea, California, 11-219 fms.

Genus **Megaluropus** Hoek

This genus is perplexing, for it can be assigned not only to the Gammaridae but to the Argissidae, as well. The family Argissidae is monogeneric now that the genus *Phylluropus* K. H. Barnard has been shown to belong to *Megaluropus* and the genus *Parargissa* has been transferred to the Hyperiopsidae. The fact that K. H. Barnard (1932) described *Phylluropus* (= *Megaluropus*) in the Argissidae indicates his first belief that the animals represented in *Megaluropus* belong to the Argissidae. The critical feature is the shortened third coxa, characteristic of *Argissa* and *Megaluropus*. Otherwise the resemblance between the two genera is negligible, except for the gnathopods. Actually, *Argissa* gives the impression of belonging to the family Haustoriidae, especially in the shape of its head and last three pairs of peraeopods, whereas *Megaluropus* is distinctly related to members of the Gammaridae. In *Argissa* the first three coxae decrease in size progressively, whereas in *Megaluropus* the second coxa is the largest, followed by a smaller third and still smaller first. The writer sees no reason to place *Megaluropus* in the Argissidae and suggests that systematists consider the close relationship of *Argissa* to members of the Haustoriidae.

Megaluropus longimerus Schellenberg 1925: 151-153, fig. 14.
Figs. 20, 21

DIAGNOSIS: Gnathopod 2 of female with fourth article produced behind into a lobe extending along the hind edge of article 5; upper lip with small but sharp ventral incision; dorsal posterior edges of pleonal segments 3, 4, and 5 serrate; posterior edge of third pleonal epimeron irregularly serrate and castellate.

REMARKS: Schellenberg figured only two appendages, but his description is lengthy and there are no features on the present specimens which do not agree with his remarks.

MATERIAL EXAMINED: 190 specimens from 64 stations.

ECOLOGY: This species is limited to depths shallower than 16 fms, having a frequency of 6.6 animals per square meter in the depths of 6 to 15 fms.

DISTRIBUTION: Lagos, Nigeria; southern California.

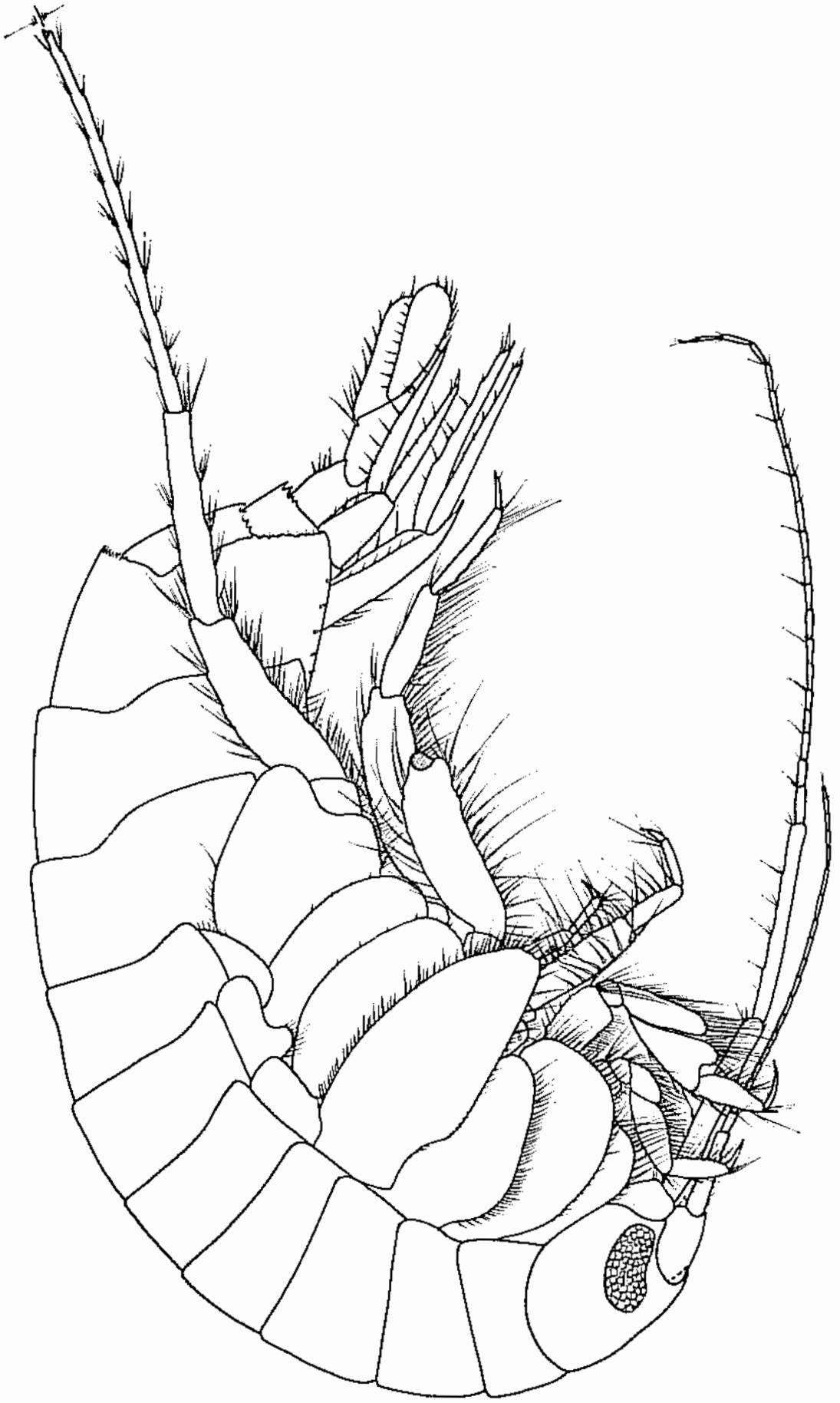

Fig. 20. *Megaluropus longimerus* Schellenberg. Female, 5.0 mm, sta. 4777: lateral view.

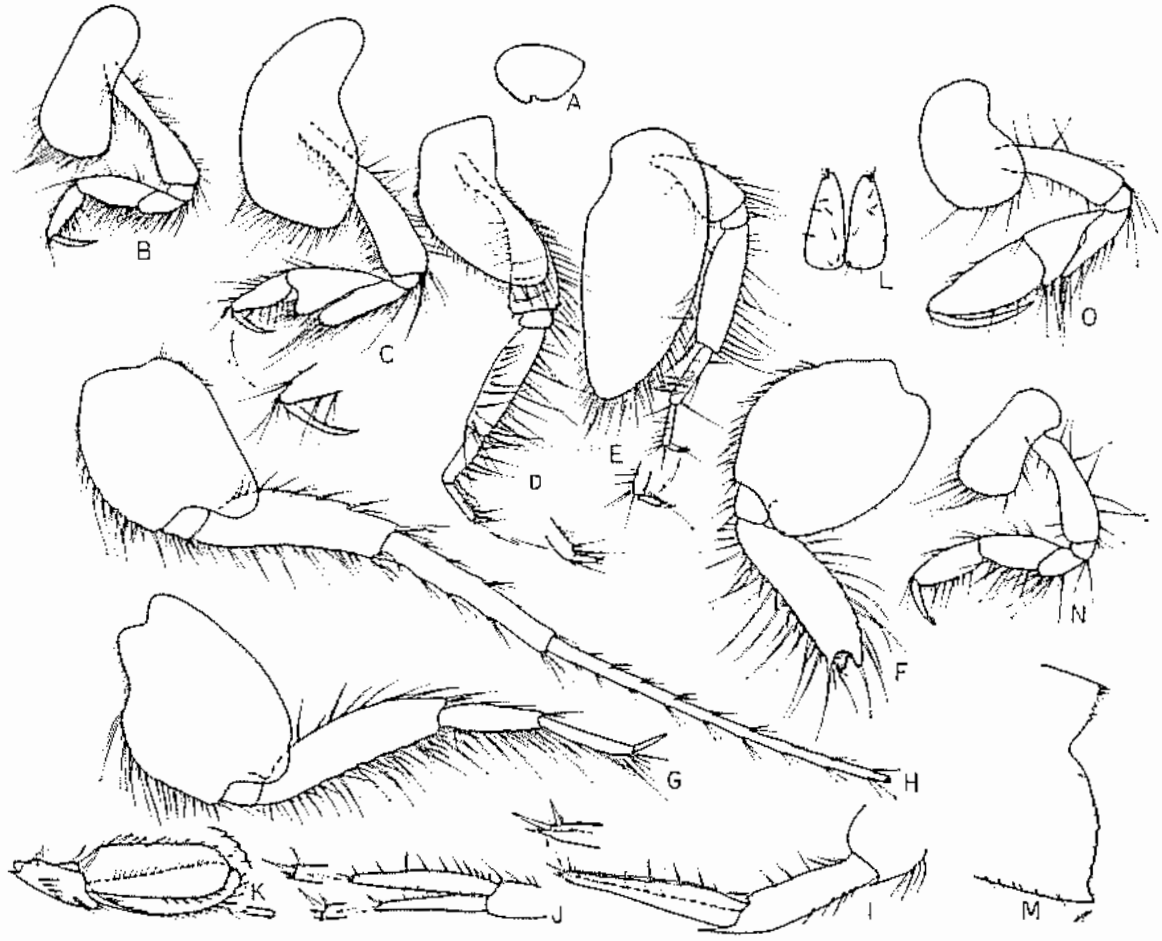

Fig. 21. *Megaluropus longimerus* Schellenberg. Female, 5.0 mm, sta. 4777: A, upper lip; B,C, gnathopods 1, 2; D,E,F,G,H, peraeopods 1, 2, 3, 4, 5; I,J,K, uropods 1, 2, 3; L, telson; M, third pleonal epimeron. Male, 4.0 mm, sta. 5657, N,O, gnathopods 1, 2.

Genus Melita Leach

The genus *Melita* is diverse and unusually well described for amphipods, except for one recurring problem: taxonomists have failed in a number of cases to examine minutely, or describe and figure clearly the dorsal tooth and spine ornamentation of the pleon. This is particularly critical in some species distinguished only on the basis of the minute ornamentation of pleonal segment 5. For instance, it is difficult for the writer to interpret the configuration of *M. somovae* Bulycheva (1952) as to whether actual chitin teeth are present on segment 5 or whether the processes are articulated spines; comparing figures and description it seems that the description labels segment 4 as 5, and segment 5 as 6. Since a reader does not know whether the terms "spines" and "denticles" refer to fixed teeth or articulated spines, taxonomists should settle on uniform terms. The writer suggests the term "teeth" for fixed processes and "spines" for articulated processes.

In the key following this discussion, reference to teeth on the pleon indicates dorsal teeth, while separate mention is made of pleonal epimeral

teeth. In some places the writer lists two species together in a single couplet member, indicating his inability to separate them by more than minor, possibly sexual and growth differences. The term "metasome" refers to pleon segments 1-3, the term "urosome" to pleon segments 4-6.

The two names *Melita gayi* (Nicolet) and *M. inaequistylis* (Dana) have been used frequently since Stebbing's (1906) Gammaridea monograph, but the confusion has never been clarified to the satisfaction of amphipod taxonomists.

The post-1906 history is as follows: *M. inaequistylis*, Chilton (1909): this author particularly fixed upon Walker's (1904) description and figures under the name of *Maera tenuicornis* (Dana) as representing the common animal in New Zealand. Walker's figures show that pleon segment 4 has two dorsal teeth and pleon segment 5 has one dorsal tooth. New Zealand is the type locality of both *M. inaequistylis* and *M. tenuicornis* of Dana, so that Chilton's conception of the species is the most important since the original description and probably should be accepted and fixed as such. Young specimens vary in the pleonal teeth, ranging from none on the fourth and fifth, to none on the fourth, to the normal formula. Chilton included *M. zeylanica* Stebbing as a synonym, but the writer doubts that this is correct in view of K. H. Barnard's (1940) further analysis and the fact that Stebbing was too proficient an observer to have overlooked the pleonal teeth. *M. inaequistylis*, Chilton (1911) is probably incorrectly identified, for pleon segment 5 is described as 2-3 toothed.

M. inaequistylis, K. H. Barnard (1916) was a mixed identification; see later statements under K. H. Barnard (1940).

M. gayi, Schellenberg (1931): this author used *M. gayi* is a senior synonym for *M. inaequistylis*, extending its distribution to the South American quartosphere; he discussed 3 distinguishing features in comparison to *M. palmata*, but none is the pleonal tooth armature, so it is doubtful that the identification represents the same animal possessed by Walker (1904).

M. zeylanica, and *M. orgasmos* K. H. Barnard (1940): this author split his identification of South African specimens formerly identified by him (1916) as *M. inaequistylis* into two species: *M. zeylanica* Stebbing and "*M. orgasmos.*" He included *M. tenuicornis* questionably under *M. zeylanica*, but stated that pleonal segments 4 and 5 lack teeth, which is not the case with Walker's *M. tenuicornis*.

CONCLUSIONS: The writer believes that a temporary nomenclatural solution to these problems, based on his appraisal of the literature is as follows: Chilton's concept of *M. inaequistylis* should be accepted, since he worked in the area of the type locality and indicated the species he had in hand was widely distributed in New Zealand and therefore likely to be the one which Dana originally described; part of Chilton's concept of the species was based on his acceptance of Walker's (1904) identification of *M. tenuicornis*, so that Walker can be used as a basis for the species; *M.*

zeylanica is a valid species but is not to include Walker's *M. tenuicornis*; K. H. Barnard has not found in South Africa anything like Chilton's and Walker's concept of *M. inaequistylis*, thus restricting that species to the Indo-Pacific; it is possible that the South American material listed as *M. gayi* by Schellenberg is the same species as *M. orgasmos* of South Africa, and it would be well for reviewers to consider this approach.

Until this question can be settled the writer suggests that *M. gayi* be returned to the list of species inquirendae and that *M. inaequistylis* stand as a valid name.

Table 2

Pleonal tooth formulas of species in genus *Melita*. Numbers refer to dorsal teeth on the posterior dorsal edge of numbered segment. (+) = large tooth.

Species	1	2	3	4	5
appendiculata (= *fresneli*)	7	7	7	5	2
subchelata	7	7	7	5	2
dentata (minimum)	5	5	7	5	5
gladiosa (minimum)	3	3	3	3	3
pallida (large only)	2	2	2	2	2
amoena	1	5	0	2	2
aculeata	1	1	1	1	0
richardi	1	1	1	1	5
valida	0	5	5	3	4
rylovae	0	2	2	0	2
lignophila J. L. Barnard (1961a)	0	1	1	1	4
formosa	0	1	1	3	4
obtusata	0	1	0-1	3	2?
somovae	0	1	0	1+	5?
machaera	0	0	1	1	2
grandimana (s = serrations)	0	0	s	3	3
californica	0	0	0	3	4
*inaequistylis**	0	0	0	2	1
solada J. L. Barnard (1961a)	0	0	0	1	4
desdichada, n.sp.	0	0	0	1	4
orgasmos	0	0	0	1	4
quadrispinosa	0	0	0	1	3
festiva	0	0	0	1	2
palmata	0	0	0	1	2
hergensis	0	0	0	1	2
abyssorum	0	0	0	1	2
oregonensis	0	0	0	0	4
nitidula	0	0	0	0	2

Species lacking dorsal pleonal teeth: *coroninii, korcana, lagunae, laevidorsum, mangrovi, nitida, parvimana, pellucida, planaterga, zeylanica.*

Notes:
**inaequistyis* (based on Walker's 1904 identification as *M. tenuicornis*, referred to by Chilton 1909).

KEY TO MARINE MELITA

1. No pleonal segment with dorsal teeth ..... Key A
1. Some pleonal segments with dorsal teeth 2
   2. Dorsal pleonal teeth only on urosome ..... Key B
   2. Dorsal pleonal teeth on both metasome and urosome .... Key C

KEY A

1. Pleonal segment 5 with 2 groups of dorsal spines 2
1. Pleonal segment 5 lacking dorsal spines, occasionally with setae 3
   2. Male gnathopod 1: finger short, stout, not reaching end of palm ..... *koreana*
   2. Male gnathopod 1: finger with distal accessory process ..... *laevidorsum*
   2. Male gnathopod 1: finger attached to lower distal end of article 6 ..... *coroninii*
   2. Male gnathopod 1: finger attached to upper distal end of article 6 ..... *nitida* and *zeylanica*
3. Male gnathopod 1: finger curved, fitting palm, attached normally 4
3. Male gnathopod 1: finger aberrant 5
   4. Article 6 of male gnathopod 1 expanded, as large as gnathopod 2 ..... *parvimana*
   4. Article 6 of male gnathopod 1 small, linear ..... *pellucida* and *planaterga*
5. Male gnathopod 1: finger articulated, stout, conical ..... *lagunae*
5. Male gnathopod 1: finger indistinctly articulated, blunt .... *mangrovi*

KEY B

1. Pleonal segment 4 lacking dorsal teeth 2
1. Pleonal segment 4 bearing one or more dorsal teeth 3
   2. Pleonal segment 5 bearing 4 teeth ..... *oregonensis*
   2. Pleonal segment 5 bearing 2 teeth ..... *nitidula* (& *M. gayi* of Stephensen 1949)
3. Pleonal segment 4 bearing 3 teeth 4
3. Pleonal segment 4 bearing 2 teeth .... *inaequistylis*, [based on Walker's (1904) figs of *M. tenuicornis*]
3. Pleonal segment 4 bearing 1 tooth 5
   4. Male gnathopod 2: finger stout, inflated, palm bearing a toothed distal process ..... *grandimana*
   4. Male gnathopod 2: finger slender, palm simple ..... *californica*
5. Pleonal segment 5 with 2 teeth 6
5. Pleonal segment 5 with 3 or 4 teeth 9
   6. Male gnathopod 2: article 6 linear, slender, article 7 malformed, obtuse ..... *festiva*
   6. Male gnathopod 2: article 6 stout, article 7 slender, acute 7

7. Finger of male gnathopod 1 normal, slender, linear; male gnathopod 2 with large defining palmar tooth ..... *abyssorum*
7. Finger of male gnathopod 1 malformed, short, blunt; male gnathopod 2 lacking tooth on palm 8
8. Head lobes notched, telsonic apices spinose ..... *palmata*
8. Head lobes unnotched, telsonic apices bare ..... *hergensis*
9. Pleonal segment 5 with 3 dorsal teeth ..... *quadrispinosa*
9. Pleonal segment 5 with 4 dorsal teeth 10
10. Eyes obsolete ..... *solada**
10. Eyes present, dark 11
11. Palm of male gnathopod 1 oblique ..... *desdichada*, n. sp.
11. Palm of male gnathopod 1 transverse ..... *orgasmos*

KEY C

1. Pleonal segment 3 lacking teeth 2
1. Pleonal segment 3 bearing one or more teeth 4
2. Pleonal segment 1 bearing a tooth ..... *amoena*
2. Pleonal segment 1 lacking teeth 3
3. Palm of male gnathopod 2 with at least 5 small teeth .... *obtusata*
3. Palm of male gnathopod 2 lacking teeth ..... *somovae*
4. Pleonal segment 1 lacking teeth 5
4. Pleonal segment 1 bearing 1 or more teeth 9
5. Pleonal segment 4 lacking teeth ..... *rylovae*
5. Pleonal segment 4 bearing 1 or more teeth 6
6. Pleonal segment 2 lacking teeth ..... *machaera*
6. Pleonal segment 2 bearing at least one tooth 7
7. Pleonal segments 2 and 3 with one tooth each 8
7. Pleonal segments 2 and 3 with 5 teeth each ..... *valida*
8. Eyes present; pleonal segment 4 with 3 teeth ..... *formosa*
8. Eyes absent; pleonal segment 4 with one tooth .... *lignophila**
9. Pleonal segments 1-4 with one tooth each 10
9. Pleonal segments 1-4 with 3 or more teeth each 11
10. Eyes present ..... *aculeata*
10. Eyes absent ..... *richardi*
11. Finger of male gnathopod 2 inflated, stout, hooked; article 6 quite expanded 12
11. Male gnathopod 2 normal, linear 13
12. Article 2 of peraeopod 5 produced below and behind ..... *subchelata*
12. Article 2 of peraeopod 5 not produced behind ..... *appendiculata* (= *fresneli*)
13. First pleonal epimeron not produced at lower corner 14
13. First pleonal epimeron acutely and strongly produced .... *gladiosa*

14. Eyes present; largest pleonal tooth dorsomedial ..... *dentata*
14. Eyes absent; largest pleonal teeth a dorsolateral pair ..... *pallida*

See J. L. Barnard (1958) for list of species.

Add:

**M. lignophila* J. L. Barnard (1961a)
**M. solada* J. L. Barnard (1961a)

Melita desdichada, new species
Fig. 22

DIAGNOSIS: Pleonal segment 4 with one dorsal tooth; pleonal segment 5 with 4 dorsal teeth, consisting of a pair on each side enclosing a spine; metasome lacking teeth; first and second pleonal epimera not produced, the third with a large, acute tooth at lower posterior corner; eyes dark; palm of gnathopod 1 oblique, the finger attached normally; article 6 of gnathopod 2 sublinear, the palm oblique, undefined by a tooth, bearing a distal process, the finger normal, fitting palm.

FEMALE: Unknown.

HOLOTYPE: AHF No. 596, male, 7 mm.

TYPE LOCALITY: Station 6455, Monterey Bay, 34-42-58 N, 121-52-28 W, 42 fms, October 1, 1959, bottom of green silt.

MATERIAL: Stations 4817 (1), 6006 (1), 6455 (1).

RELATIONSHIP: This species differs from other eastern Pacific species of *Melita* according to the key, but especially as follows: from *M. californica* Alderman (1936) by the presence of but a single tooth on pleonal segment 4; from *M. appendiculata* (= *M. fresneli*) by the untoothed metasome; from *M. oregonensis* J. L. Barnard (1954) by the presence of a tooth on pleonal segment 4; from *M. nitida* (in Shoemaker 1935) by the urosomal teeth; and from *M. palmata* (in Sars 1895) by the unexpanding palm of male gnathopod 2 which bears a distal palmar process, as well as having 4, not 2, teeth on pleonal segment 5.

DISTRIBUTION: Monterey Bay and the Pt. Conception shelf of southern California, 27-59 fms.

Netamelita, new genus

DIAGNOSIS: Uropod 3 extending well beyond end of uropods 1 and 2, the inner ramus short, scale-like; accessory flagellum uniarticulate; gnathopod 2 as small as gnathopod 1, its article 6 subequal to or shorter than article 5; mandibular palp slender, the articles linear; inner plates of maxillae 1 and 2 bearing only terminal setae.

TYPE SPECIES: *Netamelita cortada*, new species.

RELATIONSHIP: This genus differs from its closest relatives *Melita* Leach and *Melitoides* Gurjanova by the inner plates of the maxillae lacking setae on the inner margins and by the short sixth article of gnathopod 2.

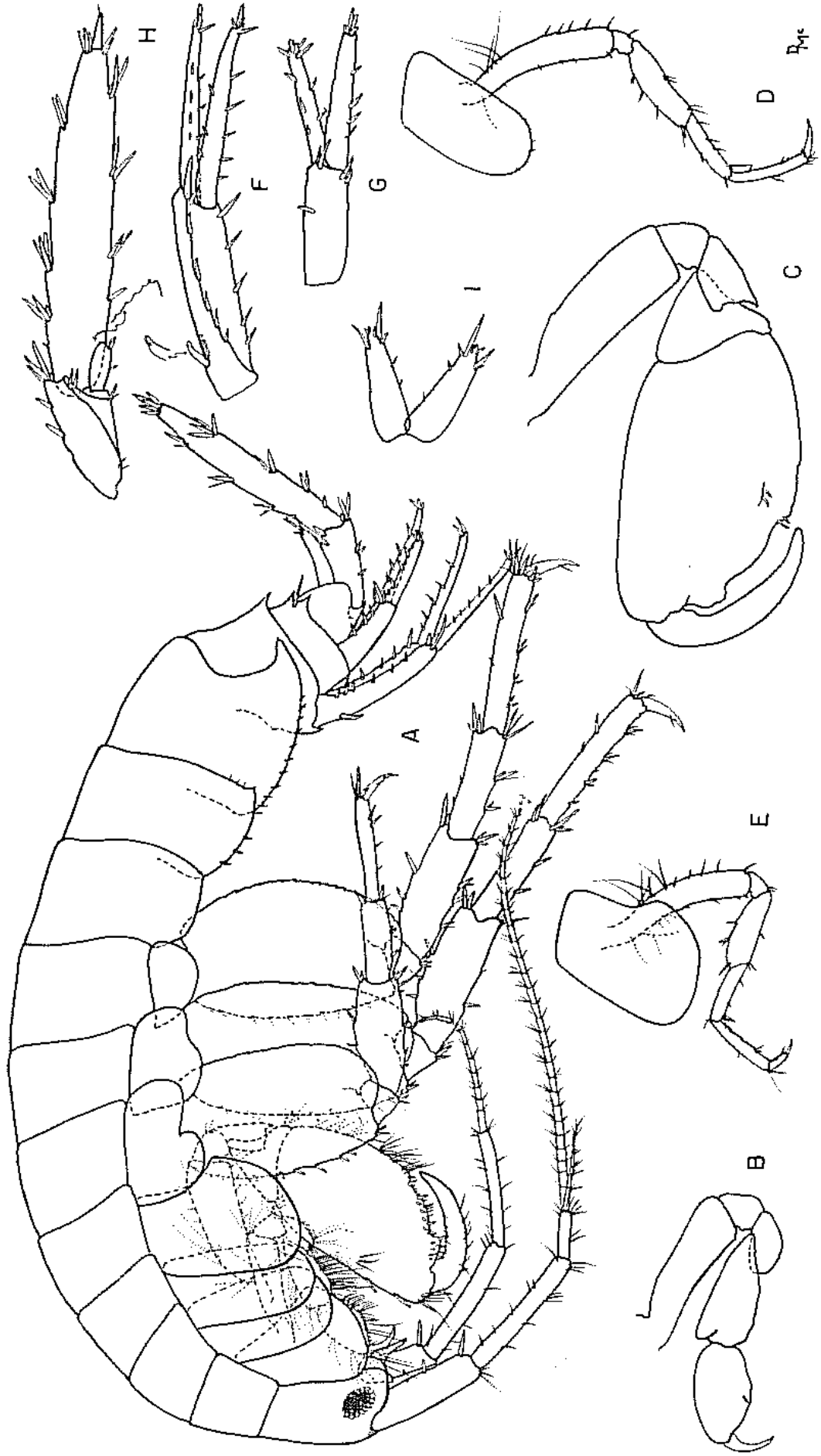

Fig. 22. *Melita desdichada*, n. sp. Male, holotype, 7.0 mm, Sta. 6455: A, lateral view; B,C, gnathopods 1, 2, minus setae; D, E, peracopods 1, 2; F,G,H, uropods 1, 2, 3; I, telson.

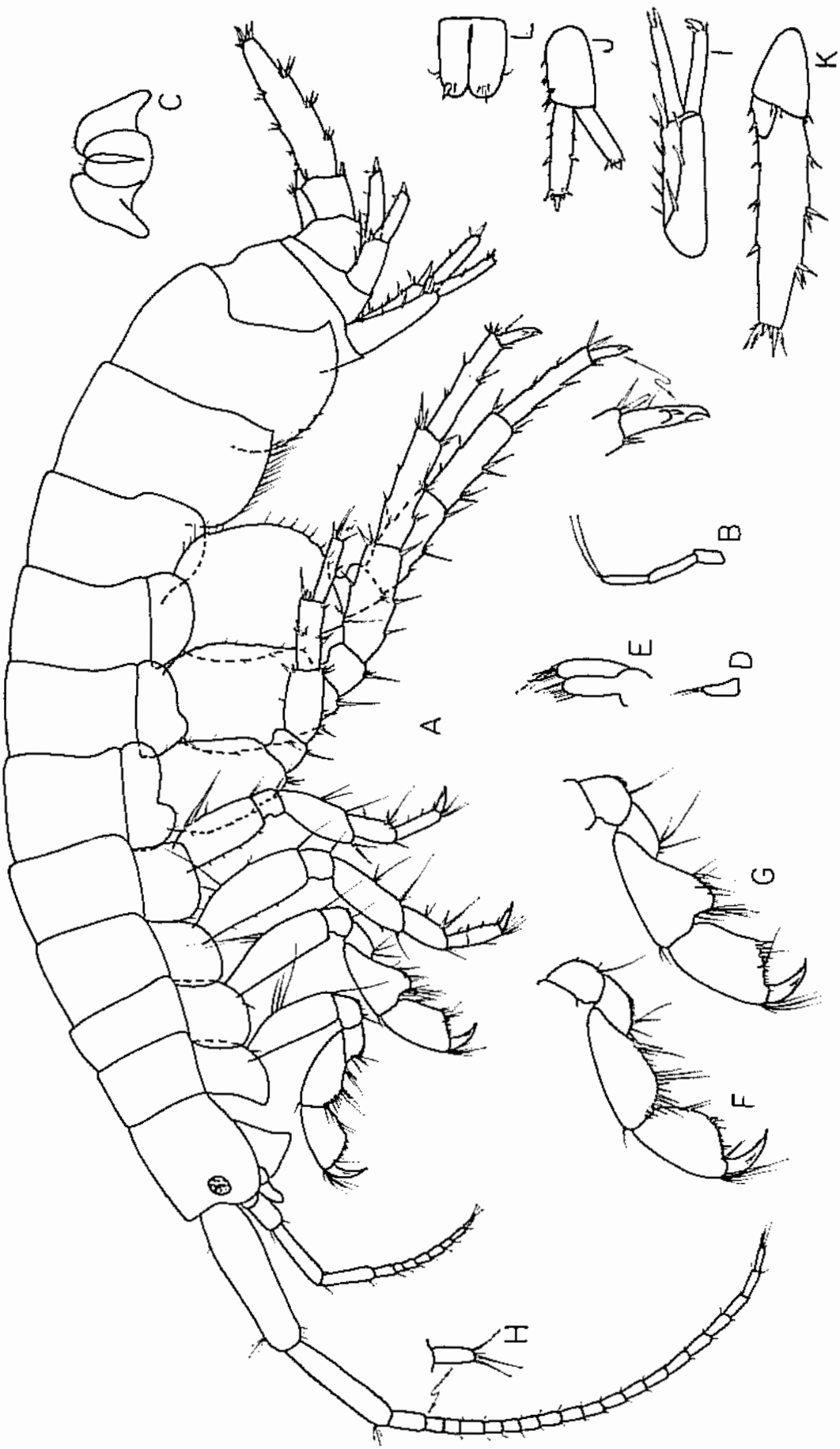

Fig. 23. *Netamelita cortada*, n. g. n. sp. Male, holotype, 3.5 mm, sta. 5562: A, lateral view; B, palp of mandible; C, lower lip; D, inner plate of maxilla 1; E, maxilla 2; F,G, gnathopods 1, 2; H, accessory flagellum; I,J,K, uropods 1, 2, 3; L, telson.

Netamelita cortada, new species

Fig. 23

DIAGNOSIS: With the characters of the genus.

HOLOTYPE: AHF No. 583, male, 3.5 mm, figured.

TYPE LOCALITY: Station 5562, off Gaviota, California, 34-26-47 N, 120-21-35 W, 11 fms, orange-peel grab of rock, January 28, 1958.

MATERIAL EXAMINED: Stations 5164 (1 juv.), 5562 (13).

REMARKS: The small second gnathopod of this species, in both adult males and females, is the most important feature distinguishing it from species of the genus *Melita*. The eyes are small and pale purple in alcohol.

Nagata (1960) has described and figured in excellent detail an undetermined genus and species of Gammaridae from Japan, undoubtedly belonging to this new genus but apparently specifically distinct from *N. cortada*. Nagata's species differs by the much greater expansion of the gnathopodal palms and the more slender peraeopods 3-5, especially in the second articles of peraeopods 3 and 4; the telson has pointed, not rounded, lobes.

DISTRIBUTION: Collected only in the northwestern part of southern California, between Pt. Conception and Gaviota, depths of 11 fms on rock bottoms.

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BENTHIC MARINE AMPHIPODA OF SOUTHERN CALIFORNIA: FAMILIES AMPHILOCHIDAE, LEUCOTHOIDAE, STENOTHOIDAE, ARGISSIDAE, HYALIDAE

By J. Laurens Barnard

Introduction

Of the families treated herein only the Stenothoidae are widely represented on the mud bottoms of the coastal shelf. The other families are confined generally to shallow waters, especially the intertidal, except for the single argissid, *Argissa hamatipes*, widely distributed on the shelf.

Since animals of intertidal and very shallow waters stray into depths slightly greater than 30 feet, at which the inshore limit of our coastal survey was drawn, it was necessary in the process of identifying the animals to investigate intertidal regions to clarify the taxonomy of species in the families considered.

See page 3 above for acknowledgements.

Family AMPHILOCHIDAE

When Schellenberg (1938) described a *Cyproidea* bearing a large molar in contrast to the type, *C. ornata* Haswell, which lacks a molar (confirmed by Walker, 1904, in his *Gallea tecticauda* = *C. ornata*), and when Hurley (1955) described a new genus *Neocyproidea* of which the species either have a triarticulate mandibular palp or none, the usefulness of mouthparts for generic criteria in the *Cyproidea*-like section of this family deteriorated, and doubt was cast on their usefulness in the *Amphilochus*-like section of the family. In order to equate this state of affairs, the writer suggests that such mouthpart differences be used to segregate genera in the *Cyproidea*-section, as well as the *Amphilochus*-section. Thus, *Cyproidea serratipalma* Schellenberg would become the type of a new genus, and *Neocyproidea peninsulae* Hurley (1955) also would become the type of a new genus. I am unclear as to the differences between *Neocyproidea* Hurley (type *Cyproidea otakensis* Chilton) and the genus *Hoplopleon* K. H. Barnard (1932) (type *H. medusarum* K. H. Barnard). Both genera lack a mandibular palp; both have elongated first urosomal segments bearing a dorsal keel; both have similar gnathopods, except that gnathopod 2 of *Hoplopleon* has a more distinct transverse palm and the dactyls of *Neocyproidea* are bilaterally spinose, perhaps overlooked in *Hoplopleon*. Nevertheless, *Neocyproidea* may be distinguished from *Hoplopleon* by the expanded second article of peraeopod 3.

The two groups of Amphilochidae (separated in couplet one in the following key) seem distinct enough to suggest the erection of subfamilies.

Since I have not studied amphilochids in the *Cyproidea*-section of the family I can only suggest a reappraisal of the generic distinctions and proceed in the key to separate the genera as they now stand, disregarding mouthparts for the *Cyproidea*-section.

Relationship of Amphilochidae and Pleustidae

In 1906 when Stebbing's monograph of the Gammaridea summarized all known amphipods of that suborder, the Amphilochidae and Pleustidae seemed relatively distinct, especially when relying on Sars' (1895) excellent monograph of the Norwegian species. No specific differences were made in the diagnoses of these two families. In fact few similar characters are discussed, and both diagnoses could be applied to either family. Early in his key to the families Stebbing segregated the Amphilochidae especially by the uncleft, long, tapering telson. At that time most known amphilochids had only a long, tapering, triangular telson. Subsequently, numerous species have been described with a short, linguiform telson much as in the Pleustidae. In Barnard and Given (1960) it was pointed out that the Pleustidae and Calliopiidae were quite similar except for the characteristic lower lip of Pleustidae which has two tilted oval outer lobes astride two small, nearly fused inner lobes. This character might also be used to separate Pleustidae from Amphilochidae, since most amphilochid lower lips are formed of two tall outer lobes with slender mandibular processes and no inner lobes. Nevertheless, the genus *Amphilochoides* assigned to Amphilochidae since 1895 has the lower lip of a pleustid, not of an amphilochid (see Sars 1895: pl. 75, fig. 2).

Amphilochids differ from pleustids primarily in the greatly reduced size of coxa 1.

In other criteria amphilochids and pleustids are similar. From a lateral view it is almost impossible to differentiate between many species of the two families. Because of variation in the families, there are no criteria of qualitative value in head, rostra, antennae, mouthparts (other than lower lips) (especially to be noted is that the upper lip is incised in both families), gnathopods (quite variable in both families), peraeopods, uropods and telson.

KEY TO FAMILY AMPHILOCHIDAE

1. Coxae 3-4 with contiguous margins overlapping, not hiding coxa 2, not immensely enlarged 2
1. Coxae 3-4 immensely enlarged, with contiguous margins abutting, hiding the vestigial first 2 coxae 10
    2. Mandibular molar large, with ridged and toothed triturating surface 3
    2. Mandibular molar small, or absent, unarmed or bearing 3 spines 6
3. Palp of maxilla 1 with 2 articles ..... *Gitanopsis*
3. Palp of maxilla 1 with one article 4
    4. Outer plate of maxilliped excavate medially, article 1 of palp much longer than other palp articles .... *Gitanogeiton*
    4. Outer plate of maxilliped straight medially, article 1 of palp subequal to article 2 5

5. Gnathopod 2 large, subchelate ..... *Amphilochopsis*
5. Gnathopod 2 small, nearly simple ..... *Gitana*

6. Maxilla 2 composed of only one elongated plate ..... *Amphilochella*
6. Maxilla 2 composed of 2 plates 7

7. Maxilla 2 degraded, the plates tiny, subequal in width ..... *Amphilochoides*
7. Maxilla 2 normal, the inner plate much broader than outer 8

8. Telson entire 9
8. Telson split ..... *Pseudamphilochus*

9. Lateral angles of pleonal segment 6 not produced ..... *Amphilochus*
9. Lateral angles of pleonal segment 6 produced as long as telson ..... *Cyclotelson*

10. Article 2 of peraeopods 4-5 linear, slender 11
10. Article 2 of peraeopods 3-5 expanded 12

11. Palm of gnathopod 2 transverse; urosome segment 3 vaulting over telson; telson small ..... *Cyproidea*
11. Palm of gnathopod 2 oblique; urosome segment 3 not vaulting over telson; telson huge ..... *Paracyproidea*

12. Urosome segment 1 short, unkeeled 13
12. Urosome segment 1 elongated, dorsally keeled 14

13. Gnathopod 2 simple; uropod 2 shortened, failing to reach end of uropod 3 ..... *Stegoplax*
13. Gnathopod 2 subchelate, with transverse palm; uropod 2 reaching end of uropod 3 ..... *Peltocoxa*

14. Article 2 of peraeopod 3 slender, linear .... *Hoplopheonoides*
14. Article 2 of peraeopod 3 expanded 15

15. Process of urosome segment 1 vaulting over following segments ..... *Peltopes*
15. Process of urosome segment 1 not vaulting over following segments 16

16. Article 2 of peraeopod 3 expanded ..... *Neocyproidea*
16. Article 2 of peraeopod 3 slender, linear ..... *Hoplopleon*

Amphilochidae in Southern California

Species of intertidal amphilochids in southern California are difficult to identify without dissection of each animal, and they pose problems of morphology and taxonomy which cannot be resolved at this time without comparison with amphilochids of other parts of the world. Some species are known to be widely distributed, e.g. *Gitanopsis pusilloides* from the eastern Pacific and New Zealand (see Shoemaker 1942, and Hurley 1955) and *Amphilochus neapolitanus* from Europe, eastern Pacific, Australasia, and south Africa. Of the latter species it must be said that some records remain dubious unless it can be confirmed that a complete dissection and

comparison was made by the identifier. In southern California a species of *Gitanopsis* mimics *A. neapolitanus* in external criteria and differs essentially only by its generic character, the large triturating mandibular molar. In *Amphilochus* this molar is vestigial and formed into a small bump which occasionally is armed with a few spines.

The similarity of the several amphilochids in southern California raises the question again of the reliability of two criteria: the mandibular molars which form generic characters, and the shapes of gnathopods, particularly the length of the long hind lobe on article 5 of gnathopod 2. A large number of specimens have been completely dissected, mounted on slides and compared among themselves and with the literature in order to determine any criteria of stability.

The extent of variation is shown in table 1 and in figure 1. These intertidal amphilochids all show the same following characters: telson short, about half as long as peduncle of uropod 3; first gnathopods almost identical (see figures), article 5 with a long but stout hind lobe which reaches about 75% along the hind edge of article 6; hands of gnathopod 2 quite large and broad; antennae, peraeopods, head, and pleonal epimera all similar.

Of particular taxonomic value are the short telsons, well developed first gnathopods and broad hands of the second gnathopods. In contrast, a number of species in both *Amphilochus* and *Gitanopsis* have elongated telsons, simple or otherwise modified first gnathopods and small, narrow second gnathopods.

It was believed possible from initial analyses of 3 distinct animals (types A, H, B of table 1 and fig. 1) that a single species might be represented. This would require proof that (1) a radical transformation took place in the mandibular molars, either from a simple bump to a strong triturating surface or vice versa; (2) that the length of article 5 of gnathopod 2 was variable and became transformed from short to long during growth; and (3) that various minor characteristics could be keyed to specific species, such as shape of first coxa, stoutness of spine on article 2 of gnathopod 2, presence or absence of spines on the hand of gnathopod 2 and size of eyes.

By rearranging the data of table 1 into the diagrams of fig. 1, it was shown that three distinct populations are present, and that the generic differences between *Gitanopsis* and *Amphilochus* hold true in young and old animals. No transformation or intergradation were seen in mandibular molars; one would have to suppose that any transformation took place in a single molt since no intergrades were seen. On this basis large molars were sought for in the internal premolt anatomy of mandibles bearing small molars but none was seen. Indeed, it was not possible to see any evidence of the next molar stage whatsoever, although it was possible to see the development of the cutting teeth and spines. Since the length of the fifth article of gnathopod 2 was consistent for two populations in both old and young it was considered that two species of *Amphilochus* were present.

Table 1

Variation in intertidal amphilochids of southern California, illustrated in diagrams of figure 1.

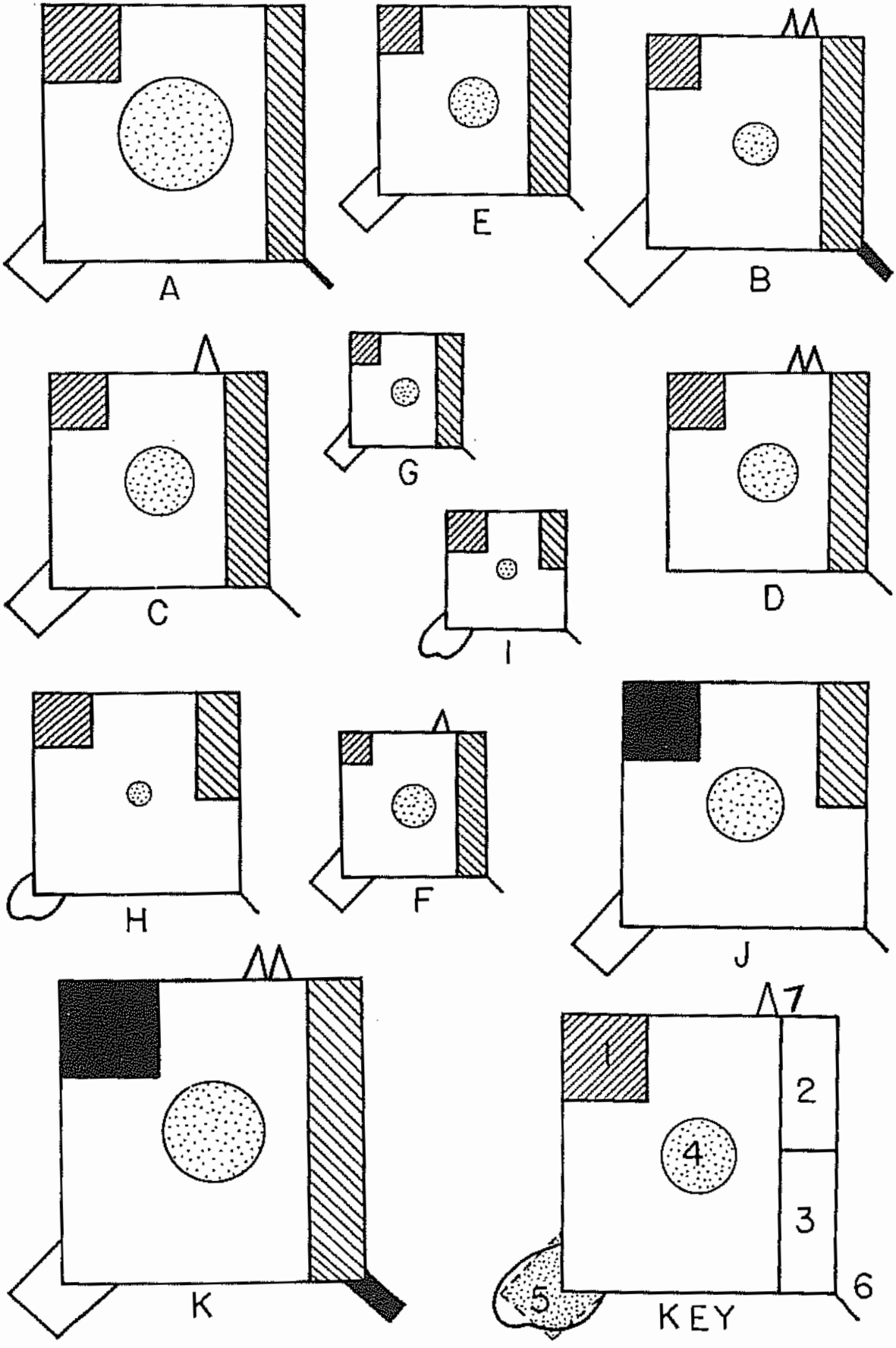
Letter on figure 1		Mandibular molar ridged	eyes large	gn. 2, art. 5 dev. full length	gn. 2, art. 6 with ant. spines	gn. 2, heavy spine on art. 2	coxa 1 lower edge straight
A	*Amphilochus neapolitanus*, 3.0 mm terminal adult	0	+	+	0	0	+
B	*Amphilochus neapolitanus*, 2.5 mm	0	0	+	2	+	+0
C,F	*Amphilochus neapolitanus*, 2.5 and 1.7 mm	0	+0	+	1	0	+
D	*Amphilochus neapolitanus*, 2.3 mm	0	+0	+	2	0	+
E,G	*Amphilochus neapolitanus*, 2.2 and 1.2 mm	0	0+	+	0	0	+
H,I	*Amphilochus litoralis*, 2.3, 2.0, 1.7, 1.5 mm	0	0	0	0	0	0
J	*Gitanopsis pusilloides*, original description	+	0+	0	0	0	+
K	*Gitanopsis vilordes*, n. sp., 3.5 mm	+	+	+	2	+	+
	Amphilochus litoralis, original description	0	0	0	0	0	?

A search was made for hatched juveniles still remaining in brood pouches so that confirmation could be made. Hatched juveniles of the short-form *Amphilochus* bore short fifth articles. The only juvenile discovered of the long-form *Amphilochus* also bore short fifth articles, indicating that article 5 increases in length after hatching but before the size of the smallest free juveniles collected (1.2 mm).

No sexual difference in any of these criteria were discovered. Almost all of the specimens were females; indeed no large animals lacking brood plates were found. A few small specimens lacking brood plates and associated with small females were found, but the demonstration of penial projections would have to be done with serial sectioning because of the small size of the animals.

→

Fig. 1. Scheme of variation in amphilochids of southern California. Each box represents an animal, the size of the box relative to its size. Key: 1 = mandibular molar, black = well developed ridged triturating molar, hatched = simple unridged, small molar; 2, 3 = length of process of article 5 on gnathopod 2, either half as long or fully as long as article 6; 4 = size of eye relative to size of animal; 5 = shape of coxa 1, whether truncate or slightly bilobed below; 6 = size of spine on posterodistal end of article 2 of gnathopod 2; 7 = number of anterior spines on article 5 of gnathopod 2. Figures are coded to table 1 for identification.


A
E
B
C
G
I
D
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K
1
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5
6
7
KEY

To summarize: in amphilochids larger than 1.2 mm the generic and specific criteria such as molars, first coxae, and second gnathopods as diagnosed in the following pages are stable. The size of the eyes and development of spines on the hands of gnathopod 2 are unstable and do not necessarily indicate specific identity, although they can be helpful as explained below.

Rapid Identification of Intertidal Amphilochids

The writer works not only as a taxonomist but as a census ecologist desiring the means to identify large numbers of specimens in as rapid and accurate a manner as possible. It is difficult, at best, to identify the amphilochids of southern California, but the following key has been useful. *Gitanopsis pusilloides* has not been recovered in southern California but is included for clarity.

1. Projecting lobe of article 5 of gnathopod 2 reaching only half way or less along hind edge of article 6 2
1. Projecting lobe of article 5 of gnathopod 2 reaching the full length of the hind edge of article 6 3
    2. Gnathopods 1 and 2 similar in size and structure, projecting lobe of article 5 on both gnathopods so short as scarcely to appose the hind edge of article 6 ..... *Gitanopsis pusilloides* (see figs. in Shoemaker 1942)
    2. Gnathopod 2 much larger than 1; hind lobe of article 5 on gnathopod 1 reaching about 75% along hind edge of article 6 ..... *Amphilochus litoralis*
3. Eyes small (width of eye much shorter than rostrum), usually round, occasionally slightly ovoid ..... *Amphilochus neapolitanus*
3. Eyes large (width of eye much longer than rostrum), usually oval 4
3. Eyes intermediate in size (dissect mandible for confirmation)
    4. Eyes with black centers surrounded by pale ommatidea ..... *Gitanopsis vilordes*, n. sp.
    4. Eyes generally diffuse, occasionally with pale evidence of central darkening ..... *Amphilochus neapolitanus* (dissect mandible for confirmation)

This key is useful in identifying about 95% of the specimens of amphilochids, the remaining 5% requiring mandibular dissection for specific (actually generic) confirmation.

Illustration of Amphilochids

Table 1 and fig. 1 show more variation in each of the three species of amphilochids than is drawn in the figures of each species. For instance, the figures of *Gitanopsis vilordes* n. sp. show two spines on the hand of gnathopod 2, and the figures of *A. neapolitanus* show none, but specimens of the latter often have these spines. The range of variation of each

species should be checked in table 1 and fig. 1 because the other figures of each species are not wholly discriminatory.

Genus Amphilochus Bate

Problems of species recognition have already been discussed in this genus. It remains to discuss the final nomenclatural assignments of the various species. The species herein recognized as *Amphilochus neapolitanus* Della Valle seems unquestionably to be that Mediterranean species. Were it not for Enequist's (1950) erection of *A. borealis* and his contrasting it with *A. brunneus* by very minor points I should assign the southern California *A. litoralis* Stout to the species *A. brunneus*. *Amphilochus litoralis* differs from *A. brunneus* in characters just as minor as those pointed out for *A. borealis* by Enequist, and I am not convinced that these are of value. The new species to be described is so similar to *A. spencebatei* that I have hesitated in its erection and carry the belief that it will prove to be a synonym of *A. spencebatei*. The only difference is the slightly produced anterodistal end of the hand of gnathopod 2, and this process is so transparent that it may have been overlooked in the original description of *A. spencebatei*. This difference is probably the result of the development of better microscopes. It would seem logical that if *Amphilochus neapolitanus* is present in southern California then *A. brunneus* and *A. spencebatei* also would be present there; on the other hand if *A. brunneus*-like and *A. spencebatei*-like species have differentiated in the eastern Pacific why has not *A. neapolitanus*? If the differences discovered in *A. litoralis* and the new species to follow were of greater magnitude it would be acceptable to consider them as distinct races or subspecies which had differentiated with low gene flow or high mutation rates in the eastern Pacific, whereas it would have to be supposed that *A. neapolitanus* had either some gene flow with its Mediterranean population or a low mutation rate.

I believe that examination of this problem in other parts of the world will confirm my suspicion that *A. litoralis* and *A. borealis* are indeed synonyms of *A. brunneus* and that the new species to follow is a synonym of *A. spencebatei*. For the sake of practical nomenclature the species are named as in the following pages.

KEY TO AMPHILOCHUS

References to species may be consulted in J. L. Barnard (1958).

1. Hand of gnathopod 2 projecting anterodistally 2
1. Hand of gnathopod 2 not projecting anterodistally 3
   2. Coxa 1 short, square; telson triangular ..... *manudens*
   2. Coxa 1 long, rectangular, telson ovate ..... *picadurus*, n. sp.
3. Telson longer than peduncle of uropod 3 ..... *tenuimanus*
3. Telson two thirds as long as peduncle of uropod 3, or less 4

4. Process of article 5 on gnathopod 2 projecting only halfway along hind edge of article 6 5
4. Process of article 5 on gnathopod 2 projecting seven eighths to fully along hind edge of article 6 7
5. Article 5 of gnathopod 1 projecting more than three fourths along hind edge of article 6 ..... *litoralis*
5. Article 5 of gnathopod 1 projecting about halfway along hind edge of article 6 6
6. Telson two thirds as long as peduncle of uropod 3, article 5 of antenna 2 subequal to article 4, mandibular palp article 3 longer than article 2 ..... *brunneus*
6. Telson half as long as peduncle of uropod 3, article 5 of antenna 2 subequal to article 4, mandibular palp article 3 shorter than article 2 ..... *borealis*
7. Hand of gnathopod 2 more than 80% as wide as long ..... *marionis*
7. Hand of gnathopod 2 less than 70% as wide as long 8
8. Antenna 1 reaching only to end of peduncle on antenna 2 ..... *spencebatei*
8. Antenna 1 exceeding end of peduncle on antenna 2 9
9. Dactyls of gnathopods attenuated at very tip ..... *filidactylus*
9. Dactyls of gnathopods not attenuated at very tip 10
10. Process of article 5 on gnathopod 2 reaching full length of article 6 ..... *neapolitanus*
10. Process of article 5 on gnathopod 2 reaching seven eighths along article 6 ..... *schubarti*

Amphilochus litoralis Stout

Fig. 2

Stout 1912: 136-140, fig. 78.
Amphilochus neapolitanus, J. L. Barnard 1959: 18 (not Della Valle).

DIAGNOSIS: Eyes always very small, round, formed of darkly pigmented centers surrounded by pale ommatidea; antenna 1 reaching beyond end of peduncle of antenna 2; gnathopod 1 subchelate, the palm slightly oblique, the projecting lobe of article 5 reaching about 75% along hind margin of article 6; gnathopod 2 considerably longer than 1, the hand quite stout but less than 70% as wide as long, the palm nearly transverse, the hind lobe of article 5 projecting only half way or less along hind edge of article 6; hands of gnathopods lacking anterodistal cusps; dactyls of gnathopods not attenuated at extreme tips; telson considerably shorter than peduncle of uropod 3; coxa 1 lobate below.

MATERIAL: 115 specimens from 11 intertidal samples at Pt. Fermin, Corona del Mar, and La Jolla, California, during the years 1947 to 1950, coll. by J. L. Barnard and one sample by R. J. Menzies, all in formalin washes of the following materials: coralline algae, rocks, the surf-grass *Phyllospadix* sp., and the algae *Egregia* sp., and *Pterocladia pyramidale*.

The species was not found in the samples collected in 12 foot depths or greater, and the deepest record is 6 feet. Reported by Stout from Laguna Beach, in *Phyllospadix*.

REMARKS: This species is very closely related to *Amphilochus brunneus* Della Valle (see Chevreux and Fage 1925) and to *A. borealis* Enequist (1950) but is distinguished by the first gnathopod which has a different appearance most easily seen when comparing figures. In essence, the hind lobe of article 5 is much longer and stouter in *A. litoralis*, enveloping more of the hind edge of article 6. *Amphilochus borealis* is very closely related to *A. brunneus* and the points of difference so well noted by Enequist are quite minor and may be subject to small genetic variables or to the genetic response in the different environments of the two species, one being from the Mediterranean, the other from the colder Skagerrak.

DISTRIBUTION: Known only from the intertidal of southern California.

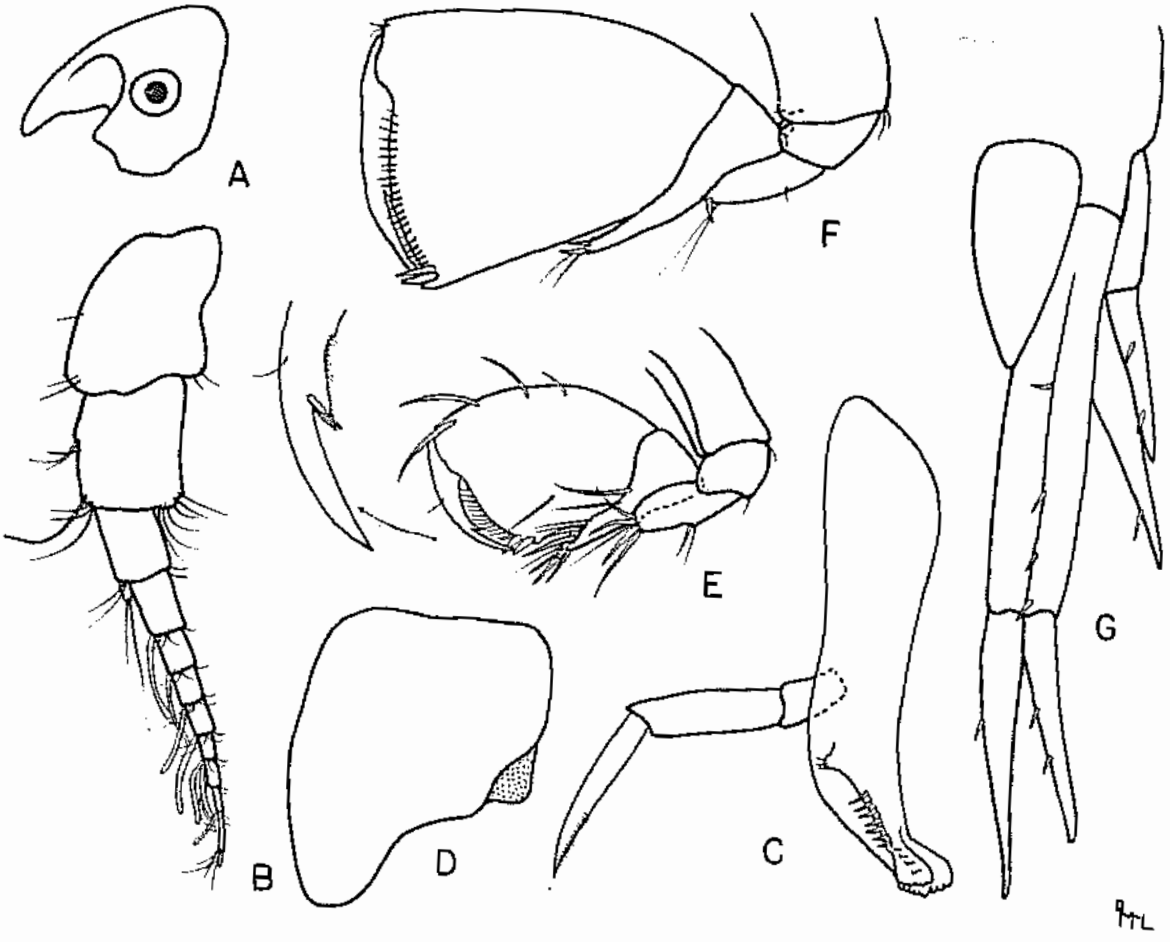

Fig. 2. *Amphilochus litoralis* Stout. Female, 2.3 mm, Barnard sta. 27: A, head; B, antenna 1; C, mandible; D, coxa 1; E,F, gnathopods 1, 2; G, telson and uropods 3 and 2.

Amphilochus ?neapolitanus Della Valle
Fig. 3

Stebbing 1906: 150; Chevreux and Fage 1925: 112-113, figs. 106-108.

DIAGNOSIS: Eyes usually small, round or slightly oval, formed of darkly pigmented centers surrounded by pale ommatidea, occasionally large (see figures), the dark centers not distinct; antenna 1 reaching beyond peduncle of antenna 2; gnathopod 1 subchelate, the palm slightly oblique, the projecting lobe of article 5 reaching about 75% along hind margin of article 6; gnathopod 2 considerably larger than 1, the hand quite stout but less than 70% as wide as long, the palm nearly transverse, the hind lobe of article 5 projecting fully along hind edge of article 6; hands of gnathopods lacking anterodistal cusps; dactyls of gnathopods not attenuated at extreme tips; telson considerably shorter than peduncle of uropod 3; coxa 1 quadrate, with straight lower edge.

MATERIAL: 108 specimens from 10 intertidal samples at Pt. Fermin, Corona del Mar, La Jolla, California and Ensenada, Baja California, during the years 1947-1950, coll. by J. L. Barnard and 2 samples by R. J. Menzies, in formalin washes of the following materials: rocks, *Phyllospadix* (surf grass), the alga *Egregia*, and various coralline algae. In 2 samples from depths of 12-30 feet and in one sample at 60 feet (total of 3 specimens from 3 samples).

REMARKS: As in all of the southern California intertidal amphilochids the first antenna bears a uniarticulate accessory flagellum not mentioned previously in *A. neapolitanus*; apparently this has been overlooked in other amphilochids because Hurley described it for *Gitanopsis pusilloides* Shoemaker.

The telson of specimens at hand is somewhat more pointed than figured by Chevreux and Fage (1925), and in the large aberrant adults with large eyes the second article of the first antenna is quite broadened and setose along one distal margin.

The first coxa has a straight lower edge in contrast to that of *Amphilochus litoralis* in which it forms an anterior lobe so that the lower edge is oblique and slightly excavate.

The anterior spination on the hand of gnathopod 2 varies from no submarginal spines to 1 or 2 spines.

This species is separated with difficulty from *Gitanopsis vilordes*, n. sp., but most of the specimens have small eyes in contrast to the large eyes of *Gitanopsis*. When in doubt, one must dissect the mandible.

DISTRIBUTION: Probably circumtropical and warm-temperate.

Amphilochus picadurus, new species
Fig. 4

DIAGNOSIS: Eyes medium size, subcircular, formed of darkly pigmented centers surrounded by pale ommatidea; antenna 1 reaching only to end of peduncle on antenna 2; gnathopod 1 subchelate, the palm oblique, the

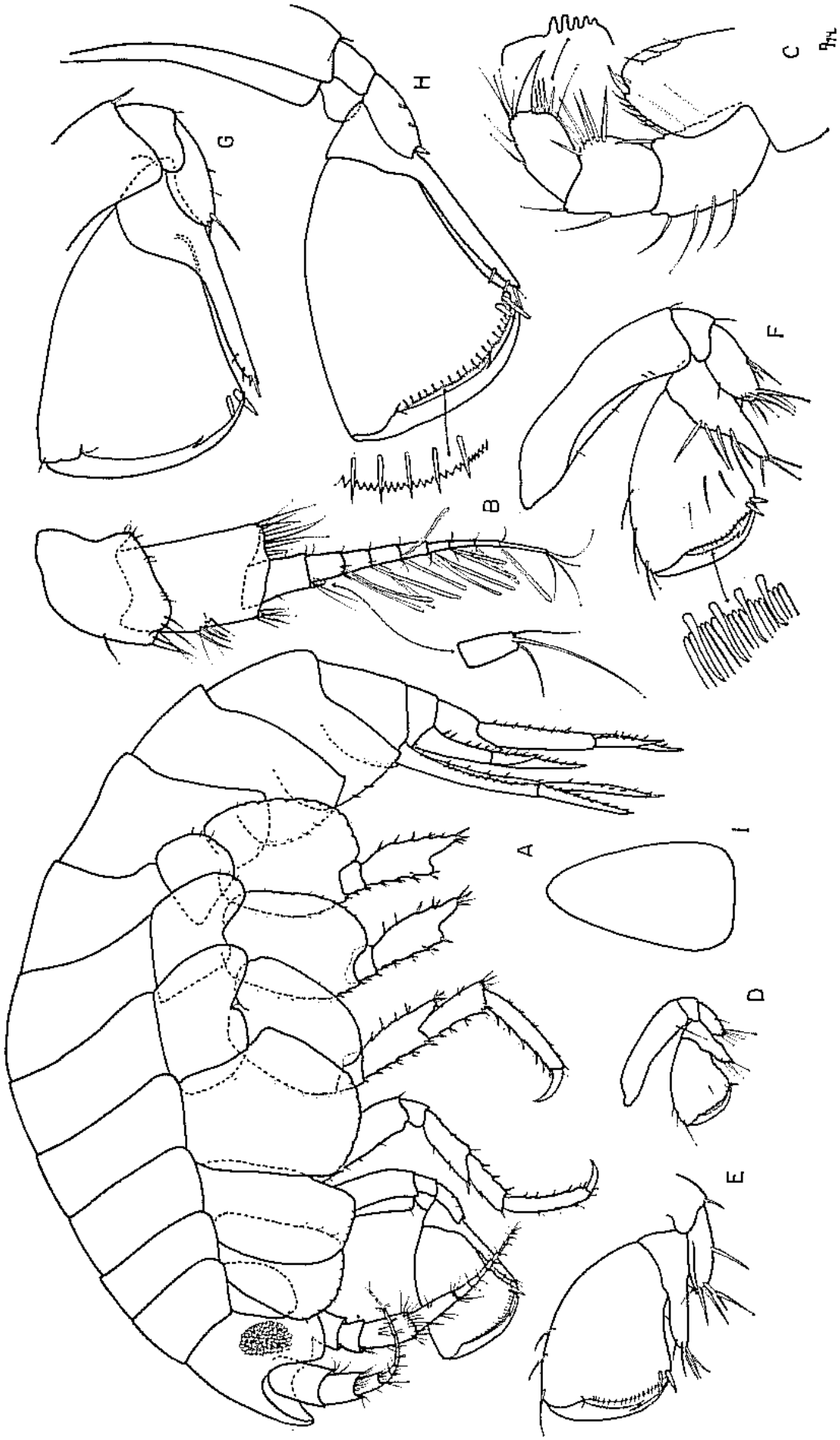

Fig. 3. *Amphilochus neapolitanus* Della Valle. Female, 2.5 mm. Barnard sta. 33: A, lateral view; B, antenna 1; C, part of maxilliped; D,E,F, views of gnathopod 1; G,H, views of gnathopod 2; I, telson.

projecting lobe of article 5 reaching about halfway along hind margin of article 6; gnathopod 2 considerably larger than 1, the hand moderately stout, less than 70% as broad as long, the palm nearly transverse, the hind lobe of article 5 projecting almost fully along hind margin of article 6; hand of gnathopod 2 bearing a small cusp at anterodistal end; dactyls of gnathopods not attenuated at extreme tips; telson considerably shorter than peduncle of uropod 3; coxa 1 long, rectangular, lobate below.

HOLOTYPE: AHF No. 5727, female, 2.5 mm.

TYPE LOCALITY: Station 4856, off Palos Verdes Pt., 33-47-30 N, 118-25-20 W, 11 fms, February 8, 1957, bottom of green mud and rock.

MATERIAL: 66 specimens from 15 stations. A subtidal species in depths of 2 to 20 fathoms, with an overall density of 0.4 animals per square meter on the coastal shelf.

RELATIONSHIP: As stated in the introduction to this genus the writer considers it probable that this species is a synonym of *A. spencebatei*, from which it differs only by the small anterodistal cusp of the hand on the second gnathopod. What is of interest is the great similarity in the first coxa, the length of the first antenna and the length of the projecting lobe on article 5 of gnathopod 1.

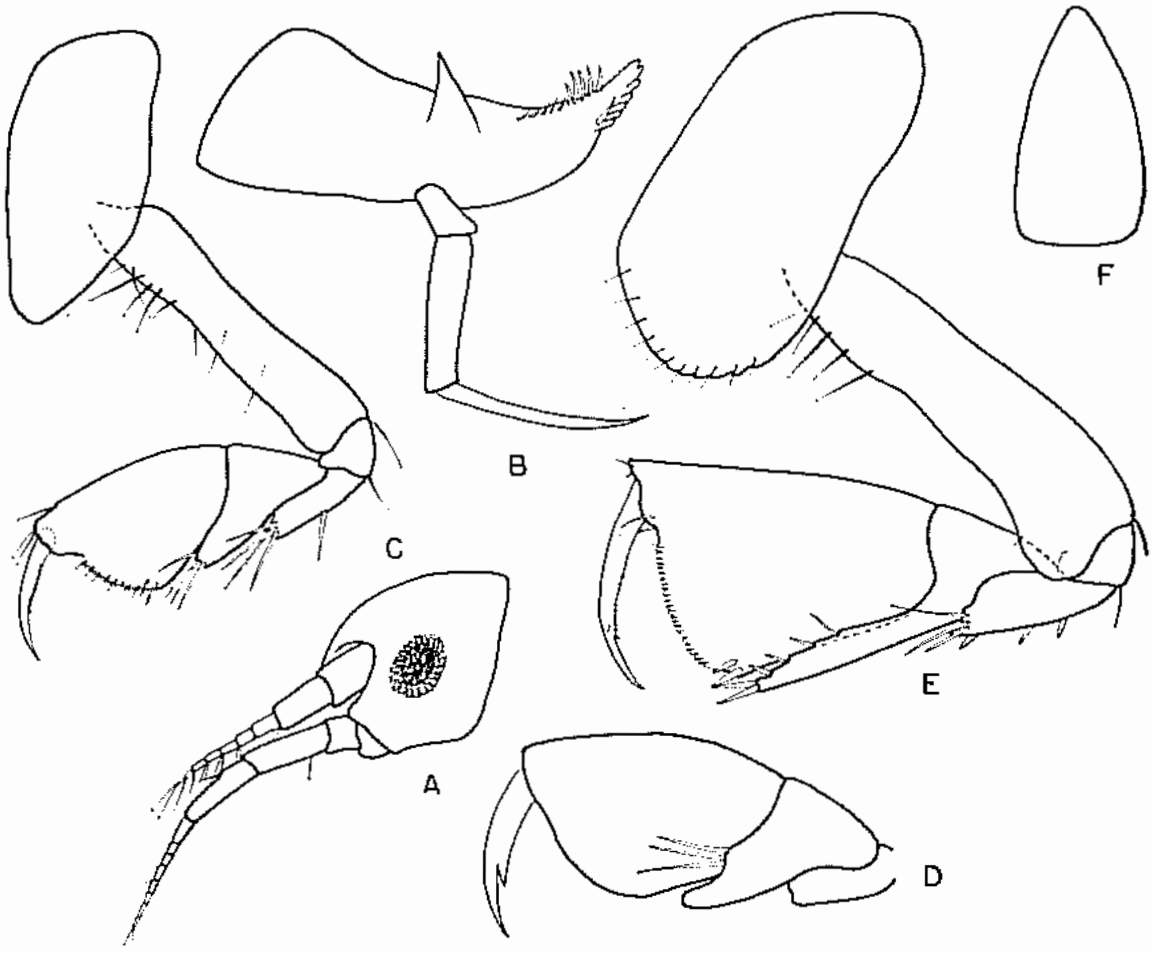

Fig. 4. *Amphilochus picadurus*, n. sp. Female, 2.7 mm, sta. 4856: A, head; B, mandible; C,D, gnathopod 1; E, gnathopod 2; F, telson.

Although simple, the mandibular molar of this species is much longer and sharper than in the other two species of *Amphilochus* described herein.

Genus Gitana Boeck

Gitana calitemplado, new species

Fig. 5

DIAGNOSIS: Sixth articles of gnathopods 1 and 2 about 1.7 times as long as fifth articles; article 5 of gnathopod 1 with posterior lobe short, not opposing hind edge of article 6; article 5 of gnathopod 2 produced into a slender but short lobe, apposed to posterior edge of article 6 for about one fourth of its length, the lobe blunt, not acute; article 6 of peraeopods 1 and 2 about 1.5 times as long as article 5.

HOLOTYPE: AHF no. 597, female, 2.2 mm.

TYPE LOCALITY: Station 6103, San Pedro Bay, 33-39-00 N, 119-09-03 W, 17 fms, February 19, 1959.

MATERIAL: 20 specimens from 10 stations.

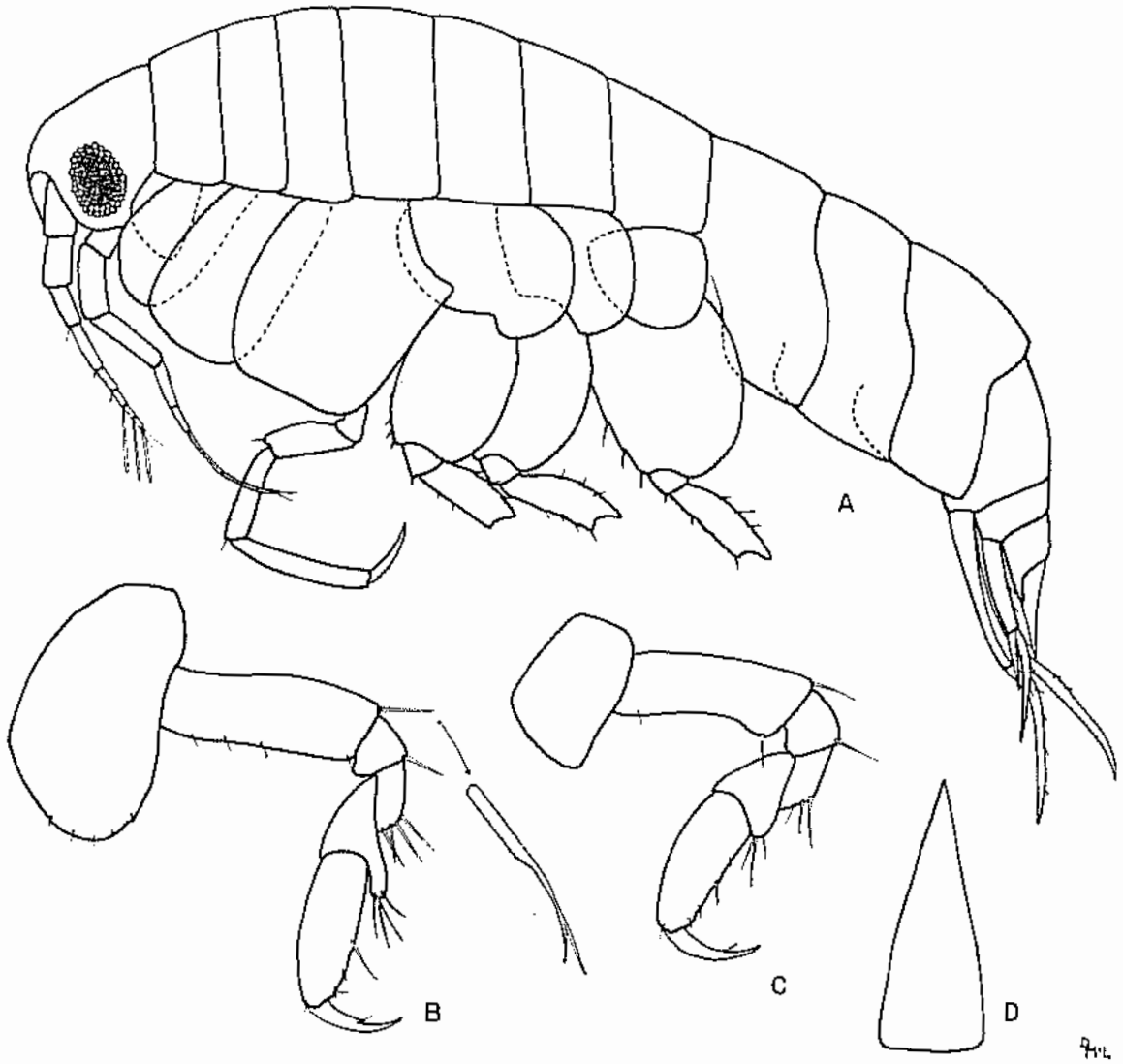

Fig. 5. *Gitana calitemplado*, n. sp. Female, 2.0 mm, sta. 4863: A, lateral view; B,C, gnathopods 2, 1; D, telson.

RELATIONSHIP: This species differs from the three other species of *Gitana*, *G. abyssicola*, *G. rostrata*, and *G. sarsi* (all in Sars 1895: pls. 78-79) by the very elongated sixth articles of the gnathopods and the first two peraeopods. The condition of the hind lobes of the fifth articles on the gnathopods also is significant, especially in distinguishing the species from *G. sarsi* which has acute hind lobes, whereas in *G. calitemplado* they are blunt.

The mouthparts are those of *Gitana*, with a large ridged mandibular molar, a uniarticulate first maxillary palp, and a non-excavate inner margin of the outer plate on the maxilliped. The third uropods are missing on all of the specimens at hand, as well as the ends of peraeopods 3-5.

ECOLOGY: A rare species, with an overall density of 0.2 animals per square meter on the coastal shelf, but limited to depths of 5 to 30 fathoms, with a frequency of 1.6 animals per square meter.

Genus Gitanopsis Sars

KEY TO GITANOPSIS

1. Pleon segments 1 and 2 each bearing a dorsal tooth ..... *bispinosa*
1. Pleon segments 1 and 2 dorsally smooth 2
2. Gnathopod 1 simple, lacking distinct palm 3
2. Gnathopod 1 subchelate, bearing distinct palm 4
3. Process of article 5 on gnathopod 2 short, not apposing hind edge of article 6 ..... *simplex*
3. Process of article 5 on gnathopod 2 long, reaching fully along hind edge of article 6 ..... *inaequipes*
4. Telson as long or longer than peduncle of uropod 3 5
4. Telson two thirds as long as peduncle of uropod 3 or less 7
5. Article 6 of gnathopod 2 large, about three fourths as wide as coxa 2, the process of article 5 reaching fully along hind edge of article 6 ..... *inermis*
5. Article 6 of gnathopod 2 small, about half as wide as coxa 2, the process of article 5 not reaching fully along hind edge of article 6 6
6. Sixth articles of gnathopods 1-2 scarcely constricted proximally ..... *squamosa*
6. Sixth articles of gnathopods 1-2 strongly constricting proximally ..... *arctica*
7. Process of article 5 on gnathopod 2 short, scarcely apposing hind edge of article 6 ..... *pusilloides*
7. Process of article 5 on gnathopod 2 long, reaching almost fully along hind edge of article 6 8
8. Hand of gnathopod 2 almost as broad as long ..... *magdai*
8. Hand of gnathopod 2 less than 70% as broad as long 9

9. Process of article 5 on gnathopod 2 reaching only half way along hind edge of article 6 ..... *pusilla** and *tortugae**
9. Process of article 5 on gnathopod 2 reaching three fourths along hind edge of article 6 ..... *vilordes*, n. sp.

*indistinguishable

Gitanopsis vilordes, new species

Fig. 6

DIAGNOSIS: Pleon segments dorsally smooth; eyes large; gnathopod 1 large, similar in structure to gnathopod 2, subchelate, the process of article 5 reaching about three fourths along hind edge of article 6; gnathopod 2 larger than 1, the posterodistal end of article 2 with stout spine, article 6 with 2 stout anterior spines, process of article 5 reaching fully along hind edge of article 6; telson much shorter than peduncle of uropod 3; coxa 1 quadrate.

HOLOTYPE: AHF No. 4920, female, 3.0 mm.

TYPE LOCALITY: Barnard station 27, intertidal of Pt. Fermin, October 21, 1949, wash of alga *Egregia* sp.

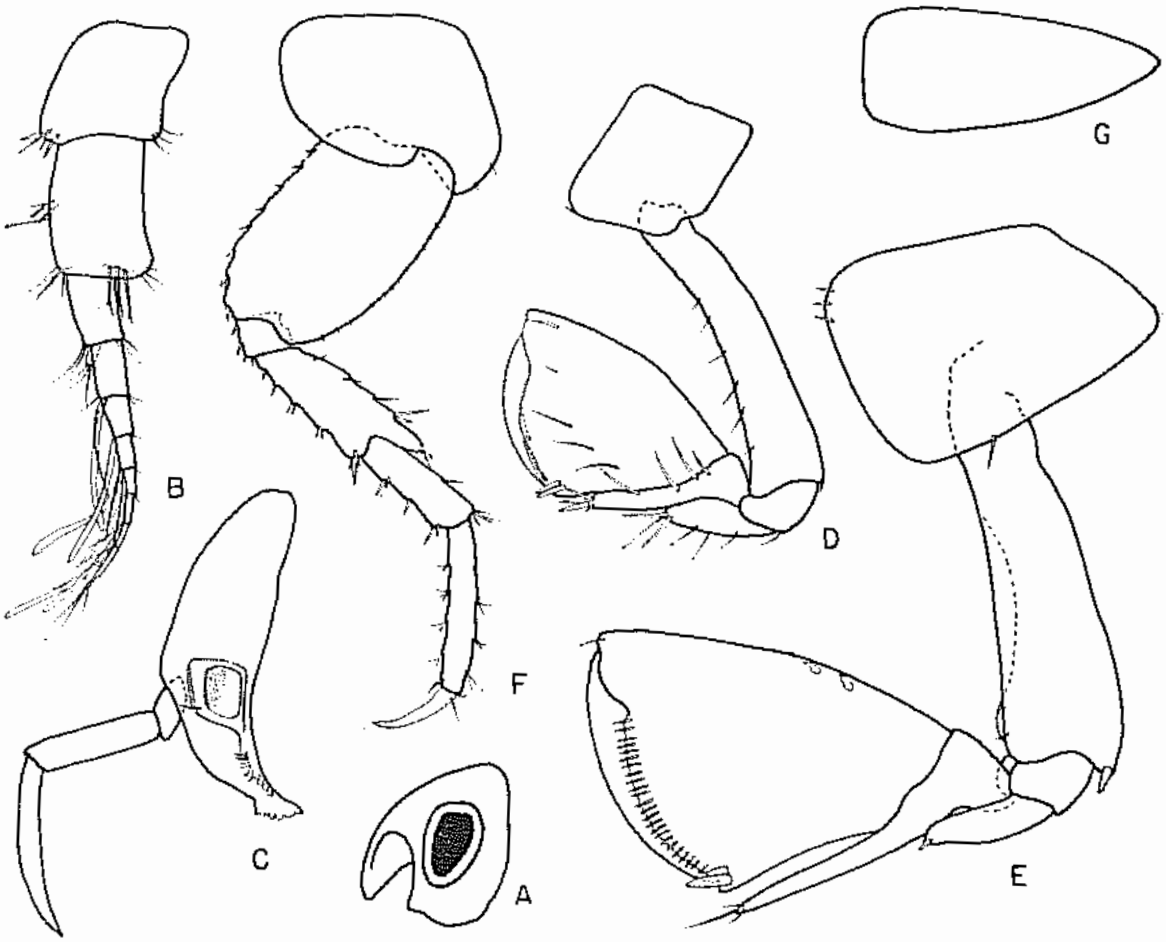

Fig. 6. *Gitanopsis vilordes*, n. sp. Holotype, female, 3.0 mm, Barnard sta. 27: A, head; B, antenna 1; C, mandible; D,E, gnathopods 1, 2; F, peraeopod 4; G, telson.

MATERIAL: 12 specimens from 2 interidal samples at Pt. Fermin, in 1949 and 1950, coll. J. L. Barnard from rock wash and alga *Egregia* sp. Three specimens from 3 subtidal samples in depths of 10 to 15 fathoms.

RELATIONSHIP: This species is closely related to both *Gitanopsis pusilla* K. H. Barnard (1916) and *G. tortugae* Shoemaker (1933). Even though Hurley (1955) refigured parts of *G. pusilla*, I am unable to distinguish it from *G. tortugae*. The new species apparently differs from both species by the slightly longer process of article 5 on gnathopod 1, and is notably different from *G. tortugae* by its large eyes. Its further relationship may be seen in the key to *Gitanopsis* above.

Family LEUCOTHOIDAE

Genus Leucothoe Leach

Leucothoe alata J. L. Barnard

Figs. 7 D, E, F

Leucothoe minima, J. L. Barnard 1952: 9-12, pl. 1 (not Schellenberg 1925).
Leucothoe alata J. L. Barnard 1959: 19-20, pl. 1.

MATERIAL: 10 specimens from 3 open-sea stations.

RECORDS: Shallow water algal bottoms from 10 fms or less near San Diego, Pt. Conception and Monterey Bay, California.

REMARKS: The sixth article of gnathopod 1 is more slender than seen in the forms of this species from Morro and Newport Bays.

Leucothoe spinicarpa (Abildgaard)

Figs. 7 A, B, C

Sars 1895: 283, pl. 100, pl. 101, fig. 1; Stebbing 1906: 165-166; Gurjanova 1951: 486-488, fig. 319.

MATERIAL: 6 specimens from 3 stations.

RECORDS: Shallow water algal stations, less than 10 fms depth, from Santa Monica Bay, Pt. Conception and Monterey Bay. A species widely distributed from subarctic waters to south temperate regions; perhaps universally distributed.

REMARKS: The palmar margin of gnathopod 2 in the present specimens is not crenulate but bears pairs of setules. In young specimens (Fig. 7A) the third article of antenna 1 is relatively longer in relation to articles 1 and 2 than in adult specimens which are figured by Sars. The length of this article has been an important distinguishing characteristic. It appears to the writer that as growth proceeds this article remains the same size while articles 1 and 2 elongate, and, thus, it is relatively smaller in adults than in juveniles. This does not appear to be the case in *L. alata*, another local species. Demonstration of such differential growth may necessitate revisions in the taxonomy of the genus.

Family THAUMATELSONIDAE

This family was erected in 1938 by Gurjanova for a group of genera split off from the Stenothoidae and the former Metopidae that are aberrant in their fused urosomal segments and in their large telson which apparently

is considerably thickened dorsoventrally. The thickened telson is most strongly developed in *Prothaumatelson nasutum* (Chevreux 1912) and perhaps least in *Thaumatelson cultricauda* K. H. Barnard (1932). Fusion lines delineating segments of the urosome are seen in some species and not in others. In 1955 Shoemaker described a new species *Prothaumatelson carinatum* in which the telson was normally stenothoid and only the last two urosomal segments were distinctly fused, the first urosomal segment being distinct. This species forms an intergrade between true stenothoids and true thaumatelsonids. In the following pages the writer describes another new species which forms a link between these two families; like Shoemaker's species it has the first urosomal segment distinct and a normal stenothoid telson, but, unlike *P. carinatum* and all other known thaumatelsonids, not all of the last 3 peraeopods have slender basal articles. Of course, many true stenothoids also have these slender peraeopods.

There should be concern over just where to split off the Thaumatelsonidae in light of Shoemaker's species and the one to follow, particularly because of the telsonic variability in described thaumatelsonids and the

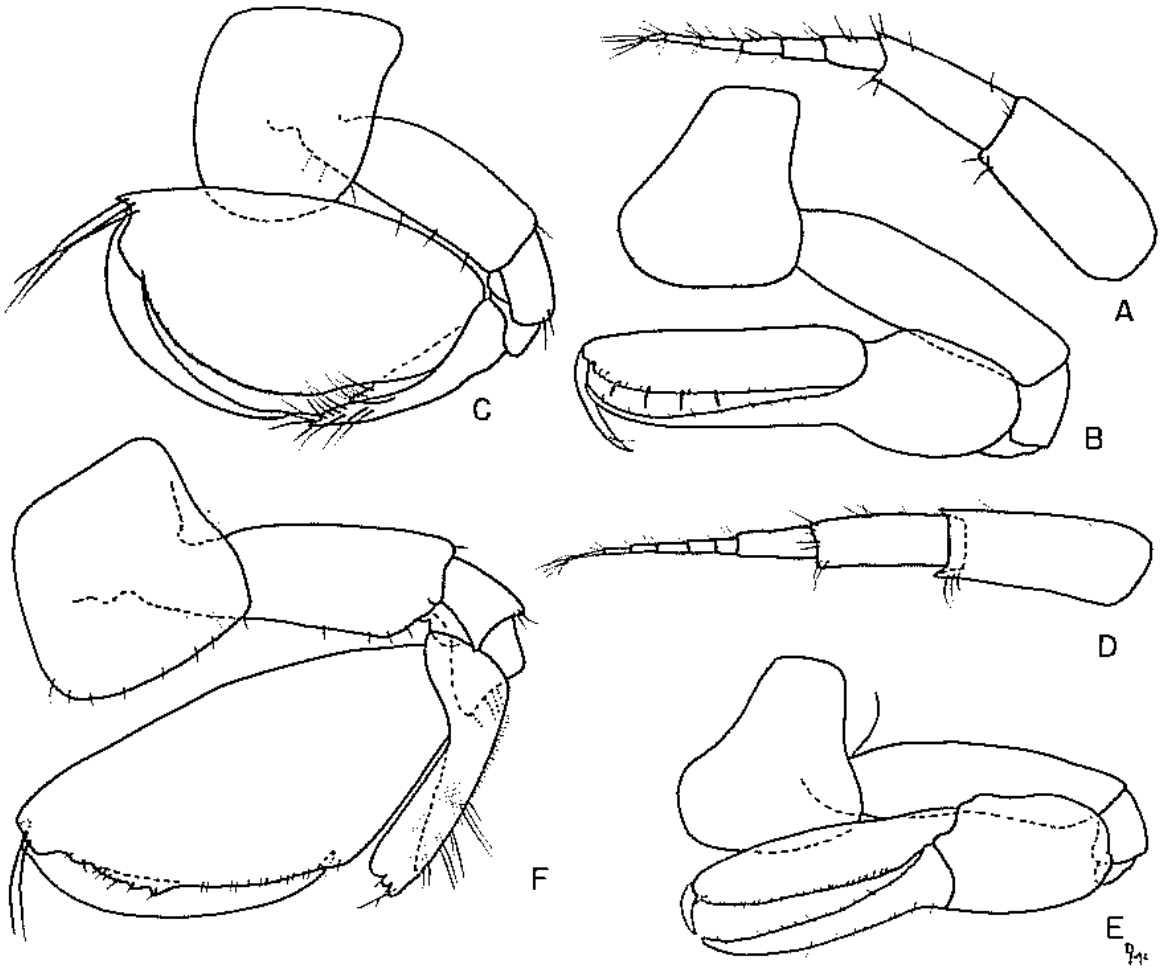

Fig. 7. *Leucothoe spinicarpa* (Abildgaard). Male, 2.75 mm, sta. 6425: A, antenna 1; B,C, gnathopods 1, 2. *Leucothoe alata* J. L. Barnard. Male, 3.0 mm, sta. 6425: D, antenna 1; E,F, gnathopods 1, 2.

variation in the degree of fusion of urosomal segments even in obvious thaumatelsonids. For the time being, the writer suggests leaving Shoemaker's species in the genus *Prothaumatelson* of the Thaumatelsonidae, because it forms a neat link to the type species of *Prothaumatelson*. Both species have chelate second gnathopods, but the type species, *P. nasutum* has the fully modified telson. Thus, *Prothaumatelson* is the only stenothoid-thaumatelsonid genus with chelate second gnathopods.

The writer prefers to assign the following new species to the Stenothoidae, and on that basis it falls into the genus *Stenothoides* Chevreux, if one ignores the fusing of the last two urosomal segments. The very great difficulty in seeing the urosomal segments in these small, shiny, translucent animals suggests the possibility that other known stenothoids also have these segments fused. The new species is quite clearly related to other species in *Stenothoides*.

It would appear to the writer that the Thaumatelsonidae are simply a group of species continuing the general degradation seen in the Stenothoidae. This degradation is marked by evanescence of the mandibular palps, linearization of the basal articles of the peraeopods, fusion of the palp articles on the first maxillae, complete loss in most cases of the accessory flagellum, etc. It is difficult to recognize a family such as the Thaumatelsonidae as more than a group of species, perhaps of polyphyletic origin, which have gone one step further in their degeneration. The obvious relationship to the Stenothoidae causes one to suggest that the Thaumatelsonidae be considered a subfamily rather than a full family. However, there is argument in the other direction: for instance, that the Liljeborgiidae are nothing more than Gammaridae with reduced mandibular molars and yet are kept as a distinct family, and Bulycheva's partitioning of the Talitridae into subtilely distinct families.

Family STENOTHOIDAE

This family has a plethora of variation involving criteria of mouthparts, gnathopods, and peraeopods. Two species which have identical male second gnathopods may be in entirely different genera and so the systematist is forced to dissect completely each species in a fauna repeatedly until he learns the extent of variation in that fauna, after which he can proceed to identify species on the basis of characters recognized without dissection.

In a fauna such as that of southern California, the initial exploration is difficult because the animals of this family are quite small, but on the other hand the diversity is quite low compared with that of the northwestern Pacific (Gurjanova 1951). It is easy to break off mandibular palps during dissection, and it is quite difficult to decide whether a first maxillary palp is biarticulate or uniarticulate because the joint lines are difficult to resolve. Furthermore, the distinctions between genera are not as great as the excellent keys of Gurjanova (1938) (1951) and Shoemaker (1955) would indicate: for instance, there is little difference in the degree

of expansion of the second article on peraeopod 5 between *Metopella longimana* and *Mesometopa extensa*, but this is the principal difference between these two genera, and the situation is intergraded by *Metopella neglecta* which has the upper half of that article expanded and the lower half narrowed.

In addition, the systematist is frustrated by such cases as *Metopella pacifica* Holmes (1908) from Monterey, California, and the new species of *Metopella* to follow from southern California which, indeed, have identical second male gnathopods and apparently the same peculiar disparity between peraeopods 1 and 2. Yet the first gnathopods are entirely different, for in *M. pacifica* the first gnathopod is subchelate and in the new species it is simple. The systematist is left with the same sense of disproportion as noted above in the case of *Leucothoe spinicarpa*, where so much variation is encountered in the same species that most previous systematic work is disarranged.

It is apparent that *Mesostenothoides* Gurjanova (1938) is a synonym of *Stenothoides* Chevreux (1900). This error probably arose when Gurjanova relied on Chevreux and Fage's (1925) incorrect assignment of their *latipes* to *Stenothoides*. The type species of *Stenothoides, S. perrieri* Chevreux (1900) has *both* pereaeopods 3 and 4 bearing a slender second article, and only peraeopod 5 has the expanded second article. All remaining species assigned to *Stenothoides* since that time have been like *S. latipes* Chevreux and Fage (1925) a species which has only peraeopod 3 bearing a slender article while both peraeopods 4 and 5 support an inflated article. Thus, the type of *Mesostenothoides* must fall to *Stenothoides*, and a new name must be provided for all other species previously assigned to *Stenothoides*.

Stenothoides Chevreux, new synonymy

Stenothoides Chevreux 1900: 55.
Mesostenothoides Gurjanova 1938: 280.

DIAGNOSIS: Article 2 of peraeopods 3-4 slender; article 2 of peraeopod 5 broad; palp of mandible uniarticulate or absent; palp of maxilla 1 uniarticulate.

TYPE SPECIES: *Stenothoides perrieri* Chevreux (1900).

LIST OF SPECIES:

Stenothoides (?) *bicoma*, n. sp.
Stenothoides perrieri Chevreux
Mesostenothoides pirloti Gurjanova
Mesostenothoides slastnikovi Gurjanova
Mesostenothoides smirnovi Gurjanova
Mesostenothoides uenoi Gurjanova

Stenothoides (?) **bicoma**, new species

Fig. 8

DIAGNOSIS OF MALE: Last two urosomal segments fused but pleon not otherwise aberrant as in some species assigned to Thaumatelsonidae (see

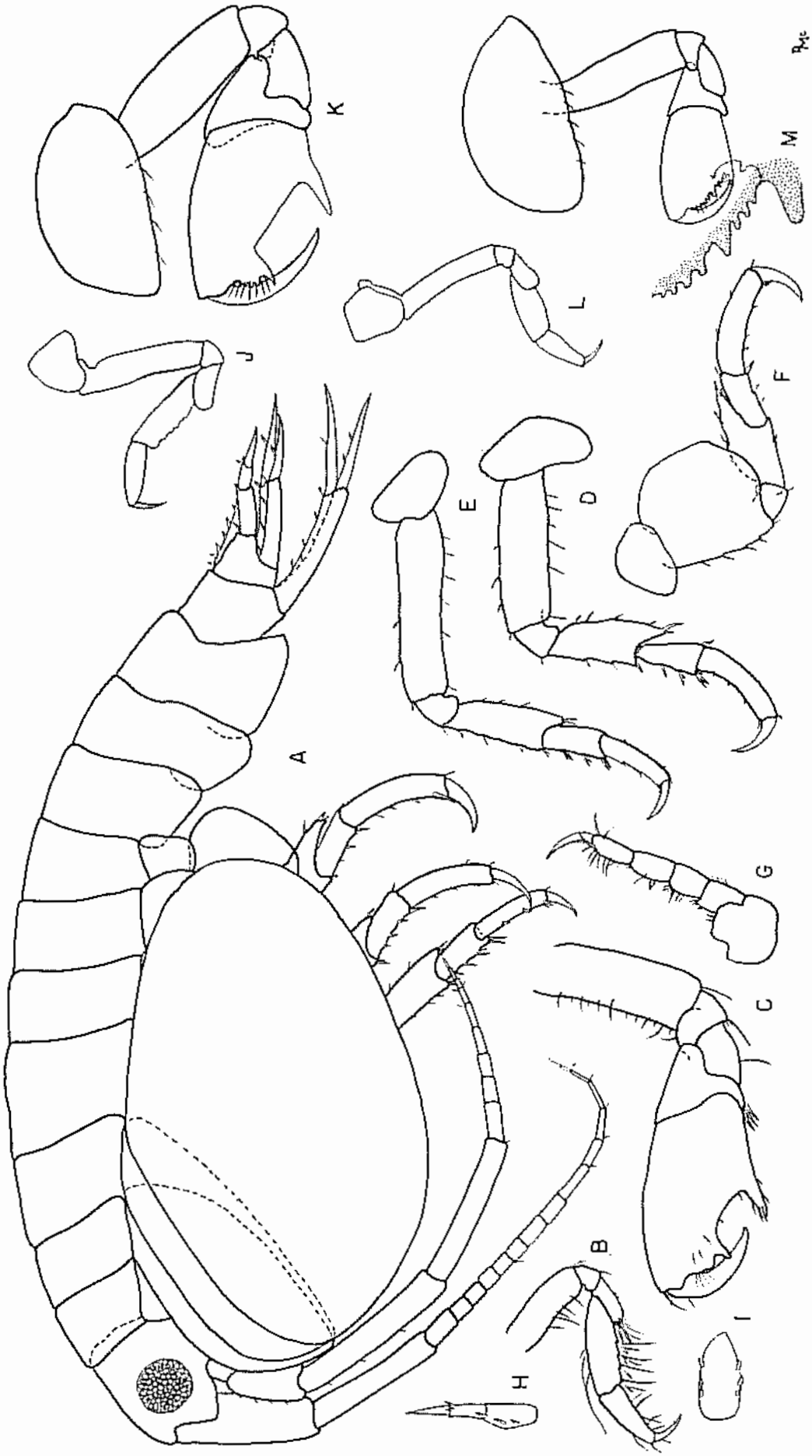

Fig. 8. *Stenothoides bicoma*, n. sp. Male, 1.5 mm, sta. 4845: A, lateral view; B,C, gnathopods 1, 2; D,E,F, peracopods 3, 4, 5; G, maxilliped; H, uropod 3; I, telson. Male, 4 mm, sta. 5202: J,K, gnathopods 1, 2, minus setae. Female, 3.5 mm, sta. 5202: L,M, gnathopods 1, 2, minus setae.

previous discussion); telson bearing three lateral spines on each side; gnathopod 1 with article 5 longer than article 6, its article 7 simple, not setose, its article 4 scarcely produced; palm of gnathopod 2 oblique, bearing a large multitoothed process near finger hinge and a large, acute defining process, with the excavation between them being quadrate; antennae subequal in length; mandible lacking palp; palp of maxilla 1 uniarticulate.

FEMALE: Palm of gnathopod 2 slightly oblique, defined by a distinct tooth at hind corner and bearing along the palmar margin well-developed teeth, one of which is larger than the others.

HOLOTYPE: AHF No. 5616, male, 3.0 mm.

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

MATERIAL: 90 specimens from 29 stations.

RELATIONSHIP: This species is distinguished among members of the genus *Stenothoides* by the elongated fifth article of the first gnathopod, but is otherwise particularly related to *S. slastnikovi* Gurjanova (see 1951) by the male second gnathopod.

ECOLOGY: This species has an overall density of 2.2 animals per square meter on the coastal shelf. It is distributed principally between the depths of 21 and 40 fms, but is found as shallow as 6 fathoms and as deep as 60 fathoms.

Stenula, new name

Stenothoides Chevreux, Chevreux and Fage 1925: 130 (not Chevreux 1900); Gurjanova 1938: 279-280; Gurjanova 1951: 445.

DIAGNOSIS: Article 2 of peraeopod 3 slender; article 2 of peraeopods 4-5 broad; palp of mandible and palp of maxilla 1 each uniarticulate.

TYPE SPECIES: *Stenothoides latipes* Chevreux and Fage, 1925.

SPECIES ASSIGNED TO THIS GENUS:

Stenothoides angusta Shoemaker
Stenothoides arctica Gurjanova
Stenothoides bassarginensis Gurjanova
Stenothoides beringiensis Gurjanova
Stenothoides carinatus Gurjanova
Stenothoides latipes Chevreux and Fage (type)
Stenula modosa, new species
Stenothoides ratmanovi Gurjanova
Stenothoides serripes Gurjanova
Stenothoides ussuriensis Gurjanova

Stenula modosa, new species

Fig. 9

DIAGNOSIS OF FEMALE: Eyes quite large, round, occupying almost the entire side of the head; gnathopod 1 simple, the hind edge of article 6 with slender (not stout) setae, the finger bearing slender setae on its hind edge; palp of mandible as long as width of mandibular apex, slender; fourth articles of peraeopods 3-5 not strongly produced posteriorly;

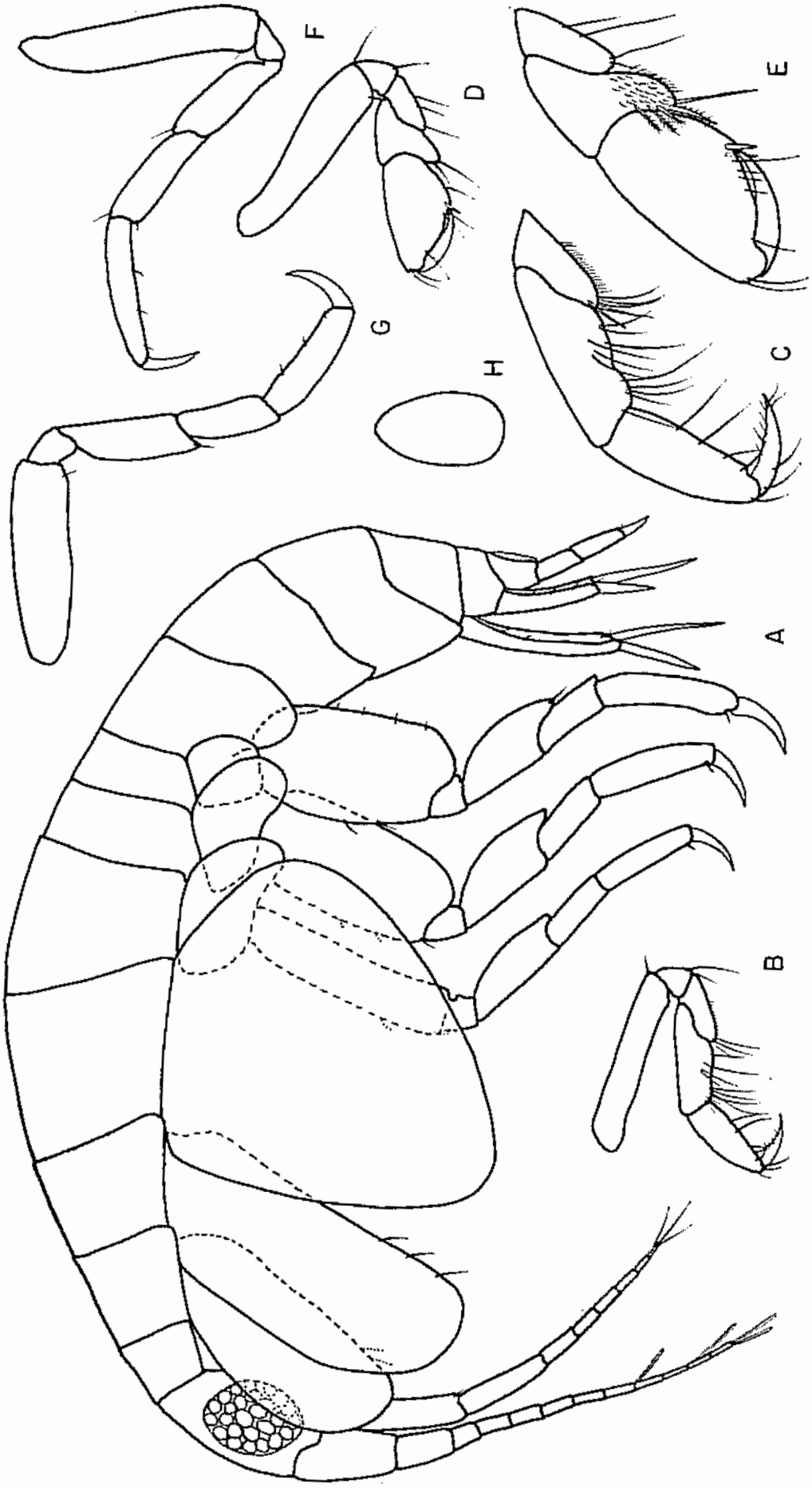

Fig. 9. *Stenula modosa*, n. sp. Female, holotype, 2.0 mm, sta. 4821: A, lateral view; B,C, gnathopod 1; D,E, gnathopod 2; F, G, peraeopods 1, 2; H, telson.

first article of ramus of uropod 3 longer than peduncle; uropod 3 lacking spines except for one at articulation of articles 1 and 2 of ramus; telson linguiform, unarmed; body not carinate.

MALE: Unknown.

HOLOTYPE: AHF No. 5728, female, 2 mm.

TYPE LOCALITY: Station 4821, near Pt. Conception, 34-25-48 N, 120-14-40 W, 50 fms, bottom of green mud, January 17, 1957.

MATERIAL: 3 specimens from 3 stations.

ECOLOGY: Recorded from depths between 31 and 50 fathoms.

RELATIONSHIP: This species resembles *Stenothoides angusta* Shoemaker (1955) by its large eyes, but differs by the shorter hind lobes on the fourth articles of peraeopods 3-5 which in *S. angusta* overextend and reach the ends of the fifth articles.

The simple first gnathopod of the new species distinguishes it from *S. carinatus* Gurjanova (1953), *S. arctica* Gurjanova (1951), *S. bassarginensis* Gurjanova (see Gurjanova 1951), and *S. serripes* Gurjanova (1955). It differs by its large eyes from *S. beringiensis* Gurjanova (1948), *S. ratmanovi* Gurjanova (1948), *S. ussuriensis* Gurjanova (1948), and *S. latipes* Chevreux and Fage (1925).

Only the female of the species is known, so that the size of the eyes is necessarily used to distinguish it from some of the species, but with the discovery of the male there may be other criteria available for distinction.

Genus **Metopa** Boeck

Metopa dawsoni, new species

Figs. 10, 11

DIAGNOSIS OF MALE: Gnathopod 1 with article 6 about half as long as article 5 and both articles with their edges parallel, its article 7 short, about a third as long as article 6, bearing 4-5 setules along inner margin, its article 2 slender, its article 4 not strongly produced behind; gnathopod 2 with nearly transverse palm defined by a large deflexed tooth which points medially when not flattened on the microscopic slide, its palm with a large excavation and a multitoothed process near finger hinge, its article 7 failing to reach the defining tooth, its article 3 produced anteriorly, its article 4 unusual in forming a thin, transparent process on the medial side of article 5 and bearing an anterior spine, its article 5 bearing minute denticulation along anterior edge; antenna 1 slightly longer than antenna 2; accessory flagellum forming a minute bump; coxa 4 not sinuate along lower margin; third pleonal epimeron slightly attenuated and quadrate at lower corner; telson with 3 lateral spines on each side; fourth article of peraeopods 4-5 stout.

FEMALE: Article 6 of gnathopod 2 longer than in the male, about two thirds as long as article 5; gnathopod 2 like that of male but principal palmar excavation much smaller, the defining tooth much smaller and not deflexed so that the palm is largely formed of the toothed portion seen

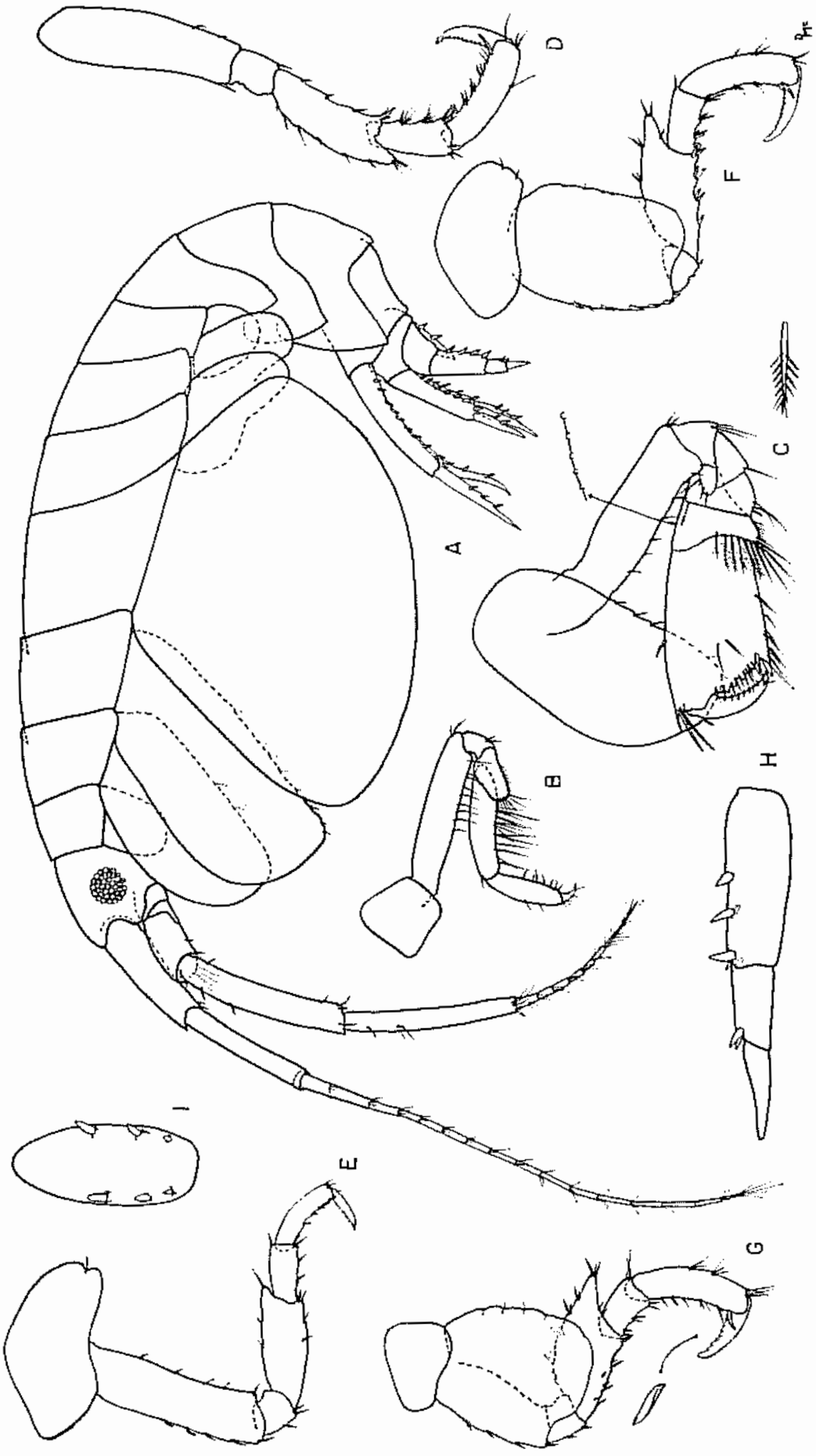

Fig. 10. *Metopa dawsoni*, n. sp. Female, 3.8 mm, sta. 5828: A, lateral view; B,C, gnathopods 1, 2; D,E,F,G, peraeopods 2, 3, 4, 5; H, uropod 3; I, telson.

in the male, the finger nearly reaching end of palm, its article 3 more strongly produced than in male.

HOLOTYPE: AHF No. 598, male, 3.0 mm.

TYPE LOCALITY: Station 6098, off Pt. Fermin, 33-38-45 N, 118-14-45 W, 24 fms, February 19, 1959.

MATERIAL: 36 specimens from 12 stations.

RELATIONSHIP: The genus *Metopa* is large, with 46 species. A key to

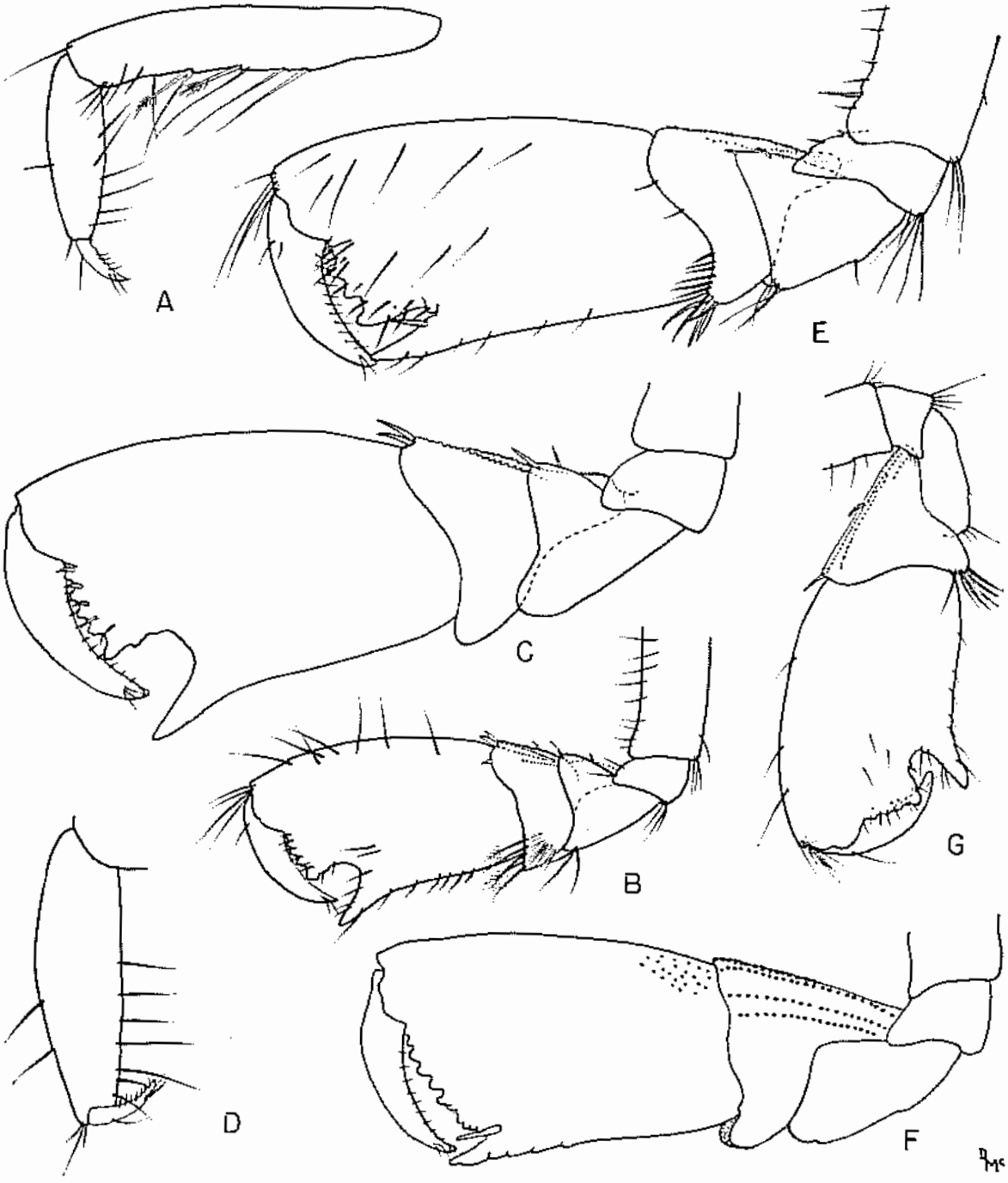

Fig. 11. *Metopa dawsoni*, n. sp. Male, 4.3 mm, sta. 6105: A,B,C, gnathopods 1, 2, 2. Female, 3.8 mm, sta. 5828: D,F, gnathopods 1, 2. Female, 5.0 mm, sta. 6132: E, gnathopod 2. Male, holotype, 3.0 mm, sta. 6098: G, gnathopod 2.

the species was published by Gurjanova (1951). The genus *Prometopa* Schellenberg (1926) was referred to *Metopa* by Gurjanova (1948) but separated in her generic key again in 1951. *Prometopa* differs from *Metopa* by the presence of an indistinctly biarticulate accessory flagellum. The new species herein has a minute, 1-jointed accessory flagellum. By retaining the genus *Prometopa*, it is possible to state that the genus *Metopa* is confined to the northern hemisphere.

Metopa dawsoni differs from several other species in the genus by minor characteristics as follows: From its closest relative, *Metopa wiesei* Gurjanova (see 1951), it differs by the different angle of projection of the last tooth on the finger-hinge process of male gnathopod 2, (in *M. wiesei* it projects posteriorly whereas in *M. dawsoni* it projects distally) and by the much more elongated fifth article of gnathopod 1 and shorter article 7. From *Metopa alderi* (Bate) (see Sars 1895: pl. 86) it differs by the much more elongated fifth article of gnathopod 1, with more slender sixth article, the shorter seventh article, and the presence of telsonic spines. In gnathopod 1, *M. dawsoni* differs in like respect from *M. spectabilis* (see Sars 1895: pl. 87) and *M. boeckii* (see Sars 1895: pl. 88). The female of *M. dawsoni* resembles closely the female of *M. robusta* Sars (1895: pl. 96, fig. 1) but differs by the stouter first gnathopod and less strongly produced fourth articles of peraeopods 4-5.

ECOLOGY: This species has an overall density of 0.9 animals per square meter on the coastal shelf. It ranges in depth from 31 to 100 fathoms.

Genus Metopella Sars

Metopella nasutigenes (Stebbing 1888) should be transferred to the genus *Probolisca*, because of its biarticulate first maxillary palp.

Metopella aporpis, new species
Figs. 12, 13

DIAGNOSIS OF MALE: Articles of antenna 1 not produced; article 6 of gnathopod 1 shorter than article 5, simple, its edges parallel, its posterior edge with 4-5 long setae; article 7 of gnathopod 1 half as long as article 6, with 3-4 setae on posterior edge; palm of gnathopod 2 oblique, formed of a shallow quadrate excavation bounded on both sides by a long, sharp tooth, the posterior one forming the defining tooth, the anterior tooth being an extension from a minutely toothed process near the finger hinge; gnathopod 2 with article 7 nearly reaching end of palm, its article 4 forming a medial translucent lobe projecting anteriorly and appressed to the side of article 5, the anterior edge of article 5 with rows of minute denticles; peraeopod 1 much longer than peraeopod 2 and poorly spinose, peraeopod 2 having numerous stout posterior spines on article 5 and 6; telson with 2 lateral spines on each side near base.

Mandibular palp long, apparently biarticulate; first maxillary palp uniarticulate.

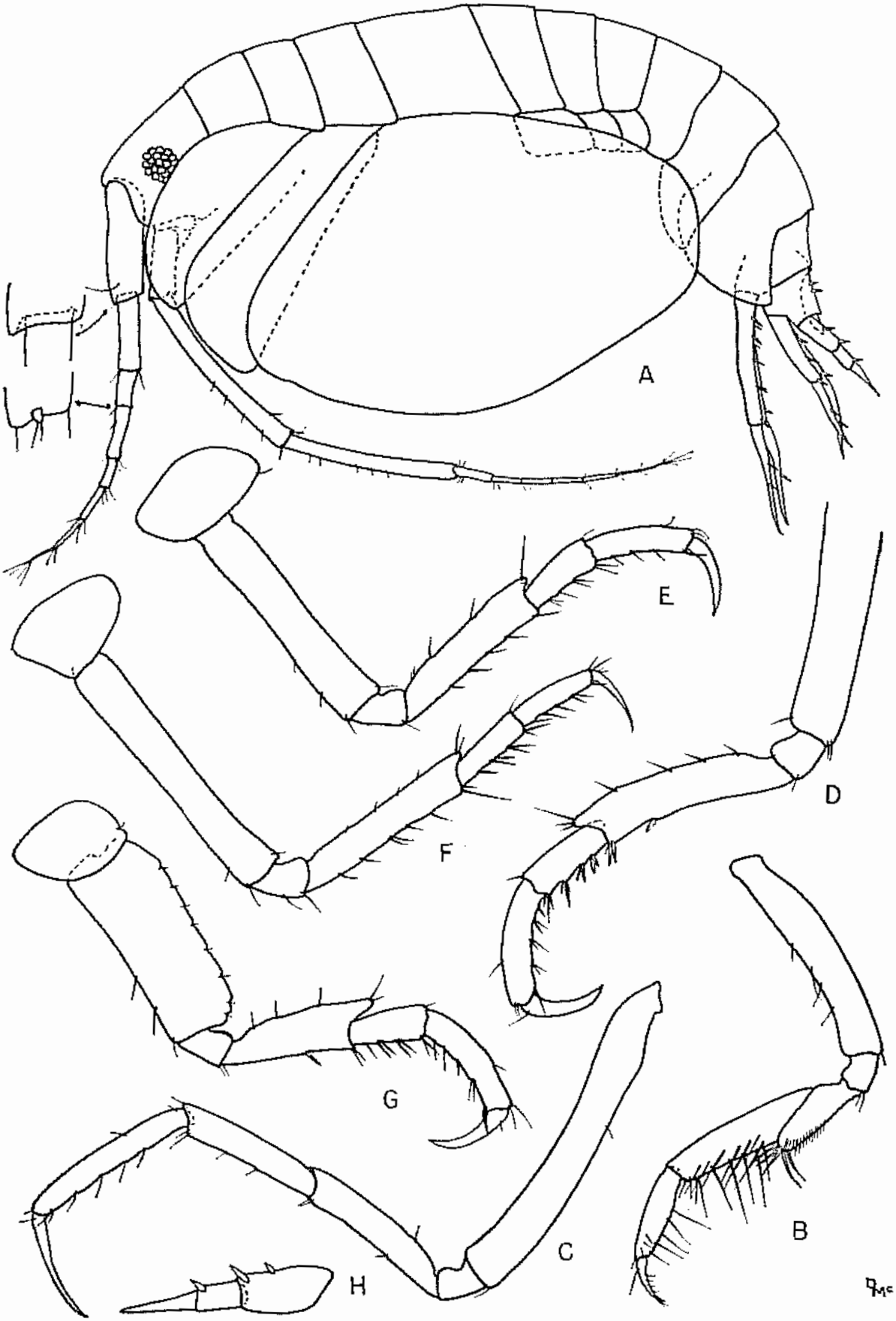

Fig. 12. *Metopella aporpis*, n. sp. Male, holotype, 2.4 mm, sta. 4834: A, lateral view; B, gnathopod 1; C,D,E,F,G, peraeopods 1, 2, 3, 4, 5; H, uropod 3.

FEMALE: Gnathopod 2 with palm oblique, irregularly toothed, with one large medial tooth and a large defining tooth, the finger failing to reach end of palm; telson with 4 spines on each side near base.

HOLOTYPE: AHF No. 5729, male, 2.4 mm.

TYPE LOCALITY: Station 4834, near Pt. Mugu, 34-00-20 N, 119-01-45 W, 77 fms, rock bottom, February 6, 1957.

RELATIONSHIP: This species is closely related to *Metopella pacifica* (Holmes 1908), from Monterey, California, but differs by the simple, not subchelate, first gnathopod. The resemblance of second gnathopods is amazing, and one wonders if the configuration of gnathopod 1 as drawn for *M. pacifica* were correct.

The new species differs from *M. buynitzkii* Gurjanova (see 1951), *M. macrochira* Gurjanova (see 1951) and *M. carinata* (Hansen) (Gurjanova 1951) by the elongated fifth article of gnathopod 1 and by the quite different configuration of male gnathopod 2. It differs from *M.*

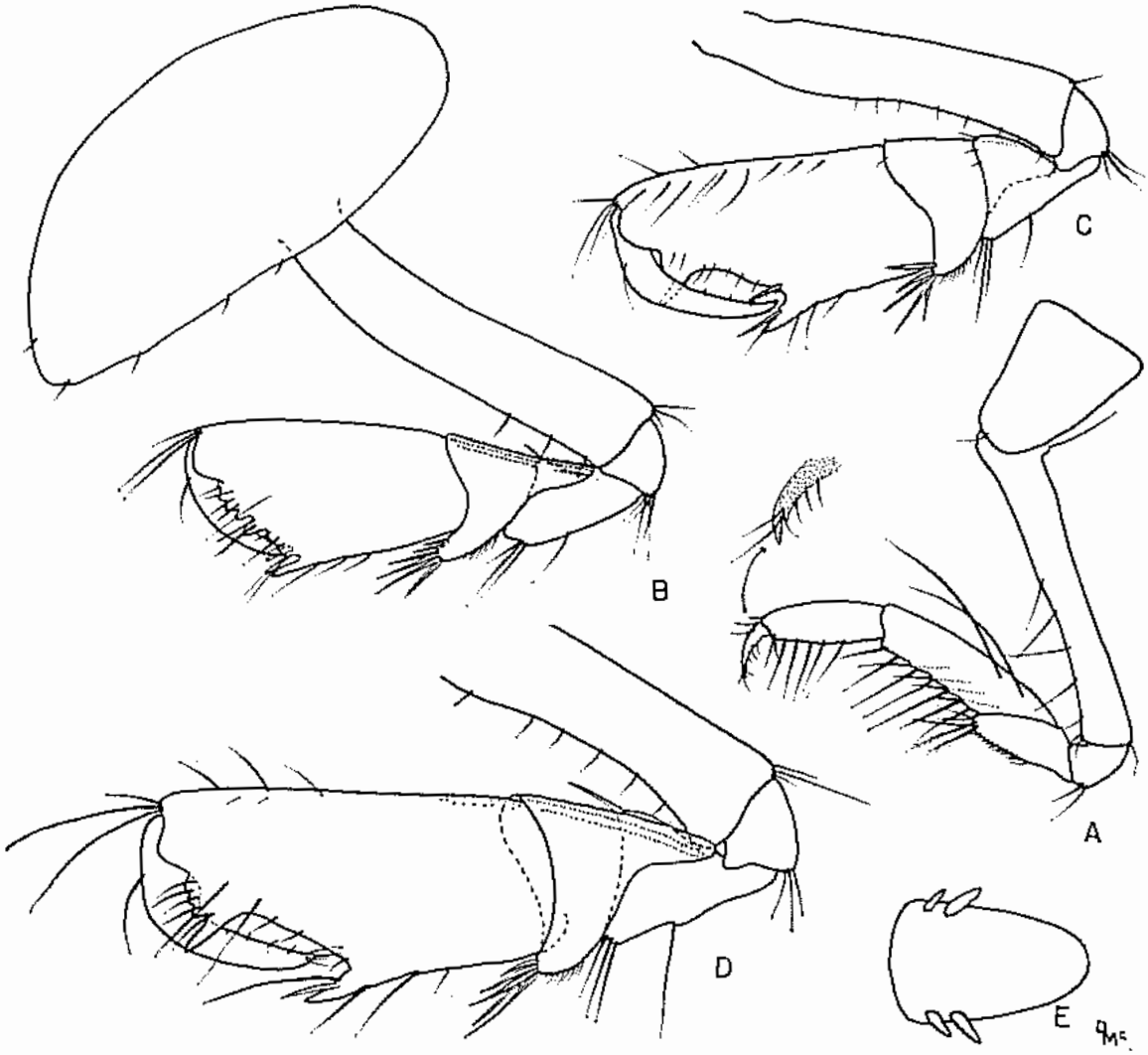

Fig. 13. *Metopella aporpis*, n. sp. Female, 2.5 mm, sta. 4834: A,B, gnathopods 1, 2. Male, holotype, 2.4 mm: C,D, medial and lateral view of gnathopod 2; E, telson.

nasuta (Boeck) (in Sars 1895) by the unproduced first article of antenna 1; from *M. neglecta* (Hansen) (see Sars 1895) by the parallel edges of article 2 on peraeopod 5; from *M. longimana* (Boeck) (see Sars 1895) by the second male gnathopod, which in *M. longimana* has a nearly transverse palm; and from *M. angusta* Shoemaker (1949) by the palmar processes on male gnathopod 2.

MATERIAL: 5 specimens from 3 stations.

ECOLOGY: Known from 2 stations in southern California at depths of 46 and 77 fms and from Monterey Bay at 14 fms.

Parametopella Gurjanova

Gurjanova 1938: 281; Gurjanova 1951: 478.

DIAGNOSIS: Mandible lacking palp; palp of maxilla 1 uniarticulate; second articles of peraeopods 3-5 slender, not expanded.

Barnard's (1958) Index erred in listing *Stenothoe minuta* Holmes (1905) as having been transferred to *Parametopella* by Gurjanova (1948). This was a technical error, and *S. minuta* rightly belongs in *Stenothoe*.

Parametopella ninis, new species

Figs. 14, 15

DIAGNOSIS OF FEMALE: Gnathopod 1 slender, simple, its articles 5 and 6 equal in length, the hind margin of article 6 with 4 slender setae, the hind margin of article 7 with 3 slender setae; gnathopod 2 small, slender, its article 5 nearly two thirds as long as article 6, with broad hind lobe, becoming subacute at apex, the palm oblique, straight, defined by 2 spines; articles of antennae simple, not produced; telson with 2 lateral spines on each side.

MALE: Unknown.

HOLOTYPE: AHF No. 586, female, 1.9 mm.

TYPE LOCALITY: Station 5711, Santa Monica Bay, 33-55-54 N, 118-31-16 W, 31 fms, April 18, 1958.

RELATIONSHIP: This species differs from *P. stelleri* (see Gurjanova 1951) by the more slender first gnathopod, the slimness of the posterior setae of article 6, and the unproduced articles of the antennae as well as the second gnathopods which are known for the male in *P. stelleri*. It differs from *P. cypris* (Holmes 1905: 484) by the slightly longer fifth article of gnathopod 2 which has a broad hind lobe, not a slender, apically rounded, slightly constricted lobe as seen in *P. cypris*.

The writer cannot clearly discern the line separating urosome segments 5 and 6. Despite the large number of specimens no male was found; all specimens have brood plates.

MATERIAL: 37 specimens from 24 stations.

ECOLOGY: This species has an overall density of 0.5 animals per square meter on the coastal shelf. It is restricted to depths between 31 and 100 fathoms.

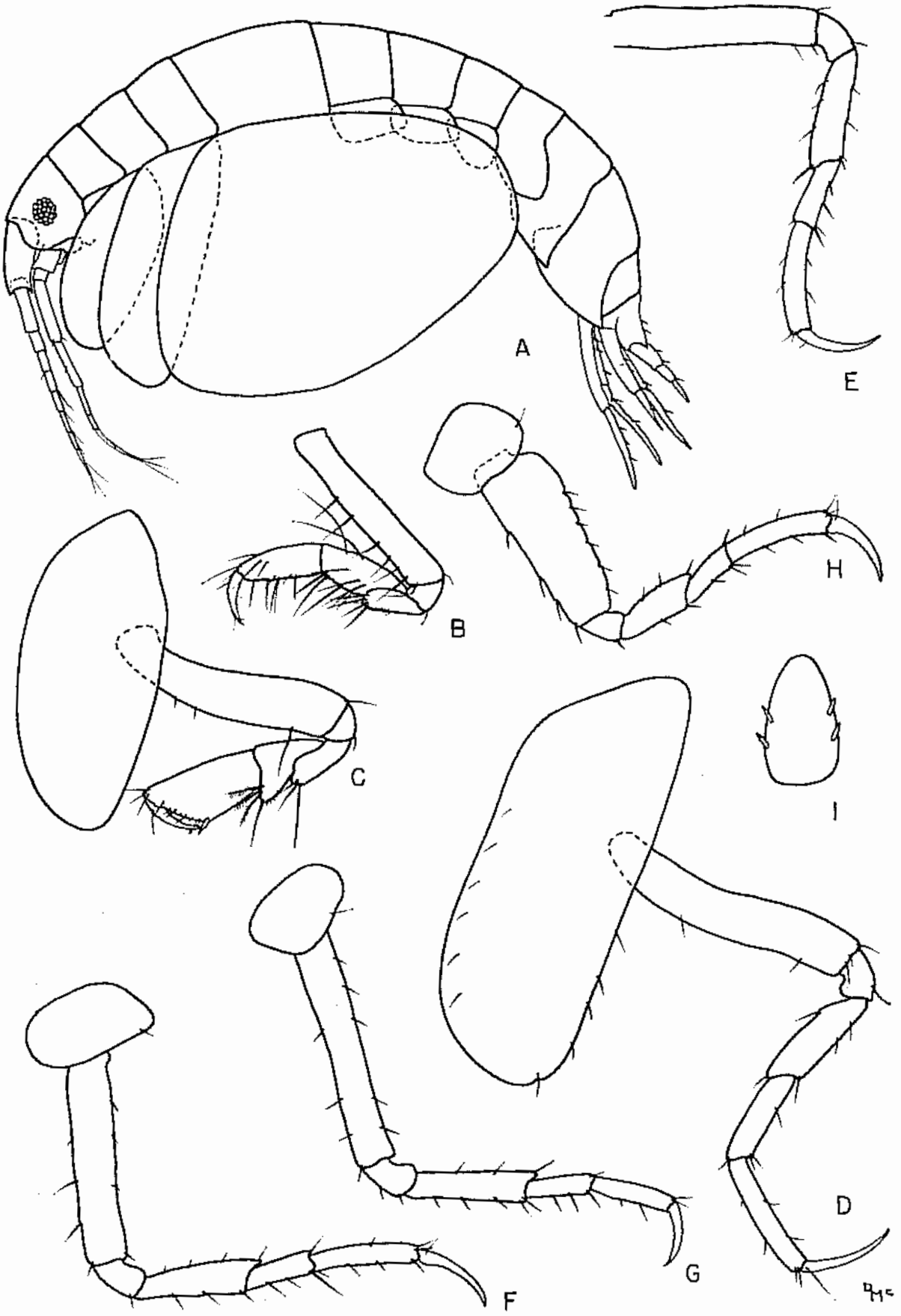

Fig. 14. *Parametopella ninis*, n. sp. Female, holotype, 1.9 mm, sta. 5711: A, lateral view; B,C, gnathopods 1, 2; D,E,F,G,H, peraeopods 1, 2, 3, 4, 5; I, telson.

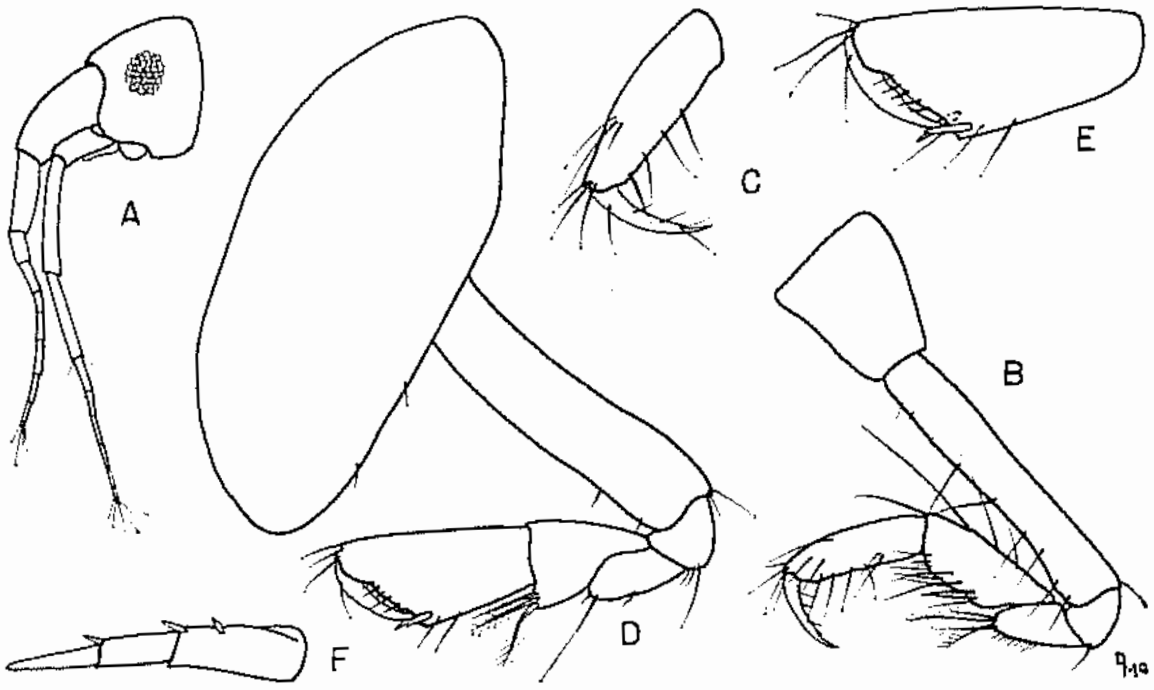

Fig. 15. *Parametopella ninis*, n. sp. Female, 2.8 mm, sta. 5163: A, head; B,C, gnathopod 1; D,E, gnathopod 2; F, uropod 3.

Genus Proboloides Della Valle

Proboloides tunda, new species

Fig. 16

DIAGNOSIS: Eyes absent; antennae quite long; article 2 of first antenna 1.6 times as long as article 1; accessory flagellum absent; first gnathopod with article 6 three fourths as long as article 5, bearing a distinct palm which is defined by a group of 5 stout dispersed spines, its article 4 not strongly produced; gnathopod 2 with medial side of article 3 sharply produced forward, its article 4 with a sharp distally produced tooth, its article 6 of intermediate slenderness, its palm quite distinct, oblique, shorter than hind margin of article 6, with a flat-bottomed excavation for half its length, the entire length sculptured into head-like processes, defined by a slight process bearing 2 spines; fourth articles of peraeopods 3-5 narrow, scarcely produced; telson with 3 lateral spines on each side.

Palp of mandible triarticulate, palp of maxilla 1 biarticulate.

HOLOTYPE: AHF No. 5910, male, 5 mm; no brood plates, no penial projections.

TYPE LOCALITY: Station 6809, off Santa Cruz Island, 33-54-39 N, 119-46-24 W, 302 fathoms, December 22, 1959, bottom of shale, mud, sand.

MATERIAL: Station 6809, (3 specimens; the two besides the holotype are in fragments).

RELATIONSHIP: Most species of *Proboloides* are distributed in the

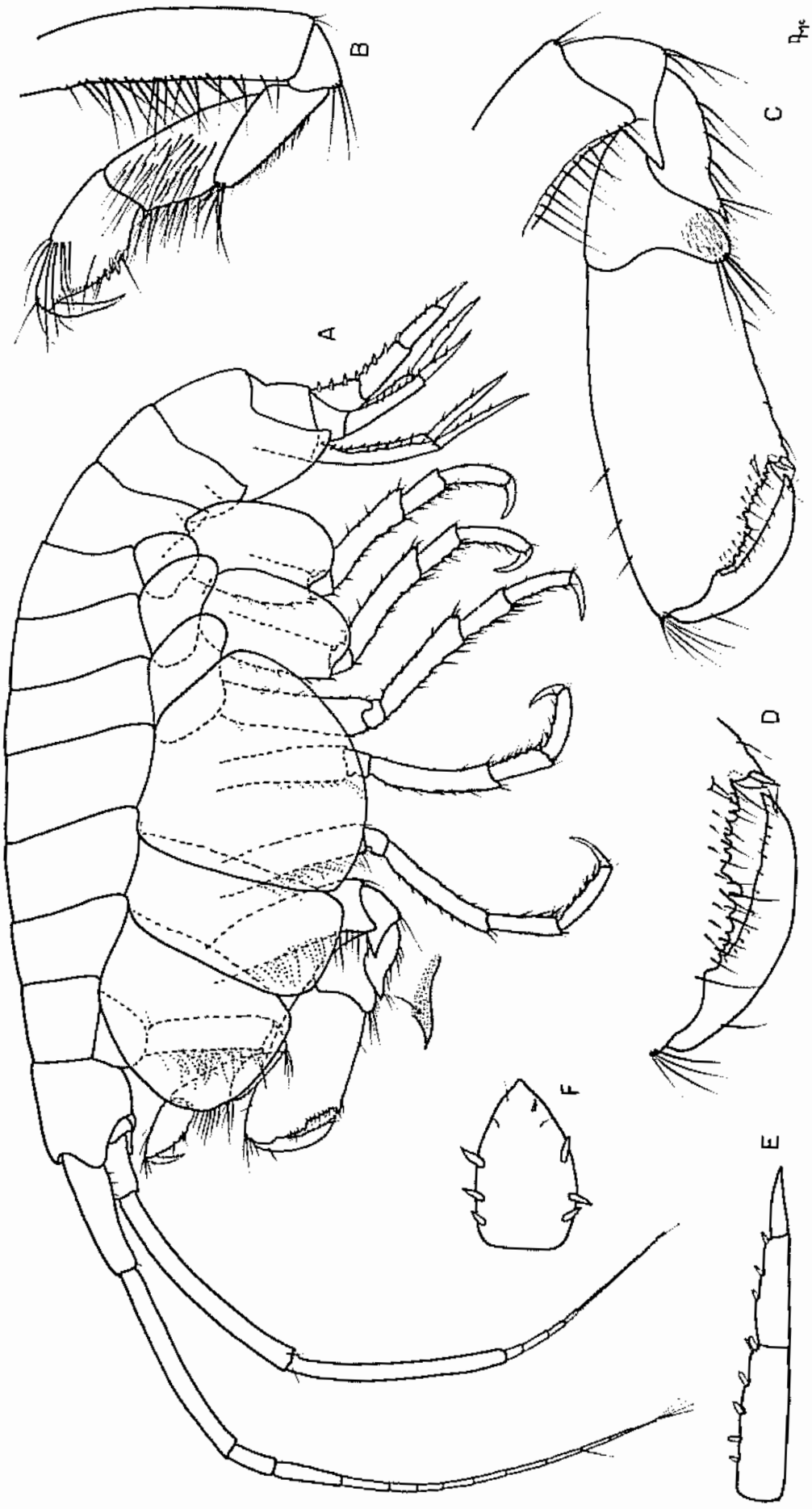

Fig. 16. *Proboloides tunda*, n. sp. ♂Male, holotype, 5.0 mm, sta. 6809: A, lateral view; B,C,D, gnathopods 1, 2, 2; E, uropod 3; F, telson.

southern Hemisphere and most of them belong to the subgenus *Metopoides* which has a small accessory flagellum. In the northern Hemisphere apparently the only other species to have the narrow, unproduced fourth article of peraeopod 3 is *P. grandimanus* (Bonnier 1896, Bay of Biscay, 950 m) another deep water species like the present one. Bonnier has drawn that species with an eye on one drawing and none on the other, and mentions small round eyes in his description, but one wonders whether this might be part of the brain which resembles an eye on the present specimens. The second gnathopods of the new species differ considerably from those of *P. grandimanus*, and the latter is aberrant for its large first coxa and small second one.

Genus Stenothoe Dana

Stenothoe estacola, new species

Fig. 17

DIAGNOSIS OF MALE: Gnathopod 1 with article 4 scarcely projecting behind, with article 6 almost twice as long as article 5, the palm quite oblique but well defined by 3 spines; gnathopod 2 rather small, stout, its article 6 not elongated, the palm oblique but well defined by a large shallow bump and with 3 small blunt cusps; telson with 3 lateral spines on each side; back not carinate; peduncle of uropod 3 shorter than ramus, the second article of ramus straight, armed with rows of minute serrations; fourth articles of peraeopods 3-5 of intermediate expansion.

FEMALE: Gnathopod 1 like that of male; gnathopod 2 smaller and more slender than in male, the palm lacking ornamentation, longer than hind margin of article 6 but well defined by several spines.

HOLOTYPE: AHF No. 556, male, 3.0 mm.

TYPE LOCALITY: Barnard sta. 6, Corona del Mar, California, February 6, 1955, intertidal wash of crustaceans from reef-like beds built by the polychaete worm, *Phragmatopoma* sp.

MATERIAL: Barnard stas. 4 (29), 6 (22), 23 (1).

RELATIONSHIP: This species differs from *Stenothoe monoculoides* (Montagu) (see Sars 1895: pl. 82, fig. 1, and Chevreux and Fage 1925: fig. 132) by the stouter male second gnathopod, its palm being armed with short cusps and by the multispinose telson; the female differs by its longer palm of gnathopod 2; from *S. brevicornis* Sars (1895: pl. 82, fig. 2) it differs by the shorter peduncle of uropod 3 and the less produced fourth article of gnathopod 1. From *S. barrowensis* Shoemaker (1955) it differs by the relatively elongated sixth article of gnathopod 1 and the stouter second gnathopod with larger and fewer palmar cusps. From *S. adhaerans* Stebbing (1888: pl. 39) it differs by the defining spines on the palm of female gnathopod 2 and the much shorter peduncle of uropod 3.

ECOLOGY: An intertidal species recovered from Corona del Mar and Pt. Fermin in formalin washings of 3 kinds of materials, sponge (*Sphecio-spongia* sp.), beds of arenaceous encrusting polychaete, *Phragmatopoma* sp., and in calcareous algae.

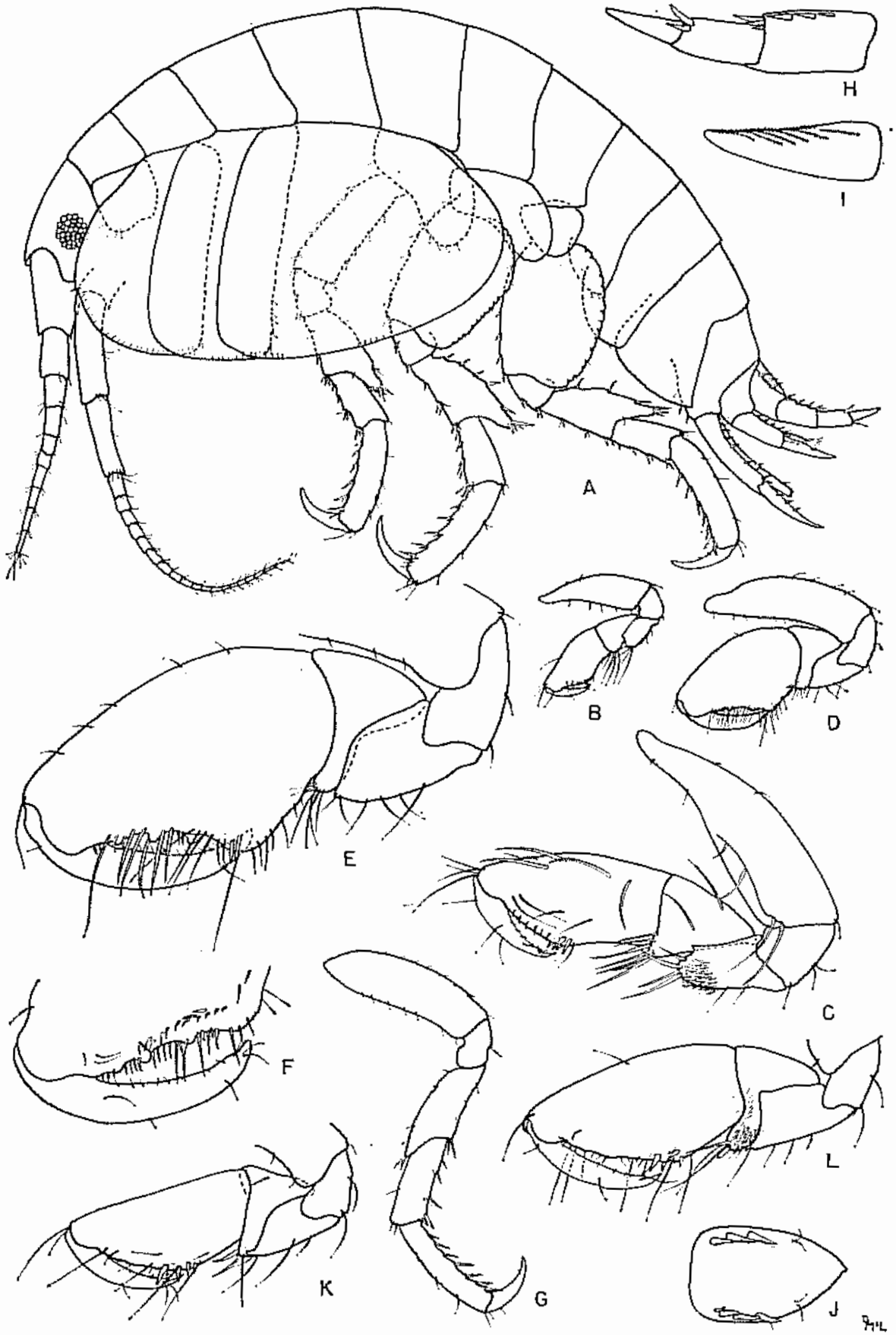

Fig. 17. *Stenothoe estacola*, n. sp. Holotype, male, 3.0 mm, Barnard sta. 6: A, lateral view; B,C, gnathopod 1; D,E,F, gnathopod 2; G, peraeopod 1; H, uropod 3; I, detail of second ramal article of uropod 3; J, telson. Female, 2.0 mm; K,L, gnathopods 1, 2.

Stenothoe frecanda, new species

Fig. 18

DIAGNOSIS: Article 4 of gnathopod 1 strongly projecting distally and behind; gnathopod 2 with palm and hind margin contiguous, bearing near finger hinge a small tent-shaped process with 2 small ones distal to it (these less well developed in female), the palm lined with short setae, not denticulate, with article 7 as long as article 6, stout, lined on inner edge with short setae; telson with 3 lateral spines on each side; back not carinate; second article of ramus on uropod 3 straight, not geniculate, the peduncle slightly longer than ramus; fourth articles of peraeopods 3-5 of intermediate expansion.

HOLOTYPE: AHF No. 587, male, 3.6 mm.

TYPE LOCALITY: Station 5632, off San Mateo Pt., 33-22-50 N, 117-39-00 W, 36 fms. February 22, 1958.

MATERIAL: 23 specimens from 6 stations.

ECOLOGY: This species has an overall density of 0.3 animals per square meter on the coastal shelf, but is confined to depths of 35-50 fathoms where its frequency is 0.8 animals per square meter.

RELATIONSHIP: This species is related to *Stenothoe valida* Dana (see J. L. Barnard 1953) but differs by the distal palmar teeth of gnathopod 2 projecting perpendicularly to the palmar axis rather than obliquely from it. It differs from *S. marina* (Bate) (see Sars 1895: pl. 80) by the terminally stout finger of the gnathopods and by the greater similarity between male and female second gnathopods, as well as the non-denticulate condition of the palms.

Family ARGISSIDAE

Genus Argissa Boeck

Argissa hamatipes (Norman)

Argissa typica Boeck, Sars 1895: 141-142, pl. 48.
Argissa hamatipes, Walker 1904: 246; Stebbing 1906: 277; Shoemaker 1930: 37-40, figs. 15-16; Stephensen 1931: 261; Stephensen 1935: 140; Stephensen 1940: 41; Stephensen 1944: 52; Gurjanova 1951: 327-328, fig. 193.

MATERIAL EXAMINED: 307 specimens from 99 stations.

ECOLOGY: This is the first eastern Pacific record. The species has an overall density of 2.4 specimens per square meter on the coastal shelf. Considering its past records of occurrence in relatively deep cold temperate waters it is strange that the species is predominatntly shallow in southern California. The following table shows the density per square meter in several depth classes:

Depth class, fms.	10	20	30	40	50	100
Density/sq. m.	11.2	5.7	1.7	1.6	0.5	1.1

DISTRIBUTION: North Atlantic in Gulf of St. Lawrence; Kattegat and northern Britain north to Kola Bay; Greenland; Chuckchi, Bering, Okhotsk and Japan Seas; California; 4-1096 m.

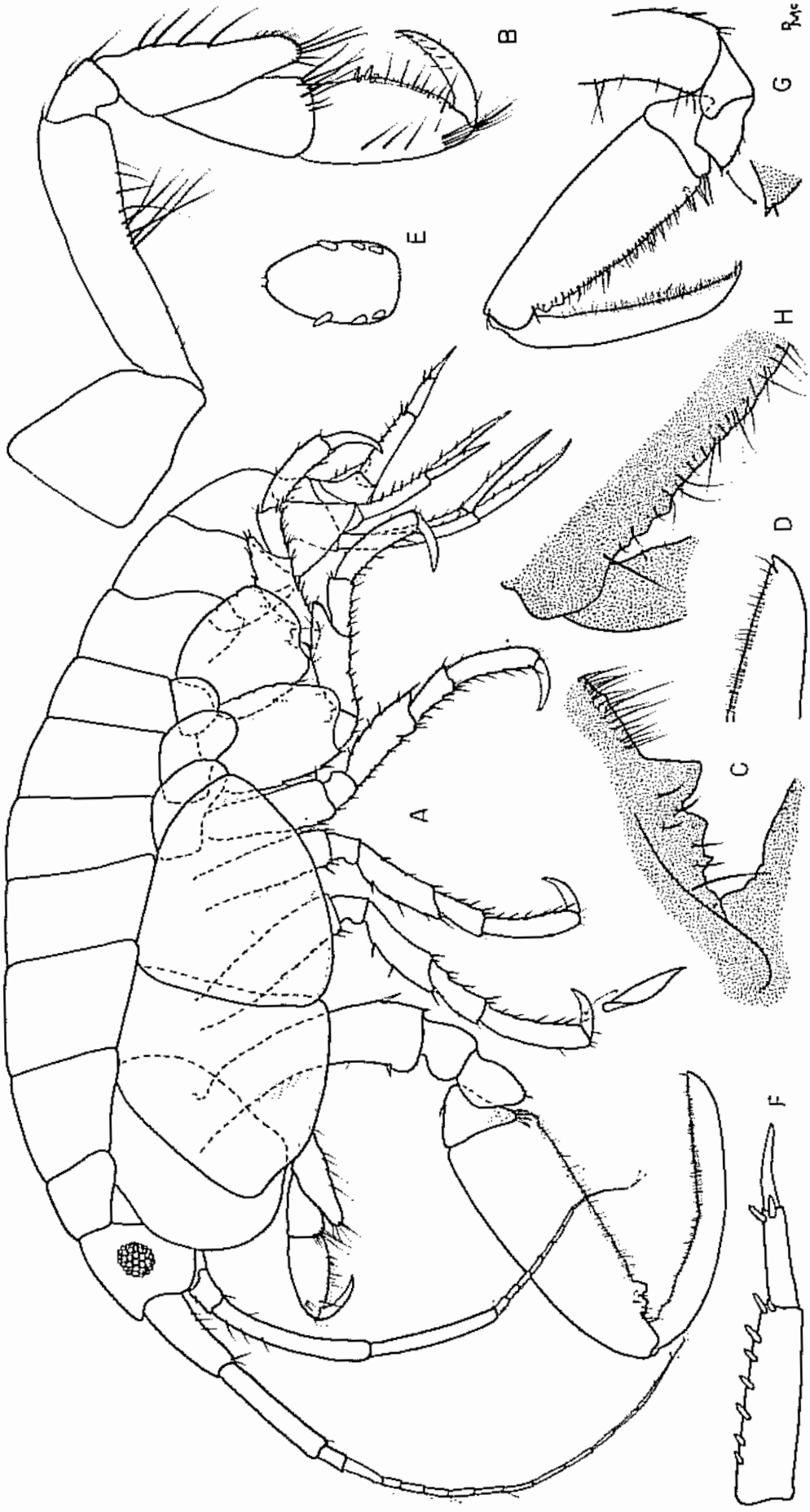

Fig. 18. *Stenothoe frecanda*, n. sp. Male, 4.0 mm, sta. 6001: A, lateral view; B, gnathopod 1; C, palmar teeth of gnathopod 2; D, apex of article 7 of gnathopod 2; E, telson; F, uropod 3. Female, 4.0 mm, sta. 4935: G, gnathopod 2; H, palmar teeth of gnathopod 2.

Family HYALIDAE

Bulycheva (1957) split this family and the Hyalellidae away from the Talitridae but did not firmly assign all of the talitrid genera to the three resulting families, as noted by J. L. Barnard (1958). She continued the fusion of *Parhyale* and *Parallorchestes* made by Gurjanova (1951), although the type of *Parallorchestes* (*P. ochotensis*) clearly bears a biarticulate first maxillary palp in contrast to the uniarticulate palp of *Parhyale*.

The family Hyalidae differs from the Talitridae, according to Bulycheva, by the uniarticulate first maxillary palp and other rather quantitative features involving first antennae, maxillipeds, branchiae and habitat. Clearly *Parallorchestes* transcends Hyalidae and Talitridae by its coincidental possession of a biarticulate first maxillary palp and a long, unguiform fourth maxillipedal palp article. It is clearly related to *Parhyale* and Hyalidae, however, in all other features except for the first maxillary palp. Unfortunately, the use of such a character as a primary point of segregation is weak when some genera lack such a palp altogether. Other students of the Talitridae have not yet published confirmation or rebuttal of Bulycheva's ideas, so the writer continues to use Bulycheva's familial designation but believes *Parallorchestes* should be segregated from *Parhyale*. As such, *Parallorchestes* is monotypic, since *Parhyale zibillina* Derzhavin has a uniarticulate first maxillary palp (see Bulycheva 1957), although Shoemaker (1956) believed it possible that *P. zibillina* was a *Parallorchestes*.

Genus Hyale Rathke

Hyale nigra (Haswell), new synonymy

Figs. 19, 20

Allorchestes niger Haswell 1879: 319-320; Haswell 1885: 96, pl. 11, figs. 1-3.
Hyale niger, Stebbing 1906: 571; Schellenberg 1928: 659-661, fig. 204; K. H. Barnard 1937: 162-163; Ruffo 1938: 170.
Allorchestes frequens Stout 1913: 650-651.
Hyale frequens, Shoemaker 1941: 187; Shoemaker 1942: 17; Hewatt 1946: 199; J. L. Barnard 1952: 23; J. L. Barnard 1954: 23.

DIAGNOSIS OF MALE: Body not carinate; antenna 2 about half as long as body, slender, not heavily setose; antenna 1 exceeding peduncle of antenna 2; gnathopod 1 with article 5 showing the posterior lobe moderately well defined and projecting, more so than described by Schellenberg (1928), with article 6 rectangular, elongated, not expanding distally, the hind edge with slight declivity armed with setae, the palm oblique and scarcely distinct but defined by a pair of stout spines, with article 7 short, stout; gnathopod 2 with article 2 bearing a large, rounded distal lobe, its article 3 with large anterior lobe, its article 6 large, less than twice as long as broad, the palm oblique, shorter than hind margin of article 6, lined with spines, not defined by a spine, the hind margin of article 6 with 2 small declivities, with article 7 stout, fitting palm; peracopods lacking a distinctly large serrated distal spine on article 6, the hind

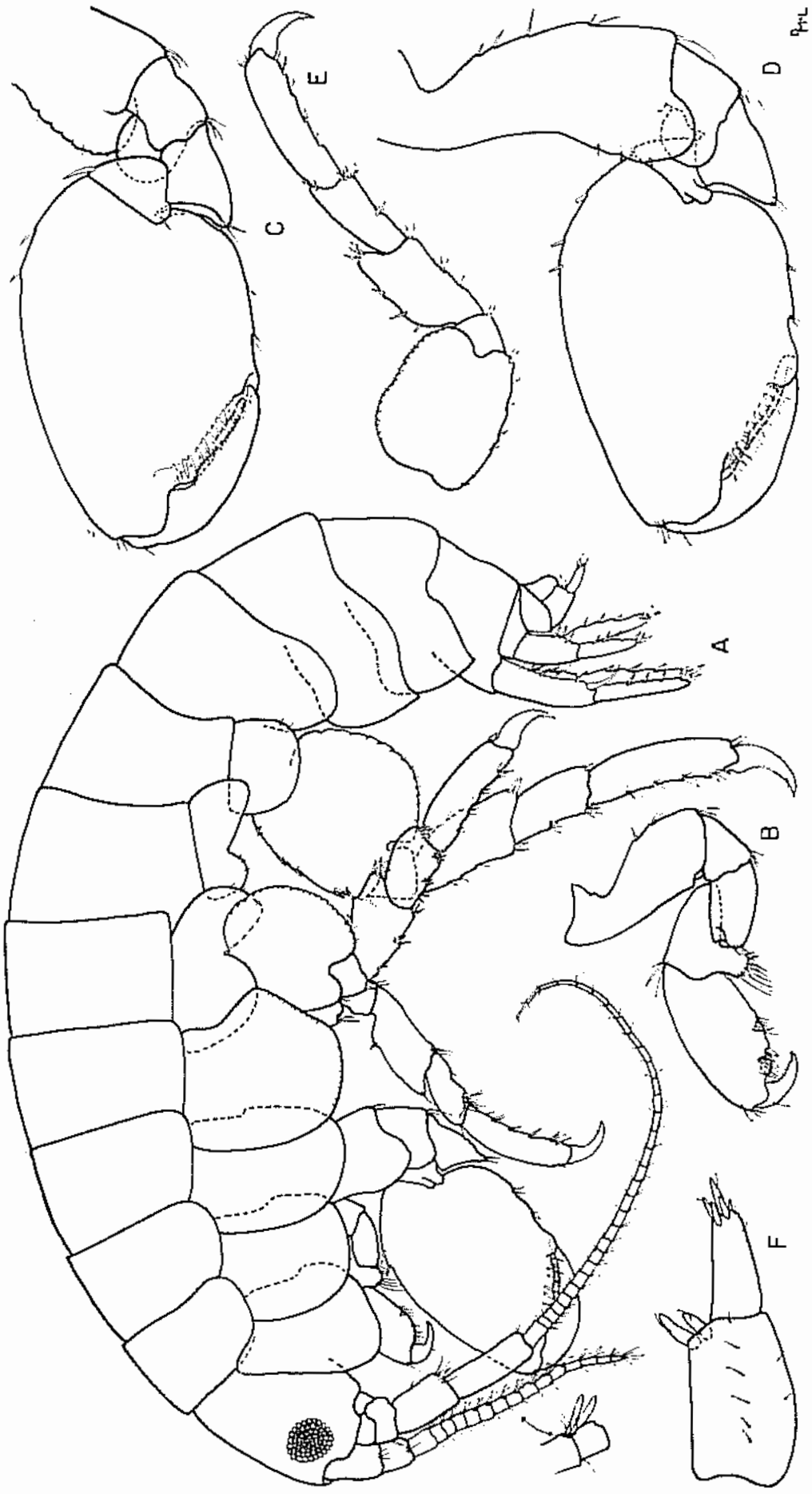

Fig. 19. *Hyale nigra* (Haswell). Male, 9 mm, Barnard sta. 32: A, lateral view; B, gnathopod 1; C,D, gnathopod 2; E, peraeopod 4; F, uropod 3.

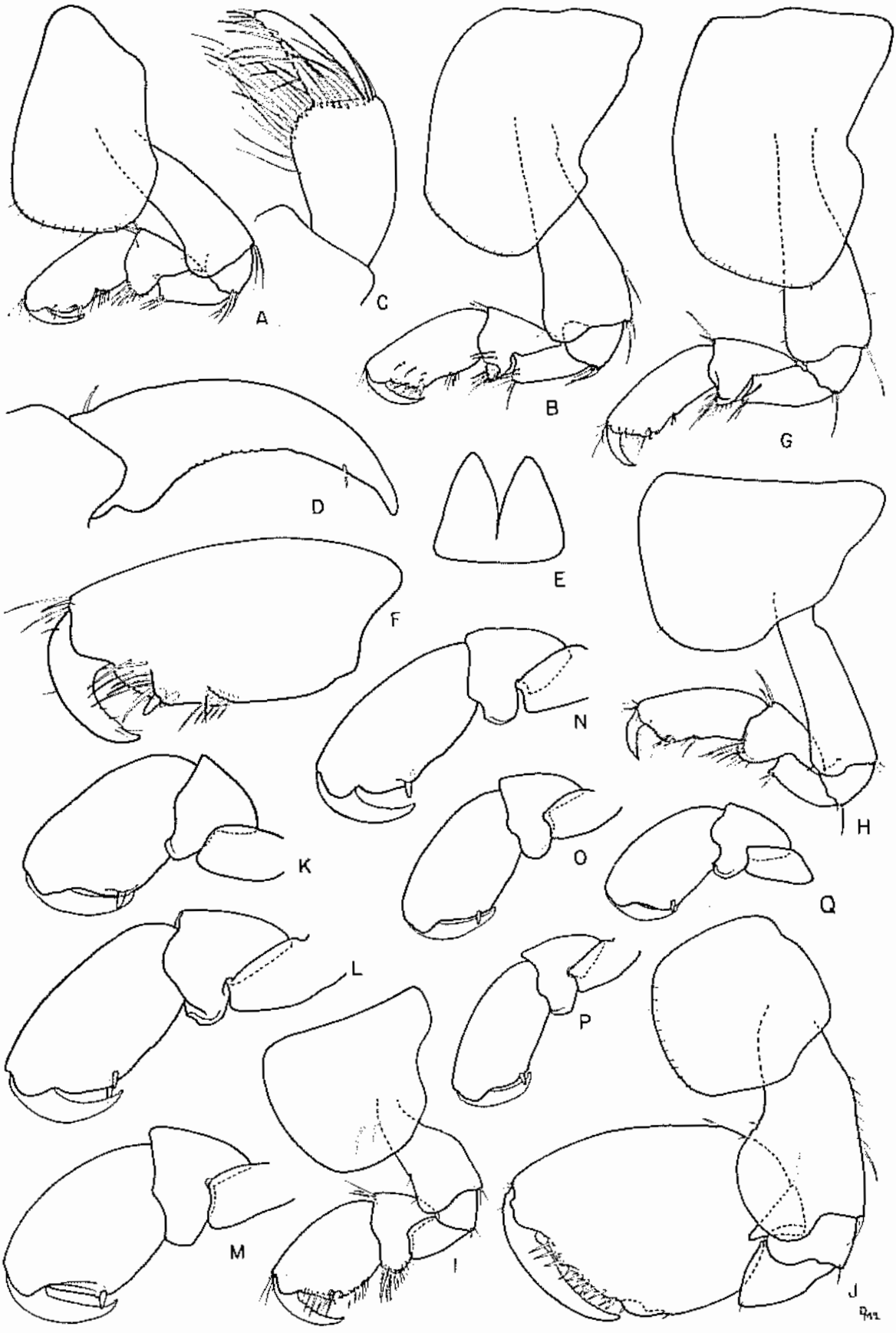

Fig. 20. *Hyale nigra* (Haswell). Female, 7 mm, Barnard sta. 32: A,B, gnathopods 1, 2. Male, 9 mm: C, end of maxillipedal palp; D, dactyl of peraeopod 5; E, telson; F, end of gnathopod 1. Female, 4 mm, Barnard sta. 24: G,H, gnathopods 2, 1. Male, 5 mm, Barnard sta. 24: I,J, gnathopods 1, 2. K,L,M,N,O,P,Q, gnathopod 1 of various males from southern California.

edges of sixth articles on peraeopods 3-5 lacking setae; dactyls very minutely pectinate on inner edges and bearing a minute distal seta; article 4 of maxillipedal palp with short, not long apical setae. Length 9.0 mm.

FEMALE: Gnathopods 1-2 like first gnathopod of male, but sixth articles more slender, the posterior declivity less setose.

REMARKS: The identification is based on Schellenberg's figures and description of the species; he compared his Red Sea specimens with some from Australia, the type area of the species. Except for the slightly better defined hind lobe of article 5 on gnathopod 1 the present specimens correspond well with Schellenberg's study.

This is the first record of this species from the eastern Pacific Ocean.

VARIANTS: In southern California some sexually mature male specimens of 4-5 mm length, mixed with specimens as described above, have the sixth article of the first gnathopod much stouter with a longer palm and longer seventh article (fig. 20 I). The hand of the second gnathopod also is stouter, shorter, and bears only one posterior declivity. The writer is inclined to believe that these are phenotypes since intermediacy can be seen in the stoutness of this article (Figs. 20 K-Q). When comparing microscopically other features of animals from the two populations there is good correspondence in all minor details, such as lengths of antennae, shapes of segments on appendages and uropods, and minute details of spination. I believe that Stout's description of *Allorchestes frequens* applies to the form bearing a slender first gnathopod, so that if breeding studies show the stout form to be a race of the species it will require a new name. The temporary acceptance of the stout form as a variety of *H. nigra* may well have systematic consequences on other species of *Hyale* since the shape of the sixth article of the first gnathopod is supposed to remain relatively uniform. The palm of gnathopod 2 in both stout and slender forms has near the finger hinge a small flat process which is scarcely distinguishable; in preserved specimens it appears distinctly pigmented with yellow-ochre and so is more conspicuous than as drawn herein.

MATERIAL: 2200 specimens from 26 intertidal samples, ranging from Dillon Beach (Marin County, central California) to La Jolla, California, and points in between such as Morro Bay (open coast), Pt. Fermin, Corona del Mar and Laguna Beach; particularly abundant on *Phyllospadix* roots, *Egregia* and coralline algae, and also collected from the sponge *Leucetta losangelensis*. Collectors: J. L. Mohr, R. J. Menzies, E. Y. Dawson and the writer in the years 1947 to 1960.

Also collected from 2 subtidal samples in southern California in depths of 12-20 feet (2 specimens).

DISTRIBUTION: Australia; Arabian Sea; Red Sea; Mediterranean; California.

Genus Najna Derzhavin

Najna ?consiliorum Derzhavin

Figs. 21, 22

Derzhavin 1937: 97, pl. 6, fig. 2 (not seen); Gurjanova 1951: 826-827, fig. 578.

REMARKS: I have figured this species completely because of discrepancies between the specimens at hand and the figures and description of Gurjanova (1951), the only reference I have to this species. These discrepancies are the shorter fourth palp article of the maxilliped, the shorter

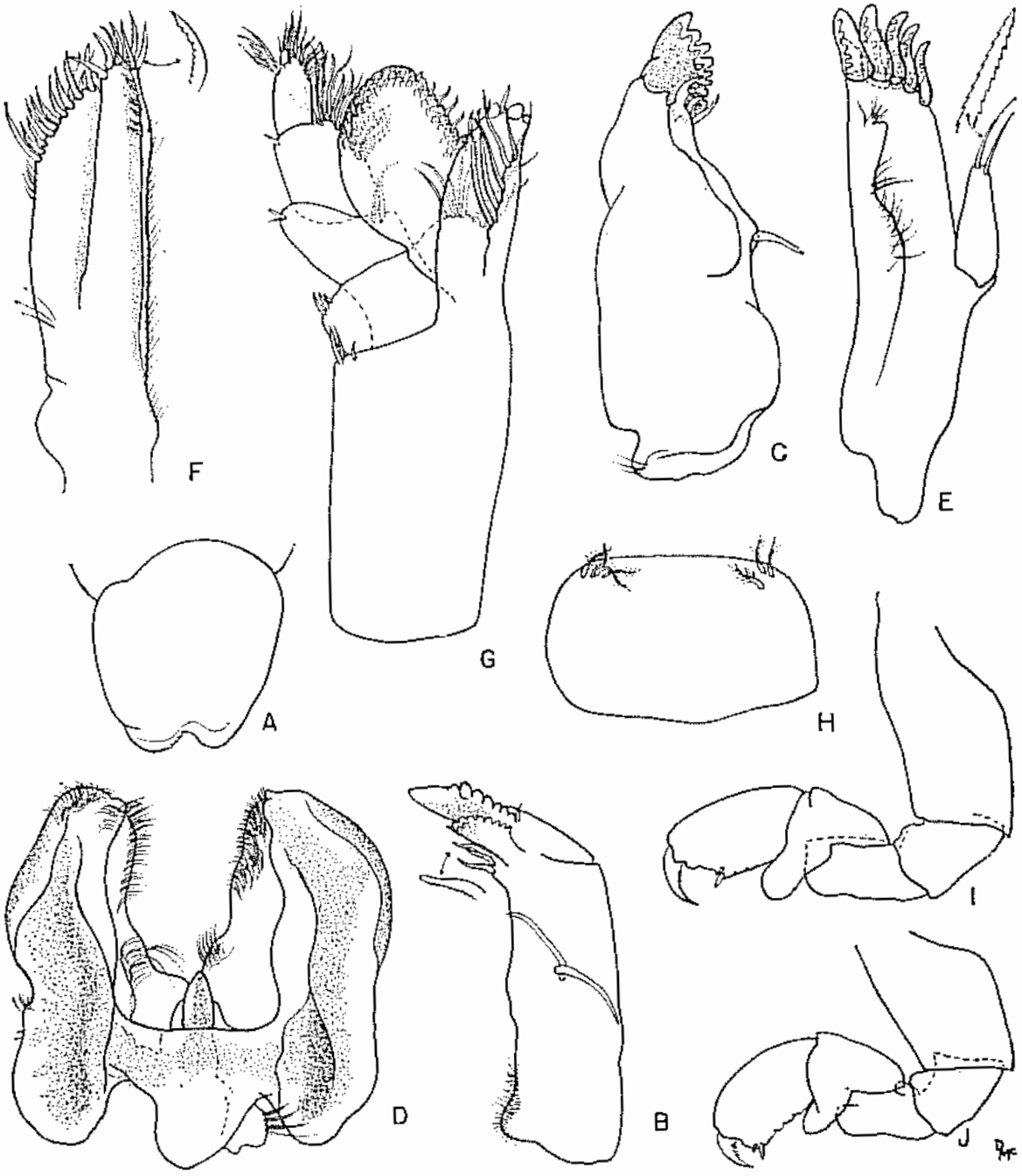

Fig. 21. *Najna ?consiliorum* Darzhavin. Male, 8 mm. sta. 4822: A, upper lip; B,C, mandibles; D, lower lip; E,F, maxillae 1, 2; G, maxilliped; H, telson; I,J, gnathopods 1, 2, minus setae.

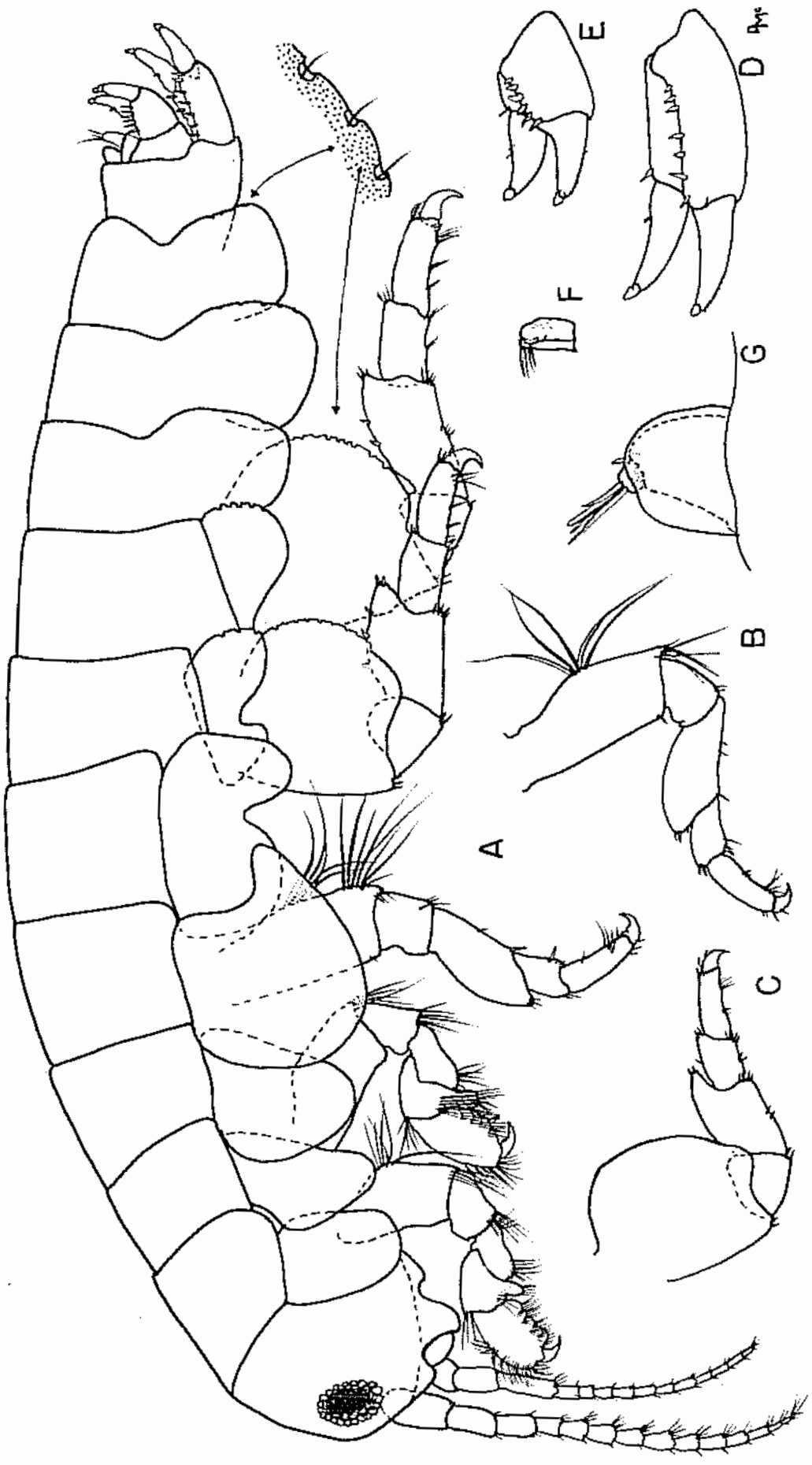

Fig. 22. *Najna ?consiliorum* Derzhavin. Male, 8 mm, sta. 4822.: A, lateral view; B,C, peracopods 1, 3; D,E,F,G, uropods 1, 2, 3, 3.

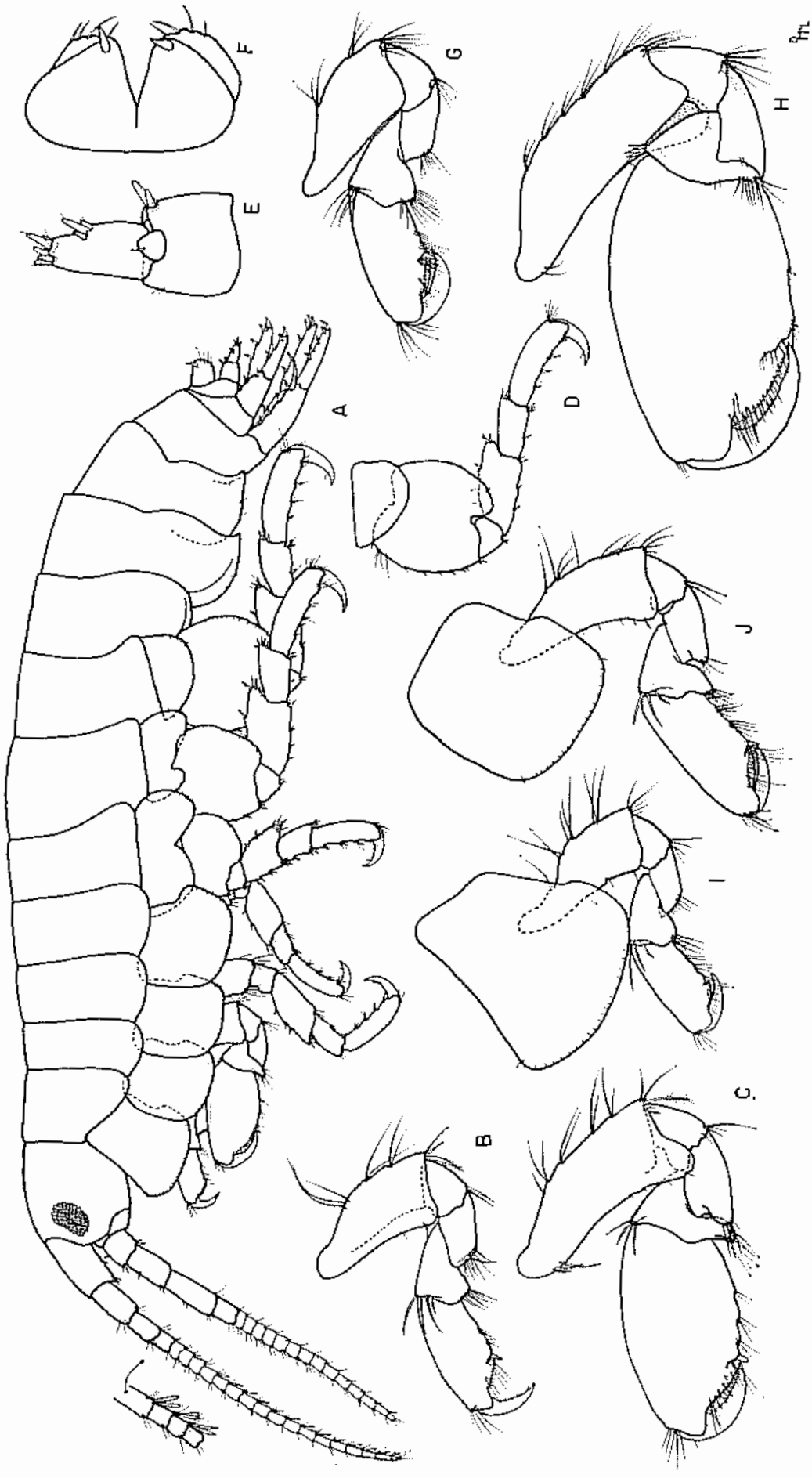

Fig. 23. *Parallorchestes ochotensis* (Brandt). Young male, 7.8 mm, Barnard sta. 12; A, lateral view; B,C, gnathopods 1, 2; D, peraeopod 5; E, uropod 3; F, telson. Male, 12 mm: G,H, gnathopods 1, 2. Female, 8 mm: I,J, gnathopods 1, 2.

third uropod (as attached to the animal, the only drawing of the third uropod being attached to the animal in Gurjanova's figure) and the different shaped inner plate of the maxilliped, which may simply be a difference of mounting technique. In Gurjanova's two figures of the maxilliped the inner plate is conical from two views, but in the present specimens it is a narrow, rectangular plate surmounted by three stout spine-teeth. It is so stiffly attached to the rest of the maxilliped it often lies with its conical aspect toward the viewer.

The third uropod is composed of a small, short peduncle with a minute scale-like ramus, whereas Gurjanova figured and described the ramus as being half as long as the peduncle.

MATERIAL: 5 specimens from 4 stations.

ECOLOGY: This species is limited to algal bottoms shallower than 10 fathoms and is quite rare in southern California.

Genus Parallorchestes Shoemaker

DIAGNOSIS: A genus either of Hyalidae or Talitridae with biarticulate first maxillary palp and long unguiform fourth palp article on the maxilliped; uropod 3 with well developed outer ramus and a small scale-like inner ramus; fifth article of male gnathopod 2 with posterior lobe separating articles 4 and 6; telson bilobed; gnathopod 1 subchelate, gnathopod 2 large, subchelate in male.

Parallorchestes ochotensis (Brandt)

Fig. 23

Allorchestes ochotensis Brandt, Holmes 1904: 233-234, fig. 118.
Parallorchestes ochotensis (Brandt), Shoemaker 1941: 184-185; J. L. Barnard 1952: 23-24, pl. 5, fig. 1; J. L. Barnard 1954: 24.
Parhyale ochotensis (Brandt), Gurjanova 1951: 814-815, fig. 568; Buycheva 1957: 82-83, fig. 28.
Parhyale kurilensis Iwasa 1934: 1-7, pls. 1-2, text fig. 1; Iwasa 1939: 284-285.

REMARKS: In cold northern waters this species reaches a length of 43 mm, and the pleon segments become rather enlarged dorsally. In southern California the species reaches a length of about 13 mm. Since Iwasa's figures (repeated by Gurjanova and Bulycheva) are not typical of southern Californian specimens I have redrawn the species for clarification of local workers.

MATERIAL: Intertidal of southern California, 4 samples.

DISTRIBUTION: Okhotsk Sea, Kuriles, Alaska; Pacific Coast of America south to southern California.

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