BENTHIC AMPHIPODA OF SUBMARINE CANYONS AND BASINS OF CALIFORNIA

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INTRODUCTION

The shelf of southern California and its offshore islands is incised by numerous submarine canyons, many of which debouch onto trough and basin floors of the borderland area (Emery, 1960; Emery and Hülsemann, 1963). They are of particular interest to biologists, because they bring bathyal depths (200 - 1000 m) close to shore where food supplies might be higher than in comparable depths on the continental slopes. Their gradients and possibly their sediments are probably similar to those of regular continental slopes, although sediments of the slopes in southern California have not been well explored (Emery, 1960).

Where canyon heads come close to shore, sand moved by longshore currents is entrapped and flows down canyon axes. Sediments accumulating on the shoreward canyon floors occasionally are set in motion as turbidity flows, possibly either as the result of seismic activity or because of increments in overburden. These sedimentary masses, mixed with water, flow down the canyon axes and in certain canyons flow onto the fans of submarine basin slopes (Emery and Hülsemann, 1963). An inherent catastrophic unstability to the substratum of the biota proves worthy of examination.

Particularly interesting is the opportunity to report upon bathyal gammaridean amphipods collected in quantitative samples. Because the canyon bathyal fauna merges with that of the subsill and somewhat impoverished borderland basins, amphipod assessments already published by Hartman and Barnard (1958, 1960) have been perfected and included herein, along with data from the continental slopes that have accumulated from examination of samples reported upon by Hartman (1955).

METHODS AND MATERIALS

Benthic samples, primarily from the canyon axes, were collected either with an orange-peel grab or a Campbell (modified Van Veen) grab from 1952 to 1962 in the following canyons from north to south along the mainland shelf: Monterey, Hueneme, Mugu, Dume, Santa Monica, Redondo, San Pedro Sea Valley, Newport, La Jolla and Coronado. The following insular canyons were sampled: Santa Cruz, Santa Catalina, Tanner and San Clemente Rift Valley. Samples were also taken in the San Diego Trough. These 201 samples, plus a few additional basin and slope samples, supplement the basin samples discussed by Hartman and Barnard (1958, 1960) to form the basis of the present treatment of the amphipod fauna. Hartman (1963) has already discussed the polychaetes and general faunistic condition of the canyon samples.

The orange-peel grab collected at each station a plug of sediment with a surface area of about 0.25 m^2 and the Campbell grab about 0.55 m^2. The depth of penetration of the grabs varies but this is considered to be inconsequential in the collecting of Amphipoda as most of the organisms are presumed to inhabit the upper few centimeters of the substrate. A few listriella Amphipoda may inhabit the deeply thrust tubes of maldanid polychaetes. Deeply burrowing organisms of groups other than Amphipoda are of course sampled erratically by benthic grabs, depending on the compactness of the substrate. Therefore, the values of standing crop and frequency of organisms are only approximate; absolute values await the invention of a perfect sampler. Equation of samples according to their areal coverage is acceptable in view of the commonly practiced comparison of various marine communities in the literature regardless of type of sampler.

After recovery, samples were washed aboard ship (R/V VELERO IV) through a screen of 0.7 mm mesh and the residues preserved for sorting in the laboratory. Sedimentary volumes of samples are reported by Hartman (1963).

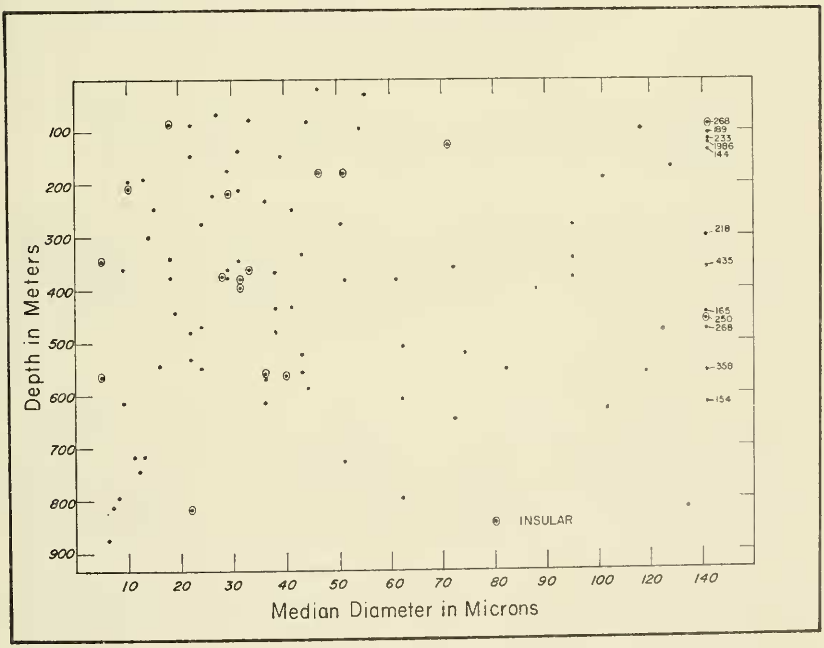
The faunal composition of canyon samples is extremely variable and can be associated only sketchily with depth and assumed thermal provinces, sediments, geomorphology and distances from shore (as based on USHO charts). Mapping and sampling of canyons must be continued on a larger scale than at present but restricted to smaller regions and shorter time scales before valid correlations can be made between biotas and environmental parameters.

Usage of the term "community" in this paper conforms to the Petersen concept (Thorson, 1957).

THE CANYON ENVIRONMENT

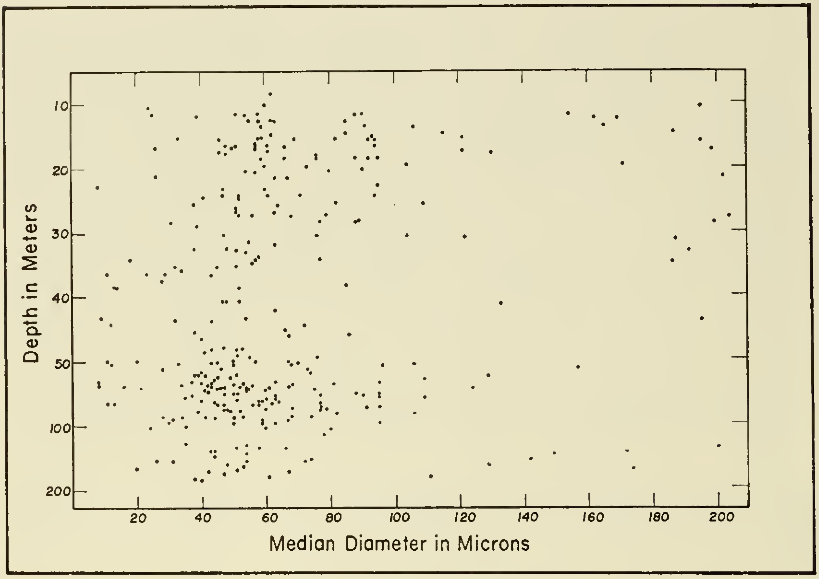
Physical

Although turbidity currents are known to sweep down canyon axes (Emery, Hülsemann and Rodolfo, 1962; Johnson, 1964), and rather continuous cascades of sand pour into canyon heads (Dill, 1962), the lasting deleterious effects appear to be minor, as most canyon samples reported upon herein and in Hartman (1963) contained significant animal populations. However, none of the samples is known to have been taken from an area of recent disturbance. Occasionally samples showed evidence of impoverished faunas, but indicator species point to the presence of outflowing fresh water from exposed aquifers (Hartman, 1963). A great diversity of canyon sediments occurs even though canyon heads entrap medium sands of shallow water. Emery and Hülsemann's (1963) data for canyons 0 - 50 m above axes (plotted in Graph 1 as a scatter diagram, and averaged in Table 1) show the great range in median par-



Graph 1. Scatter diagram of axial canyon sediments (0-50 m above axes) in California. Plain dots represent inshore coastal canyons, dots enclosed with circles represent insular canyons. Data from Emery and Hülsemann (1963).

ticle diameter of the sediments. One may compare the scatter diagram of median diameters for the coastal shelf shown in Graph 2.



Graph 2. Scatter diagram of sediments from samples proportionally distributed by depth and area on the coastal shelf of southern California, 10-183 m.

Emery, Hülsemann and Rodolfo (1962) believe that the net result of turbidity flows is of benefit to benthic populations, especially on the aprons at the seaward ends of the canyons and below sill depths of the basins. There, of course, the muddy suspensions bring down water with higher than normal oxygen content, as well as quantities of organic matter. Water of high oxygen tension can be detected as long as two years later. and this may be of some influence on canyon populations above sill depths in or near the oxygen-minimum layer of the sea. The concept that canyons, through frequent sedimentary movements, provide more organic matter for bathyal biota than do continental slopes at the same depths may have a relationship to the survival of refugees from a pre-cooled abyssal realm. The enormous variability of canyon sediments also would provide a diversity of niches for an ancient fauna possibly compressed into bathyal depths (see Bruun, 1957; Madsen, 1961; Menzies and Imbrie, 1957; Zenkevitch and Birstein, 1960; and J. L. Barnard, 1961b, 1962d, for notes on the bathyal theory). If 84% of the ocean floor known as abyssal once supported a warm-water fauna of great antiquity that, because of cooling of the deep-sea, found refuge in 8% of the sea floor at bathyal depths, then one must balance the consequences of greatly decreased living space against a higher food supply per unit of area. Elucidation of the organic-matter cycle awaits experimental methods and solution of the uniformity: thermostrophic controversy awaits new methods and additional careful study of deep-sea faunas.

Large particles of organic matter have been discovered frequently in samples from nearshore basins and trenches (Bruun, 1959; Heezen, Ewing and Menzies, 1955) and in the present samples, especially those from Monterey Canyon (see data, Hartman, 1963). Such accumulations must indicate that low-density organic matter is transported more quickly and frequently to great depths in canyons before decomposition, than is mineral matter. That organic accumulations probably are disposed of by organisms rapidly is shown in the similar organic carbon content of canyon and shelf sediments (Table 1), for if biota (including bacteria) were not disposing of organic matter quickly, the canyon sediments would have much higher organic contents. Nevertheless, the samples containing macroscopic pieces of organic debris have not borne large populations of organisms. This has been observed also in the large accumulation of organic debris off the Santa Clara River on the Ventura coastal shelf, where sediments contain twigs and stems transported from land by the river, probably in great quantities after brush-fires. Here the normally expected high densities of ophiuroids and other characteristic community dominants have been reduced considerably. Most of this debris probably contains a high content of insoluble and poorly-digestible residues that few Metazoa are adapted to utilize. Whether it has a toxic effect on benthic populations or whether its presence makes the sediments more difficult to burrow into are problems for experimentation.

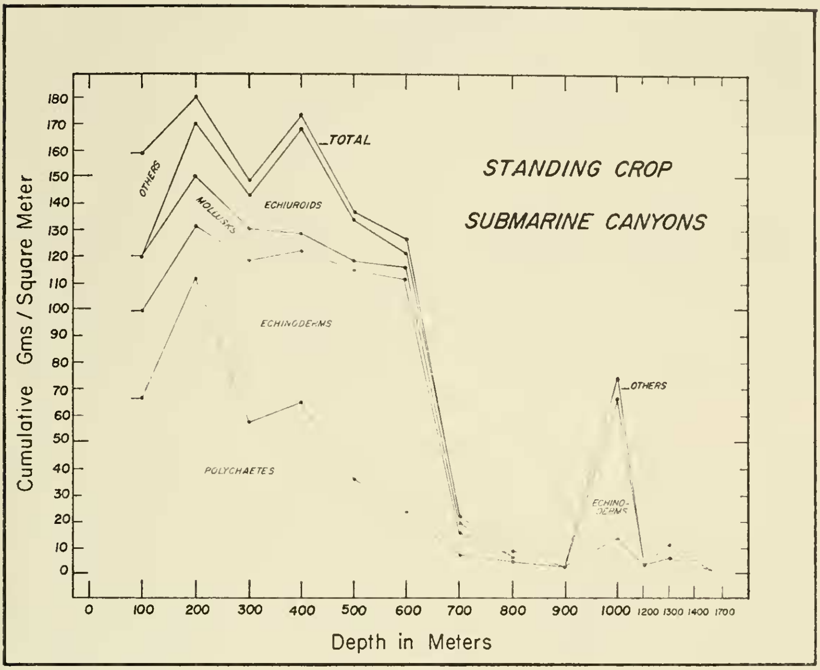
After a turbidity flow, a portion of the formerly buried and labile organic materials that are resuspended probably settle out as a veneer covering the sediments and become available to the first animal immigrants. Perhaps in Monterey Canyon this had occurred just before sampling that poorly diverse population, largely composed of motile organisms such as amphipods and cumaceans. The densest accumulations of debris, fragments larger than 0.5 mm, apparently consisting of surf-grass or eel-grass, were taken at stations 6490 and 6494, in depths of 906 and 750 m respectively. The most conspicuous and dominant organisms were *Protomedeia articulata*, a large amphipod, with 20 and 111 specimens, respectively, and *Leucon* sp., a cumacean. The problem remains whether a turbidity flow scatters organic material so widely that no accumulation as dense as that in Monterey Canyon would result after settling. The grassy material appeared remarkably fresh, although it was greenish-black. Pockets full of debris in areas of high repose may have been accumulated through mechanisms other than movement of sediments. Perhaps gradients are sufficient in some canyon axes to permit cascading and saltation of debris, but continuing impulsion by water movement would have to be presumed. Descending currents in canyons have not been demonstrated, although they might be predicted, especially where canyons intersect lagoons. Because of evaporation and winter cooling of water in shallow lagoons, density currents might be established that flow slowly part way down the canyon axis. Indeed, Monterey Canyon impinges upon the mouth of Elkhorn Slough (hydrographic conditions poorly known). The only other canyon with evidence of high accumulation of organic material is Newport Canyon, from which came several samples composed of black sulfide ooze. Coincidentally, that canyon lies near the mouth of Newport Bay, another lagoon supporting eel-grass (but not as densely as at Elkhorn Slough, because of human influences). Another conjecture is that canyon topography influences formation of surface-water eddies in which organic material is trapped, becomes waterlogged and sinks to the canyon floor.

Off the Congo River (*Vema* samples, information from Dr. R. J. Menzies) one may presume that debris accumulates in the canyon simply from waterlogging of enormous supplies that are present. But the canyons of California are not served by large rivers, hence their source of organic matter has to lie elsewhere.

Biological

STANDING CROP

Individually, the several canyons with their distinct profiles and different distances from shore are difficult to compare. The small number of samples per canyon adds to this difficulty, because patchiness of sediments and therefore patchiness of biological distributions occur. This is well demonstrated in the erratic recovery of brissopsid urchins. Even the levels of polychaete standing crop differ enormously and inconsistently at similar depths in each canyon, although consistency with sediment-type is apparent, the finer sediments supporting larger crops. By grouping all of the canyon samples, regardless of the artificiality so incurred, a significant impression of the trend of decreasing crop with depth is seen



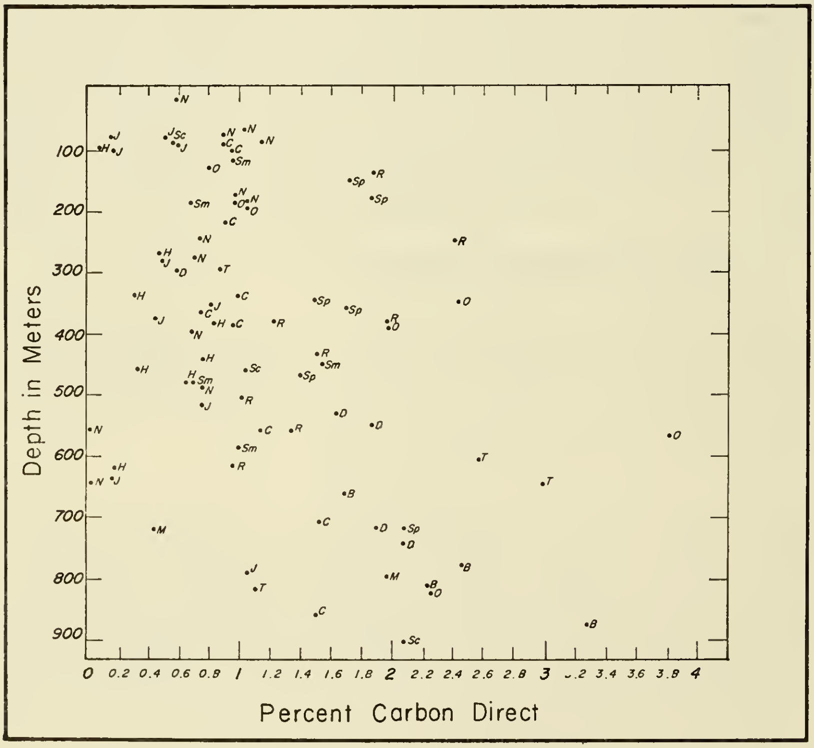
Graph 3. Cumulative standing crop in submarine canyons related to depth, data reduced from Hartman (1963).

(Graph 3), because sufficient samples are grouped into several depth classes so as to ameliorate erratic biomass levels. Most striking and perhaps significant is the sudden drop in biomass between 600 and 700 m that may be related to the oxygen minimum layer which occurs between 500 and 700 m in this latitude (Emery, 1960, p. 108).

The standing crop of the depth classes of 100 - 500 m in the canyons approximates that of the typical levels on the outer sandy-silt (or silty-sand) shelf of southern California (compare Barnard and Hartman, 1959, figs. 4-6), in depths of about 60 to 100 m. Echinoderms and echiuroids represent a larger share of the standing crop in canyons than they do on the outer shelf, this share being taken partly from the polychaetes and especially from the mollusks.

DENSITY OF ORGANISMS

Polychaetes dominate the benthos of the inshore continental canyons whereas echinoderms are numerically more abundant in the insular canyons (Tables 2-3, by summation of values in all depth classes). The data of these tables are computed from figures presented in Hartman (1963), assuming that the Campbell grab covers an area of 0.55 m^2 and the orange-peel grab 0.25 m^2. The tables give trends and approximations rather than absolute values, because the various depth classes of each canyon have not been exhaustively sampled to the point of diminishing returns of previously unassessed variability. The abundance of polychaetes and echinoderms in the canyons in depths of 0-200 m closely approximates the averaged density for the coastal shelf (Table 4), but mollusks are slightly less and crustaceans are much less abundant in the canyons. The insular canyon sediments apparently are not significantly different in grain size from those of mainland canyons, as shown by the scatter diagram (Graph 1) of median diameters, although they appear to have slightly higher carbon percentages (Graph 4) or are, at least, on



Graph 4. Scatter diagram of axial canyon carbon percentages in sediments, quoted as percent carbon direct. Symbols of canyons: C = Catalina, D = Dume, H = Hueneme, J = La Jolla, M = Mugu, N = Newport, O = Coronado, R = Redondo, SM = Santa Monica, SP = San Pedro sea valley, T = Tanner, B = basin below sill depth. Data from Emery and Hülsemann (1963).

the high side of the scatter diagram. To some extent the low number of crustaceans in canyon heads (Table 3) may be the result of sampling errors, although a large proportion of the samples was taken with the Campbell grab which presumably does not suffer much loss of small motile organisms.

The very low recoveries of mollusks in the shallow parts of the insular canyons seem significant. The low recovery of crustaceans in all of the canyons, plus their division into so many orders, results in such scanty material that general statements about crustacean community ecology cannot be made. Depth zonation is apparent however.

COMMUNITY ASSEMBLAGES

Canyon samples are dominated by the following organisms: *Pectinaria californiensis*, *Maldane sarsi*, *Capitella capitata*, *Chloeia pinnata*, *Pista disjuncta*, *Dentalium rectius*, *Heteromastus filobranchus*, *Ancistrosyllis tentaculata*, *Spiophanes fimbriata* and *Nothria iridescens* and *Lysippe annectens*. All are polychaetes except the scaphopod *Dentalium*. Large and conspicuous, but not in great abundance, are the following: *Brissopsis pacifica* and *Brisaster townsendi* (echinoids); *Arynchite* sp. and *Listriolobus pelodes* (echiuroids); *Cerebratulus* sp. (nemertean); *Solemya* sp., *Yoldia* sp. (clams); *Asychis disparidentata*, *Glycera americana*, *G. robusta*, *Onuphis vexillaria*, *Lumbrineris* sp. and *Praxillella pacifica* (polychaetes). The depth zonation of some of these and of other important species is depicted in Graph 6. The eurybathicity of these species is striking.

Table 5 lists the communities found on the coastal shelf of southern California, in order of their importance. The occurrence of these community types in the canyons is insignificant except for *Capitella*, a genus that is more frequently abundant in canyons than on the coastal shelf. The most important canyon species is *Pectinaria californiensis*, which on the shelf is a subdominant of the *Amphiodia urtica* and *Amphiodia-Cardita* communities.

The codominant frequency (Graph 5) suggests those samples to be tested for community appellations and they have been selected by inspection of the lists published by Hartman (1963). No group of stations is large enough to ensure statistical uniformity, but as assembled they show considerable differences in the frequency of the various species (Table 6). Of 109 stations of the inshore (coastal, non-insular) canyons, 78 can be assigned to one of the nine different associations. Most of

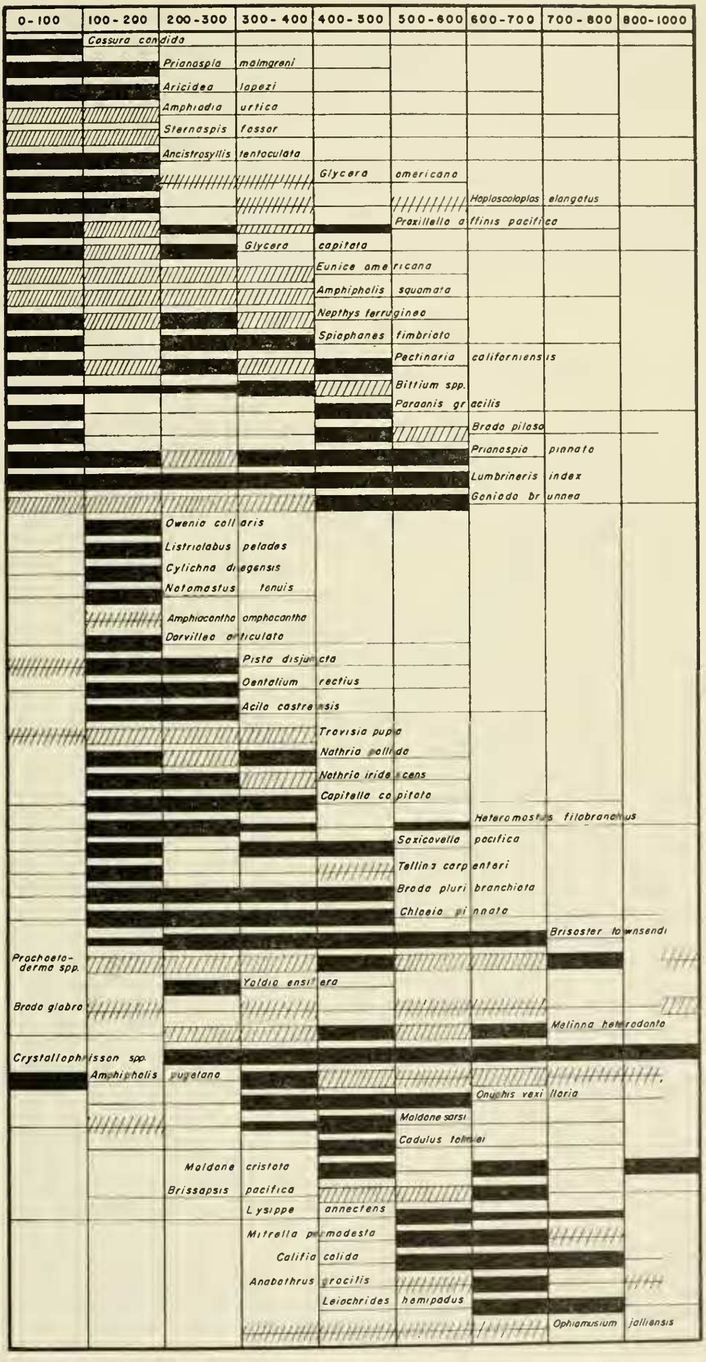
	Pectinaria	Maldane	Capitella	Chloeia	Pista	Dentalium	Heteromastus	Ancistrosyllis	Spiophanes	Nothria
Pectinaria californiensis	24									
Maldane sarsi	2	9								
Capitella capitata	3	0	9							
Chloeia pinnata	4	2	0	8						
Pista disjuncta	2	0	0	1	7					
Dentalium rectius	3	0	0	0	2	6				
Heteromastus filobranchus	2	0	0	3	1	1	6			
Ancistrosyllis tentaculata	4	0	0	1	0	0	0	5		
Spiophanes fimbriatus	2	0	0	1	0	1	0	0	5	
Nothria iridescens	1	0	0	0	0	0	0	0	0	4

Graph 5. Codominant frequency of most often occurring dominants in the submarine canyons. Single cumulative domination is shown for each species in each square at the right edge.

the remaining 31 samples are poor in diversity and total specimens, many being deep-water samples in which low diversity is to be expected. They might be assignable to the *Lysippe* zone if one were to accept the Thorson rule that only half of the samples of a community require the presence of a major dominant. Many are characterized by *Califia calida* and some by various species of *Aricidea.*

In five of the nine associations, *Pectinaria* is a major dominant, but whether those associations should be coalesced as a megacommunity or segregated is a matter for consideration when more exploration of the world's benthic communities and slope depths has occurred. The co-occurrence of *Pectinaria* with either *Capitella* or *Ancistrosyllis* results in high frequency values for *Pectinaria,* but its occurrence with *Dentalium* results in low values. Both *Pectinaria* and *Dentalium* live in hard conical tubes and *Pectinaria* may be affected either spatially or biologically by the presence of *Dentalium.*

The associations are not indelibly fixed, as Barnard and Ziesenhenne (1961) have pointed out in the gradation of the *Amphiodia* shelf-



Graph 6. Distribution with depth of important benthic organisms of submarine canyons, arranged approximately in depth sequences. Thickness of bar indicates frequency of the species. Solid bars represent the species in both insular and coastal canyons, hatched bars represent the species in insular canyons when they are not prominent in the coastal canyons.

community into *Onuphis* zones. *Capitella* often occurs with *Pectinaria*, but in other samples (see list in Table 6) it occurs in high frequency without *Pectinaria*. *Pectinaria* must be examined not so much from the shallow-water end of the spectrum, as from the deeper end. In the shallow-water *Amphiodia*-community, it forms a major subdominant and one might assume that it has migrated to the canyons from that locus. Because the continental slopes have been poorly studied, it is unknown whether *Pectinaria* indicates a "normal" community or whether it is an opportunistic dominant of unstable substrate. At first I had expected

		PECTINARIA												CHLOEIA			HETEROMASTUS					
		Hoplo	Pectin.		Dentalium			Capitella			Ancistrosyllis											
		5114	7730	6897	4846	5661	7054	7043	7039	2190	5367	7030	3164	7284	5639	6909	7160	2148	2149	6903	5674	6499	5688
Hoploscoloplos	5114			40																			
Pectinaria	7730	38				31			31			37				34					19		
	6897	37	44																				
Dentalium	4846	20	26	14																			
	5661	28	46	63	23				21			26			+ Maldane	24					15		
	7054	19	34	26	42	39																	
Capitella	7043	24	27	29	8	26	21			6													
	7039	27	34	46	8	45	16	79				28				22					14		
	2190	28	36	30	18	18	25	54	50														
Ancistrosyllis	5367	21	31	25	14	20	33	17	12	25			57										
	7030	31	44	41	14	38	24	26	36	26	37					32					16		
	3164	35	46	35	22	26	32	27	22	45	36	36											
CHLOEIA	7284	33	44	58	13	51	24	26	45	31	38	60	43										
	5639	8	5	7	4	5	5	4	4	15	4	4	9	14			34						
	6909	21	20	25	13	17	30	18	16	33	26	20	24	27	29						22		
	7160	36	40	27	24	27	20	25	22	38	17	25	33	34	30	43							
HETERO-MASTUS	2148	16	20	14	27	2	10	17	14	46	9	11	31	18	11	16	30						
	2149	23	17	18	18	9	18	9	5	27	16	13	31	24	30	31	49	22			27		
	6903	22	17	11	24	10	11	4	1	12	15	7	17	3	7	10	29	34	20				
	5674	11	6	7	11	2	3	2	0	8	6	6	10	2	2	11	14	15	14	29			
	6499	29	22	23	33	18	22	14	12	31	23	18	29	27	18	28	42	43	31	32	16		
	5688	3	10	4	24	1	4	1	1	8	8	4	10	3	1	3	17	30	13	30	12	47	
TOTALS EACH SAMPLE		510	607	584	400	514	458	458	495	604	433	524	599	618	216	461	622	436	438	345	187	558	234
Maldane	6497	1	5	3	8	8	12	2	1	7	5	5	6	1	58	12	4	4	8	14	14	8	2
Lysippe	6503	0	3	0	2	1	1	0	0	3	0	0	3	1	1	1	1	1	0	0	3	2	0

Graph 7. Representative samples of the submarine canyons with paired coefficients of association and their means summarized by blocks. Samples restricted to the *Pectinaria* and *Heteromastus* communities with their subassemblages and with comparisons to typical samples of the *Maldane* and *Lysippe* zones.

that canyon samples would reveal a haphazard occurrence of species indicating unstability of bottom, with each sample representing a different starting point in a myriad of successional regimes. This impression was entertained after observing the occurrence of *Listriolobus pelodes*, *Dorvillea articulata*, and various species of *Diopatra* in canyon samples in depths and in combinations with other species that were not normal for the coastal shelf. The strength of that expectation is not fully dissipated by the discovery of identifiable assemblages that indicate either a degree of stability in the substrate or a rapid repopulation of substrates after their consolidation.

Hartman (1955) presented partial analyses of numerous slope samples (50 - 300 fms) in which *Pectinaria* is often mentioned, but in which *Chloeia pinnata* is more abundant and with *Maldane* may represent the principal community dominant of the upper bathyal outside of canyons.

Capitella capitata has been suggested by Hartman (1963) as an indicator of undersea leakage from emergent sweet-water aquifers in canyons. It is tolerant not only of brackish waters but of polluted conditions in waters of normal salinity and may thus be an indicator of natural putrefaction. It lives in high densities in the inner harbor of Los Angeles in waters of normal salinity but low dissolved oxygen (see Reish, 1959 and Reish and Barnard, 1960). Its occurrence in some canyon samples may be related to high contents of organic matter in the sediments that are restrictive to other metazoans. *Capitella* appears to tolerate wide ranges of physical conditions that are restrictive to most organisms but apparently is seldom found with other animals. In the depth-sediment scheme (Graph 11), the *Capitella* samples are grouped in the coarse sediment range, indicating the presence of percolating water that must leak through coarse sediments. In bays and harbors *Capitella* inhabits fine-grained sediments (Reish, 1959).

SAMPLE ASSOCIATIONS, METHODS

Despite their faults, trellis diagrams of association between pairs of samples, based on the percentage composition in each sample of each species, matching species in samples and summing the minimum percentages for an index of association, have been used to examine the interrelationships of canyon samples. Samples of low diversity more often match as pairs with high association indices than samples of low diversity matched with samples of high diversity. Thus, sample 4851 in Graph 8, with 66 species and 657 specimens, is a poor matching partner with 6779, having 18 species and 116 specimens. Both are dominated by *Maldane sarsi* and, indeed, 4851 has nearly twice as many specimens

MALDANE

	6497	6821	5639	3179	3178	2219	3399	3180	6779	7155	6850	4851	7729	7028	
6497															
6821	54														
5639	60	52													
3179	53	51	56												
3178	65	50	69	45											
2219	39	37	54	45	39										
3399	49	42	36	37	46	37									
3180	42	41	28	56	31	31	33								
6779	44	36	34	35	38	39	41	28							
7155	33	29	29	25	25	37	33	24	29						
6850	26	30	22	22	24	25	26	25	24	22					
4851	23	26	21	28	16	22	13	27	14	21	16				
7729	14	27	12	14	9	17	13	18	11	22	11	22			
7028	15	26	11	14	10	11	11	20	8	26	7	21	42		
	517	501	484	481	467	433	417	404	381	355	280	270	232	222	
7730	4	13	5	5	2	11	4	7	2	12	4	9	49	35	Pectinaria
6503	2	2	0	3	3	6	7	6	1	1	3	1	1	2	Lysippe

LYSIPPE

	6503	2317	7050	6828	2336	7051	
6503							
2317	57						
7050	32	19					
6828	20	17	29				
2336	27	23	25	20			
7051	23	16	39	18	23		
	159	132	144	104	118	119	
6820	3	2	3	7	5	4	Anobothrus
7043	0	3	3	1	0	2	Pectinaria—Capitella
4846	2	4	1	3	1	1	Pectinaria—Dentalium
5367	6	6	4	5	0	6	Pectinaria—Ancistrosyllis

Graph 8. Representative samples of the *Maldane* and *Lysippe* communities of submarine canyons with paired coefficients of association and comparison to typical samples of other communities.

of *Maldane* as 6779, but sample 4851 is swamped with so many specimens of other species that *Maldane* represents only 31.0% of the total specimens in the sample. This method does not consider that 4851 may be a climax sample with its full diversity whereas 6779 may be in an early stage of succession. Nor does it take into account that the *Maldane* community may be composed of numerous subcommunities, in a few samples of which (such as 4851) all the submembers are represented, whereas satellite samples may represent only minor members.

An alternate method may be used, viz.: in two samples to be compared the most diverse one is designated the "type," the less diverse, the "satellite"; percentage compositions of all species of the "satellite" are calculated; those same species in the type-sample also are extracted and percentage compositions calculated; then the two samples are compared by summation of minimum compositional percentages. Here the relationship of the satellite sample is compared to that portion of the type-sample that might be visualized as one of its subcommunal components. Such a comparison is made for 4851 as the type and 6779 as the satellite, both dominated by *Maldane*. The resultant index of association is 47.7. The "standard" index of association computed by the conventional method is only 21.8 because of swamping of *Maldane* by other species in 4851.

Station 4851 is also compared with 5674, a sample dominated by *Heteromastus* and with a conventional index of association of 6.5. In the alternate method the index is 45.6, indicating the importance of *Nothria iridescens, Praxillella pacifica* and *Heteromastus* in both samples and suggesting the possibility that 4851 represents a bottom area on which the *Maldane* community and its associates are mixed with a *Nothria iridescens* subcommunity. Indeed, 4851 also has a significant number of *Pectinaria*, more specimens than in some other *Pectinaria*-dominated samples. There is no way to account for such mixed samples as 4851, or for species-impoverished samples such as 5674, or samples with impoverishment of the dominant species, except to assume that large sampling devices do collect closely contiguous but independent assemblages.

As a comparison, samples from the well-explored *Amphiodia urtica* community off southern California were interrelated using the trellis-presentation (Graph 9). Out of 67 samples, 20 were selected as having 180 or more specimens of *Amphiodia urtica* (extending from 180 to more than 600). Although some sample pairs had rather low indices of association, all were clearly dominated by *Amphiodia urtica.* As in the canyon samples, some *A. urtica* samples were swamped with numerous individuals of other species. In some cases a few species existed in high frequency and in other cases samples had nearly twice as many species with low numbers of specimens, but both reduced the prominence of the *Amphiodia* as a numerical dominant. Again, the overlaying of subcommunity matrices on the background of the basic community must be considered, for within the *Amphiodia* community may be seen numerous subcommunities that become prominent in certain samples, even though the basic *Amphiodia* structure is maintained. Indices of association extend from 24 to 75 with a median of 51. The principal dominants of the *Amphiodia* community are summed as to their percentage compositions in the left column of Graph 9, with a range of 27% to 81%. These samples are a good representation of the classical Petersen marine community (Thorson, 1957), but their strong variation permits wide latitude in the assignment of samples to a community nucleus. Those samples with highest coefficient interrelationships are also those samples generally having the most individuals of *Amphiodia* (Graph 9). Summation of the total coefficient values for each sample shows a range of nearly 50% of the highest value.

AMPHIODIA URTICA COMMUNITY OF THE COASTAL SHELF

Coefficient rank decreasing →

No. AMPHIODIA per sample	% DOMINANTS	STATION	4859	4935	5092	5354	5370	4757	5108	4768	4924	4772	4878	5372	4920	4837	4871	5255	4835	5098	4785	4817
546	65	*4859*																				
510	74	*4935*	67																			
648	80	*5092*	67	74																		
444	68	*5354*	65	63	65																	
465	81	*5370*	70	72	75	64																
436	63	*4757*	51	71	67	60	62															
383	66	*5108*	67	72	66	64	70	63														
420	57	*4768*	51	60	62	65	60	63	60													
356	63	*4924*	62	68	61	65	61	61	63	60												
297	69	*4772*	46	69	69	59	69	65	65	63	62											
252	69	*4878*	64	62	65	65	65	61	62	62	59	63										
203	59	*5372*	62	61	60	64	63	58	67	58	60	57	66									
389	68	*4920*	62	68	71	59	69	56	64	54	65	65	56	57								
285	59	*4837*	50	52	51	57	48	51	47	51	55	46	46	46	48							
240	50	*4871*	54	52	47	52	50	48	55	54	53	48	52	52	43	46						
337	50	*5255*	54	47	47	51	41	53	41	49	50	41	42	39	43	58	42					
315	40	*4835*	46	41	44	50	45	47	40	45	43	41	44	42	37	46	39	54				
274	45	*5098*	45	43	42	47	40	44	41	46	42	41	43	38	35	43	44	49	47			
191	29	*4785*	32	31	27	38	30	35	33	37	30	25	34	33	25	32	36	43	40	37		
188	27	*4817*	43	30	29	33	29	39	29	37	31	24	28	33	28	43	31	39	36	35	41	
TOTALS of Coefficients for each sample			1125	1103	1089	1086	1083	1076	1069	1055	1051	1040	1039	1016	1005	916	898	883	829	802	650	631

MEDIAN COEFFICIENT = 51
RANGE 24—75
DOMINANTS:
Amphiodia urtica
Amphiodia squamata
Pectinaria californiensis
Phaloe glabra
Paraphoxus bicuspidatus
Paraphoxus similis

Graph 9. The *Amphiodia urtica* community of the shelf of southern California, represented by 20 of the samples having the dominant most abundant, with paired coefficients of association and totals for each sample.

Another example is the *Listriolobus* community (Barnard and Hartman, 1959) of which 12 samples chosen for their extreme variability are presented in Graph 10. Contrary to the *Amphiodia* community in which dominance of *Amphiodia* in standing crop is also reflected in the high frequency of individuals, the *Listriolobus* community is dominated by a low number of individuals having a heavy bodyweight. *Listriolobus* ranges in frequency from 1% to 8% of the specimens in a sample. A type-sample is 5419 in which *Listriolobus* represents 8% of the specimens, *Ceratocephala* sp. (a specifically characteristic species) 9%, *Saxicavella* sp. (another indicator species) 16%, *Callianassa* sp.

LISTRIOLOBUS COMMUNITY of the Coastal Shelf

Coefficient rank decreasing ⟶

Median coefficient = 32
Range 16 — 64

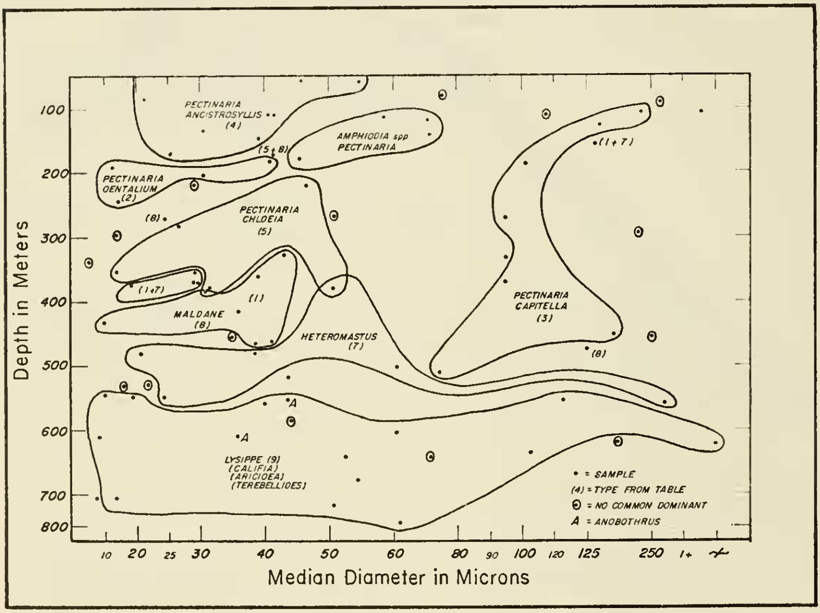
	5419	5414	5400	5413	5262	5404	5410	5330	5261	5166	4826	5421
5419												
5414	40											
5400	62	40										
5413	38	64	35									
5262	43	29	37	30								
5404	58	34	49	30	30							
5410	39	32	34	34	39	32						
5330	29	32	27	31	32	27	38					
5261	32	28	32	25	48	24	31	36				
5166	31	27	31	25	27	29	28	36	33			
4826	24	38	26	39	27	20	23	28	25	25		
5421	20	36	25	34	16	21	17	27	16	24	26	

% OF FAUNA IN EACH SAMPLE RANKED

Heterophoxus	9	9	12	7	8	11	6	3	3	3	1	2
Amphiodia	2	9	2	8	4	2	16	14	4	3	4	2
Ceratocephala	9	20	7	13	0	1	0	0	2	0	6	3
Listriolobus	8	2	6	2	5	7	8	2	2	3	4	1
Saxicavella	16	3	8	3	1	11	2	0	0	1	1	1
Callianassa	4	0	1	1	10	2	6	5	12	5	0	0
Phoronopsis	14	1	6	0	2	5	2	3	2	0	0	0
Terebellides	1	1	3	1	4	2	5	1	3	3	3	1
Listriella goleta	4	2	1	2	7	2	2	2	3	1	0	0
Axinopsis	1	2	2	1	1	2	0	5	0	2	3	5
Pectinaria	1	3	1	4	2	3	3	0	0	1	1	3
Sternaspis	1	0	0	3	4	0	2	2	2	0	3	1
Marphysa	1	0	5	0	0	1	0	1	4	2	0	0
Paecilochaetus	4	0	3	0	2	0	0	1	2	0	0	0
Pinnixa	0	0	2	0	2	0	1	0	3	2	0	1
TOTALS	75	52	59	45	51	49	53	39	40	23	26	20

Graph 10. The *Listriolobus* community of the shelf of southern California, represented by 12 samples selected for their spectral range between greatest extremes, with paired coefficients of association above and the percent of specimens of dominants in each sample below.

(a genus nearly restricted to the *Listriolobus* bed on the coastal shelf) 4%, *Phoronopsis* sp. (another characteristic, nearly exclusively limited species) 14%. These taxa, plus others shared with adjacent communities, such as *Amphiodia* and *Pectinaria,* comprise 75% of the specimens in the sample (Graph 10). Unlike the *Amphiodia* community, in which only 6 species regularly comprise more than 50% of the specimens (owing to predominance of *Amphiodia*), the *Listriolobus* community commonly requires tabulation of 14 species to comprise 50% of the specimens of a sample. The samples in Graph 10 show the extremes of variability, whereas the heart of the community, represented by about 20 samples not shown, is more typical of sample 5419.



Graph 11. Depth-sediment partitioning of community assemblages of submarine canyons based on those samples analyzed for median diameters and those fitting the schematic dominations of graphs 7 and 8.

THE CANYON ASSOCIATIONS

Selected canyon samples are prearranged in the trellis diagram of Graph 7, and extend from "typical" samples dominated by *Pectinaria* alone, to *Pectinaria* with *Dentalium*, *Pectinaria* with *Capitella*, *Pectinaria* with *Ancistrosyllis*, then with *Chloeia*, and one with *Ancistrosyllis-Chloeia-Maldane* together; on the right are samples dominated by

Heteromastus, those to the middle having *Chloeia* as a subdominant and thus overlapping the *Pectinaria-Chloeia* bundle. Only a few of the intercomparable values exceed 50, in contrast to the *Amphiodia* trellis diagram, but resembling the *Listriolobus* diagram. Summation of the coefficient values gives a range from 187 to 622. Those samples with *Pectinaria* as a dominant have a range of 400 to 622 (excluding station 5639, a *Maldane* sample included for its high count of *Pectinaria*). The *Heteromastus* samples range from 187 to 622 also (including station 7160, a mixture of *Pectinaria* and *Heteromastus*). Except for station 5674, a sample poor in diversity and abundance of specimens, the *Heteromastus* samples are scarcely less well related to the *Pectinaria* side than are some of the marginal samples of the *Listriolobus* community among themselves. *Heteromastus* is especially connected to *Pectinaria* through those samples sharing *Chloeia* as a principal subdominant. *Heteromastus* samples are related more to *Pectinaria*-bottoms than are *Maldane* samples, as evidenced by the best *Maldane* sample (6497) being compared with other samples in Graph 8. A *Lysippe* sample also is compared. Despite the spectral arrangement of the samples, with no clear break between various community appellations and despite the overlap of dominations, especially in those samples such as 5639 where several of the dominant species exist together, the arrangement, as seen in Table 6, indicates a discrete *Maldane* community; a "*Lysippe*" community that represents deepwater; and a *Heteromastus* assemblage that probably is a major subdivision of the widely-occurring *Pectinaria* community. The *Pectinaria* community has numerous variants in which several subdominants alternatively occur. The unity of the samples is also shown by the codominance of both *Pectinaria* and *Heteromastus* in stations 7032 and 3166 and both *Pectinaria* and *Maldane* in 6819 (as well as examples shown in Graph 8).

Without sufficient sedimentary data (only 55 of the canyon samples were analyzed for sediments), it is possible only to suggest that the *Pectinaria* subcommunities may be controlled by sediments and depth together. In Graph 11 those samples of Table 6 that have been clearly assigned to communities and that have been analyzed for sediments are delimited into community groups. A clear-cut depth partitionment is shown of *Ancistrosyllis*, followed by *Dentalium*, then *Chloeia*, then *Maldane* (less clearly), and *Heteromastus* within the finer-grained sediments. On the coarse side, *Pectinaria* and *Capitella* dominate. In deeper waters are grouped the amalgamated *Lysippe* samples. The overlap of communities is shown in the group of samples denoted by "1 & 7" that are *Pectinaria* mixed with *Heteromastus* and by a codominant sample belonging to both *Maldane* and *Pectinaria-Chloeia* types, another overlap being shown between *Heteromastus* and *Pectinaria-Chloeia.*

THE BORDERLAND BASINS

The borderland of southern California has 13 enclosed basins (Hartman and Barnard, 1958, 1960; Emery, 1960), in which 165 benthic biological samples have been obtained, nearly half of which were collected in San Pedro Basin (Table 7). Hartman and Barnard have already discussed the fauna of these basins, but at that time a number of the amphipods had not been identified.

Subsill waters of the nearshore basins of Santa Barbara, Santa Monica and San Pedro have very low dissolved oxygen values (0.2-0.3 ml/L) and the faunas are impoverished, the number of amphipods averaging only $1.5/m^2$. In the deeper offshore basins the oxygen values are higher (0.4-2.0 ml/L) and the number of amphipods per square meter is 6.0, but the small number of samples and low density does not permit assessment of more than a fraction of the probable amphipod fauna. It will be necessary to utilize benthic trawls with fine-mesh nets to collect all of the very rare species before a complete knowledge of the fauna is reached. Nevertheless, the present samples give us valuable indications of the kinds of abundant species (Table 8).

The basins support 28 identifiable species and a number of others (Appendix II) that have not been identified because of fragmentation of specimens. Only 7 of the 28 species are unique, so far, to the basins (Table 9), the remainder having been found above sill depths, primarily in the submarine canyons (because most slope sampling has been done in that environment).

The shallowest basins (San Pedro, Santa Monica, Santa Barbara), with low dissolved oxygen and low densities of animals, support a rather large proportion of eurybathic organisms. Of the 9 species of amphipods, 5 are primarily deep sublittoral species: *Ampelisca pugetica*, *A. macrocephala*, *Heterophoxus oculatus*, *Monoculodes norvegicus* and *Urothoe varvarini*. *Heterophoxus oculatus* is truly a eurybathic organism and the others are of cold-temperate occurrence. The remaining four species are among the most abundant in the canyons: *Ampelisca coeca*, *Harpiniopsis epistomata*, *Liljeborgia cota* and *Byblis barbarensis*.

The next group, Santa Catalina, Santa Cruz, San Nicolas and Tanner Basins, supports only *Heterophoxus oculatus* and *Urothoe varvarini* of the deep sublittoral group, but the deep sublittoral and shallow bathyal *Nicippe tumida* is a member of the fauna. Several other cold-water sublittoral species, such as *Paraphoxus oculatus*, *Leptophoxus falcatus*, *Ampelisca eoa* and *Sophrosyne robertsoni* are present also, these species not being found in the warm-temperate sublittoral of southern California. *Pardaliscella symmetrica*, an upper slope species, is found in San Nicolas Basin.

The remaining deeper basins have less biotic diversity but also support *Heterophoxus oculatus*. San Clemente Basin has a member of *Lepidepecreella,* heretofore considered a littoral cold-water genus, and strangely enough, *Phoxocephalus homilis*, a deep sublittoral warm-temperate species, has been found there.

More intensive sampling, no doubt, will reveal additional deep sublittoral species that stray into the basins, but these should be offset by an increased recovery of rare (low frequencies of individuals), optimally bathyal species. The straying of sublittoral and shallow bathyal taxa into the basins probably would not occur were the basins located far offshore.

THE AMPHIPODA

Frequency of Amphipoda in Basin and Canyons

The frequency of Amphipoda in the shallow-water canyon heads is scarcely less than that on the coastal shelf (compare densities at 100 m for shelf and canyon in Table 10), perhaps indicating the unstable substratum, but also perhaps denoting errors because of the difficulty of obtaining samples in canyons. The grabbing device may hit steep slopes in the narrow canyon heads during or after sampling and small crustaceans may be lost in the recovery. Fast-moving demersal species may sense and escape the descending grab. The substratum in the shallow heads is sandy and the density of organisms is known to decrease on sandy bottoms, as shown by Barnard (1963), although the figure of 257 individuals/m^2 in the inshore sands in depths of less than 10 m is roughly half that in the canyon heads on substrata in less than 100 m of depth.

The frequency of Amphipoda declines erratically with depth in the canyons, indicating the need for consideration of many more samples to eliminate not only sampling error, but to equate the variations of sediments and other environmental factors. Nevertheless, four provinces of density appear in the data in these depths: (1) between 0 and 100 m, where the average density is 588 individuals/m^2, (2) between 101 and 500 m, where the density is 54/m^2, (3) between 501 and 1000 m, where the density is 14.7 individuals/m^2, and (4) between 1001 and 1600 m, where the density is 2.8 individuals/m^2.

The seaward, deeper ends of many of the canyons debouch onto basin floors, especially the biotically impoverished shoreward basins of Santa Barbara, Santa Monica and San Pedro. The frequency of Amphipoda drops to 1.5 individuals/m^2 below sill depths, although the slopes and canyon fans above sill depths (475 to 737 m) support between 7 and 21 (or as many as 43) individuals/m^2. Canyon floors well below sill depths, that empty onto trough floors or onto deeper basins, continue to support 11 individuals/m^2. The deeper outer basins (numbers 4-12 in Table 7) support 6 individuals/m^2, but apparently these basins, although having sill depths well below oxygen minimum layers, have depleted biotic frequencies, because two samples on the Patton escarpment above sill depths have an average of 20 individuals/m^2. Unfortunately, no samples from nonbasin areas of the deep borderland, except on the slopes of San Pedro, Santa Monica and Santa Barbara basins, have been taken so that these values can not be confirmed.

Diversity and Dominance of Amphipoda in the Canyons

About 185 species of Amphipoda occur on the coastal shelf of southern California in water depths of 5 to 183 m, according to my records and a manuscript in preparation. The intertidal has not been assessed.

The most abundant amphipod species on the coastal shelf are shown in Table 11, the most abundant in depths of 92-183 m in Table 12 and the most abundant in depths of 4-10 m in Table 13. Amphipoda of the shallowest 100 m of the canyons (Table 14) are a mixture of species from the above zones. The first two taxa of Table 14, *Aoroides* and *Parapleustes*, are phycophilous, the former probably building tubes attached to algae, surf-grass and plant debris. These are unusually high rankings for both species, as the latter is almost exclusively an intertidal form. The remaining species of the canyon heads comprise a high number (9 out of 16) of the common shelf species, as marked with asterisks in Table 14. The high rank of *Ischyrocerus pelagops* is another indication of the predomination of plants and/or plant debris on substrates of canyon heads. Little relationship is shown to the upper slope fauna (Table 12) except for the presence of *Protomedeia articulata*, a species that is not necessarily characteristic of slope faunas because it occurs also in moderate shelf depths on silty bottoms.

Conspicuously absent from the list of important canyon-head Amphipoda is *Paraphoxus bicuspidatus*, the most abundant shelf and slope amphipod.

In depths of 101-200 m, the canyon fauna compares most favorably with that on the upper coastal slopes, 92-183 m (see Tables 12 and 15).

Eleven of the 15 important canyon species are in the abundancy list from the slope. Here *Paraphoxus bicuspidatus* occurs in its expected high density.

The most common amphipods in each depth interval in the canyons are shown in Table 16. The most important is the eurybathic *Heterophoxus oculatus*, occurring from the shallow shelf through most of the depth range that has been sampled. *Ampelisca macrocephala* exists as an oculate subspecies in depths shallower than 300 m, becoming largely the blind subspecies *unsocalae* in greater depths. Deep-water influence starts at 301 m with harpinias commencing to predominate. *Protomedeia articulata* and *Paraphoxus daboius*, in depths of 701-1000 m, are enclosed in parentheses to indicate that the former species is restricted largely to Monterey Canyon and that the latter species represents a possible abnormal depth displacement. Indeed, *Paraphoxus obtusidens* in 401-500 m is abnormally displaced, but *P. calcaratus* is truly a cold-water form not found in shallow waters of southern California. The families Phoxocephalidae and Ampeliscidae predominate; they are burrowing and tube-dwelling organisms dominating most open-sea sublittoral and bathyal substrates.

The occurrence of *Maera simile* in depths of 201-300 m is an unusual record of a primarily eulittoral phycophilous organism.

A partially subjective assessment of the optimal environment of the taxa has been made in order to place each canyon species in the scheme of Table 17, showing the decline of shelf species and the increase of slope species in relation to depth intervals in the canyons. Between 400 and 600 m the faunal balance is shifted from its primarily sublittoral character to its primarily bathyal condition.

Some species that have been assigned to the shelf fauna occur primarily on its deeper margin. Many of those listed below live in shallow waters in colder latitudes and have been displaced to the shelf edge in southern California, but do not descend far into the slope environment: *Monoculodes norvegicus*, *Orchomene pacifica*, *Ericthonius hunteri*, *Haploops spinosa* and probably all of those species listed in Table 18 between *Bathymedon roquedo* and *Monoculodes norvegicus*.

Ascent and Descent of Species in the Canyons and Basins

That canyons cutting the full width of the shelf might afford pathways for shelf animals descending to greater depths than normal was suggested when the spoon-worm *Listriolobus pelodes* (see Barnard and

Hartman, 1959) was brought up in a deepwater sample in Hueneme Canyon (177 m). The distribution of this species had been rather thoroughly investigated, and it was known to be replaced on the upper coastal slope by other genera of spoon-worms. Because *Listriolobus* lives on sediments that are very finely particulate for the coastal shelf, its perimeter is limited to a small area of silt on the Santa Barbara coastal platform. Other areas of suitable sedimentary texture for *Listriolobus* would lie somewhere on the low-gradient fans at the base of the coastal slope and canyons; these presumably would be in waters too deep for *Listriolobus.*

Continental slopes have been poorly studied, although Emery and Terry (1956) reported on a slope sediment with a median diameter of 22μ, approximately the same as that found in the *Listriolobus* beds. But presumably the average slope sediment is coarser than the average outer shelf sediment (75-100 m), hence restricting *Listriolobus.* The sediments of submarine canyons are patchy and extend from black muds bearing coarse organic matter to coarse sands pouring down the canyon heads; but generally as the gradient decreases the sediments become finer and merge with basin or trough muds and clays. Some canyon bottoms support sediments of extremely high organic content, producing hydrogen sulfide and methane.

The find of *Listriolobus* in Hueneme Canyon indicated that some shelf species descend to greater than normal depths wherever suitable sedimentary texture exists. Perhaps other species descend regardless of texture; they may be dependent on factors such as the availability of organic matter. The two variables, grain size and organic content, are usually complementary but the supply of organic matter to patches of fine sediment trapped on the coastal slope far from shore may be too low to support feeding by various organisms. Some species may ignore the steep thermal inclines in favor of adequate food supplies or absence of competition.

The lack of slope biological samples hinders the detection of other shelf species that descend only down canyons, but presumably a number of taxa listed in Table 19 have descended to greater than normal depths in the canyons. Their maximum depths (within 10 m) on the coastal shelf are based on 348 samples. Some marked with asterisks are known to be associated with algae and may have been rafted down the canyon slopes. Insular shelves and slopes of the offshore islands have not been adequately sampled but a few samples from those places revealed species living at greater depths than on the mainland shelf, apparently because the offshore waters are more transparent and algae live at greater depths than on the mainland shelf. Hence, the descent of the species indicated in Table 19 may have other causes than factors associated with a canyon environment.

The ascent of bathyal species along canyon pathways cannot be determined because of sparse data on their occurrence in normal environments of the slope. The shallowest known member of the bathyal fauna is *Harpiniopsis fulgens*, recorded at 128 m but extending to depths of 2000 m. This great eurybathicity suggests, however, the probability that the species normally occurs in shallow depths. Other harpinias do not occur in depths shallower than 300 m. The deep-sea species of *Ampelisca*, *Byblis*, *Liljeborgia* and *Leptophoxus* do not ascend to depths shallower than 400 m in these latitudes.

Amphipod ecologists must note the unusual association of *Ampelisca lobata* and *Paraphoxus abronius* with plants, the former being especially associated with intertidal surfgrass, perhaps inhabiting the interstices at the root level, and the latter almost always being associated with samples bearing masses of red algae (whether or not attached to the substratum is not known).

The genus *Listriella* represents an interesting case that is linked to the *Listriolobus* situation. Mills (1962b) has published evidence that a species of *Listriella* on the Atlantic coast of America is a commensal with polychaetes, especially maldanids. In southern California *Listriella* is particularly associated with the *Listriolobus* community wherein maldanid polychaetes also are predominant. Three of the five species, *Listriella albina*, *L. goleta* and *L. eriopisa*, are confined primarily to fine-silt beds bearing *Listriolobus* and each species declines in frequency toward the edge of the coastal shelf, but is rather prominent in canyon samples. *Listriella albina* notably has a second area of maximum density in the canyons in depths of 300 to 400 m (Table 20). Host-specific association between most listriellas and maldanids is not apparent in data of either canyons or the *Listriolobus* bed, although *Listriella albina* is strongly associated with *Maldane sarsi*. Generally, samples containing any maldanids have several genera and species. At least 18 species of maldanids in 13 genera have been recovered in the canyons and two or more species of *Listriella* usually occur in maldanid samples. Occasionally samples having *Listriella* do not have maldanids. A single maldanid, *Axiothella rubrocincta* (see Barnard, 1964 and Reish, 1963), inhabits Bahía de San Quintín but it is not associated with

Listriella melanica. On the other hand, the amphipod is strongly correlated* with *Pista alta* (Terebellidae), suggesting that listriellas may also live in association with polychaetes of families other than Maldanidae.

Depth Distribution of the Amphipoda in the Canyons and Basins

The known depth distributions of those species collected in the submarine canyons and basins have been arranged in Table 18. Extreme depths and mid-depths are quoted. The species are arranged in groups depending on their occurrence in shallowest water depth and in each group according to their greatest depth penetration.

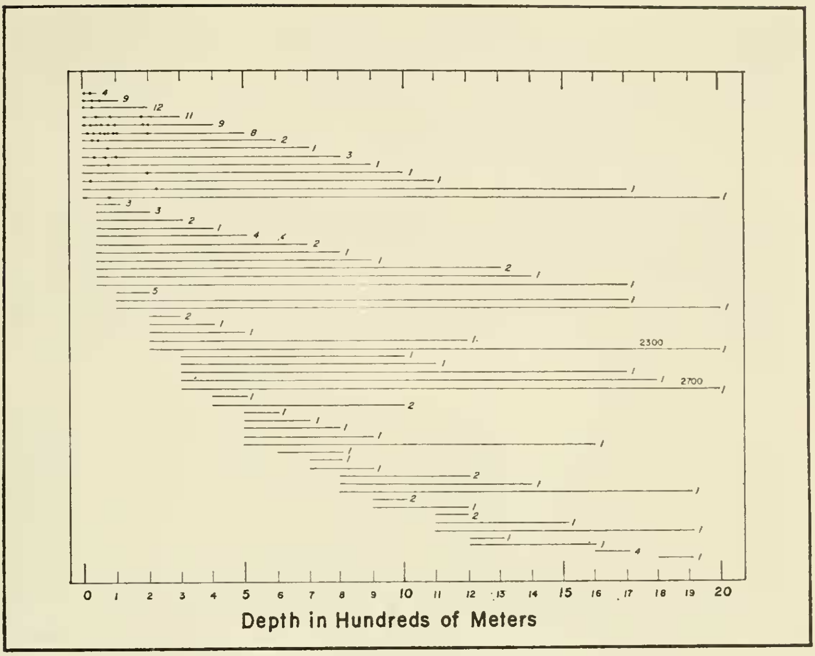
Only four species are restricted to water of less than 30 m in depth. The next group of species has minimum depths of less than 20 m, but occurs from 82 to 1941 m in maximum depth. There follows a group of species with minimum ranges of 21-100 m and then progressively groups of species with minimum depth extremes of 100, 200, 300, 400 m, etc.

The largest group of species has its minimum depths between 0 and 20 m, but there is a surprisingly high percentage of the taxa demonstrating rather strong penetration to greater depths. Of the 64 species (Graph 12 and Table 21) occurring in waters of 0-40 m, only 13 are restricted to depths shallower than 100 m and 11 extend to depths exceeding 500 m. A similar situation occurs in that group of species having minimum depths between 40 and 100 m (Graph 12). Only 3 of the 21 species are confined to waters of less than 100 m and 8 occur in depths greater than 500 m.

Knowledge of the bathymetric ranges of species confined to depths exceeding 300 m is more imperfect than of those known from less, because the distributions of the shallow water species are based on more than 400 shelf and upper slope samples that supplement the samples taken from the canyons and basins.

Potentially, almost all of the coastal shelf species known in depths of 200 m or less might be found in the submarine canyons, at least in their shoreward parts. In this study, 92 species having depth ranges of 0-200 m on the shelf have been collected in the canyons, although 185 species are known to occur on the shelf in those depths. The density of sampling in the canyons has not approached that on the shelf, and probably

*$r = 0.432534$, $N = 91$.



Graph 12. Extremes of known depth distribution of amphipod species collected in the submarine canyons and basins. Each bar represents a species or a group of species having similar depth ranges. In depths greater than 100 m the ranges are classed to the nearest 100 m. Shallower than 100 m the species are grouped in classes of 0 and 40 m. For instance, the first bar shows four species having depth ranges limited to 0-40 m. Bar 3 shows 12 species having ranges of 0-200 m. Bar 16 shows three species having depth ranges between 40 and 200 m.

On the bars near the top of the graph are dots representing the depths at which the species have their highest densities. Bar 6 shows 8 dots, each representing the highest density for each of the 8 species having that depth range. On bars 1-5 most of the species have their densest populations in 0-10 m and a single dot represents those species. Thus, in bar 2, with 9 species, only 2 have their highest densities in depths exceeding 10 m. Insufficient data are available for species below bar 14.

25 of the 185 known shelf species are associated with subtidal algae. These amphipods may be carried into the heads of canyons only in association with detached algae.

Comparison of the Faunal Composition of Canyons and Basins With That of the World Bathyal Zone

Although bathyal depths have been defined as exceeding 200 m (Hedgpeth, 1957), I have used in the following treatment the depth of

300 m in order to exclude a large number of sublittoral species recorded sparsely from depths of 200-300 m. That depth is believed to be more significant for the upper limit of the bathyal fauna in the mid-latitude submarine canyons than is the 200 m depth, for at 300 m the first truly bathyal taxa, the harpinias, are found.

The broader distribution of Amphipoda in the Pacific Ocean outside of southern California is poorly known. Only a few of the littoral and bathyal species that have been reported upon by Gurjanova (1938, 1951, 1952, 1953, 1955, 1962) from the northwestern Pacific, the Japan Sea, Okhotsk Sea and Bering Sea have been discovered in southern California, but a significant proportion of these occur in the north-eastern Atlantic (Table 22).

As shallow water species are of no concern to this discussion, it commences with those species of Table 22 having median depths of 266 m or more. *Westwoodilla caecula* forma *acutifrons* (266 m) and the typical form represent the only members of this diverse boreal genus occurring as far south as southern California. The closely related, if not synonymous, genus *Bathymedon* is diversified in southern California, but none of the known boreal species has been found there. Another oedicerotid genus, *Monoculodes*, has the species *M. latissimanus* and *M. norvegicus* present in southern California, but none of the other numerous boreal species is known to occur that far south, even in bathyal depths.

Of the three species of boreal *Bruzelia*, only one, *B. tuberculata*, extends to southern California, although one new species is described and other new species are believed to occur in Cedros Trench material being studied at this time.

Paraphoxus oculatus, the only species of that enormously diverse genus living in the northeastern Atlantic, occurs also in the Pacific Ocean. It submerges toward the tropics. In southern California waters its minimum recorded depth is 239 m. Except for *Paraphoxus calcaratus* and the reports herein of *P. daboius*, *P. abronius*, *P. obtusidens* and *P. spinosus*, all appearing to be abnormally displaced bathymetrically, *Paraphoxus oculatus* is the deepest dwelling member of the 44 species in the genus. Its wide range and eurybathicity may be connected with its presumed penetration from the Pacific to the northeastern Atlantic Ocean (see remarks by J. L. Barnard, 1958a); otherwise, *Paraphoxus* is confined to the western Atlantic and Indo-Pacific Oceans.

Paraphoxus calcaratus is a shallow-water member of the northwestern Pacific fauna that submerges tropicwards in southern California, as, unlike the other Californian species of *Paraphoxus*, it rarely occurs in shallow waters, having its minimum depth at 75 m.

A subspecies, possibly an ecotype of the deepwater north Atlantic *Leptophoxus falcatus*, is a relatively important member of the bathyal southern Californian amphipod fauna.

Urothoe varvarini, an haustoriid, is eurybathic in southern California, occurring between 31 and 1292 m, and members of its deeper populations are blind. Its distribution resembles that of its close relative, *U. elegans*, a species found between 0 and 3100 m in the Atlantic Ocean but submerging towards the tropics.

Several circumboreal species occur in southern California: *Hippomedon denticulatus*, *Ampelisca macrocephala*, and those already discussed — *Westwoodilla c. acutifrons*, *Bruzelia tuberculata, Paraphoxus oculatus*, and *Leptophoxus falcatus*. Possibly, with the records here obtained, one must also consider *Haploops spinosa* and *Sophrosyne robertsoni* as circumboreal. Cosmopolitan (or bipolar) species include *Argissa hamatipes* and possibly *Nicippe tumida*, both of which are eurybathic. The second record herein of *Sophrosyne robertsoni* in 70 years is an indication not only of the need for more sampling in the bathyal, but also of the rarity of the species or its concealment in a special habitat that is sampled only by accident.

Ampelisca eoa is a shallow-water, north Pacific species submerging tropicwards in southern California, where its minimum depth is 210 m. *Ampelisca furcigera* is a deepwater north Pacific species extending southward as far as southern California at relatively similar depths in the bathyal.

By excluding eurybathic species and any known to occur in depths of less than 100 m, one tallies 47 species of bathyal amphipods from southern California (Table 18), of which 8 have been reported outside of the northeastern Pacific. This sparse occurrence of extrinsic members of the fauna is artificial, for bathyal explorations in other parts of the Pacific are few.

The systematic relationship of the bathyal fauna to the local sublittoral fauna appears to be rather low. Indeed, many of the genera are different (Table 23). Only 9 of 27 genera are sublittoral in character, the remaining 18 genera occurring only in the bathyal. Of course, many of the "bathyal" genera exist in the sublittoral of the cold-temperate zone. Twenty-nine of the bathyal species belong to bathyal genera, and 17 belong to sublittoral genera. I find no evidence of close morphological relationship to local sublittoral species for any of the 17 bathyal species belonging to littoral genera. This statement needs qualification by stating the inability, at present, to trace relationships in such diverse genera as *Ampelisca* and *Byblis*, especially the latter in which interspecific differences are minor. Except for *Ampelisca* and *Paraphoxus* and possibly *Metopa*, the other so-called sublittoral genera are poorly represented on the southern Californian coastal shelf and indeed are more diverse in the boreal. The boreal orientation of the bathyal fauna of southern California is seen especially in the genera *Protomedeia*, *Monoculodes*, *Liljeborgia*, *Tryphosa*, *Schisturella*, *Bruzelia*, *Leptophoxus*, *Proboloides*, *Bathymedon*, *Sophrosyne*, and *Lepidepecreella*. However, some of these genera also are well represented in the antiboreal, such as *Liljeborgia*, *Tryphosa*, *Proboloides* (subgenus *Metopoides*), and *Lepidepecreella*. *Paroediceroides* also has an antiboreal attitude, but one must question whether it is distinct from *Monoculodes*. *Thrombasia*, *Tosilus* and *Coxophoxus* are newly erected and their further distribution is unknown. The single species placed in *Melphidippa* is questionably assigned.

PROSPECTUS

Future studies on canyons might include the following:

1. Concentration of study on one canyon in greater detail than attempted in this survey.

2. Microtopography: use of undersea vehicles and focused-beam bathymetric sounding to chart microrelief of canyons (Buffington, 1964) in detecting areas for sampling of sediments and life. Presumably, the canyon axis has flat areas where fine sediments are trapped and organic content is therefore high; perhaps these are places in which coarse organic debris reaches stabilization after saltation.

3. Establishment of several semi-permanent undersea stations equipped with television for observation of sedimentary movements and biotic activities. A platform or observation chamber equipped with television, current meters, salinometers, thermistors, sediment traps and other devices could be submerged into fixed position with the aid of a diving vehicle; recording devices might be self-contained or connected by cable to a shore station (several California laboratories are situated close to favorable study areas).

4. The study of currents is of first importance; perhaps the fixed benthic recording station could be equipped with a buoy suspended above it, to the cable of which are attached recording current meters at inter-

vals. Thus, benthic currents as well as areas of upwelling might be detected simultaneously. Epibenthic current meters would have to be paired to detect both horizontal and vertical motion.

5. A series of sediment traps at substrate level and above should be used to collect sediments for studies of depositional rates and accretion of organic matter. Traps might be attached to long flexible arms so that they could be positioned remotely adjacent to canyon walls or at the bases of declivities, on benches and in "plunge pools." Large deep tubs of sediments devoid of metazoan life might be established and monitored for biotic succession. The seasonal variability and origin of settling larvae could be determined simultaneously. A series of standards might be developed that would indicate the stage of development of a specific sample, thus reflecting the temporal aspects of any previous environmental catastrophe.

6. Identification of the kinds and sources of organic debris.

7. Determination of the viability of those species that may be existing vegetatively (non-reproducing organisms recruited from shallow water).

8. Establishment of an alarm system in supposedly active canyons for warning of turbidity flows so that post-catastrophic sampling and exploration by undersea vehicles could be undertaken to monitor the return of the fauna to climax conditions.

SUMMARY

1. Soft bottoms in canyon heads, 15-100 m, have a more diverse algal-dwelling amphipod fauna than is found on the coastal shelf in the same depths, but the fauna is not identifiable with that from sand of either very shallow water (4-10 m), the coastal shelf (11-91 m), or the upper coastal slope (92-183 m), because it represents a mixture of elements from those areas. *Paraphoxus bicuspidatus*, a common inhabitant of shelf and slope, is scarce.

2. In depths of 101-200 m the benthic amphipod fauna compares favorably with upper coastal slopes of 92-183 m and *Paraphoxus bicuspidatus* occurs abundantly.

3. Although standing crop is erratic from sample to sample, there is a significant decrease between depths of 600 and 700 m from a level of

about 125 to about 20 g/m^2. This marked decline corresponds with the occurrence of the oxygen minimum layer.

4. Four decreasing steps in the density of amphipod individuals occur in canyons, the first at 0-100 m (588 individuals/m^2), the second at 101-500 m (54/m^2), the third at 501-1000 m (14.7/m^2), and the fourth at 1001-1600 m (2.8/m^2). Below sill depths of the borderland basins, the average number of amphipods is 6.0/m^2, except in the shallow nearshore basins where only 1.2 individuals/m^2 are found, apparently in relationship to low dissolved oxygen in subsill waters.

5. There is little change in the faunal composition between the deeper ends of the submarine canyons and the subsill parts of the basins. So far only five amphipod species have been found in the basins that have not been collected in the canyons, although, because several basin systems have greater bottom depths than the canyons, more species are to be expected when trawling with fine nets is undertaken.

6. Widespread and consistently deleterious effects of sediment movement within canyon axes have not been detected. Not all canyon samples have produced amphipods, but all have produced faunal elements of one kind or another. Hartman (1963) has reported on the occurrence of specifically impoverished, brackish and pollution-tolerant canyon faunas that probably result from the emergence of aquifers.

7. Specifically impoverished topical faunas, dominated in part by the amphipod *Protomedeia articulata* in Monterey Canyon, appear to be related to large quantities of organic debris that have settled *en masse*. The poor diversity indicates that a slump may have demolished the prior fauna and that *Protomedeia* and several species of polychaetes represent an early succession.

8. About half of the known coastal shelf Amphipoda have been collected in the shallow depths of the canyons and probably more are present. No faunal disparities except those mentioned in paragraphs 1 and 7 above have been detected that would indicate that canyons comprise a special or a restrictive environment. This statement is supported by the broad spectrum of sediment types collected in the canyon axes.

9. Bathyal indicator species, especially the harpinias, occur at minimum depths of approximately 300 m in the canyons.

10. Several sublittoral Amphipoda seem to be abnormally displaced to great depths via canyon pathways. In some cases this displacement may

be connected with the descent of organic materials, especially detached algae, down the canyon axes. Until non-canyon slopes can be sampled, these displacements must remain figmentary, but the rather restricted depth distribution of these species on the coastal shelf suggest that they are abnormally displaced.

11. The shallowest nearshore basins support a large proportion of eurybathic species, suggesting an association between eurybathicity and tolerance to environmental stresses such as low oxygen values. Nevertheless, only 9 species of amphipods have been collected in the nearshore basins.

12. Deeper offshore basins with oxygen values higher than the shallower nearshore basins have a more diversified amphipod fauna and fewer shelf species.

13. The bathyal amphipod fauna of southern California has little connection with the local sublittoral fauna. Apparently the bathyal members have been derived from cold-temperate sublittoral faunas that have submerged towards the tropics.

14. Seventy-two percent of the 109 samples of the coastal canyons can be divided into 4 major assemblages, based on the polychaetes *Pectinaria*, *Heteromastus*, *Maldane*, and *Lysippe*. The remaining samples are not allocated either because of mixing of dominants or the absence of dominants. A significant proportion of samples from deepwater (600 + m), is not assignable to Petersen-type communities because of the low densities of organisms, absence of clearly dominating species and the lack of subdominant indicator species. The *Pectinaria* and *Heteromastus* assemblages are clearly related to each other through overlapping samples and tests of minimum faunal percentages. The *Pectinaria* (*sensu stricto*) samples may be further subdivided according to the presence of other subdominants: *Capitella*, *Ancistrosyllis*, *Chloeia*, *Dentalium*. A sketchy differentiation in a depth-sediment scheme can be demonstrated. The *Pectinaria-Capitella* association is confined largely to coarse sediments with wide depth range. The *Pectinaria-Ancistrosyllis* association is restricted to finely particulate sediments of shallow water. Fine sediments of slightly deeper water support, in succession, the *Pectinaria-Dentalium* and *Pectinaria-Chloeia* associations followed by the *Maldane* complex. The *Heteromastus* association is scattered across the scheme from coarse to fine sediments in depths between 400 and 550 m, and below that depth the remaining samples are lumped into a *Lysippe-Califia-Aricidea-Terebellides* group that needs further study.

ACKNOWLEDGMENTS

The field work was made possible by a grant (G-9060) to the Allan Hancock Foundation by the National Science Foundation. My gratitude is extended to those persons and institutions listed by Hartman (1963). This paper was written during my tenure at the Allan Hancock Foundation 1957-1960 and at the Beaudette Foundation of California 1960-1964, and I am indebted to those institutions for their support. Miss Jacqueline M. Hampton of the Beaudette staff prepared several of the figures and drafted all of the graphs. My thanks go especially to Dr. Olga Hartman and Dr. K. O. Emery for their aid and cooperation, and to Mrs. Dorothy M. Halmos and her staff of the Allan Hancock Library for interlibrary loans and reference work.

TABLE 1

Some sedimentary characteristics of canyons and the coastal shelf.

	Canyons, 0-50 m above axis 55 samples	Coastal shelf 10-183 m 348 samples
Median of all Median diameters, mm	0.039 (0.059)*	0.059 (0.130)*
Median point of percent Carbon	1.05 (1.76)*	0.53*

*From Emery 1960, p. 181, Table 12, carbon computed in reverse from organic matter.

TABLE 2

Frequency of animal groups in depth classes of insular canyons, Coronado, Tanner and Catalina, compiled from data of Hartman (1963). Tabulated data represent individuals/m^2.

Depth class, m	Polychaetes	Echinoderms	Mollusks	Crustaceans	Others	Total
100	327	1395	15	76	2	1815
200	342	276	18	142	15	793
300	217	45	12	41	11	326
400	336	138	17	46	6	543
500	112	581	33	120	11	857
600	577	36	72	20	39	744
700	187	53	191	21	14	466
1000	232	48	22	39	16	357
1600	58	21	11	12	21	123

TABLE 3

Frequency of animal groups in depth classes of mainland canyons, Monterey, Hueneme, Mugu, Dume, Redondo axes, Newport and La Jolla, compiled from data of Hartman (1963). Tabulated data represent individuals/m².

Depth class, m	Polychaetes	Echinoderms	Mollusks	Crustaceans	Others	Total
100	1590	73	111	159	83	2016
200	1075	36	163	319	97	1690
300	379	9	67	38	12	505
400	602	29	33	37	13	714
500	267	9	326	71	9	399
600	130	10	28	56	17	241
700	87	8	38	5	7	145
1000	95	5	15	52	15	182

TABLE 4

Frequency of animal groups in depth classes of all canyons of California, except Santa Cruz Canyon (data incomplete), compiled from data of Hartman (1963). Tabulated data represent individuals/m².

Depth class, m	Polychaetes	Echinoderms	Mollusks	Crustaceans	Others	Total
100	1377	366	157	130	61	2091
200	1738	164	191	298	72	2463
300	661	23	67	37	12	800
400	623	47	26	35	13	744
500	312	44	160	43	10	569
600	229	25	37	29	21	341
700	98	12	53	7	19	189
1000	144	13	19	28	13	217
1600	43	15	9	9	12	88
*Coastal shelf, 10-183 m	1424	532	470	1352	125	3903

*Based on 348 samples apportioned equally to depth classes and geographic zones.

TABLE 5

Communities of the coastal shelf of southern California, based on 348 samples apportioned to the 1061 square miles according to depth and geographic area.

Name of community	Percent occurrence on shelf	No. of dominant occurrences in 142 canyon samples
Amphiodia urtica	20.2	4 (islands)
Nothria-Tellina	19.5	0
Amphiodia-Cardita	10.1	0
Listriolobus	6.6	2
Amphioplus	5.5	1
Diopatra	4.3	1
Nothria-Spiophanes	4.0	0
Chloeia-Pectinaria	4.0	4
Amphiodia-Onuphis	2.9	0
Onuphis	2.9	1
Amphiacantha	2.6	0
Amphiodia digitata	1.7	0
Tharyx	1.4	2
Amygdalum	1.1	0
Chaetopterus	0.9	0
Spiophanes missionensis	0.9	0
Pinnixa	0.9	0
Nothria iridescens-Tellina	0.6	0
Branchiostoma	0.6	0
Capitella	0.6	9
Sthenelanella	0.3	0
Pherusa-Onuphis	0.3	0
Ampelisca	0.3	0
Macoma	0.3	0
Sipunculus	0.3	0
Ophiothrix	0.3	0
Dendraster	0.3	0
No community dominant	7.2	+

TABLE 6

The grouping of canyon samples according to their dominants with distribution of species in the samples.

Group Number	1	2	3	4	5	6	7	8	9
Dominants	Pect.	Pect. Dent.	Pect. Cap.	Pect. Anc.	Pect. Chl.	Het. Chl.	Het.	Mald.	Lysip.
Sample numbers	2189	4846	2190	3164	5639+	2148	5531	2219	2317
	5114	5661	7039	5367	6815	2149	5688	3178	2336
	5115	6854	7043	7030	6909	6498	6903	3179	6503
	6818	7054	7045	7284+	7160+	6499	6910	3180	6820*
	6897				7174	7160+		3399	6828
	6898				7284+			4851	7047
	7052							5639+	7050
	7286							6497	7051
	7287							6779	7728
	7730							6821*	
								6850*	
								7028	
								7155	
								7729	
Individuals/m^2[a]									
Pectinaria	272	97	650	590	245	53	2	30	1
Dentalium	2	155	0	21	1	2	0	13	0
Capitella	1	0	7977	19	1	0	0	0	0
Ancistrosyllis	3	11	0	373	79[c]	6	2	0	1
Chloeia	23	1	42	88	293	110	6[c]	52[c]	1
Heteromastus	21	45	22	47	4[c]	198	515	1	0
Maldane sarsi	2	1	1	0	217[c]	8	0	209	2
Lysippe	0	0	0	0	0	0	0	0	42
Nothria iridescens	4	0	0	0	0	4	2	33	0
Spiophanes fimbriata	28	6	1	17	43	1	1	4	1
Pista disjuncta	22[b]	34	0	7	4[c]	0	0	6[c]	0
Haploscoloplos	46	4	6	3	1	6	36	2	0
Aricidea lopezi	1	0	0	49[c]	2	0	0	0	1
Related Samples	3000	7285	6780	5006	2218	7523	5674	2793	7041
	5046		6781	5250	2727		6900		
	6501		6899	7029	5505		7288		
	6822*		7046	7031	5532		7289		
	6845*			7038	6816				

Mixed Samples: 7032 and 3166 = *Pectinaria* & *Heteromastus*; 6819 = *Pectinaria* & *Maldane*

* = island canyon sample
\+ = in two communities
(a) = for purposes of equating OPG and CG samples
(b) = estimate
(c) = largely one sample

TABLE 7

Density of Amphipoda in basins off southern California.

Name of Basin	Number of Samples	Number of amphipods per m^2 (to nearest 0.25)	Sill Depth, m
1. Santa Barbara	5	2.0	475
2. Santa Monica	26	0.0	737
3. San Pedro	72	2.0	737
4. Santa Catalina	11	6.25	974
5. Santa Cruz	9	9.0	1085
6. San Nicolas	11	5.0	1106
7. Tanner	6	8.0	1165
8. West Cortes	4	2.0	1362
9. San Clemente	6	3.0	1816
10. East Cortes	3	10.0	1415
11. Long	3	7.0	1697
12. Velero	2	0	1902
Patton Escarpment	2	20.0	
Shallow Basins (1-3)		1.5	
Deep Basins (4-12)		6.0	

TABLE 8

The abundant species and genera of amphipods in the borderland basins of southern California.

Name of species	Number of individuals in the samples
Heterophoxus oculatus	28
Harpiniopsis fulgens	16
Liljeborgia cota	8
Harpiniopsis epistomata	8
Coxophoxus hidalgo	6
Pardaliscella symmetrica	5
Harpiniopsis emeryi	5
Name of genus	
Harpiniopsis	40
Ampelisca	21
Heterophoxus	28
Byblis	9
Liljeborgia	8
Coxophoxus	6
Pardaliscella	5

TABLE 9

Amphipoda known from the basins but not from the submarine canyons.

Harpiniopsis excavata, Bonnierella linearis californica, Sophrosyne robertsoni, Hirondellea fidenter, Lepidepecreella charno, Coxophoxus hidalgo, Ampelisca amblyopsoides.

TABLE 10

Density of Amphipoda in relation to depth in submarine canyons of California.

Depth class, m	No. of Samples	Total m^2	No. of Amphipoda	No. of species	No. of Amphipoda per m^2
100	8	2.00	1176	55	588
200	23	8.50	873	60	103
300	20	8.50	374	46	44
400	21	8.25	187	29	23
500	21	8.50	368	27	43
600	19	7.50	70	15	9.3
700	17	7.25	61	21	8.4
800	13	5.75	160	16	28
1000	9	4.50	76	20	17
1600	5	2.50	7	6	2.8
10–100 (Shelf)	300	60.00		Ca. 150	695
3–10	100	10.00			257

TABLE 11

Abundant Amphipoda of the coastal shelf of southern California, 5-183 m, based on 348 samples, listed in rank, with number of individuals/m^2.

Paraphoxus bicuspidatus, 58; *Ampelisca brevisimulata*, 44; *Heterophoxus oculatus*, 31; *Ampelisca cristata*, 27; *Paraphoxus abronius*, 23; *Metaphoxus frequens*, 22; *Photis brevipes*, 21; *Amphideutopus oculatus*, 21; *Ampelisca macrocephala*, 17.3; *Paraphoxus similis*, 16.7; *Para-*

phoxus epistomus, 16.1; *Paraphoxus obtusidens*, 15.9; *Paraphoxus stenodes*, 14.3; *Aoroides columbiae*, 14.0; *Ampelisca pacifica*, 13.6; *Photis lacia*, 12.0; *Acuminodeutopus heteruropus*, 12.5; *Ampelisca pugetica*, 10.8; *Eurystheus thompsoni*, 7.7; *Listriella goleta*, 7.3; *Byblis veleronis*, 7.2.

TABLE 12

Abundant Amphipoda of the coastal shelf and upper slope of southern California, 92-183 m, based on 48 samples, listed in rank, with number of individuals/m².

Paraphoxus bicuspidatus, 98; *Ampelisca macrocephala*, 84; *Ampelisca romigi*, 45; *Heterophoxus oculatus*, 35; *Metaphoxus frequens*, 33; *Photis lacia*, 27; *Ampelisca pacifica*, 21; *Phoxocephalus homilis*, 19.0; *Westwoodilla caecula* & *acutifrons*, 15.6; *Ampelisca brevisimulata*, 13.4; *Orchomene decipiens*, 12.0; *Nicippe tumida*, 11.0; *Ampelisca pugetica*, 10.0; *Protomedeia articulata*, 9.6; *Lysianassa holmesi*, 9.2; *Paraphoxus similis*, 8.6; *Paraphoxus robustus*, 8.3; *Urothoe varvarini*, 8.1; *Pardisynopia synopiae*, 7.1; *Lysianassa oculata*, 6.5.

TABLE 13

Abundant Amphipoda on bottoms of 2-5 m on the coastal shelf of southern California (after J. L. Barnard 1963, Table 16), with numbers of individuals/m². Phycophilous species are marked with asterisks.

Paraphoxus epistomus, 55; *Synchelidium* spp., 2 species, 31; *Mandibulophoxus uncirostratus*, 30; *Photis lacia*, 25; *Paraphoxus bicuspidatus*, aberrant form, 25; *Paraphoxus abronius*, 9.7; *Eohaustorius washingtonianus*, 9.5; *Ampelisca compressa*, 9.2; **Aoroides columbiae*, 7.5; *Monoculodes hartmanae*, 4.9; **Ampithoe* sp., 4.4; *Paraphoxus variatus*, 4.1; **Batea transversa*, 4.1; *Paraphoxus heterocuspidatus*, 3.8; *Ischyrocerus pelagops*, 3.0; **Photis* spp. juveniles, 2.9; *Photis brevipes*, 2.7; *Atylus tridens*, 2.6; *Megaluropus longimerus*, 2.3; *Paraphoxus jonesi*, 2.0; *Argissa hamatipes*, 1.4; *Ampelisca cristata*, 1.0; *Paraphoxus lucubrans*, 1.0; *Tiron biocellata*, 1.0; *Acuminodeutopus heteruropus*, 0.9; **Amphilochus picadurus*, 0.6; *Paraphoxus stenodes*, 0.6; *Paraphoxus obtusidens*, 0.5; *Ericthonius brasiliensis*, 0.5; *Parapleustes pugettensis*, 0.5; *Uristes entalladurus*, 0.4; **Eurystheus thompsoni*, 0.4; *Cerapus tubularis*, 0.4.

TABLE 14

Abundant Amphipoda in submarine canyons, 15-100 m.

Name of species	No. of individuals in 8 samples	Ecological type
**Aoroides columbiae*	197	A
Parapleustes pugettensis	89	A
**Paraphoxus stenodes*	75	B
**Paraphoxus epistomus*	65	B
**Photis brevipes*	56	A
**Listriella goleta*	43	S
**Paraphoxus obtusidens*	41	B
**Synchelidium* sp.	32	B
**Ampelisca cristata*	32	T
**Ampelisca macrocephala*	28	T
Ischyrocerus pelagops	24	A
**Ampelisca brevisimulata*	23	T
Paraphoxus fatigans	20	B
Paraphoxus spinosus	19	B
Ampelisca compressa	17	T
Protomedeia articulata	14	T

A = algal dweller; B = burrower; T = builder of tubes; S = ?maldanid commensal.
* = a major shelf species.

TABLE 15

Abundant Amphipoda in submarine canyons, 101-200 m. Species are listed in rank, with their numbers of specimens in 23 samples. Species also dominating slope depths of 92-183 m are marked with asterisks. See Table 12.

**Heterophoxus oculatus,* 118; **Metaphoxus frequens,* 114; **Paraphoxus bicuspidatus,* 107; **Ampelisca macrocephala,* 72; **Phoxocephalus homilis,* 67; * *Orchomene decipiens,* 34; **Photis lacia,* 31; *Maera danae,* 30; **Paraphoxus similis,* 30; **Westwoodilla c. acutifrons,* 22; **Nicippe tumida,* 16; *Pachynus barnardi,* 12; *Photis brevipes,* 10; *Listriella eriopisa,* 10; **Ampelisca pacifica,* 10.

TABLE 16

The most abundant Amphipoda in each depth regime of the submarine canyons, abstracted from Appendix I. See Table 14 for the depths of 15-100 m.

Depth, m	No. of samples	Amphipod	No. of specimens in the samples
100–200	23	*Heterophoxus oculatus*	118
		Metaphoxus frequens	114
		Paraphoxus bicuspidatus	107
		Ampelisca macrocephala	72
		Phoxocephalus homilis	67
		Orchomene decipiens	34
		Photis lacia	31
		Maera danae	30
		Paraphoxus similis	30
		Westwoodilla c. acutifrons	22
201–300	20	*Heterophoxus oculatus*	69
		Ampelisca macrocephala	51
		Phoxocephalus homilis	28
		Maera simile	22
		Ampelisca pacifica	16
301–400	21	*Ampelisca macrocephala*	51
		Heterophoxus oculatus	33
		Phoxocephalus homilis	18
		Harpiniopsis fulgens	13
401–500	21	*Paraphoxus calcaratus*	99
		Photis spp. juvs.	93
		Paraphoxus obtusidens	48
		Harpiniopsis epistomata	26
		Phoxocephalus homilis	17
		Byblis ?veleronis	16
		Heterophoxus oculatus	9
501–600	19	*Harpiniopsis epistomata*	32
		Ampelisca macrocephala unsocalae	6
		Byblis barbarensis	6
		Liljeborgia cota	5
601–700	17	*Ampelisca macrocephala unsocalae*	22
		Harpiniopsis epistomata	7
		Proboloides tunda	7

TABLE 16 (Cont.)

Depth, m	No. of samples	Amphipod	No. of specimens in the samples
701–800	13	(*Protomedeia articulata*)	111
		Harpiniopsis epistomata	16
		oedicerotid	7
		Harpiniopsis fulgens	5
		Ampelisca macrocephala unsocalae	4
		Byblis barbarensis	4
		Heterophoxus oculatus	4
801-1000	9	(*Protomedeia articulata*)	20
		Ampelisca macrocephala unsocalae	14
		(*Paraphoxus daboius*)	9
		Harpiniopsis epistomata	4
1001–1620	5	None Abundant	

TABLE 17

Percent of shelf (sublittoral) and slope (bathyal) species of Amphipoda in depth intervals of the canyons, from Appendix I.

Depth, m	Total no. of species	No. from shelf	No. from slope	No. of Eurybathic	Unknown
15-100	56	54	0	2	0
101-200	60	56	2	2	0
201-300	46	41	1	2	2
301-400	29	21	4	3	1
401-500	27	17	7	3	0
501-600	15	5	9	1	0
601-700	20	7	12	1	0
701-800	16	7	8	1	0
801-1000	20	2	16	2	0
1001-1620	6	0	6	0	0

TABLE 18

Known depth distribution of Amphipoda recorded from submarine canyons and basins of California. The species are arranged in successive groups according to their minimum depths, group one in depths of 0-20 m, group 2 in depths of 20-100 m, with succeeding groups in intervals of 100 m thereafter. Within each group the species are arranged by their mid-depths.

Name of species	Depth, m Minimum	Maximum	Mid-depth
Ischyrocerus pelagops	0	24	12
Pseudokoroga rima	2	30	16
Megaluropus longimerus	9	27	18
Acuminodeutopus heteruropus	1	82	41
Synchelidium sp. G	2	89	46
Ampithoe mea	0	89	45
Synchelidium rectipalmum	2	90	46
Parapleustes pugettensis	0	120	60
Atylus tridens	0	135	68
Monoculodes hartmanae	1	142	72
Amphideutopus oculatus	2	162	82
Synchelidium shoemakeri	0	168	84
Podocerus cristatus	0	171	86
Ericthonius brasiliensis	0	171	86
Melita dentata	0 (north)	177 "672"	89
Eurystheus thompsoni	0	218	109
Maera simile	0	221	111
Ceradocus spinicaudus	0 (north)	221	111
Microdeutopus schmitti	0	221	111
Ampelisca lobata	0	234 (?549)	117
Photis brevipes	0	266	133
Ampelisca compressa	1	330 (?676)	166
Maera danae	2	362	182
Gitanopsis vilordes	0	374	187
Aoroides columbiae	0	298 (?374)	199
Paraphoxus obtusidens	0	459	230
Paraphoxus epistomus	0	507	254
Paraphoxus spinosus	2	519	261
Melphisana bola	13	76	45
Paraphoxus variatus	5	93	49
Paraphoxus lucubrans	9	91	50

TABLE 18 (Cont.)

Name of species	Depth, m Minimum	Maximum	Mid-depth
Photis bifurcata	11	93	52
Listriella melanica	12	97	55
Sympleustes subglaber	18	116	67
Paraphoxus heterocuspidatus	13	146	80
Lysianassa holmesi	11	167	89
Opisa tridentata	17	162	90
Photis lacia	11	180	96
Anonyx carinatus	15	180	98
Ampelisca milleri	15	187	101
Ampelisca hancocki	9	210	110
Stenothoides bicoma	15	218	117
Westwoodilla c. acutifrons	12	266	139
Paraphoxus abronius	9	274	142
Ampelisca cristata	6	310	158
Paraphoxus robustus	4	319	162
Paraphoxus stenodes	5	374	190
Pachynus barnardi	12	373	193
Paraphoxus fatigans	12	385	199
Prachynella lodo	10	459	235
Ampelisca brevisimulata	16	456	236
Listriella goleta	12	459	236
Paraphoxus bicuspidatus	8	475	242
Ampelisca romigi	3	504	254
Metaphoxus frequens	13	496	255
Listriella eriopisa	11	560	286
Acidostoma hancocki	15	672	344
Listriella albina	16	721	369
Ampelisca pugetica	9	765	387
Protomedeia articulata	18	906	462
Hippomedon denticulatus	0	924	462
Argissa hamatipes	4	1096	550
Ampelisca macrocephala	5	1686	846
Heterophoxus oculatus	2	1941	972
Bathymedon roquedo	22	107	65
Garosyrrhoe bigarra	44	89	67
Paraphoxus tridentatus	55	89	72
Hippomedon tenax	88		88
Dexamonica reduncans	51	180	116

TABLE 18 (Cont.)

Name of species	Depth, m Minimum	Maximum	Mid-depth
Monoculodes emarginatus	55	200	128
Haploops spinosa	88	171	130
Photis macrotica	55	221	138
Metopella aporpis	84	218	151
Paraphoxus similis	31	324	178
Ericthonius difformis (*hunteri*)	68	352	210
Byblis veleronis	31	422 (?786)	227
Orchomene pacifica	46	421	234
Ampelisca pacifica	24	496	247
Pardisynopia synopiae	53	496	275
Phoxocephalus homilis	62	644	353
Paraphoxus calcaratus	75	689	382
Monoculodes norvegicus	20	786	403
Orchomene decipiens	35	793	414
Paraphoxus daboius	77	813	445
Urothoe varvarini	31	1292	662
Harpiniopsis similis hondanada	57	1298	678
Nicippe tumida	34	1367	701
Ampelisca macrocephala unsocalae	72	1687	880
Pardaliscella symmetrica	92	1749	921
Protomedeia prudens	121		121
Schisturella cocula	162		162
Thrombasia tracalero	167		167
Syrrhoe sp.	177		177
Monoculodes perditus	177		177
Bruzelia tuberculata	121	565	343
Harpiniopsis fulgens	128	2059	1094
Pardaliscoides fictotelson	218		218
Mesometopa neglecta roya	221		221
Ampelisca furcigera	210 (60 in north)	384	297
Monoculodes glyconica	226	503	365
Paraphoxus oculatus	(27) North 239	1135	685
Leptophoxus falcatus	(56) North 249	2258	1255
Harpiniopsis naiadis	338	976	657
Monoculodes latissimanus	344	1096	720
Harpiniopsis epistomata	371	1626	999

TABLE 18 (Cont.)

Name of species	Depth, m Minimum	Maximum	Mid-depth
Liljeborgia cota	366	1821	1094
Harpiniopsis emeryi	344	2702	1234
Uristes californicus	(420)	924	672
Harpiniopsis excavata	425	5110	2768
Byblis bathyalis	496	950	723
Melphidippa (?) amorita	496		496
Proboloides tunda	545	611	578
Ampelisca coeca	553	793	673
Byblis barbarensis	503	902	703
Bathymedon covilhani	549	1533	1041
Oediceropsis elsula	644		644
Ampelisca romigi ciego	603	813	708
Bathymedon kassites	750	906	823
Oediceropsis morosa	813		813
Byblis tannerensis	813	1138	976
Ampelisca plumosa	813	1821	1317
Oediceropsis trepadora	875	1406	1141
Schisturella zopa		914	914
Tosilus arroyo		976	976
Harpiniopsis profundis	(385) 976	1135	1056
Hirondellea fidenter		1227	1227
Ampelisca amblyopsoides	1123	1481	1299
Ampelisca eoa	1135 (421 in north)	1833	1481
Harpiniopsis petulans		1265	1265
Sophrosyne robertsoni		1298	1298
Bonnierella linearis californica	1292	1608	1450
Metopa samsiluna		1620	1620
Tryphosa index		1620	1620
Coxophoxus hidalgo		1675	1675
Bruzelia ascua		1687	1687
Lepidepecreella charno		1895	1895

TABLE 19

Amphipoda occurring in greater depths on canyon floors than on the coastal shelf. Species associated with plants are marked with an asterisk (*).

Name of Species	Apparent Maximum Coastal Shelf Depth, m	Known Canyon Depth, m
**Atylus tridens*	10	135
**Ceradocus spinicaudus*	20	221
**Gitanopsis vilordes*	30	374
**Paraphoxus abronius*	40	274
Paraphoxus heterocuspidatus	30	146
Paraphoxus stenodes	50	374
**Photis bifurcata*	50	93
Paraphoxus lucubrans	50	91
Paraphoxus variatus	50	93
Monoculodes hartmanae	50	142
Microdeutopus schmitti	60	221
Stenothoides bicoma	70	218
Paraphoxus epistomus	100	507
**Ampelisca lobata*	100	221
Ampelisca cristata	200	310

TABLE 20

Frequency of *Listriella* in individuals/m^2 in various depth classes on the coastal shelf and in the canyons.

	Depth, m, on the coastal shelf					
	10	20	30	40	50	100
eriopisa	1.6	4.6	1.9	1.6	0.3	1.2
goleta	4.0	16.3	14.4	1.6	3.0	0.4
albina	0.3	2.1	0.7	0	0	0.4

	Depth, m, in the canyons							
	100	200	300	400	500	600	700	800
eriopisa	1.0	1.2	0.5	0.1	0	0.1	0	0
goleta	14.3	0.5	0.3	0.4	0.1	0	0	0
albina	0	0.3	1.5	1.0	0	0.4	0	0.2

TABLE 21

Number of species of Amphipoda per depth class in the canyons and basins of California. Based not only on direct collections, but implemented also by inclusion of the known depth range from all sources of the species collected in the canyons and basins.

Depth Class, m	0–20	21–40	41–100	101–200	201–300	301–400	401–500
No. of species	64	64	81	76	74	51	44

501–600	601–800	801–1000	1001–1200	1201–1600	1601–2000+
35	34	31	25	18	16

TABLE 22

List of Amphipoda discussed in this paper that are known from geographic areas outside of the northeastern Pacific. Arranged in order of increasing median depth, from Table 18.

Name of species	Median depth, m	Extrinsic Distribution
Megaluropus longimerus	18	West Africa
Ampithoe mea	45	NW Pacific
Podocerus cristatus	86	Australasia
Ericthonius brasiliensis	86	Tropicopolitan
Melita dentata	89	?Circumboreal
Haploops spinosa	130	NW Atlantic
Ampelisca compressa	166	West Atlantic
Maera danae	182	West Atlantic
Ericthonius difformis	210	?Circumboreal
Paraphoxus obtusidens	230	NW & SE Pacific
Orchomene pacifica	234	NW Pacific
Paraphoxus epistomus	254	West Atlantic
Paraphoxus spinosus	261	West Atlantic
Westwoodilla caecula, forma *acutifrons*	266	NE Atlantic
Ampelisca furcigera	297	Japan Sea
Bruzelia tuberculata	343	NE Atlantic
Paraphoxus calcaratus	382	NW Pacific
Monoculodes norvegicus	403	?Circumboreal
Hippomedon denticulatus	462	NE Atlantic

TABLE 22 (Cont.)

Name of species	Median depth, m	Extrinsic Distribution
Argissa hamatipes	550	?Cosmopolitan
Urothoe varvarini	662	NW Pacific
Paraphoxus oculatus	685	North Atlantic
Nicippe tumida	701	?Cosmopolitan
Monoculodes latissimanus	720	North Atlantic
Ampelisca macrocephala	846	Circumboreal
Leptophoxus falcatus ssp.	1255	North Atlantic
Sophrosyne robertsoni	1298	Firth of Clyde
Bonnierella linearis ssp.	1450	Peru
Ampelisca eoa	1481	NW Pacific

TABLE 23

List of genera found in both the sublittoral and bathyal of southern California and the number of local bathyal species in each genus.

Sublittoral-Bathyal Genera: *Ampelisca* (5), *Byblis* (3), *Liljeborgia* (1), *Metopa* (1), *Monoculodes* (2), *Paraphoxus* (1), *Protomedeia* (1), *Tryphosa* (1), *Uristes* (2).

Bathyal Genera: *Bathymedon* (2), *Bonnierella* (1), *Bruzelia* (2), *Coxophoxus* (1), *Harpiniopsis* (7), *Hirondellea* (1), *Lepidepecreella* (1), *Leptophoxus* (1), *Melphidippa* (1), *Mesometopa* (1), *Pardaliscoides* (1), *Oediceropsis* (4), *Proboloides* (1), *Schisturella* (2), *Sophrosyne* (1), *Syrrhoe* (1), *Thrombasia* (1), *Tosilus* (1).

SYSTEMATICS

Data on depths and new records are not included because the summarized depth ranges may be found in table 18 for all species herein discussed. Station records are noted and the reader may find precise data for each station in Hartman (1963).

Family AMPELISCIDAE

Ampelisca amblyopsoides J. L. Barnard

Ampelisca amblyopsoides J. L. Barnard 1960a: 24-25, fig. 4.

Basin material: 6346(3).

Slope material: 3030(1).

Ampelisca brevisimulata J. L. Barnard

Ampelisca brevisimulata J. L. Barnard 1954b: 33-35, pls. 23-24.

Canyon material: 4851(4), 5006(1), 5367(13), 5960(2), 6899(2), 7030(1), 7031(8), 7038(1).

Slope material: 3204(1).

Ampelisca coeca Holmes

Ampelisca coeca Holmes 1908: 515-516, fig. 24; J. L. Barnard 1960a: 25-26, fig. 5.

Canyon material: 7047 (one specimen, 19 mm), 7050(1), 7051(1).

Basin material: 2440(1).

Slope material: 2369(1).

Remarks: The large specimen of 7047 has uropod 1 as long as uropod 2, in contrast to J. L. Barnard's review of the species.

Ampelisca compressa Holmes

Ampelisca compressa Holmes 1905: 480-481, fig.; Kunkel 1918:66; J. L. Barnard 1960a: 31-32.

Ampelisca vera J. L. Barnard 1954b: 23-26, pls. 14-16.

Canyon material: 3000(1), 3180(1), 3385(1), 4851(5), 5367(15), 6812(?3), 6821(2), 7031(2).

Slope material: 3204 (3), 2227(5), 2228(?1).

Ampelisca cristata Holmes

Ampelisca cristata Holmes 1908: 507-508, figs. 16-17; J. L. Barnard 1954b (incl. formae): 26-29, pls. 17-18; J. L. Barnard 1959c: 18 (incl. formae).

Canyon material: 4852(30), 5367(1), 7031(1).

Slope material: 2361(1).

Ampelisca eoa Gurjanova

Ampelisca eoa Gurjanova 1951: 313-314, fig. 178; J. L. Barnard 1960a: 25.
Ampelisca catalinensis J. L. Barnard 1954b: 7-9, pls. 1-2.

Basin material: 2849(1), 2850(1), 5938(4), 6348(2), 6350(1).

Remarks: In the boreal Pacific ranging from 421 to 1000 m, in southern California from 1135 to 1833 m.

Ampelisca furcigera Bulycheva

Ampelisca furcigera Bulycheva 1936: 242-244, figs. 1-3; Gurjanova 1938: 256, fig. 4; Gurjanova 1951: 314-316, fig. 180; J. L. Barnard 1960a: 26-27, fig. 6.

Slope material: 2227(2), 2344(1), 2423(1), 3204(1).

Remarks: In the boreal Pacific ranging from 60 to 386 m, in southern California from 210 to 384 m.

Ampelisca hancocki J. L. Barnard

Ampelisca hancocki J. L. Barnard 1954b: 37-38, pl. 26.

Canyon material: 6803(5), 6846(1).

Slope material: 3204(1).

Ampelisca lobata Holmes

Ampelisca lobata Holmes 1908: 517-518, fig. 25; Shoemaker 1942: 7; J. L. Barnard 1954b: 11-14, pls. 5-6 (with references).
Ampelisca articulata Stout 1913: 639-640.

Canyon material: 6805(3), 6806(2).

Slope material: 2227(1), 2230(?1).

Ampelisca macrocephala Liljeborg

Ampelisca macrocephala Liljeborg.—Gurjanova 1951: 308-309, fig. 171; J. L. Barnard 1954b: 41-43, pl. 29; J. L. Barnard 1960a: 28.

Canyon material: 3176(1), 3385(1), 4851(56), 4852(2), 6494(1), 6499(1), 6803(25), 6804(2), 6806(7), 6818(2), 6819(4), 6821(3), 6835(13), 6845(15), 6846(4), 6849(22), 6897(6), 6898(2), 6909?(5), 7038(5), 7039(4), 7044(1), 7045(2), 7135(1).

Basin material: 2343(3).

Slope material: 2227(33), 2344(1), 3204(11).

Ampelisca macrocephala unsocalae J. L. Barnard

Ampelisca macrocephala unsocalae J. L. Barnard 1960a: 28-30, fig. 7.

Canyon material: 5046(1), 6803(2), 6808(1), 6812(?8), 6820(2), 6830(1), 6833(13), 6836(3), 6909(3), 6911(14), 6912(1), 6915(26), 6916(4), 7032(1), 7396(1), 7728(?1).

Basin and Patton Escarpment: 5937(1), 5938(1), 6348(3).
Slope material: 2228(13), 2367(6), 2852(2), 3031(1), 5616(2).

Ampelisca milleri J. L. Barnard

Ampelisca milleri J. L. Barnard 1954b: 9-11, pls. 3-4.
Canyon material: 6803(?1).

Ampelisca pacifica Holmes

Ampelisca pacifica Holmes 1908: 511-513, figs. 20-22; J. L. Barnard 1954b: 31-33, pls. 21-22.
Canyon material: 4851(3), 6803(4), 6806(12), 6836(2), 6845(3), 6846(4).
Slope material: 2227(9), 3204(2).

Ampelisca plumosa Holmes

Ampelisca plumosa Holmes 1908: 509-510, fig. 18; J. L. Barnard 1960a: 30-31, fig. 8.
Canyon material: 6833(2).
Basin material: 5937(3), 5938(2), 6351(3).

Ampelisca pugetica Stimpson

Ampelisca pugetica Stimpson.—J. L. Barnard 1954b: 49-51, pls. 35-36; J. L. Barnard 1960a: 31, fig. 9.
Ampelisca californica Holmes 1908: 513-515, fig. 23.
Ampelisca gnathia J. L. Barnard 1954b: 46-48, pls. 33-34.
Canyon material: 3180 (1), 6779 (2), 6803 (12), 6804 (3), 6806 (4), 6819 (4), 6821 (2), 6822 (1), 6836 (1), 6849 (1).
Basin material: 2343 (3).
Slope material: 2227 (7), 3204 (1), 7134 (1), 7135 (1), 7136 (1).

Ampelisca romigi J. L. Barnard

Ampelisca romigi J. L. Barnard 1954b: 18-20, pls. 10-11; J. L. Barnard 1960a: 34.
Ampelisca isocornea J. L. Barnard 1954b: 20-21, pl. 12.
Canyon material: 6804 (2), 6835 (2).
Slope material: 2414 (1).

Ampelisca romigi ciego, new subspecies

(Figs. 1, 2)

Ampelisca romigi J. L. Barnard 1954b: 18-20, pls. 10, 11.

Diagnosis: Like the stem subspecies, but corneal lenses absent and the outer ramus of the third uropod less uncinate.

Juvenile animals lack the notch on the anterior edge of article 5 of pereopod 5.

Holotype: AHF No. 607, ?female, 9.5 mm.

Type locality: Station 6833, Tanner Canyon, 32°-37′54″N, 118°-5′-40″ W, 813 m, January 29, 1960, bottom of green muddy sand.

Canyon material: 6834(2), 6833(2).

Ampelisca spp.

Material: 5925(3), 5940(1), 5942(1), 5943(1), 6834(1).

Genus **Byblis** Boeck

Byblis.—Stebbing 1906: 111-112.

Remarks: Although Schellenberg (1931) had precedent in assigning *B. subantarctica* to *Byblis* because of the condition of *B. anisuropa* Stebbing (1908), I am transferring it to the genus *Ampelisca* and I believe that *B. anisuropa* also should be removed to *Ampelisca.*

Since the early concepts of *Ampelisca* and *Byblis* based on European faunas were formulated, several intergrading species have been discovered. *Byblis* differed from *Ampelisca* in the dense setation on the anteroventral edge of the lobe on article 2 of pereopod 5, between the ventral border and its juncture with the stem of the article. In addition, article 6 of pereopod 5 was narrow and article 7 spiniform. Another character of *Byblis* was the short, broad telson, never cleft more than halfway, whereas in *Ampelisca* the telson was elongated, deeply cleft and had tapering apices. Species such as those named above have been described and assigned to *Byblis.* They lack the full setation of pereopod 5 but bear the narrow sixth and seventh articles. Those species also have deeply cleft telsons of medium elongation and they should be transferred to *Ampelisca,* even though the sixth and seventh articles of pereopod 5 are typical of *Byblis.* They join a similar species, *Ampelisca byblisoides* K. H. Barnard (1925).

This arrangement leaves *Byblis* with typical setation of pereopod 5 and a short telson cleft halfway or less. *Byblis subantarctica* is very closely related to and possibly synonymous with *Ampelisca hemicryptops* K. H. Barnard (1930).

Key to Species of **Byblis**

1. Corneal lenses absent 2
1. Corneal lenses present 10
2. Cleft of telson one fourth or less 3
2. Cleft of telson halfway or more 5
3. Lateral cephalic lobe with ventral margin parallel to dorsal margin of head .... *ceylonica*

3. Ventrolateral margin of head oblique 4
4. Article 2 of antenna 1 about half as long as article 4 of antenna 2 .... *abyssi*
4. Article 2 of antenna 1 about as long as article 4 of antenna 2 .... *guernei*
5. Antenna 1 extending beyond peduncle of antenna 2 6
5. Antenna 1 as short as peduncle of antenna 2 8
6. Article 5 of pereopod 3 with long posterior lobe, coxae 2-4 shorter than coxa 1 .... *antarctica*
6. Article 5 of pereopod 3 lacking posterior lobe, coxae 2-4 as long as coxa 1 7
7. Antenna 1 scarcely exceeding peduncle of antenna 2, rami of uropod 3 multiserrate on facing edges .... *tannerensis*, n. sp. (in part)
7. Antenna 1 nearly as long as antenna 2, uropod 3 with one serration on medial edge of outer ramus .... *crassicornis*
8. Antenna 2 longer than body .... *barbarensis*
8. Antenna 2 shorter than body 9
9. Antenna 1 extending slightly beyond end of peduncle of antenna 2 .... *tannerensis*, n. sp. (in part)
9. Antenna 1 scarcely exceeding article 4 of antenna 2 .... *minuticornis*
10. Ventral pair of corneal lenses situated beneath lateral cephalic margin, not visible laterally, head bearing distinct rostrum nearly half as long as article 1 of antenna 1 .... *securiger*[1]
10. Ventral pair of corneal lenses situated on lateral cephalic surface, rostrum absent or very short 11
11. Article 5 of pereopod 2 four times as long as article 5 of pereopod 1 .... *lepta*
11. Article 5 of pereopods 1 and 2 subequal in length 12
12. Cleft of telson one fifth or less 13
12. Cleft of telson one third or more 14
13. Article 5 of antenna 2 shorter than article 4, article 6 of pereopods 1 and 2 much longer than article 5 .... *gaimardi*
13. Article 5 of antenna 2 equal to article 4, article 6 of pereopods 1 and 2 not much longer than article 5 .... *longicornis*
14. Antenna 1 exceeding peduncle of antenna 2 by a length equal to article 5 of antenna 2, or less 15

[1] *Haploops securiger* K. H. Barnard (see 1932) is removed to *Byblis* because article 2 of pereopod 5 is distally broadened.

14. Antennae 1 and 2 subequal in length 20
15. Article 2 of first antenna 1.5 times as long as article 1 or less 16
15. Article 2 of first antenna twice as long as article 1 or longer 17
16. Ventral and anterior margins of head blending evenly .... *crenulata* [and *daleyi* (of Giles, 1890)[2]]
16. Ventral margin of head sharply set off from anterior [these two species are separated by the shape of article 2 of pereopod 5 which should be examined in the original] .... *affinis* and *rhinoceros*
17. Article 5 of pereopod 5 scarcely longer than article 6 18
17. Article 5 of pereopod 5 one and seven-tenths times as long as article 6 .... *kallarthra*
18. Article 2 of antenna 1 nearly half as long as article 4 of antenna 2 19
18. Article 2 of antenna 1 one-fourth as long as article 4 of antenna 2 .... *serrata*
19. Article 4 of antenna 2 longer than peduncle of antenna 1 .... *veleronis* (in part)
19. Article 4 of antenna 2 shorter than peduncle of antenna 1 .... *affinis* (in part)
20. Pereopod 4 with acute cusp on ventral edge of article 2 .... *mucronata*
20. Pereopod 4 lacking acute cusp on article 2 21
21. Corneal lenses very small .... *erythrops*
21. Corneal lenses large 22
22. Anteroventral corner of head rounded, corneal lenses occupying corner .... *veleronis* (in part)
22. Anteroventral corner of head sharp, corneal lenses posterior to corner .... *bathyalis* and ?*japonica*

Byblis barbarensis J. L. Barnard

Byblis barbarensis J. L. Barnard, 1960a: 34, fig. 11 (in part, see *B. tannerensis*).

Canyon material: 6808(1), 6812(1), 6820(2), 6831(3), 6837(1), 7047(4), 7051(1).

Basin material: 3731(2).

[2] ?*B. daleyi* Giles of Pirlot (1936) has article 3 of antenna 1 nearly three times as long as article 1 and therefore differs from Giles' account.

Byblis bathyalis, new species

(Figs. 3, 4)

Diagnosis: Antenna 1 nearly as long as antenna 2; antenna 2 nearly as long as body; corneal lenses large, lower pair occupying ventral margin of head posterior to sharp anteroventral cephalic cusp; pereopod 2 not elongated and enlarged like *Byblis lepta* (Giles); pereopod 4 lacking acute cusp on article 2; article 7 of pereopod 5 more than half as long as article 6; facing edges of rami of uropod 3 serrate; telson cleft almost halfway.

Holotype: AHF No. 609, female, 9.7 mm.

Type locality: Station 6836, Tanner Canyon, California, 32°-36′-00″N, 119°-05′-18″W, 496 m, January 29, 1960.

Canyon material: The 17 specimens of type material and two specimens from station 6838. The latter specimens have article 7 of pereopod 5 almost as long as article 6 and the rami of uropod 3 are considerably less serrate than in the type-series.

Relationship: This species differs from *Byblis veleronis* J. L. Barnard (1954b) in the shape of the head, the ventrolateral corner being pointed and the lower lens not occupying that corner, whereas in *B. veleronis* the rounded anteroventral corner of the head is occupied by the lower lens. *Byblis affinis* Sars differs from this species in the shorter cleft of the telson and the shorter first antenna. The material attributed to *Byblis daleyi* (Giles) by Pirlot (1936) is very similar but the anteroventral cephalic corner is rounded and the telson is less deeply cleft.

The identification of this material with *Byblis japonica* Dahl (1944) is problematical, for several points in that description are not sufficiently detailed to permit perfect relationship. The exact condition of the anteroventral corner of the head is not clear, the third uropod is drawn from a lateral, not a dorsal view; but the third pleonal epimeron of the present species is much more broadly lobed posteriorly than in *B. japonica* and the seventh article of pereopod 5 is longer.

The very strong serrations on the rami of uropod 3 distinguish this species from *B. erythrops* Sars (see 1895) and *B. crassicornis* Metzger (see Sars, 1895); the large cuticular lenses differ from the small ones of *B. erythrops*; *B. crassicornis* lacks lenses.

Byblis tannerensis, new species

(Figs. 5, 6)

Byblis barbarensis J. L. Barnard, 1960a: 34, fig. 11 (in part, station 5935).

Diagnosis: Antenna 1 exceeding peduncle of antenna 2 by length of article 5 of antenna 2; antenna 2 about as long as first 9 body segments; corneal lenses absent (holotype with calcareous concretion on left side of head, absent on right); front of head concave for insertion of antenna 1, rostrum moderately prominent, lateral cephalic lobe slightly pointed; anteroventral margin of head weakly oblique; pereopod 2 not elongated and enlarged like that of *Byblis lepta* (Giles); article 5 of pereopod 3 lacking posterior lobe; article 7 of pereopod 5 half as long as article 6; coxa 4 shallow; distolateral end of peduncle of uropod 2 with short falciform process; facing edges of rami of uropod 3 serrate; telson cleft almost halfway.

Holotype: AHF No. 605, ?male, 9.5 mm.

Type locality: Station 6833, Tanner Canyon, California, 32°-37′-54″N, 18°-58′-40″W, 813 m, January 29, 1960.

Canyon material: 3 specimens from the type locality.

Basin material: 5935, Catalina Basin (2) (identified as *B. barbarensis* in Barnard (1960a) and Hartman and Barnard (1960)).

Relationship: The antennae of this blind species are intermediate between those of *B. barbarensis* J. L. Barnard (1960a) and those of *B. crassicornis* Metzger (see Sars 1895: pl. 66, fig. 1). In *B. crassicornis* the first antenna is nearly as long as the second; in *B. barbarensis* it scarcely exceeds the peduncle of antenna 2. Article 7 of pereopod 5 is shorter than in either of the other species and coxa 4 is much more shallow. Margins of the rami of uropod 3 of *B. crassicornis* are almost smooth.

Byblis veleronis J. L. Barnard

Byblis veleronis J. L. Barnard 1954b: 52-54, pls. 37-38.

Canyon material: 6803(2), 6804(?16), 6805(2), 6806(4), 6819 (1), 6846(1), 7728(1).

Slope material: 2227(5), 2344(1), 2423(1), 3031(2).

Byblis spp.

Material: 5941(1), 6092(2), 6338(1), 6343 (1), 6809 (1).

Haploops spinosa Shoemaker

(Figs. 7, 8)

Haploops spinosa Shoemaker 1931:13-18, figs. 5, 6.

Haploops tubicola.—J. L. Barnard 1960a: 35 (not Liljeborg in Sars 1895); ?Holmes 1908:518.

Canyon material: 4851(1).

Remarks: Barnard (1960a) overlooked the row of spines on the ventral margin of article 3 on pereopod 5 when he identified his specimens as *H. tubicola.*

Other material: 8 specimens from 3 stations.

Distribution: Formerly known from northwestern Atlantic Ocean, especially Nova Scotia, 0-2295 m. Recorded here from southern California, 88-171 m.

Family AMPHILOCHIDAE

Gitanopsis vilordes J. L. Barnard

Gitanopsis vilordes J. L. Barnard 1962c: 131-132, fig. 6.

Canyon material: 5505(1).

Family AMPITHOIDAE

Ampithoe ?mea Gurjanova

Amphithoe [sic] *mea* Gurjanova 1938: 361-364, fig. 53; Gurjanova 1951: 882-885, fig. 616.

Material: 4852(1), 6803(1).

Remarks: This species will be discussed in a forthcoming work by the writer on the genus *Ampithoe* of southern California.

Family AORIDAE

Acuminodeutopus heteruropus J. L. Barnard

Acuminodeutopus heteruropus J. L. Barnard 1959c: 29-30, pl. 7; J. L. Barnard 1961a: 179, fig. 1.

Canyon material: 4852(7).

Aoroides columbiae Walker

Aoroides columbiae Walker 1898: 285, pl. 16, figs. 7-10; Thorsteinson 1941: 83-84, pl. 6, figs. 65-66; J. L. Barnard 1954a: 24-26, pl. 22; J. L. Barnard 1959c: 33; Nagata 1960: 175, pl. 16, fig. 94; J. L. Barnard 1961a: 180.

Aoroides californica Alderman 1936: 63-66, figs. 33-38.

Canyon material: 4852(195), 5505(?1), 6499(4), 6803(2), 6821(?1), 6835(?1), 7285(3).

Microdeutopus schmitti Shoemaker

Microdeutopus schmitti Shoemaker 1942: 18-21, fig. 6; J. L. Barnard 1959c: 32-33, pl. 9; J. L. Barnard 1961a: 180.

Canyon material: 6805(1), 6806(3).

Family ARGISSIDAE

Argissa hamatipes (Norman)

Argissa hamatipes (Norman).—Stebbing 1906: 277; Shoemaker 1930: 37-40, figs. 15-16; Stephensen 1931a: 261; Stephensen 1935: 140; Stephensen 1940: 41; Stephensen 1944: 52; Gurjanova 1951: 327-328, fig. 193; J. L. Barnard 1962c: 151; Gurjanova 1962: 392-393.
Argissa typica Boeck.—Sars 1895: 141-142, pl. 48.

Canyon material: 6819(1).

Family ATYLIDAE

Atylus tridens (Alderman)

(Fig. 9)

Nototropis tridens Alderman 1936: 58-59, figs. 20-25.
Atylus tridens Mills 1961: 26-32, figs. 3, 4C.

Canyon material: 7043(1).

Relationship: This small specimen fits *Atylus serratus* (Schellenberg 1925) in Mills' (1961) key because the metasomal carinae are obsolete. It differs from *A. serratus* in various minor characteristics, such as the longer rostrum, the spination and setation of the appendages, the absence of a process on article 2 of pereopod 4, but especially in the very short fifth articles of pereopods 3-5 which are elongated in *A. serratus*. *Atylus tridens* differs from *A. swammerdami* (see Sars 1895: pl. 163) in these same ways. From *A. minikoi* (Walker 1905), *A. tridens* differs in the slightly produced posterodistal corner of article 2 on pereopod 3 (note damage on one side of animal), but especially in the absence of dorsal notches on urosomites 4 and 5-6 (fused). I am confused by Pillai's (1957) redescription of *A. minikoi* for it differs in many ways from the animal described by Walker (1905).

Family COROPHIIDAE

Ericthonius brasiliensis (Dana)

Ericthonius brasiliensis (Dana).—Stebbing 1906: 671-672; J. L. Barnard 1955a: 37-38 (with references); Pillai 1957: 60, fig. 16, 3-7; J. L. Barnard 1959c: 39; J. L. Barnard 1961a: 183.

Canyon material: 4851(1), 4852(4), 6803(1).

Ericthonius ?difformis Milne Edwards

(Fig. 10)

Ericthonius difformis Milne Edwards.—Sars 1895: 604-605, pl. 216, fig. 1; Stebbing 1906: 672-673; Chevreux and Fage 1925: 354, fig. 362; Dahl 1946: 6-8, figs. 4, 5; Gurjanova 1951: 950-951, fig. 661.

Ericthonius hunteri (Bate).—Sars 1895: 605, pl. 216, fig. 2; Stebbing 1906: 673; Holmes 1908: 543; Chevreux and Fage 1925: 354-356, fig. 363; Enequist 1950: 344-345, fig. 62; Gurjanova 1951: 951, fig. 662; Shoemaker 1955a: 68.

Canyon material: 6805(1), 6806(7), 6909(3).

Remarks: Schellenberg (1942), Dahl (1946) and Enequist (1950) have discussed whether *E. hunteri* (Bate) is the juvenile and therefore the junior synonym of *E. difformis*. A male specimen of 6909 has gnathopod 2 similar to the very advanced form shown by Enequist (1950, fig. 62) under the name *E. hunteri*.

Family DEXAMINIDAE

Dexamonica reduncans J. L. Barnard

Dexamonica reduncans J. L. Barnard 1958a: 130-132, pls. 26, 27.

Canyon material: 7038(4).

Family GAMMARIDAE

Ceradocus spinicaudus (Holmes)

Maera spinicauda Holmes 1908: 539-541, fig. 45.

Ceradocus spinicauda.—J. L. Barnard 1954a: 18-19; J. L. Barnard 1962b: 86-88, figs. 10, 11.

Canyon material: 6805(1), 6806(1).

Maera danae (Stimpson)

Maera danae (Stimpson).—Shoemaker 1955a: 53-54 (with references).

Maera loveni.—J. L. Barnard 1962b: 103, fig. 19 (not Bruzelius).

Canyon material: 3179(2), 4851(30).

Maera simile Stout

Maera simile Stout 1913: 644-645; Shoemaker 1942: 12; J. L. Barnard 1959c: 24-25, pl. 4; J. L. Barnard 1961a: 179.

Maera inaequipes.—J. L. Barnard 1954a: 16-18, pls. 16-17 (not Costa).

Canyon material: 6805(8), 6806(14).

Megaluropus longimerus Schellenberg

Megaluropus longimerus Schellenberg.—J. L. Barnard 1962b: 103, figs. 20, 21.

Canyon material: 7031(1).

Melita dentata (Krøyer)

Melita dentata (Krøyer).—Sars 1895: 513-514, pl. 181, fig. 1; Gurjanova 1951: 749-750, fig. 518.

Canyon material: 5531(1).

Family HAUSTORIIDAE

Urothoe varvarini Gurjanova

Urothoe varvarini Gurjanova 1953: 219-221, figs. 3, 4; J. L. Barnard 1957; 82-84; Gurjanova 1962: 426-428, fig. 142.

Canyon material: 3166(1), 5960(2), 6803(6), 6805(3), 6806 (3), 6833 (?1+2), 6836(3), 6838(1), 7497(?1).

Basin material: 6348(1).

Slope material: 2413(1), 2414(1), 3204(1).

Family ISCHYROCERIDAE

Bonnierella linearis californica, new subspecies

(Fig. 11)

Bonnierella linearis J. L. Barnard 1964a: 42-43, fig. 33.

Diagnosis: Male gnathopod 1 conspicuously smaller than gnathopod 2, palm smooth; gnathopod 2 with posterior margin of article 6 shorter than palm, palm with 3 sharp or prominent cusps, that nearest dactylar hinge slightly bifid; apex of telson more rounded than in typical subspecies; article 2 of gnathopod 2 not produced distolaterally; apex of outer ramus on uropod 3 with very short knobs in contrast to elongated projections of typical subspecies; lateral cephalic lobe typically very sharp.

Holotype: AHF No. 608, male, 3 mm.

Type locality: Station 6348, Tanner Basin, 32°-37′-30″N, 119°-27′-50″W, 1292 m, August 16, 1959.

Basin material: The holotype and a female, 2.75 mm, from station 6339.

Relationship: This material bears closer relationship to *B. linearis* J. L. Barnard (1964a), described from Peru, than to other species in the genus and although several good differences are present I have decided to recognize them only at the infra-specific level. The female gnathopod of the new subspecies is more strongly ornamented on the palm than in *B. linearis linearis* but this may be a matter of age difference.

These specimens have very distinct epistomal processes, similar to the process of *B. lapisi* (J. L. Barnard 1962d) and probably indicate that such were overlooked on other species of *Bonnierella*. However, *B. linearis* and *B. lapisi* both differ from other species in the genus in the small size of the male first gnathopods; this may be evidence of generic distinction.

Antennae and all pereopods are missing on the male holotype, but a few pereopods have been drawn from those remaining on the female specimen.

The mouthparts all resemble those drawn for *B. linearis linearis*.

Ischyrocerus pelagops J. L. Barnard

Ischyrocerus pelagops J. L. Barnard 1962a: 56-58, fig. 25.

Canyon material: 4852(36). An unidentified specimen of *Ischyrocerus* was recorded at 6815.

Family LILJEBORGIIDAE

Liljeborgia cota J. L. Barnard

Liljeborgia cota J. L. Barnard 1962b: 83-86, figs. 8, 9.

Slope material: 2792(1), 7135(4).

Canyon material: 6497(1), 6832(3), 6833(1), 7154(1), 7288(3), 7289(2), 7290(2).

Basin material: 2335(1), 2729(1), 5933(1), 6338(1), 6339(1), 6347(1), 6348(1), 6351(1), 6828(1).

Remarks: Specimens from station 6832 represent an additional kind of aberrancy not noted by Barnard (1962b): all teeth of pleonites 1-5 are as large as the largest shown in Barnard's figure 8G.

Genus Listriella J. L. Barnard, 1959a

In bathyal depths the five Californian species of this genus are difficult to distinguish. Like other amphipods descending into deeper waters they lose pigment in varying degrees and the eyes become reduced or lost. An aberrant form of *Listriella eriopisa* and forms of *L. goleta* are morphologically similar to the normally blind *L. albina*, also known from shallow water. In shallow water all of these taxa are clearly distinct because of pigmentary displays.

Numerous and clearly identifiable *L. albina* are present in the samples at hand. The specimens are characterized by lack of eyes, short antennae, greatly expanding sixth article of gnathopod 1, somewhat shortened outer ramus of uropod 3, and the presence of a palmar notch on gnathopod 2. Most nearly related to these is a specimen from 7289, bearing slight traces of eyes, equal rami of uropod 3 and short antennae. This I name *L. eriopisa*, aberrant form; it is simply a pigmentless specimen. An individual from 4823 has well developed eyes but otherwise is like that of 7289. The next most nearly related is from 7845 and represents a normally pigmented *L. goleta* with shortened antennae. Next is a specimen from 6806 having eyes, no pigment, elongated antennae but long equal rami of uropod 3, which I assign to *L. goleta;* then follows a specimen from 5006 having pigment and characters of *L. goleta* but short equal rami of uropod 3. (Reexamination of shallow water *L. goleta* shows that individuals like that of 5006 are not uncommon.)

Finally, a remarkable specimen from 7288, apparently assignable to *L. albina*, bears immense third uropods with thickened inner rami but otherwise has the aspect of *L. eriopisa.*

Listriella albina J. L. Barnard, giant form

(Fig. 12)

Listriella albina J. L. Barnard 1959a: 25-26, figs. 11, 12.

Material: Specimens all blind, pigmentless, having article 6 of gnathopod 1 characteristically expanding as grossly as shown in the original description.

Remarks: One giant male specimen (5.4 mm) from 7288 might be considered a blind specimen of *L. eriopisa* because of the greatly elongated inner ramus of the third uropod, but other features characteristic of *L. albina* remain: gnathopod 2, with its palmar notch, the strongly convex third pleonal epimeron, the equally long pereopods 4 and 5 and the elongated antennae. However, article 6 of gnathopod 1 is less trapezoidal than it is in shallow-water specimens.

Canyon material: 2148(1), 2190(3), 2191(9), 2317(1), 3000 (1), 5046(1), 6501(1), 6849(3), 6854(1), 6912(1), 6916(1), 7029 (2), 7285(1), 7288(1).

Slope material: 2362(1).

Listriella eriopisa J. L. Barnard

Listriella eriopisa J. L. Barnard 1959a: 22-24, figs. 8-10.

Canyon material: 2191(1), 2192(4), 3180(1), 4846(1), 5367(1), 6845(1), 6854(1), 7029(1), 7030(2), 7038(2), 7284(2), 7285(1), 7289(1), 7730(1).

Slope material: 5616(2).

Remarks: Three forms of this species are now apparent: (1), the normally pigmented form with unequal rami of uropod 3; (2), the normally pigmented form with equal rami of uropod 3; and (3), an unpigmented form with equal rami of uropod 3; eyes of the latter often are obsolescent.

Listriella goleta J. L. Barnard

Listriella goleta J. L. Barnard 1959a: 20-22, figs. 5-7.

Material: Normal form with elongated antennae and pigment, but some specimens having rami of uropod 3 equal, others unequal:

Canyon material: 3166(1), 5006(9), 5367(15), 6498(1), 6804 (1), 6806(1), 7030(8), 7038(1), 7044(10), 7284(1).

Slope material: 5616(4), depth 72-459 m.

Form with shortened antennae and reduced pigment:

Canyon material: 2192(2), 5505(1), 7845(1), depth 113-374 m.

Listriella melanica J. L. Barnard

Listriella melanica J. L. Barnard 1959a: 16-18, figs. 1, 2.

Canyon material: 4852(7).

Family LYSIANASSIDAE

Acidostoma hancocki Hurley

(Fig. 13)

Acidostoma hancocki Hurley 1963: 37-40, figs. 9, 10.

Canyon material: 6837 (juvenile 1.8 mm), 7174(1), 7403(1).

Remarks: Figures of pereopods, uropod 2 and maxilla 1 are given to supplement Hurley's fine portrayal of this species. The small first maxillary palp is distinct on this small specimen and the peduncle of uropod 2 is not as strongly expanded as it is in the adult stage.

Anonyx carinatus (Holmes)

Lakota carinata Holmes 1908: 498-500, fig. 9; Thorsteinson 1941: 56, pl. 2, figs. 16, 17; Gurjanova 1962: 302-303, fig. 100.

Anonyx carinatus.—Hurley 1963: 103-108, figs. 32-34.

Canyon material: 6845(1), 6846(1).

Slope material: 2447(1).

Hippomedon denticulatus (Bate)

Hippomedon denticulatus (Bate).—Sars 1895: 56-57, pl. 20; Stebbing 1906: 59; Chevreux and Fage 1925: 53-54, fig. 37; Gurjanova 1951: 233-234, fig. 96; Gurjanova 1962: 106, fig. 23 only.

Canyon material: 6845 (4).

Hippomedon tenax, new species

(Fig. 14)

Diagnosis: Third pleonal epimeron with nearly straight posterior margin, ventral corner with almost symmetrically tapering, medium-sized, acute posterior tooth, scarcely upturned; other pleonal epimera rounded or quadrate posteriorly; pleonite 4 rounded dorsally; telson medium in length, cleft more than halfway, apices tapering, each armed with a spine; eyes absent; articles 5 and 6 of gnathopod 1 equal in length, palm oblique, distinct from posterior margin of article 6; mandibular palp article 3 about three fourths as long as article 2; article 2 of pereopod 5 not constricted distally; coxae lacking conspicuous teeth; article 1 of antenna 1 not produced distally, article 1 of flagellum elongated; outer ramus of uropod 3 apparently biarticulate; lateral cephalic lobes short; gnathopod 2 short, stout.

Holotype: AHF No. 5811, male, 4 mm. Unique.

Type locality: Station 5829, off Ventura, California, 34°-10′-55″ N, 119°-25′-45″W, 88 m, August 21, 1958.

Relationship: This species most closely resembles *Hippomedon geelongi* Stebbing (1888: pl. 11) but differs in the shorter cephalic lobes and stouter second gnathopod. It differs from *H. minusculus* (Gurjanova, see 1962) in the elongated basal flagellar article of antenna 1. It is remarkably similar to *H. propinquus eous* Gurjanova (1962) but that subspecies has a shorter sixth article of gnathopod 1 and bears distinct eyes.

Hippomedon granulosus Bulycheva (1955, see Gurjanova 1962) differs from this species in the shorter sixth article of gnathopod 1 but otherwise there is close correspondence. *Hippomedon strages* J. L. Barnard (1964a) differs from *H. tenax* in the same way as *H. granulosus*; in addition the palm of gnathopod 1 is longer than the posterior margin of article 6.

This specimen bears resemblance to *Tryphosa coeca* Holmes (1908) from Monterey Bay. Unlike the figures of *T. coeca* it has a much stouter second gnathopod, slightly longer first gnathopod and larger tooth of the third pleonal epimeron. Holmes did not figure the head, coxa 4, and other characters of his species.

Hirondellea fidenter, new species

(Figs. 15, 16)

Diagnosis: Eyes not apparent; article 7 of gnathopod 1 greatly overlapping palm; third pleonal epimeron broadly convex posteriorly, ventral corner rounded; fourth pleonite not strongly produced dorsally; inner ramus of uropod 2 strongly constricted; telson long, deeply cleft.

Holotype: AHF No. 5919, male, 4.7 mm. Unique.

Type locality: Station 6336, San Nicolas Basin, California, 33°-09′-00″N, 118°52′-10″W, 1227 m, August 14, 1959.

Relationship: Of the six species described since the erection of the genus, *Hirondellea fidenter* resembles the type more than it does the others. In its long and deeply cleft telson, it is especially similar to *Hirondellea trioculata* Chevreux (see 1900), but it differs from that species in the strongly overlapping dactyl of gnathopod 1 and the broadly rounded posterior edge of the third pleonal epimeron. From *H. gigas* (Birstein & Vinogradov 1955) it differs in the narrower, more deeply cleft telson, the narrower rami of uropod 3 and the broadly rounded posterior edge of the third pleonal epimeron. The genus *Hirondellea* includes species having the inner ramus of uropod 2 constricted or not constricted, the present species having that constriction.

Genus **Lepidepecreella** Schellenberg

Lepidepecreella Schellenberg 1926: 281.

Including the one described here, six species are known for this genus. With one or possibly two exceptions, their interspecific differences are rather minor, at best quantitative, and somewhat suggestive of the situation in presumably pelagic and semiparasitic genera such as *Trischizostoma*, reviewed by J. L. Barnard (1961b). *Lepidepecreella bidens* (K. H. Barnard 1930) is that member most distinct from the type-species, *L. ctenophora* Schellenberg (1926), differing from it by the presence of a nasiform process on article 2 of pereopod 3. *Lepidepecreella ovalis* K. H. Barnard (1932) was stated to have its rostrum extending as far as the epistomal process, hence differing from all other species. The remaining species, *L. emarginata* Nicholls (1938), *L. cymba* (Goës, see Stephensen 1931b), *L. ctenophora,* and the following new species differ among themselves in minor characters as seen in the following key. They may represent races or ecophenotypes of a polymorphic species.

Key to Species of **Lepidepecreella**

1. Article 2 of pereopod 3 with posterodistal nasiform process .... *bidens*
1. Article 2 of pereopod 3 rectangular, linear 2
2. Telson emarginate, articles 5 and 6 of gnathopod 1 subequal .... *emarginata*
2. Telson convex, article 6 of gnathopod 1 longer than article 5 3
3. Rostrum extending to apex of epistomal process, third pleonal epimeron with distinct posteroventral tooth .... *ovalis*

3. Rostrum very short, third pleonal epimeron lacking distinct posteroventral tooth, posterior edge serrate 4
4. Posterior lobe on article 4 of pereopod 3 half as long as article 5.......... *charno*, n. sp.
4. Posterior lobe on article 4 of pereopod 3 as long as article 5 5
5. Epistome marked ventrally with distinct notch, coxa 5 broader than coxa 6 .... *cymba*
5. Epistome not marked ventrally with distinct notch, coxa 5 narrower than coxa 6 .... *ctenophora*

Lepidepecreella charno, new species

(Fig. 17)

Diagnosis: Rostrum short; article 6 of gnathopod 1 longer than article 5; epistome not marked ventrally with notch; posterior lobe of article 4 on pereopods 3 and 4 only half as long as article 5, this lobe on pereopod 5 as long as article 5; coxa 5 broader than coxa 6; third pleonal epimeron with serrate posterior edge, lacking distinct tooth at posteroventral corner; telson evenly convex apically.

Holotype: AHF No. 5911, female, 4.5 mm. Unique.

Type locality: Station 6091, San Clemente Basin, off Baja California, 32°10′30″ N, 117°57′10″ W, 1895 m, January 14, 1959.

Relationship: Differing from both *L. cymba* and *L. ctenophora* in the short posterior lobe of article 4 on pereopod 3, from *L. ctenophora* by the broad coxa 5 which in that species is narrower than coxa 6, from *L. emarginata* in the convex telson and long sixth article of gnathopod 1, from *L. ovalis* in the short rostrum and lack of a tooth on the third pleonal epimeron and from *L. bidens* in the linear, unproduced second article of pereopod 3.

Lysianassa holmesi (J. L. Barnard), new combination

Aruga holmesi.—J. L. Barnard 1955b: 100, pls. 27-28; J. L. Barnard 1959c: 18; Gurjanova 1962: 299-301, figs. 98-99.

Canyon material: 3385(11).

Slope material: 2789(1).

Lysianassa oculata (Holmes), new combination

Aruga oculata Holmes 1908: 505-507, figs. 14-15.

Lysianopsis oculata.—Hurley 1963: 74, fig. 21c (with references).

Canyon material: 4852(1), 5367(3), 6846(2).

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Opisa tridentata Hurley

Opisa tridentata Hurley 1963: 26-30, figs. 4, 5.

Canyon material: 5960(2).

Orchomene decipiens Hurley, new combination

Orchomenella decipiens Hurley 1963: 127-130, figs. 43, 44.

Canyon material: 2192(1), 4846(1), 4851(2), 5114(4), 5676(1), 6780(1), 6781(17), 6845(4), 6846(1), 7038(1), 7047(1), 7174(1), 7284(4).

Slope material: 2789(2).

Orchomene pacifica Gurjanova, new combination

Orchomenella pacifica Gurjanova 1938: 252-254, fig. 3; Gurjanova 1951: 287, fig. 155; Gurjanova 1962: 174-177, figs. 52, 53.

Canyon material: 7038(5), 7044(1).

Slope material: 2843(1).

Pachynus barnardi Hurley

Pachynus barnardi Hurley 1963: 31-35, figs. 6, 7.

Canyon material: 3385(2), 4851(1), 5367(1), 5960(4), 6499(1), 6835(1), 6845(2), 6898(1), 6909(1), 7029(1), 7054(1), 7174(1).

Slope material: 2361(1).

Prachynella lodo J. L. Barnard

Prachynella lodo J. L. Barnard 1964b: 233, fig. 7.

Canyon material: 6804(1), 6822(2), 7038(2), 7044(1).

Pseudokoroga rima J. L. Barnard

Pseudokoroga rima J. L. Barnard 1964c: 95-99, figs. 14-17.

Canyon material: 4852(2).

Schisturella Norman

Schisturella Norman 1900: 208

Diagnosis: Mouthparts arranged in a quadrate bundle; mandible with a distinct, non-dentate cutting edge, strongly triturate molar, palp attached level with molar; maxilla 1 with biarticulate palp; gnathopod 1 subchelate or nearly simple; telson cleft more than one-fourth of its length; coxa 1 very small, largely hidden by coxa 2, about half as long as article 2 of gnathopod 1; branchiae pleated on one side; upper lip lobately produced in front of epistome; inner ramus of uropod 2 with deep marginal incision.

Type species: Tryphosa pulchra Hansen.

Remarks: Both Dahl (1959) and J. L. Barnard (1961b) have discussed or given keys to the ambasialike lysianassid genera. Barnard erred in his assignment of *Ambasiopsis robustus*, which should be transferred to *Schisturella* (=*S. robusta* (Barnard)). Dahl's *Schisturella galatheae* should be transferred to *Neoambasia*, temporarily. That species has a long first coxa and lacks a notch on the inner ramus of uropod 2. Dahl's species differs from *N. tumicornis* by the well-developed spines on the outer plate of maxilla 1.

Schisturella is also characterized by a short, subconical, posterior process on the third article of antenna 2, which in one new species to follow is obsolescent.

Lakota rotundata (K. H. Barnard, see J. L. Barnard 1962d) keys to *Neoambasia* but it differs from that genus as does *S. galatheae* in the well-developed spines on the outer plate of maxilla 1 and in the constriction on the inner ramus of uropod 2. I retain that species in *Lakota* (=*Anonyx*) but one must note its transition to *Neoambasia* and the probability that it is a member of the genus *Pseudonesimus* Chevreux. The latter genus may be synonymous with *Schisturella.*

Chironesimus has been fused with *Anonyx* by Gurjanova (1962) and the genus *Lakota* Holmes revived to include *C. rotundata.* As noted elsewhere, this is a course difficult to put into practice. Hurley (1963) has wisely included *Lakota* with *Anonyx*.

Key to Species of **Schisturella**

1. Third pleonal epimeron with tooth at posteroventral corner 2
1. Third pleonal epimeron rounded-quadrate posteriorly 3
2. Eyes present, palm of gnathopod 1 very oblique, obsolescent .... *cocula*, n. sp.
2. Eyes absent, palm of gnathopod 1 transverse .... *zopa*, n. sp.
3. Palm of gnathopod 1 subtransverse, distinct from posterior margin of article 6, eyes absent .... *robusta*
3. Palm of gnathopod 1 very oblique, barely distinct from posterior margin of article 6, eyes present .... *pulchra*

Ambasiopsis robustus J. L. Barnard (1961b) is removed to *Schisturella,* becoming *S. robusta* (Barnard).

Schisturella galatheae Dahl (1959) is removed to *Neoambasia.*

Schisturella cocula, new species

(Figs. 18, 19)

Diagnosis: Third pleonal epimeron with posteroventral tooth; palm of gnathopod 1 scarcely distinct from posterior margin of article 6; lobe of upper lip tapering; eyes present.

Holotype: AHF No. 589, male, 6.7 mm. Unique.

Type locality: Station 5996, off Pt. Conception, California, 34°-23′-05″ N, 120°-26′-45″ W, 162 m, December 16, 1958.

Remarks: Tubular accessory gills are present on coxae 5 and 6.

Schisturella zopa, new species

(Fig. 20)

Diagnosis: Third pleonal epimeron with a tooth at the posteroventral corner; palm of gnathopod 1 transverse; lobe of upper lip tapering; eyes absent.

Holotype: AHF No. 5413, ?male, 2.9 mm. Unique.

Type locality: Station 2847, Catalina Canyon, 33°-22′-30″N, 118°-36′-38″W, 914 m, June 23, 1954.

Remarks: Gills were not satisfactorily analyzed. The process on the third peduncular article of antenna 2 is obsolescent. An aesthetasc but not a spine is present on the distal end of article 1 of the first antennal flagellum.

Sophrosyne robertsoni Stebbing and Robertson

(Figs. 21, 22)

Sophrosyne robertsoni Stebbing and Robertson 1891: 31-34, pl. 5A; Stebbing 1906: 21-22.

Basin material: 6832(2), Tanner Basin, 1298 m.

Remarks: The crucial identifying characters of this species, forming a combination distinct from the other two species of the genus, *S. hispana* (Chevreux) and *S. murrayi* Stebbing, are as follows: the shape of gnathopod 2, the furnishment of its palm with tasseled setal bundles, the shape of the third pleonal epimeron with a narrow but long posterior tooth, the dorsal configuration and lateral ridges of urosomite 1, the poor ventral extension of article 2 on pereopod 5, and the short cleft of the telson. Dim brownish-purple lateral spots may form the vestigial eyes, although Stebbing and Robertson did not perceive eyes. This is the first record of this strange genus since the original descriptions of the three species in 1887, 1888 and 1891.

Thrombasia, new genus

Diagnosis: Basal articles of both flagella on antenna 1 elongated; upper lip very strongly lobate in front; molar of mandible rather weak, palp attached level with molar, article 3 about 70 percent as long as article 2; inner plate of maxilla 1 with 2 apical setae, outer plate with long, well-developed spines; lobes of maxilla 2 not gaping, similar in shape; outer plate of maxilliped with small, imbedded medial spines, apex with 2 large spines; gnathopods 1 and 2 with transverse palms; coxa 1 not greatly shortened, triangular, as long as article 2 of gnathopod 1, partially hidden by coxa 2; inner ramus of uropod 2 incised; uropod 3 with biarticulate outer ramus; telson cleft halfway.

Type species: Thrombasia tracalero, new species.

Relationship: According to the review of ambasia genera by Dahl (1959), this genus comes close to *Neoambasia* Dahl (1959) (type *Ambasiopsis tumicornis* Nicholls 1938); but considering the degree to which ambasia genera have been fragmented and the numerous weakly developed characters distinguishing the present species from *N. tumicornis*, it becomes necessary to erect still another monotypic genus to receive it. From *Neoambasia* the new genus differs in the much more strongly produced upper lip, the elongated basal articles on both flagella of antenna 1, the weakly developed mandibular molar, the well-developed spines on the outer plate of maxilla 1, and the constriction on the inner ramus of uropod 2. The long first coxa distinguishes the genus from *Ambasia, Schisturella,* and *Metambasia;* the subchelate first gnathopod, produced labrum and mandibular palp location distinguish it from *Ambasiella;* the presence of spines on the outer plate of the maxilliped and the weak mandibular molar distinguish the genus from *Ambasiopsis.*

Thrombasia tracalero, new species

(Figs. 23, 24)

Diagnosis: With the characters of the genus.

Description: Eyes absent; lateral cephalic lobes stongly projecting and subacute; second pleonal epimeron slightly produced at posteroventral corner; third pleonal epimeron with large but not elongated posterior tooth.

Holotype: AHF No. 5414, male, 4.5 mm. Unique.

Type locality: Station 2789, slope of Santa Monica Basin, 33°-49′-59″N, 118°-34′-05″W, 167 m, May 22, 1954.

Tryphosa index, new species

(Fig. 25)

Diagnosis: Lateral cephalic lobes large, strongly projecting, subacute apically, eyes pale straw-colored in alcohol, large, composed of numerous hexagonal cells; epistome large, broadly rounded in front;

third pleonal epimeron with straight, unserrated posterior edge and small tooth at ventral corner; urosomite 1 with upright acute carina. Mouthparts like *T. sarsi* (=*T. nana* Sars 1895: pl. 27, fig. 1) except outer plate of maxilliped as shown herein. Branchiae attached to coxae 5 and 6, each with a tubular accessory gill.

Holotype: AHF No. 604, male, 6.5 mm. Unique.

Type locality: Station 6840, San Clemente Rift Valley, 32°-44′-35″N, 118°-12′-43″W, 1620 m, January 30, 1960.

Relationship: Closely related to *T. trigonica* (Stebbing 1888: pl. 9) but differing from it in the presence of faint eyes, in the tooth of third pleonal epimeron being smaller and more distinctly separated from the posterior margin, and in the posterior lobe of pereopod 5 being narrowed distally. The new species may prove to be a race of *T. trigonica.*

Tryphosa propinqua Chevreux (1926) is similar to *T. index* but its epistome is less strongly produced and the cephalic lobes are apically rounded, not subacute.

Uristes californicus Hurley

Uristes californicus Hurley 1963: 91-96, figs. 27-29.

Canyon material: 6836(2).

Family MELPHIDIPPIDAE

Melphidippa (?) amorita, new species

(Fig. 26)

Description: This specimen has the aspect of a melphidippid but its two most important parts, the antennae and uropod 3, are missing. It cannot be firmly relegated to the Melphidippidae and, because of the telson, it cannot be assigned to *Melphidippa;* until its missing parts are discovered, the species is of provisional assignment.

Characters relating it to Melphidippidae: eyes bulging; coxae very short, but unlike other melphidippids the last three coxae are not bilobed; mouthparts all like *Melphidippa;* gnathopods and pereopods elongated, gnathopods slender and poorly subchelate; pleonites 1-5 each with a long dorsal tooth, marginal serrations present on pleonal epimera 1-4; uropods 1-2 elongated and with shortened outer rami.

Telson rather short, the short cleft forming gaped bilateral, acute lobes, not characteristic of other melphidippids.

Holotype: AHF No. 6012, female, 6.4 mm. Unique.

Type locality: Station 6836, Tanner Canyon, 32°-36′-00″N, 119°-05′-18″W, 496 m, January 29, 1960.

Melphisana bola J. L. Barnard

Melphisana bola J. L. Barnard 1962b: 81-83, fig. 7.

Canyon material: 7031 (1).

Family OEDICEROTIDAE

Bathymedon covilhani J. L. Barnard

(Fig. 27)

Bathymedon covilhani J. L. Barnard 1961b: 85, fig. 53.

Canyon material: 6820 (1), 6831 (1).

Basin material: 6344 (1), 6810 (1).

Remarks: Although the epistome appears to be somewhat more produced than in the Panamanian type specimen, the gnathopods, telson, head and pereopod 3 relate the present specimens to the original material. The retention of antenna 1, missing in the type specimen, permits its description: article 3 is as long as article 2 and longer than article 1. This discovery shows the relationship of *B. covilhani* to *B. gorneri* Gurjanova (1951). The two species may prove to be either identical or races of a single stem. Gurjanova's Bering Sea species should be examined for the condition of its epistome. In comparison to *B. gorneri*, *Bathymedon covilhani* has more strongly notched distal ends of article 5 on the gnathopods, a less projecting mandibular molar, a more slender first mandibular palp article, a shorter fourth article of the maxillipedal palp, and a convexly projecting telsonic apex.

Bathymedon kassites, new species

(Fig. 28)

Diagnosis: Eyes practically obsolete, formed of granular material in the rostrum and dorsal cephalon, rostrum very small, anterior edge of head below antennal corner nearly vertical; articles 5 and 6 of gnathopods subequal in length; posterior lobes on fifth articles of gnathopods strongly projecting, lobe on gnathopod 2 sharper, palms longer than posterior margins of sixth articles; peduncle of antenna 1 intermediate in length between that of *B. candidus* and that of *B. palpalis* (see J. L. Barnard 1961b), article 3 much shorter than article 1; coxa 1 produced forward but not greatly; pereopods 3-4 with article 2 slender; pleonite 4 unarmed; telson apically rounded, bearing two very stout spines.

Holotype: AHF No. 5918, female, 3.2 mm.

Type locality: Station 6494, Monterey Canyon, California, 36°-46′-58″ N, 121°-55′-56″W, 750 m, October 3, 1959.

Canyon material: 6490 (1), 6494 (7).

Relationship: This species resembles *B. candidus* J. L. Barnard

(1961b) in the nearly vertical cephalic margin below the antennal corner and the long palms of the gnathopods, but differs in the longer posterior lobes on the fifth articles of the gnathopods and in the armament of the telson being composed of two stout spines, instead of several slender setae. It is related to *B. ivanovi* Gurjanova (1952) but differs in the stoutness of the telsonic spines and the longer posterior lobes on the fifth articles of the gnathopods.

From *B. palpalis* K. H. Barnard (1916, and see J. L. Barnard 1961b) this species differs in the rounded, not emarginate telson, but has the two stout spines typical of *B. palpalis.* Antenna 1 of the new species is slightly shorter, the first coxa is less strongly produced forward and the posterior lobe of article 5 on gnathopod 2 is larger than in *B. palpalis.*

Bathymedon roquedo J. L. Barnard

Bathymedon roquedo J. L. Barnard 1962e: 354, fig. 2.

Canyon material: 2725(1).

Monoculodes emarginatus J. L. Barnard

Monoculodes emarginatus J. L. Barnard 1962e: 361-363, fig. 4.

Canyon material: 6845(2).

Monoculodes glyconicus J. L. Barnard

Monoculodes glyconica J. L. Barnard 1962e: 363, fig. 5.

Canyon material: 7288(1).

Slope material: 2843(3).

Monoculodes hartmanae J. L. Barnard

Monoculodes hartmanae J. L. Barnard 1962e: 363-365, figs. 5-7.

Canyon material: 4852(1), 7031(2), 7044(1).

Monoculodes latissimanus Stephensen

(Fig. 29)

Monoculodes latissimanus Stephensen 1931a: 244-245, fig. 70; Gurjanova 1951: 585, fig. 392.

Canyon material: 2190(1), 6819(4).

Remarks: These specimens, although as badly broken as the type or more so, mostly lacking ends of pereopods, antennae and uropods, fit Stephensen's description in gnathopods, telson, and head, although the rostrum is slightly longer. In this regard they call attention to the even closer relationship between *M. latissimanus* and *M. abacus* J. L. Barnard (1961b) than that noted by Barnard, although the telson remains distinctive for *M. latissimanus.* It may prove necessary to regard these species as races, thereby demonstrating a common distribution of bathyal forms as widely separated as the north Atlantic and the Tasman Sea.

Monoculodes norvegicus (Boeck)

Monoculodes norvegicus (Boeck).—Sars 1895: 301-302, pl. 107, fig. 1; Stebbing 1906: 265-266; Shoemaker 1930: 67; Stephensen 1931a: 247; Stephensen 1938: 228-229; Stephensen 1940: 39; Gurjanova 1951: 582-583, fig. 389; J. L. Barnard 1962e: 367.

Canyon material: 7044(1), 7728(1).

Basin material: 2439(1).

Monoculodes perditus, new species

(Fig. 30)

Diagnosis: Rostrum medium in length, slightly deflexed, reaching end of article 1 of antenna 1, tapering acutely; lateral cephalic lobes short, obtuse; eye(s) very pale; largely located on rostrum, anterior edge of eyes about one third back on rostrum; dactyls of pereopods 1 and 2 as long as sixth articles; coxa 4 with straight, unproduced posterior margin; gnathopods stout, palm of gnathopod 1 longer than posterior margin of article 6, article 5 with stout, medium-sized lobe; article 6 of gnathopod 2 intermediate between slender and stout, palm and posterior margin of article 6 subequal, article 5 with posterior lobe of medium length and slenderness, reaching to defining corner of palm and facing posterior edge of article 6; all pleonal epimera rounded at corner; telson slightly emarginate distally.

Notes: Head of larger male damaged and restored as accurately as possible in the drawing; head of holotype undamaged as drawn; only one fifth pereopod is present and it probably has abnormally stunted articles 5-7.

Holotype: AHF No. 6014, male, 2.9 mm.

Type locality: Station 6845, Coronado Canyon, California, 32°-30′-16″N, 117°-16′-50″W, 177 m, February 1, 1960.

Material: 2 specimens from the type locality.

Relationship: This species differs from *M. coecus* Gurjanova (see 1951) in the much stouter articles 5 and 6 of gnathopod 2. From *M. diamesus* Gurjanova (see 1951), *M. perditus* differs in the non-acute, obtuse, lateral cephalic lobe, the larger lobe of article 5 of gnathopod 1, the shorter posterior margin of article 6 of gnathopod 1, and the longer posterior lobe of article 5 on gnathopod 2. From *M. minutus* Gurjanova it differs in the emarginate telson and shorter posterior lobe of article 5 on gnathopod 1. *M. perditus* bears resemblance to *M. latimanus* (Goës) (see Sars 1895: pl. 108) but differs in the much longer dactyls of pereopods 1 and 2 and the emarginate telson.

Oediceropsis (Paroediceroides) Schellenberg, 1931

Paroediceroides, as stated by J. L. Barnard (1961b), is closely related to *Oediceroides* Stebbing, differing mainly in the posteriorly produced coxa 4; in this regard it is also related to some species of *Monoculodes* Stimpson, that genus intergrading with *Oediceroides* in the configurations of the gnathopods. In addition, *Paroediceroides trepadora* Barnard (1961b) has affinities with *Oediceropsis* Liljeborg (see Sars 1895: pl. 114). Barnard (1961b) erred in his key to the Oedicerotidae, as *Oediceropsis* does possess a posteriorly produced coxa 4. Barnard mentioned that the mouthparts of *P. trepadora* were like those of *Oediceropis*. That genus has been described as having lateral eyes; Schellenberg (1931) described *Paroediceroides* as having eyes fully fused. *Pareoediceroides trepadora* lacks eyes, and might be assigned to either genus. *Paroediceroides* should be reduced to subgeneric status under *Oediceropsis;* by disregarding eyes, the subgeneric differences may be denoted as the presence of a swollen first article of antenna 2 in *Oediceropsis* and a small unswollen first article in *Paroediceroides.*

Oediceropsis (Paroediceroides) elsula, new species

(Fig. 31)

Diagnosis: Rostrum very short, reaching about a third of the way along article 1 of antenna 1; lateral cephalic lobes exceeding rostrum in forward extent, rounded; eyes absent; posterior lobe of article 5 of gnathopod 1 short and blunt; telson truncated; coxa 1 with rounded anteroventral corner; process of coxa 4 blunt. Uropod 3 missing.

Holotype: AHF No. 6015, female, 3.6 mm. Unique.

Type locality: Station 6837, Tanner Canyon, California, 32°-34′-36″N, 119°-02′-48″ W, 644 m, January 29, 1960.

Relationship: This species differs from *Oediceropsis trepadora* (J. L. Barnard 1961b) and *O. morosa*, n. sp., in the very short rostrum. It differs from *Oediceropsis brevicornis* Liljeborg (see Sars 1895: pl. 114) in the lack of eyes, the unswollen first article of antenna 2 (a subgeneric difference) and the longer first antenna.

Oediceropsis proxima Chevreux (1908) also lacks eyes. The new species may not be distinct from *O. proxima* although coxa 4 is bluntly and not acutely produced and the posterior lobe of article 5 on gnathopod 2 is shorter and blunter.

Oediceropsis sinuata Schellenberg (1931) has fused eyes and an emarginate telson, among other characters of distinction.

Oediceropsis (Paroediceroides) morosa, new species

(Fig. 32)

Diagnosis: Rostrum slender, acute, reaching two thirds along article 1 of antenna 1; lateral cephalic lobes not projecting as far forward as rostrum, subacute; eyes absent; posterior lobes of fifth articles of gnathopods projecting but only moderately slender; pereopods 1 and 2 with very slender articles; telson truncated; coxa 1 with truncated anteroventral corner; coxa 4 with posterior process blunt. Uropod 3 missing. Mouthparts like *Oediceroides rostrata* (Stebbing 1888: pls. 60, 61, as *O. conspicua*) but inner lobe of maxilla 1 with only 2 setae.

Holotype: AHF No. 6016, female, 5.5 mm. Unique.

Type locality: Station 6833, Tanner Canyon, 32°-37′-54″N, 118°-58′-40″W, 813 m, January 29, 1960.

Relationship: This species differs from *Oediceropsis trepadora* (J. L. Barnard 1961b) in the anteriorly truncate first coxa.

Oediceropsis (Paroediceroides) trepadora (J. L. Barnard), new combination

(Fig. 33)

Paroediceroides trepadora J. L. Barnard 1961b: 96, fig. 64.

Material: 6839, male, 5.0 mm.

Remarks: This specimen corresponds to that figured by Barnard in all characters except pereopod 4 which has a more slender article 2. From lateral view the cephalic lobe seems sharper but further rotation of the head shows that the lobe fits the figure of Barnard; it is shown herein in a subsidiary figure.

Mouthparts are like those of *Oediceropsis brevicornis* Liljeborg (Sars 1895: pl. 114).

Synchelidium sp. G, var.

Canyon material: 5006(1), 6803(15).

Synchelidium rectipalmum Mills

Synchelidium rectipalmum Mills 1962a: 17-19, figs. 5, 6B.

Canyon material: 4852(6).

Synchelidium shoemakeri Mills

Synchelidium shoemakeri Mills 1962a: 15-17, figs. 4, 6A.

Canyon material: 4852(9), 6499(1).

Synchelidium spp.

Canyon material: 6835(2), 7031(1), 7039(1).

Westwoodilla caecula forma acutifrons Sars

Halimedon Mülleri Boeck.—Sars 1895: 327-329, pl. 115.

Westwoodilla caecula (Bate).—Enequist 1950: 333-338, figs. 40-56; Gurjanova 1951: 541-543, fig. 357: (*coecula, sic*); Mills 1962a: 5-9, figs. 1, 6A.

Halimedon acutifrons Sars 1895: 329-330, pl. 116, fig. 1.

Canyon material: 5960(11), 6821(1), 6845(9), 6846(1), 7043(1), 7174(2), 7285(1). An unidentifiable specimen of *Westwoodilla* was collected at basin station 2439.

Slope material: 2789(5), 3204(7).

Family PARDALISCIDAE

Nicippe tumida Bruzelius

Nicippe tumida Bruzelius.—Sars 1895: 410-411, pl. 144, pl. 145, fig. 1; Stephensen 1931a: 215-216, chart 38; Enequist 1950: 325-326, figs. 14, 15; Gurjanova 1951: 509-510, fig. 333; J. L. Barnard 1959b: 39-40, figs. 1, 2.

Canyon material: 4851(4), 5505(2), 6845(4), 6849(1), 6854(8), 7039(1), 7174(14), 7285(2).

Basin material: 5929(1), 6828(1).

Slope material: 2789(1).

Pardaliscella symmetrica J. L. Barnard

Pardaliscella symmetrica J. L. Barnard 1959b: 40-42, figs. 3, 4.

Canyon material: 6837(1), 6845(1), 7038(1).

Basin material: 5933(1), 6340(?1), 6341(?1).

Pardaliscoides (?) fictotelson, new species

(Fig. 34)

Diagnosis: Telson cleft about one-fourth of its length, most of the cleft formed by a deep and broad terminal emargination separating telsonic apices broadly, remainder of cleft very narrow and forming a short incision, each apex of telson with at least one long seta; rami of uropod 3 subfoliaceous and not more than twice as long as peduncle; each pleonal epimeron with a tooth at posteroventral corner, tooth of second epimeron longest; urosomites 1 and 2 each with a posterodorsal crestlike tooth.

Holotype: AHF No. 5921, male, 2.7 mm.

Type locality: Station 6805, Santa Cruz Canyon, 33°-56′-03″N, 119°-52′-03″W, 218 m, December 22, 1959.

Material: Three specimens from the type locality.

Relationship: This species differs from the type species, *P. tenellus* Stebbing (see 1897), in its poorly cleft, basally united telson with gaping apices; in *P. tenellus* the telson is very deeply cleft with gaping apices; the mouthparts are similar to those shown by Stebbing and the first antenna fits the generic definition, having article 2 longer than article 1. The second maxillary lobes appear slightly more narrow and the inner lobe of the second maxilla is more weakly developed in the present specimen. It is in poor condition, for pereopods 3 and 5 are missing, and uropods 1 and 2, the antennae, and the head are damaged.

The new species differs from *P. longicaudatus* Dahl (1959) in the short rami of uropod 3 and in the slightly projecting posteroventral corner of the third pleonal epimeron. The first and second pleonal epimera were not described for *P. longicaudatus.*

Pardisynopia synopiae J. L. Barnard

Pardisynopia synopiae J. L. Barnard 1962b: 77-79, figs. 3, 4.

Canyon material: 6836(2), 6845(1), 6846(4).

Slope material: 2789(1).

Tosilus, new genus

Diagnosis: Mouth parts not forming a conelike bundle; upper lip with bilaterally symmetrical lobes; lower lip apparently with inner lobes fused (not satisfactorily analyzed); mouthparts otherwise like those of *Pardaliscoides* (see Stebbing 1897: pl. 12), with long maxillipedal palp, short outer plates and obsolescent inner plates similar to those of *Necochea* J. L. Barnard (1962d), inner plate of maxilla 1 even more weakly developed, similar to that of *Necochea;* maxilla 2 with distinct lobes as drawn herein; mandible with palp; antenna 1 with accessory flagellum, articles 1-3 of peduncle successively shorter; fifth articles of gnathopods very short, not lobed, sixth articles about six times as long as fifth, slender, tapering, simple; pereopods simple; urosomal segments not dorsally produced; uropod 3 exceedingly small, not as long as the short ramus of uropod 2; telson short, cleft halfway.

Type species: Tosilus arroyo, new species.

Relationship: This genus resembles *Parpano* J. L. Barnard (1964a) in its miniaturized uropod 3, but the telson is cleft in *Tosilus* and entire in *Parpano.* The gnathopods also are similar. Apart from the small uropod 3, *Tosilus* differs from other pardaliscids as follows: from *Pardaliscoides* Stebbing in the short peduncular article 2 of antenna 1; from *Halice* Boeck in the short telson and short fifth articles of the gnathopods; from *Pardaliscella* Sars in the obsolescent inner plates of the maxillipeds and first maxillae and the short fifth article of the gnathopods; from *Pardaliscopsis* Chevreux in the symmetrical upper lip and gnathopods; from *Necochea* J. L. Barnard in the well-developed second maxillae and normal coxae; from *Parahalice* Birstein & Vinogradov (1962) in the simple pereopods; from *Arculfia* J. L. Barnard (1961b) and *Princaxelia* Dahl (1959) in the gnathopods and lack of urosomal teeth.

Tosilus arroyo, new species

(Fig. 35)

Diagnosis: With the characters of the genus.

Description: Third pleonal epimeron with medium-sized, upturned tooth; coxae poorly preserved and not accurately represented in the figures herein; head poorly preserved and only partially reconstructed in the figure.

Holotype: AHF No. 6010, female, 3.8 mm. Unique.

Type locality: Station 7049, La Jolla Canyon, 32°-49′-37″ N, 117°-35′-12″W, 976 m, May 7, 1960.

Family PHOTIDAE (ISAEIDAE = senior synonym)

Amphideutopus oculatus J. L. Barnard

Amphideutopus oculatus J. L. Barnard 1959c: 34-35, pl. 10; J. L. Barnard 1961a: 181, fig. 2.

Canyon material: 5367(3), 7031(4).

Eurystheus thompsoni (Walker)

Eurystheus thompsoni (Walker).—Shoemaker 1955b: 59 (with references); J. L. Barnard 1959c: 36, pl. 11; J. L. Barnard 1961a: 182.

Canyon material: 4852(5), 6805(1).

Megamphopus sp.

Canyon material: 6803(2), 6804(2).

Photis bifurcata J. L. Barnard

Photis bifurcata J. L. Barnard 1962a: 30-31, fig. 10.

Canyon material: 4852(9).

Photis brevipes Shoemaker

Photis brevipes Shoemaker 1942: 25-27, fig. 9; J. L. Barnard 1962a: 31-33, fig. 11.

Canyon material: 4851(5), 4852(46), 5367(3), 6803(7), 6821(3), 6822(?1), 6845(3), 6846(2).

Photis lacia J. L. Barnard

Photis lacia J. L. Barnard 1962a: 42-44, fig. 18.

Canyon material: 6499(31).

Photis macrotica J. L. Barnard

Photis macrotica J. L. Barnard 1962a: 44, fig. 19.

Canyon material: 6805(9), 6806(13), 7043(4).

Photis spp.

Canyon material: Unidentifiable juveniles and females: 4851(1), 4852(3), 5960(2), 6499(4), 6803(146), 6804(91), 6806(12), 6817 (9), 6835(1), 6836(2), 6900(1), 7038(2).

Protomedeia articulata J. L. Barnard

Protomedeia articulata J. L. Barnard 1962a: 48-50, fig. 21.

Canyon material: 5114(1), 6490 (20, blind), 6494 (111, blind), 6845(2), 7044(2).

Protomedeia (?)prudens new species

(Fig. 36)

Lacking antennae, this species cannot be assigned definitely to a genus, for it might fit *Podoceropsis*, *Kermystheus*, *Megamphopus*, *Bonnierella*, *Goesia*, *Eurystheus* or *Protomedeia.*

Diagnosis: Coxa 1 angular in front but not acutely produced; coxa 2 scarcely larger than coxa 1 and bearing a medially projecting, hook-like accessory tooth; both pairs of gnathopods with greatly elongated fifth articles, article 6 of gnathopod 1 slender, bearing a projection in place of palm, posterior edge of article 6 setose and bearing stout spine just proximal to distal tooth; article 6 of gnathopod 2 much stouter than in gnathopod 1, palm transverse or essentially chelate, bearing two teeth, a short subacute middle tooth and a cheliform palm defining-tooth, posterior edge of article 6 with 2 large notches, dactyl long, overlapping palm considerably; inner ramus of uropod 3 about three-fourths as long as outer ramus; mouthparts like those of *Protomedeia fasciata* Krøyer as figured by Sars (1895: pl. 196).

Holotype: AHF No. 6017, male, 7.4 mm. Unique.

Type locality: Station 7038, La Jolla Canyon, 32°-52′-48″N, 117°-16′-32″W, 121 m, May 6, 1960.

Relationship: This species is unusual in *Protomedeia* for the elongation of article 5 of gnathopod 1, its produced palmar tooth, and the posterior notches on gnathopod 2; the medial coxal tooth of gnathopod 2 also is unique. No species of *Megamphopus* Norman has the kind of gnathopod 2 seen in this species.

Family PHOXOCEPHALIDAE

Coxophoxus, new genus

Diagnosis: Article 2 of pereopod 3 slender, scarcely wider than article 3; palp of maxilla 1 uniarticulate; flagellum of antenna 2 multiarticulate; gnathopods enlarged, first smaller than second; body of mandible lacking large process at juncture of palp, molar large, with ridged triturating surface; palp article 4 of maxilliped bearing large apical spine or spines, palp article 3 not produced; eyes present; antenna 2 lacking basal ensiform process; anteroventral corner of head unproduced; dorsoposterior edge of coxa 4 not excavate.

Type species: Coxophoxus hidalgo, new species.

Relationship: This genus combines characters of the genera *Phoxocephalus* Stebbing and *Proharpinia* Schellenberg. It differs from *Phoxocephalus* in the slender second article of pereopod 3 and from *Proharpinia* in the uniarticulate palp of the first maxilla and the unproduced cephalic corner.

Other species assigned: Phoxocephalus coxalis K. H. Barnard (1932).

Coxophoxus hidalgo, new species

(Figs. 37, 38)

Diagnosis: Article 2 of pereopod 5 hugely expanded, more than 90 percent as wide as long.

Description: The figures presented herein show the other features. The male has the enlarged eyes typical of many phoxocephalids and an elongated inner ramus of the third uropod. The distolateral surface of article 1 on antenna 1 has a process.

Holotype: AHF No. 5810, male, 4.0 mm.

Type locality: Station 5943, East Cortes Basin, California, 32°-16′-30″N, 118°-27′-55″ W, 1675 m, November 10, 1958.

Basin material: 6 specimens from the type locality.

Relationship: This species differs from *Phoxocephalus coxalis* K. H. Barnard (1932), which I assign to this genus, by the much more broadly expanded second article of pereopod 5. In *C. coxalis* the article is only about 70 percent as broad as long.

Harpiniopsis emeryi J. L. Barnard

Harpiniopsis emeryi J. L. Barnard 1960b: 334, pl. 69.

Canyon material: 2847(2), 6837(1), 6849(1), 7728(1).

Basin material: 2440(2), 2846(1), 2850(2), 3028(1), 5945(1), 6340(1).

Slope material: 2632(1), 2852(1), 3031(1).

Harpiniopsis epistomata J. L. Barnard

Harpiniopsis epistomatus J. L. Barnard 1960b: 326-328, pls. 62, 63.

Canyon material: 2219(6), 2475(1), 2793(1), 2847(1), 6779(15), 6809(5), 6820(1), 6830(1), 6851(2), 6916(15), 7032(2), 7039(1), 7047(4), 7049(1), 7154(2), 7286(1), 7288(14), 7289(2), 7290(1), 7395(2), 7396(5), 7399(1), 7402(1), 7728(2).

Basin material: 2229(22), 2410(1), 2440(2), 2636(4), 3029(1), 3031(2), 5925(4), 5930(1).

Slope material: 2369(3), 2370(1), 2411(1), 2441(1), 2625(1), 2838(1), 2843(1), 2845(1), 2852(3), 3031(2).

Harpiniopsis excavata (Chevreux)

Harpinia excavata Chevreux.—Chevreux 1900: 37-38, pl. 6, fig. 1; Stebbing 1906: 142-143; K. H. Barnard 1925: 340-341; Chevreux 1927: 73; J. L. Barnard 1960b: 353; J. L. Barnard 1962d: 47-50, figs. 37, 38; J. L. Barnard 1964a: 18-21, fig. 16.

Harpiniopsis sanpedroensis J. L. Barnard 1960b: 328-330, pls. 64, 65.

Canyon material: 6833(1).

Basin material: 2850(2).

Harpiniopsis fulgens J. L. Barnard

Harpiniopsis fulgens J. L. Barnard 1960b: 332, pls. 67, 68.

Canyon material: 4851(1), 6815(2), 6822(1), 6831(1), 6837(1), 6845(6), 6898(10), 6900(1), 6903(1), 6909(1), 6915(4), 7032(1), 7047(4), 7054(8), 7174(4), 7288(1), 7396(1).

Basin material: 4669(1), 5930(2), 5933(1), 6338(1), 6348(1), 6351(4), 6832(2).

Slope material: 2224(2), 2293(2), 2306(8), 2337(1), 2361(4), 2423(3), 2625(8), 2632(5), 2749(1), 2789(2), 2790(2), 2851(4), 3204(3).

Harpiniopsis galera J. L. Barnard

Harpiniopsis galerus J. L. Barnard 1960b: 336, pls. 70-72.

Slope material: 2227(2), 2230(?1), 2367(2), 2413(1), 2414(2), 2851(1).

Harpiniopsis naiadis J. L. Barnard

Harpiniopsis naiadis J. L. Barnard 1960b: 336-339, pl. 73.

Canyon material: 6820(4), 6850(1), 7049(1).

Slope material: 2302(2).

Harpiniopsis petulans, new species

(Fig. 39)

Diagnosis: Anteroventral corner of head unproduced; epistome acutely produced anteriorly; article 2 of pereopod 5 broad, produced downward truncately to end of article 4, with 2 small posterior teeth below 4 minute serrations; third pleonal epimeron with a very long posterior tooth curving dorsally; rami of uropod 2 naked.

Holotype: AHF No. 6011, female, 4.5 mm. Unique.

Type locality: Station 6842, Coronado Canyon, California, 32°-22′-50″ N, 117°-22′-12″ W, 1265 m, January 31, 1960.

Relationship: This species differs from *Harpiniopsis epistomata* J. L. Barnard (1960b) in the immense tooth of the third pleonal epimeron. In that character it closely resembles *H. emeryi* J. L. Barnard (1960b) but differs in the acutely produced epistome, the much larger and broader second article of pereopod 5, and the relatively short remainder of the appendage.

Harpiniopsis profundis J. L. Barnard

Harpiniopsis profundis J. L. Barnard 1960b: 330, pl. 66.

Canyon material: 6844(1), 7049(2).

Basin material: 2850(1).

Slope material: 2344(?1).

Harpiniopsis profundis J. L. Barnard var.

(Fig. 40)

Diagnosis: Differing from normal adults in (1) the somewhat broader posterior lobe on article 2 of pereopod 5, the more strongly truncated oblique ventral margin bearing shallower teeth; (2) the lack of spines on the rami of uropod 1.

Catalogued material: AHF No. 606, male, 4.8 mm.

Locality: Station 6832, Tanner Canyon, 32°-33′-36″N, 118°-55′-40″W, 1298 m, January 29, 1960.

Material: Two specimens from the catalogued locality.

Remarks: Materials under examination from deep waters off Baja California show this juvenile form to be connected to the terminal adult as figured by Barnard (1960b), through enlargement and disproportionment of the teeth of pereopod 5 and the development of spines on the inner ramus of uropod 2.

Harpiniopsis spp.

Basin material: 5937(1), 5940(1), 6092(1), 6346(1), 6347(1).

Heterophoxus oculatus (Holmes)

Heterophoxus oculatus (Holmes).—J. L. Barnard 1960b: 320-324, pls. 59-61 (with references) ; J. L. Barnard 1961b: 71.

Slope material: 2151(1), 2224(1), 2227(2), 2228(1), 2229(1), 2231(11), 2302(1), 2306(1), 2324(3), 2337(5), 2344(1), 2361(10), 2369(3), 2370(2), 2389(5), 2413(6), 2414(2), 2423(5), 2625(1), 2632(1), 2724(7), 2789(21), 2843(1), 2845(1), 2849(1), 2850(2), 2851(1), 3031(3), 3204(9), 7135(1).

Basin material: Stations 2130(1), 2636(1), 2849(1), 2850(2), 3027(3), 3028(1), 5925(1), 5926(1), 5930(2), 5933(?1), 5935(1), 6089(1), 6336(1), 6338(2), 6339(1), 6341(1), 6342(2), 6344(1), 6347(1), 6810(2), 6832(1).

Canyon material: Stations 2149(1), 2189(11), 2191(5), 2725(1), 2727(12), 3000(5), 3179(1), 3180(1), 3385(11), 4851(2), 5046(2), 5115(2) 5367(1), 5531(4), 5532(2), 5960(21), 6498(2), 6499(1), 6805(1), 6806(5), 6815(10), 6818(4), 6819(5), 6821(6), 6822(9), 6836(2), 6837(2), 6845(6), 6846(4), 6851(1), 6854(1), 6897(2), 6898(8), 6899(5), 6903(3), 6909(2), 6915(1), 7029(21), 7038(25), 7039(1), 7045(1), 7047(2), 7051(2), 7054(2), 7174(20), 7285(1), 7728(2), 7730(2).

Remarks: This species is strongly eurybathic, ranging in depth from 2 to 3 meters on shallow sands, especially in arid lagoons where winter temperatures are low, to nearly abyssal depths in the basins off southern California; and is distributed from Puget Sound, Washington, to Panama.

In slope depths greater than 200 m almost all of the specimens lack eyes. This is the most abundant canyon species but is not an indicator of bathyl depths because of its eurybathicity.

Leptophoxus falcatus icelus J. L. Barnard

Leptophoxus falcatus icelus J. L. Barnard 1960b: 308-311, pls. 53, 54.

Basin material: 2846(1), 5938(1), 6828(2).

Slope material: 2303(1), 2389(1), 2413(3), 2423(2), 2845(1), 2851(2).

Canyon material: 2793(2).

Remarks: The 2.5 mm male of 5938 has 4 posterior serrations on article 2 of pereopod 5 and is thus intermediate between the stem subspecies and *L. falcatus icelus*.

Metaphoxus frequens J. L. Barnard

Metaphoxus frequens J. L. Barnard 1960b: 304-306, pls. 51, 52.

Canyon material: 2192(2), 2725(7), 2727(19), 3385(37), 5367(1), 5960(44), 6781(2), 6806(4), 6835(1), 6836(5), 6845(9), 6846(10), 6854(1), 7038(1).

Slope material: 2231(6), 2789(12), 3204(9).

Paraphoxus abronius J. L. Barnard

Paraphoxus abronius J. L. Barnard 1960b: 203-205, pl. 5.

Canyon material: 7045(1).

Paraphoxus bicuspidatus J. L. Barnard

Paraphoxus bicuspidatus J. L. Barnard 1960b: 218-221, pls. 15, 16; J. L. Barnard 1963: 462-463.

Canyon material: 2725(8), 2727(13), 3385(40), 5367(8), 5531(1), 5532(1), 5960(11), 6845(21), 6846(12), 6854(1), 6897(2), 6904(1), 7044(3), 7045(2).

Slope material: 2231(10), 2789(6), 3204(22).

Paraphoxus calcaratus (Gurjanova)

Parpharpinia calcarata Gurjanova 1938: 271-272, figs. 9a-b; *Pararpinia calcarata.*—Gurjanova 1951: 388-392, fig. 237.

Paraphoxus calcaratus.—J. L. Barnard 1960b: 238-240, pl. 26.

Canyon material: 6804(85), 6806(5), 6836(13).

Slope material: 2367(1), 2414(4).

Paraphoxus daboius J. L. Barnard

Paraphoxus daboius J. L. Barnard 1960b: 210-212, pls. 10, 11.

Canyon material: 6803(1), 6833(9), 6836(1), 7728(1).

Slope material: 2227(14), 2228(1), 2344(2), 2367(8), 2423(5).

Paraphoxus epistomus (Shoemaker)

Pontharpinia epistoma Shoemaker 1938: 326-329, fig. 1.

Paraphoxus epistomus.—J. L. Barnard 1960b: 205-209, pls. 6-8.

Canyon material: 4852(65), 5114(1), 5367(1), 5674(1).

Paraphoxus fatigans J. L. Barnard

Paraphoxus fatigans J. L. Barnard 1960b: 209-210, pl. 9.

Canyon material: 4852(20).

Slope material: 2344(1).

Paraphoxus heterocuspidatus J. L. Barnard

Paraphoxus heterocuspidatus J. L. Barnard 1960b: 224-226, pls. 19, 20.
Canyon material: 4852(4).

Paraphoxus obtusidens (Alderman)

Paraphoxus obtusidens (Alderman).—J. L. Barnard 1960b: 249-259, pls. 33-37 (with references).

Canyon material: 3164(1), 4852(34), 6803(14), 6804(48), 6835 (4).

Slope material: 3204(2).

Paraphoxus oculatus Sars

Paraphoxus oculatus Sars.—J. L. Barnard 1960b: 240-243, pls. 27, 28 (with references).

Canyon material: 2148(3), 2149(1), 3166(1), 3179(1), 3180(2), 4851(4), 6494(1), 6815(2), 6837(?1), 6851(1).

Basin material: 2850(2).

Slope material: 2293(7), 2369(1), 2413(2), 2625(1), 2632(3), 2749(6).

Paraphoxus robustus Holmes

Paraphoxus robustus Holmes 1908: 518-521, fig. 27; J. L. Barnard 1960b: 235-236, pl. 25.

Canyon material: 2727(2), 5960(1), 6501(?1), 6806(3), 6846(6).

Slope material: 3204(1).

Paraphoxus similis J. L. Barnard

Paraphoxus similis J. L. Barnard 1960b: 230-233, pls. 22, 23.

Canyon material: 2192(1), 2725(5), 2727(1), 3385(13), 5114(1), 5367(8), 5960(3), 6817(4), 6846(6).

Slope material: 2414(3), 3204(17).

Paraphoxus spinosus Holmes

Paraphoxus spinosus Holmes 1905: 477-478, fig.; Kunkel 1918: 76-78, fig. 13; Shoemaker 1925: 26-27; J. L. Barnard 1959c: 18; J. L. Barnard 1960b: 243-249, pls. 29-31; J. L. Barnard 1961a: 178.

Canyon material: 3167(1), 4852(19), 6805(1), 6806(1), 6817 (46).

Paraphoxus stenodes J. L. Barnard

Paraphoxus stenodes J. L. Barnard 1960b: 221-224, pls. 17, 18.

Canyon material: 3166(1), 4852(55), 5505(2), 6835(2), 7031(1).

Paraphoxus tridentatus (J. L. Barnard)

Pontharpinia tridentata J. L. Barnard 1954a: 4-6, pls. 4, 5.
Paraphoxus tridentatus.—J. L. Barnard 1960b: 261-262.

Canyon material: 6803(4).

Paraphoxus variatus J. L. Barnard

Paraphoxus variatus J. L. Barnard 1960b: 198-202, pls. 3, 4.

Canyon material: 4852(2).

Phoxocephalus homilis J. L. Barnard

Phoxocephalus homilis J. L. Barnard 1960b: 301-303, pls. 49, 50.

Canyon material: 2149(1), 2191(6), 2192(3), 2725(3), 2727(2), 2999(1), 3385(19), 4851(2), 5046(1) 5115(1), 5960(13), 6497(4), 6779(1), 6806(2), 6815(10), 6845(9), 6846(1), 6854(4), 6898(16), 6899(2), 6900(1), 6911(1), 7032(8), 7038(8), 7174(9), 7285(2).

Basin material: 4669(1).

Slope material: 2293(8), 2361(1), 2418(1), 2625(1), 2632(7), 2749(10), 2789(12), 2851(8), 2852(6), 3204(1).

Family PLEUSTIDAE

Parapleustes pugettensis (Dana)

Parapleustes pugettensis (Dana).—Barnard and Given 1960: 43-45, fig. 4 (with references).

Canyon material: 4852(89).

Sympleustes subglaber Barnard & Given

Sympleustes subglaber Barnard and Given 1960: 45-46, fig. 5.

Canyon material: 6781(2).

Family PODOCERIDAE

Dulichia sp.

Canyon material: 6499(1 female).

Podocerus cristatus (Thomson)

Podocerus cristatus (Thomson).—J. L. Barnard 1962a: 67-69, figs. 31, 32.

Canyon material: 4851(2).

Family STENOTHOIDAE

Mesometopa neglecta roya, new subspecies

(Fig. 41)

References to typical subspecies:

[*Metopa neglecta* Hansen.—Sars 1895: 274-275, pl. 97, fig. 2.
Metopella neglecta (Hansen).—Gurjanova 1951: 473-474, fig. 310.
Mesometopa neglecta (Hansen).—Shoemaker 1955a: 24, figs. 8a-f.]

Description: Lateral cephalic lobe sharp as in *Mesometopa neglecta* Hansen (Sars. 1895: pl. 97, fig. 2), eye small, composed of 8 to 10 large ommatidia loosely arranged; antennae reaching to end of fifth pereonite; mandibular palp 2-articulate, appearing to be absent on one mandible and present on other; palp of maxilla 1 uniarticulate; gnathopod 1 simple, article 7 not setose; gnathopod 2 small, article 6 trapezoidal, expanded distally, palm oblique, sharply defined by a small cusp, bearing two large defining spines; article 2 of pereopods 3-4 very slender; article 2 of pereopod 5 broad proximally, suddenly constricted on distal half; articles 4 and 5 of pereopods 3-5 very slender, not produced distally; third pleonal epimeron projecting strongly posteriorly; telson with 2 marginal spines on each side.

Holotype: AHF No. 5920, female, 3.0 mm.

Type locality: Station 6806, Santa Cruz Canyon, California, 33°-56′-06″ N, 118°-52′-17″ W, 221 m, December 22, 1959.

Material: Four specimens from the type locality.

Remarks: Mesometopa gibbosa Shoemaker (1955a) should be removed to the genus *Metopella* Sars because the second article of pereopod 5 is slender. The remaining 3 species, *Mesometopa esmarki* (Boeck), *M. extensa* Gurjanova and *M. neglecta* (Hansen), differ among themselves more than the present material differs from *M. neglecta*, so these specimens are relegated to subspecific status. The larger, fewer, and more loosely compacted ommatidia of the new subspecies differ from the more numerous, smaller, more compacted ommatidia of the stem species and the proximal and distal portions of article 2 on pereopod 5 are more sharply differentiated. The palm of gnathopod 2 has a small medial cusp, not reported for *M. neglecta neglecta.* Probably the eye differences are a reflection of the greater depth recorded for the new subspecies.

Metopa (Prometopa) samsiluna, new species

(Fig. 42)

Diagnosis: Assigned to the subgenus *Prometopa* Schellenberg by possession of a vestigial accessory flagellum; mandibular palp 3-articulate, first maxillary palp uniarticulate; eyes absent; antennae very long, subequal, peduncular articles of both antennae elongated, article 2 of antenna 1 longer than article 1; coxa 2 very broad; gnathopod 1 short, with distinct palm, article 6 expanded, article 7 short, fitting palm, not setose, article 4 strongly projecting posteriorly along article 5, article 2 strongly setose anteriorly; palm of gnathopod 2 with a large medial tooth, defining corner with large tooth; lobe on article 2 of pereopods 4 and 5 narrowing posterodistally, article 4 narrow, scarcely decurrent; telson spinose.

Holotype: AHF No. 6013, female, 4.5 mm. Unique.

Type locality: Station 6840, San Clemente Rift Valley, California, 32°-44′-35″ N, 118°-12′-45″ W, 1620 m, January 30, 1960.

Relationship: This species differs from *M. boeckii* Sars (1895: pl. 88) in the presence of the medial palmar tooth on the second gnathopodal palm, the narrower distoposterior lobes on article 2 of pereopods 4-5, the broader second coxa and the shorter first gnathopod with a more projecting fourth article and more distinct palm.

From *M. spectabilis* Sars (1895: pl. 87) this species differs in the equal antennae.

Metopa alderi (Spence Bate) (Sars 1895: pl. 86) is closely related and *M. samsiluna* may be a form of *M. alderi* but it differs in the lack of eyes, the spinose telson, the longer antennae, the better developed medial palmar tooth of gnathopod 2 and the narrower distoposterior lobes on article 2 of pereopods 4-5.

The new species resembles *M. aequicornis* Sars (1885), especially in the long, equal antennae and large coxa 2, but differs in the narrow, scarcely decurrent fourth articles of pereopods 4 and 5 and the spinose telson.

Metopa layi Gurjanova (see 1951) has short articles 1 and 2 of antenna 1.

Metopa sp.

(Fig. 43)

Material: One female, 2.2 mm, from Station 6499, Monterey Canyon.

Relationship: This specimen has affinities with *Metopa pusilla* Sars (1895: pl. 90, fig. 1) and may be identified with it although minor differences are noted as follows: the first gnathopod is slightly stouter and article 4 does not project posteriorly as much; coxa 4 is more elongated antero-posteriorly.

From *M. longicornis* Sars (1895: pl. 90, fig. 2) this species differs in the strongly projecting posterodistal corner of article 4 on pereopod 5. The female gnathopod 2 of *M. tenuimana* Sars (1895: pl. 91, fig. 1) is more slender and the palm more oblique than in the present material, but the figures of that species in Stephensen (1931) are close to the material at hand. Article 2 of pereopod 4 is stouter in *M. bruzelii* Goës (Sars 1895: pl. 92, fig. 1) then in the present specimen. The posterior lobe of article 5 on female gnathopod 2 is much stouter and longer in *M. invalida* Sars (1895: pl. 94, fig. 2). Article 4 of pereopod 5 is much stouter in *M. aequicornis* Sars (1885: pl. 15, fig. 5). Article 6 of gnathopod 1 is less tumid medially than in *M. boeckii* Sars (1895: pl. 88).

The specimen also bears comparison to *M. layi* Gurjanova (see 1951) but article 6 of gnathopod 1 in that species is slightly stouter.

Metopella (?) aporpis J. L. Barnard

Metopella aporpis J. L. Barnard 1962c: 142-145, figs. 12, 13.

Canyon material: 6805 (3).

Remarks: Further study of the mandible of this species reveals no small basal article on the palp, hence the single long article (similar to *Mesostenothoides pirloti* Gurjanova 1951: 466, fig. 305A) indicates that this species should be assigned to *Metopelloides;* but its first gnathopod bears no similarity to other species of that genus which have article 5 much shorter than 6 (except two species having very short gnathopod 1, in one case with a palm). Since the present species is distinct from any known species of *Metopelloides*, I prefer to retain it temporarily in *Metopella* until a more thorough study is made of the classificatory value of mandibles and maxillae in this family.

Proboloides tunda J. L. Barnard

(Fig. 44)

Proboloides tunda J. L. Barnard 1962c: 147-149, fig. 16.

Canyon material: 7041 (2), 7290 (3).

Remarks: The second gnathopod illustrated here is more fully developed than that shown by Barnard (1962b).

Stenothoides bicoma J. L. Barnard

Stenothoides (?) *bicoma* J. L. Barnard 1962c: 135-137, fig. 8.

Canyon material: 4852 (1), 6805 (1).

Family SYNOPIIDAE (=Tironidae)

Bruzelia ascua, new species

(Figs. 45, 46)

Diagnosis: Rostrum long, straight, nearly in line with cephalic axis, dorsum of head with two sharp bilateral keels, eyes not visible; pereonite 1 lacking dorsal tooth, all following pereonal, metasomal and the first two urosomal segments with a long, acute, dorsal projection each; each pereonal and metasomal segment with a subdorsal tooth and a lateral tooth, the lateral teeth of pereonites occurring at ventral margins just above coxae; coxae 5 and 6 each with a laterally projecting tooth; coxa 4 much shorter than 3, with a posterior cusp and dorsoposterior excavation; second and third pleonal epimera each with a slender, long, unserrated posteroventral tooth; second articles of pereopods 3-5 each with 2 or 3 medium-sized posterior cusps, posteroventral corners strongly produced.

Holotype: AHF No. 5812, male, 4.7 mm. Unique.

Type locality: Station 5938, Patton Escarpment, 32°-04′-30″ N, 119°-43′-20″ W, 1687 m, November 9, 1958.

Relationship: This species differs from *Bruzelia dentata* Stephensen (1931a) in the extra set of teeth located subdorsally and laterally on the pereonal and metasomal segments, the unserrated peonal epimera and the presence of dorsal cephalic keels.

Bruzelia ascua differs from *B. australis* Stebbing (1910) in the presence of lateral and subdorsal pereonal teeth and the presence of dorsal teeth on pleonites 3-5.

Other species of *Bruzelia* have fewer dorsal teeth or much smaller dorsal carinae than those mentioned above.

Bruzelia tuberculata G. O. Sars

Bruzelia tuberculata G. O. Sars 1895: 397-398, pl. 139, fig. 2; Stebbing 1906: 275; Stephensen 1931a: 252; Stephensen 1938: 232; Gurjanova 1951: 589, fig. 395; J. L. Barnard 1962b: 73.

Canyon material: 7038 (one female, 5 mm).

Other material: 5761(1), 5828(1).

Garosyrrhoe bigarra (J. L. Barnard)

Syrrhoites bigarra J. L. Barnard 1962b: 73-75, fig. 1.

Canyon material: 6803(1).

Syrrhoe sp.

Not to be described until more materials can be obtained.

Material: 6845(1).

Unidentifiable specimens

Material: 2169(2), 2849(1), 2850(1 stenothoid), 2850(3), 4669 (1), 4851(5, *Liljeborgia* sp.?), 4852(11, *Protomedeia*?), 5046(1), 5114(1 pontogeneiid), 5938(1, ?*Haploops*), 5938(1, *Harpinioides* sp.), 5938(1, ?*Pardaliscella*), 6336(1, ?*Orchomene*), 6351(1), 6372 (1), 6803 (1, Lysianassidae), 6805(1, Stenothoidae), 6810(1), 7043 (1), 7054(1 oedicerotid).

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APPENDIX I

Depth distribution of the Amphipoda of submarine canyons of California, arranged in depth classes with lists of species and specimens.

15-100 m

Acuminodeutopus heteruropus, 7
Ampelisca brevisimulata, 23
Ampelisca compressa, 17
Ampelisca cristata, 32
Ampelisca hancocki, 5
Ampelisca macrocephala, 28
Ampelisca milleri, 1
Ampelisca pacifica, 1
Ampelisca pugetica, 12
Amphideutopus oculatus, 7
Ampithoe mea, 2
Aoroides columbiae, 197
Byblis veleronis, 2
Ericthonius brasiliensis, 4
Eurystheus thompsoni, 5
Garosyrrhoe bigarra, 1
Heterophoxus oculatus, 1
Ischyrocerus pelagops, 24
Listriella eriopisa, 3
Listriella goleta, 43
Listriella melanica, 7
Lysianassa oculata, 4
lysianassid, 1
Megaluropus longimerus, 1
Megamphopus sp., 2
Melphisana bola, 1
Mesostenothoides bicoma, 1
Metaphoxus frequens, 1
Monoculodes hartmanae, 3
Monoculodes norvegicus, 1
oedicerotid, 3
Orchomene pacifica, 1
Pachynus barnardi, 1
Paraphoxus bicuspidatus, 11
Paraphoxus daboius, 1
Paraphoxus epistomus, 65
Paraphoxus fatigans, 20
Paraphoxus heterocuspidatus, 3
Paraphoxus lucubrans, 4
Paraphoxus obtusidens, 41
Paraphoxus similis, 8
Paraphoxus spinosus, 19
Paraphoxus stenodes, 75
Paraphoxus tridentatus, 4
Paraphoxus variatus, 2
Parapleustes pugettensis, 89
Photis bifurcata, 9
Photis brevipes, 56
Photis sp., 148
Prachynella lodo, 1
Protomedeia articulata, 14
Pseudokoroga rima, 2
Synchelidium rectipalmum, 6
Synchelidium shoemakeri, 9
Synchelidium sp., 1
Synchelidium sp. G, 16
Urothoe varvarini, 6

101-200 m

Ampelisca brevisimulata, 7
Ampelisca compressa, 6
Ampelisca hancocki, 1
Ampelisca macrocephala, 72
Ampelisca pacifica, 10
Anonyx carinatus, 2
Aoroides columbiae, 4
Atylus tridens, 1
Bathymedon roquedo, 1
Bruzelia tuberculata, 1
Byblis veleronis, 1
Dexamonica reduncans, 4

Dulichia sp., 1
Ericthonius brasiliensis, 1
Haploops spinosa, 1
Harpiniopsis fulgens, 9
Heterophoxus oculatus, 118
Hippomedon denticulatus, 4
Liljeborgia sp., 5
Listriella albina, 3
Listriella eriopisa, 10
Listriella goleta, 4
Lysianassa holmesi, 2
Lysianassa oculata, 2
Maera danae, 30
Melita dentata, 1
Metaphoxus frequens, 114
Metaphoxus fultoni, 1
Metopa sp., 1
Monoculodes emarginatus, 2
Monoculodes perditus, 1
Nicippe tumida, 16
oedicerotid, 1
Opisa tridentata, 2
Orchomene decipiens, 34
Orchomene pacifica, 5
Pachynus barnardi, 12
Paraphoxus bicuspidatus, 107
Paraphoxus epistomus, 1
Paraphoxus obtusidens, 1
Paraphoxus oculatus, 4
Paraphoxus robustus, 9
Paraphoxus similis, 30
Pardaliscella symmetrica, 2
Pardisynopia synopiae, 5
Photis brevipes, 10
Photis lacia, 31
Photis macrotica, 4
Photis sp., 6
Phoxocephalus homilis, 67
Podocerus cristatus, 2
pontogeneiid, 1, (5114)
Prachynella lodo, 2
Protomedeia articulata, 3
Protomedeia (?) prudens, 1
Sympleustes subglaber, 2
Synchelidium sp., 1
Syrrhoe sp., 1
Urothoe varvarini, 2
Westwoodilla caecula acutifrons, 22

201-300 m

Acidostoma hancocki, 1
Ampelisca compressa, 3
Ampelisca lobata, 5
Ampelisca macrocephala, 25
Ampelisca macrocephala unsocalae, 26
Ampelisca pacifica, 16
Ampelisca pugetica, 7
Ampelisca romigi, 2
aorid, 1
Aoroides columbiae, 3
Byblis veleronis, 6
Ceradocus spinicaudus, 2
Ericthonius hunteri, 8
Eurystheus thompsoni, 1
Harpiniopsis fulgens, 11
Heterophoxus oculatus, 69
Ischyrocerus sp., 1
Listriella albina, 13
Listriella eriopisa, 4
Listriella goleta, 2
Maera simile, 22
Mesometopa neglecta roya, 4
Mesostenothoides bicoma, 1
Metaphoxus frequens, 5
Metopella aporpis, 3
Microdeutopus schmitti, 4
Orchomene decipiens, 2
Pachynus barnardi, 2
Paraphoxus abronius, 1

Paraphoxus bicuspidatus, 2
Paraphoxus calcaratus, 5
Paraphoxus obtusidens, 4
Paraphoxus oculatus, 6
Paraphoxus robustus, 3
Paraphoxus spinosus, 2
Paraphoxus stenodes, 2
Pardaliscoides fictotelson, 3
Photis brevipes, 4
Photis macrotica, 13
Photis sp., 1
Phoxocephalus homilis, 28
Prachynella lodo, 2
Synchelidium sp., 2
Urothoe varvarini, 6
Westwoodilla caecula acutifrons, 4
Unknown, 1

301-400 m

Ampelisca compressa, 1
Ampelisca macrocephala, 45
Ampelisca macrocephala unsocalae, 6
Ampelisca pugetica, 6
?Aoroides columbiae, 1
Argissa hamatipes, 1
Byblis veleronis, 1
Ericthonius hunteri, 2
Gitanopsis vilordes, 1
Harpiniopsis emeryi, 1
Harpiniopsis epistomata, 2
Harpiniopsis fulgens, 13
Heterophoxus oculatus, 33
Listriella albina, 8
Listriella eriopisa, 1
Listriella goleta, 3
Maera danae, 2
Monoculodes latissimanus, 5
Nicippe tumida, 4
Pachynus barnardi, 2
Paraphoxus bicuspidatus, 3
Paraphoxus oculatus, 4
Paraphoxus robustus, 1
Paraphoxus spinosus, 1
Paraphoxus stenodes, 2
Phoxocephalus homilis, 18
Synchelidium sp., 1
Urothoe varvarini, 1
Family?, 1

The 21 samples have only 170 specimens, 3 of the samples lacking amphipods, and none of them having more than 28 specimens. One would expect this body of samples to have large populations because of the medium grain-size of their sediments. This is almost exclusively a shallow water facies, except for the harpinias and the blind *Ampelisca m. unsocalae*.

401-500 m

Ampelisca brevisimulata, 2
Ampelisca macrocephala, 2
Ampelisca macrocephala unsocalae, 4
Ampelisca pacifica, 2
Ampelisca pugetica, 6
Ampelisca romigi, 2
Byblis bathyalis, 2
Byblis ?veleronis, 16
Harpiniopsis epistomata, 26
Harpiniopsis fulgens, 2
Heterophoxus oculatus, 9
Leptophoxus falcatus icelus, 1
Liljeborgia cota, 4
Listriella goleta, 1
Megamphopus sp., 2

Melphidippa (?) amorita, 1
Metaphoxus frequens, 5
Paraphoxus bicuspidatus, 1
Paraphoxus calcaratus, 99
Paraphoxus daboius, 1
Paraphoxus obtusidens, 48
Pardisynopia synopiae, 2
Photis spp., 94
Phoxocephalus homilis, 17
Uristes californicus, 2
Urothoe varvarini, 3

These 21 samples have 354 specimens, but 8 samples lacked amphipods. Essentially, this is a shallow water facies penetrated by some deep water species such as the blind subspecies of *Ampelisca macrocephala*, *Byblis bathyalis*, the harpinias, and *Liljeborgia*.

501-600 m

Ampelisca coeca, 1
Ampelisca macrocephala unsocalae, 6
Bathymedon covilhani, 2
Byblis barbarensis, 6
Harpiniopsis epistomata, 32
Harpiniopsis fulgens, 2
Harpiniopsis naiadis, 4
Heterophoxus oculatus, 2
Liljeborgia cota, 5
Listriella albina, 3
Listriella eriopisa aber., 1
Monoculodes glyconica, 1
Paraphoxus epistomus, 1
Paraphoxus ?spinosus, 1
Proboloides tunda, 2

These 19 samples, of which 9 samples lack amphipods, have 69 specimens. The high percentage of blank samples and low number of specimens perhaps is related to the oxygen minimum layer of the sea. This is a strongly mixed shallow and deep water fauna, especially dominated by *Harpiniopsis epistomata*.

601-700 m

Acidostoma hancocki, 2
Ampelisca coeca, 1
Ampelisca ?compressa, 3
Ampelisca macrocephala, 1
Ampelisca macrocephala unsocalae, 22
Ampelisca romigi ciego, 2
ampeliscid, 1
Byblis barbarensis, 2
Byblis cf. *veleronis*, 1
Harpiniopsis emeryi, 1
Harpiniopsis epistomata, 7
Harpiniopsis fulgens, 1
Heterophoxus oculatus, 2
Liljeborgia cota, 2
Oediceropsis elsula, 1
Orchomene decipiens, 1
Paraphoxus oculatus, 1
Pardaliscella symmetrica, 1
Phoxocephalus homilis, 1
Proboloides tunda, 7

These 17 samples have 60 specimens, with 6 samples lacking amphipods, probably because some are very near sill depths of San Pedro and Santa Monica basins (737 m). *Ampelisca macrocephala unsocalae* dominates the group. Species that are much deeper than their normal limits are *A. compressa,* of doubtful identification, *Proboloides tunda* and a deep water species that is near its shallow limits: *Ampelisca romigi ciego.*

701-800 m

Ampelisca coeca, 1
Ampelisca macrocephala, 1
Ampelisca macrocephala unsocalae, 4
Bathymedon kassites, 7
Byblis barbarensis, 4
Byblis veleronis, 1
Harpiniopsis emeryi, 1
Harpiniopsis epistomata, 16
Harpiniopsis fulgens, 5
Heterophoxus oculatus, 4
Listriella albina, 1
Monoculodes norvegicus, 1
Orchomene decipiens, 1
Paraphoxus daboius, 1
Paraphoxus oculatus, 1
Protomedeia articulata, 111

The 13 samples have 160 specimens; 5 samples lacked amphipods. This group of samples is dominated by the single Monterey Canyon station 6494 where 111 *Protomedeia articulata* were collected on a bottom heavy with eel-grass debris. Since that situation is not typical of canyons in southern California, additional calculations have been made in the tables in these depths to reflect the unusual population of *Protomedeia.* Otherwise, *Harpiniopsis epistomata* dominates the amphipods. Transition to deep bathyal is seen with the co-occurrence of *Ampelisca macrocephala* and its blind subspecies *A. m. unsocalae,* by the combination of *Byblis barbarensis* with *B. veleronis*, and the mixture of *Orchomene decipiens* and *Paraphoxus daboius* with other much deeper species such as *Ampelisca coeca.*

801-1000 m

Ampelisca macrocephala unsocalae, 14
Ampelisca plumosa, 2
Ampelisca romigi ciego, 2
Byblis bathyalis, 2
Byblis cf. *barbarensis*, 1
Byblis tannerensis, 3
Harpiniopsis emeryi, 2
Harpiniopsis epistomata, 4
Harpiniopsis excavata, 1
Harpiniopsis naiadis, 2
Harpiniopsis profundis, 1
Heterophoxus oculatus, 1
Liljeborgia cota, 1
Oediceropsis morosa, 1
Paraphoxus daboius, 9
Paraphoxus oculatus, 1
Protomedeia articulata, 20
Schisturella zopa, 3
Tosilus arroyo, 1
Urothoe varvarini, 3

These 9 samples, of which only one lacks amphipods, have 72 specimens. As in the 701-800 depth group, a Monterey sample is present with *Protomedeia articulata,* untypical of canyons in southern California. Otherwise, these samples are dominated by the blind subspecies of *Ampelisca macrocephala* and mixture is seen by the presence of *Paraphoxus daboius,* with the deep water harpinias, ampeliscas and byblises, the deep water species clearly dominating these depths.

1001-1620 m

ampeliscids, fragments, 2
Harpiniopsis petulans, 1
Harpiniopsis profundis, 1
Metopa samsiluna, 1
Oediceropsis (Paroediceroides) trepadora, 1
Tryphosa index, 1

Only one of these samples lacks amphipods, the other 4 bearing 7 specimens. These samples are most interesting because in their respective areas they are just above sill depths of San Clemente Basin or are in the Coronado Canyon. They are the deepest canyon samples above sill depths. Three of the species are new, so that the fauna reveals no relationship to either shallower depths of canyons or subsill faunas of basins.

APPENDIX II

List of Californian borderland basins, their samples, depths in m, and Amphipoda. Station numbers are listed first, depths in parentheses and number of specimens in brackets.

Santa Barbara Basin: 3504 (493) [0], 3731 (503) [2], 3733 (558) [0], 3503 (581) [0], 4999 (618) [0]. *Byblis barbarensis*, 2.

Santa Monica Basin: 26 samples, all but one lacking Amphipoda. Added here to the 19 samples in Hartman and Barnard (1958, 1960) are these samples taken in canyons but below sill depths of basins: 6918 (Dume), 2474 (Redondo), 6913 (Mugu), 2139 (Redondo), 6777 (Santa Monica), 6776 (Santa Monica), 2403 (Redondo). *Liljeborgia cota*, 1.

San Pedro Basin: Samples with Amphipoda are: 2410 (750), 2636 (754), 2440 (760), 2343 (765), 2335 (769), 2439 (796), 2229 (805), 7497 (833), and 66 samples lacking Amphipoda from depths of 750 to 906 m; 53 of the samples lacking Amphipoda exceed 796 m. *Ampelisca coeca*, 1, *Ampelisca macrocephala*, 3, *Ampelisca pugetica*, 3, *Harpiniopsis epistomata*, 29, *Heterophoxus oculatus*, 1, *Liljeborgia cota*, 1, *Monoculodes norvegicus*, 1, *Urothoe varvarini*, 1.

Santa Catalina Basin: 3026 (1016) [0], 2846 (1120) [2], 2850 (1135) [14], 4742 (1195) [0], 5935 (1225) [3], 2169 (1251) [2], 2130 (1260) [1], 6828 (1272) [5], 2849 (1282) [3], 3025 (1298) [0], 2848 (1305) [0], 5104 (1330) [0]. *Ampelisca eoa*, 2, *Byblis barbarensis*, 2, *Harpiniopsis emeryi*, 3, *Harpiniopsis excavata*, 2, *Harpiniopsis profundis*, 1, *Heterophoxus oculatus*, 5, *Leptophoxus falcatus icelus*, 3, *Liljeborgia cota*, 2, *Nicippe tumida*, 1, *Paraphoxus oculatus*, 2, stenothoid, 1, (2850), ?genus, 3, (2850), 2, (2169), 1, (2849).

Santa Cruz Basin: 6810 (1387) [3], 5925 (1411) [9], 3029 (1514) [1], 5928 (1520) [0], 6811 (1624) [0], 5930 (1785) [5], 3028 (1788) [2], 5929 (1850) [0], 3027 (1918) [3], 5927 (2030) [0], 5926 (2080) [1]. *Ampelisca* sp., 3, *Bathymedon covilhani*, 1, *Harpiniopsis epistomata*, 6, *Harpiniopsis emeryi*, 1, *Harpiniopsis fulgens*, 2, *Heterophoxus oculatus*, 10, *Nicippe tumida*, 1.

Tanner Basin: 6348 (1292) [9], 6832 (1298) [10], 6347 (1414) [4], 6346 (1481) [4], 6345 (1486) [0], 5120 (1527) [0], 6344 (1533) [2]. *Ampelisca eoa*, 2, *Ampelisca macrocephala unsocalae*, 3, *Ampelisca amblyopsoides*, 3, *Bathymedon covilhani*, 1, *Bonnierella linearis californica*, 1, *Harpiniopsis fulgens*, 5, *Harpiniopsis similis hondanada*, 2, *Harpiniopsis* spp., 2, *Heterophoxus oculatus*, 3, *Liljeborgia cota*, 3, *Sophrosyne robertsoni*, 2, *Urothoe varvarini*, 2.

San Nicolas Basin: 6336 (1227) [3], 6337 (1245) [0], 6342 (1551) [2], 6339 (1608) [3], 5931 (1609) [0], 6341 (1670) [2], 6340 (1731) [2], 6338 (1735) [6], 6343 (1747) [1], 5933 (1749) [5], 5116 (1796) [0]. *Bonnierella linearis californica*, 1, *Byblis* sp., 2, *Harpiniopsis emeryi*, 1, *Harpiniopsis fulgens*, 4, *Heterophoxus oculatus*, 8, *Hirondellea fidenter*, 1, *Liljeborgia cota*, 1, ?*Orchomene* sp., 1, *Pardaliscella symmetrica*, 5.

San Clemente Basin: 6089 (2036) [1], 4669 (2059) [3], 6091 (2070) [1], 5945 (2089) [1], 6092 (2100) [3], 5946 (2124) [1]. *Byblis* sp., 2, *Harpiniopsis emeryi*, 1, *Harpiniopsis fulgens*, 1, *Harpiniopsis profundis*, 1, *Harpiniopsis* sp., 1, *Heterophoxus oculatus*, 1, *Lepidepecreella charno*, 1, *Phoxocephalus homilis*, 1, Unknown, 1.

East Cortes Basin: 5944 (1797) [0], 5943 (1801) [7], 5942 (1872) [1]. *Ampelisca* spp., 2, *Coxophoxus hidalgo*, 6.

West Cortes Basin: 4675 (1487) [0], 5939 (1668) [0], 5940 (1923) [2], 5941 (1924) [1]. *Ampelisca* sp., 1, *Byblis* sp., 1, *Harpiniopsis* sp., 1.

Long Basin: 6351 (1821) [9], 6350 (1833) [1], 6349 (1961) [0]. *Ampelisca eoa*, 1, *Ampelisca plumosa*, 3, *Harpiniopsis fulgens*, 4, *Liljeborgia cota*, 1, Unknown, 1.

Velero Basin: 5947 (2276) [0], 5948 (2580) [0].

Patton Escarpment: 5937 (1426) [5], 5938 (1760) [11]. *Ampelisca eoa*, 4, *Ampelisca macrocephala unsocalae*, 2, *Ampelisca plumosa*, 4, *Bruzelia ascua*, 1, *Haploops* sp., 1, *Harpiniopsis* sp., 1, ?*Harpinioides* sp., 1, *Leptophoxus falcatus icelus*, 1, ?*Pardaliscella* sp., 1.

APPENDIX III

Distribution of the submarine canyon samples with depth, their sediments and Amphipoda.

Canyon symbols are: Ca=Santa Catalina; Cl=San Clemente; Co=Coronado; D=Dume; H=Hueneme; J=La Jolla; Mo=Santa Monica; Mt=Monterey; Mu=Mugu; N=Newport; R=Redondo; S=San Pedro sea valley; SD=San Diego trough; T=Tanner; Z=Santa Cruz.

Sample	Canyon	Depth, m	Distance Above Axis, m	Median Diameter, mm	Percent Sand	No. of Amphipoda
4852	Mu	15	105	.110	94	671
C 7031	N	16	0	.046	44	21
5006	N	37	......	......	....	12
5250	N	37	0	.055	48	1 (H_2S)
C 7044	J	79	0	.077	72	20
C 7030	N	85	3	.022	9	11
C 6803	Z	89	0	.268	93	249
5367	N	97	......	......	....	74
2725	R	107	......	......	....	25
2192	R	113	......	......	....	13
C 6781	Mo	116	0	.233	14/70	21
C 6902	Mu	119	0	1.986	29/53	0
3385	R	120	430	.042	17	126
C 7038	J	121	200	.041	35	62
2727	R	122	430	.058	47	49
C 6846	Co	123	9	.072	66	60
C 7043	J	135	0	.144	94	6
C 7284	R	137	0	.031	17	9
5661	N	140	......	......	....	0
5960	R	146	400	.072	62	116
3164	R	148	0	.039	36	1
5114	H	165	20	.128	89	8
C 6499	Mt	168	......	......	....	41
7029	N	170	4	.026	5	25
4851	Mu	171	325	.042	41	119
5531	H	177	......	......	....	6
C 6845	Co	177	2	.046	38	105
C 7054	N	178	91	.041	32	22
5688	H	183	......	......	....	0
C 6780	Mo	183	0	.102	70	1

Sample	Canyon	Depth, m	Distance Above Axis, m	Median Diameter, mm	Percent Sand	No. of Amphipoda
C 6854	S	187	0	.013	18	18
4846	H	209	0	.031	9	2
C 6822	Ca	216	0	.029	7	13
C 6805	Z	218	......	......	....	41
C 6806	Z	221	120	......	....	108
C 7174	S	221	200	.047	47	52
2358	R	229	......	......	....	0
2191	R	232	......	......	....	21
C 7730	N	236	......	......	....	4
2149	R	239	......	......	....	3
C 7285	R	246	0	.015	5	9
C 6498	Mt	260	......	......	....	3
C 6821	Ca	266	......	......	....	18
3000	Mo	268	......	......	....	7
C 6896	H	271	16	.051	45	0
C 7028	N	272	0	.024	30	0
C 7045	J	274	11	.095	88	6
C 6815	R	282	86	.027	24	25
2148	R	298	......	......	....	4
C 6835	T	298	0	.218	99	27
C 6915	D	299	0	.014	11	31
C 6501	S	319	......	......	....	2
3180	Mo	330	0	.043	37	6
C 6897	H	338	9	.095	65	11
2190	R	344	......	......	....	4
C 6849	Co	344	9	.005	1	28
C 6903	Mu	352	0	.029	35	6
C 6909	Mu	352	230	.014	5/7	14
3179	Mo	362	50	.038	20	4
C 6818	Ca	362	37	.028	17	6
3166	R	363	5	.029	33	4
C 7039	J	371	13	.095	92	8
5115	H	373	......	......	....	3
C 6898	H	373	46	.018	5	37
5505	D	374	......	......	....	7
5686	H	374	......	......	....	0
5532	H	376	0	.032	16	3
C 6816	R	378	8	.051	36	1
C 7286	R	378	0	.044-.062	40-53	1

Sample	Canyon	Depth, m	Distance Above Axis, m	Median Diameter, mm	Percent Sand	No. of Amphipoda
C 6819	Ca	379	0	.031	16	19
C 7053	N	396	0	.088	60	0
5046	D	398	......	......	....	5
C 7160	S	406	100	.019-.082	15-57	0
C 6497	Mt	410	......	......	....	6
C 7052	N	420	58	.036	16	0
2189	R	422	......	......	....	2
C 7154	S	426	......	......	....	3
3178	Mo	431	70	.010	10	0
C 7287	R	431	0	.029-.038	29-38	0
2219	S	437	......	......	....	6
2999	Mo	454	105	.035	14	1
C 6899	H	456	9	.165	36/52	9
2218	S	459	......	......	....	0
C 6804	Z	459	0	.250	90	252
5639	S	461	......	......	....	0
3399	Mo	463	190	.042	14	0
2793	R	465	125	.038	36	3
C 7155	S	468	150	......	....	0
C 6779	Mo	475	0	.125	63	18
C 6904	Mu	475	0	.268	6/89	1
C 6900	H	478	11	.022	11	3
C 7032	N	478	2	.038	36	11
C 6836	T	496	11	......	....	54
7288	R	503	0	.062	50	20
5674	D	507	......	......	....	1
C 7046	J	517	0	.074	72	0
3167	R	519	40	.043	40	1
2317	S	522	......	......	....	1
C 6916	D	530	15	.022	15	20
2151	R	542	......	......	....	0
3177	Mo	542	30	.016	6	0
C 7041	J	545	90	.010	3	2
C 6502	S	547	......	......	....	0
C 6910	Mu	548	35	.024	15	0
C 6831	Ca	549	190	.019	4	5
C 7051	N	553	0	.116	87	4
3168	R	554	35	.043	35	0
C 6820	Ca	559	0	.040	40	10

Sample	Canyon	Depth, m	Distance Above Axis, m	Median Diameter, mm	Percent Sand	No. of Amphipoda
C 7289	R	560	0	.353	95	5
C 6852	Co	566	29	.005-.036	6-32	0
2150	R	575	......	......	....	0
C 6778	Mo	583	15	.044	41	0
2723	R	602	......	......	....	0
C 6834	T	603	13	.062	62	3
C 7290	R	611	0	.036	25	6
3176	Mo	612	30	.009	2	1
C 6901	H	621	2	.154	90	0
C 6809	Z	623	350	3.46	88	10
C 7404	SD	626	......	......	....	0
C 7040	J	637	0	.103	92	0
C 7050	N	642	0	......	....	1
C 6837	T	644	53	.053	67	9
C 6911	Mu	644	0	.072	61	15
5676	D	652	......	......	....	1
C 6503	S	661	......	......	....	0
2336	S	666	......	......	....	0
C 7403	SD	672	......	......	....	1
C 6812	Z	676	400	.054	49	12
2475	R	686	......	......	....	1
C 7402	SD	703	......	......	....	1
C 6830	Ca	708	9	......	....	2
C 7048	J	708	90	.007	1	0
C 6917	D	711	0	.013	11	0
2476	R	715	......	......	....	0
C 6861	S	716	0	.011	9	0
C 6912	Mu	721	0	.051	35	2
6494	Mt	750	......	......	....	120
7396	SD	769	......	......	....	7
C 7399	SD	772	......	......	....	1
C 7395	SD	773	......	......	....	2
C 7728	SD	786	......	......	....	9
C 7047	J	793	0	.062	53	16
C 6851	Co	812	5	.022	5	4
C 6833	T	813	7	.134	93	35
C 6829	Ca	853	27	......	....	0
C 6808	Z	902	0	.028-.047	31-46	2
C 6490	Mt	906	......	......	....	20

Sample	Canyon	Depth, m	Distance Above Axis, m	Median Diameter, mm	Percent Sand	No. of Amphipoda
C 2847	Ca	914	......	......	....	6
C 6838	Cl	950	7	......	....	3
C 6850	Co	960	9	.032	31	1
C 7049	J	976	0	.011-.102	4-82	5
C 6844	Co	1105	17	.017-.044	12-41	1
C 6842	Co	1265	0	.041	40	1
C 6839	Cl	1406	0	.203	91	3
C 6841	Cl	1591	250	......	....	0
C 6840	Cl	1620	186	......	....	2

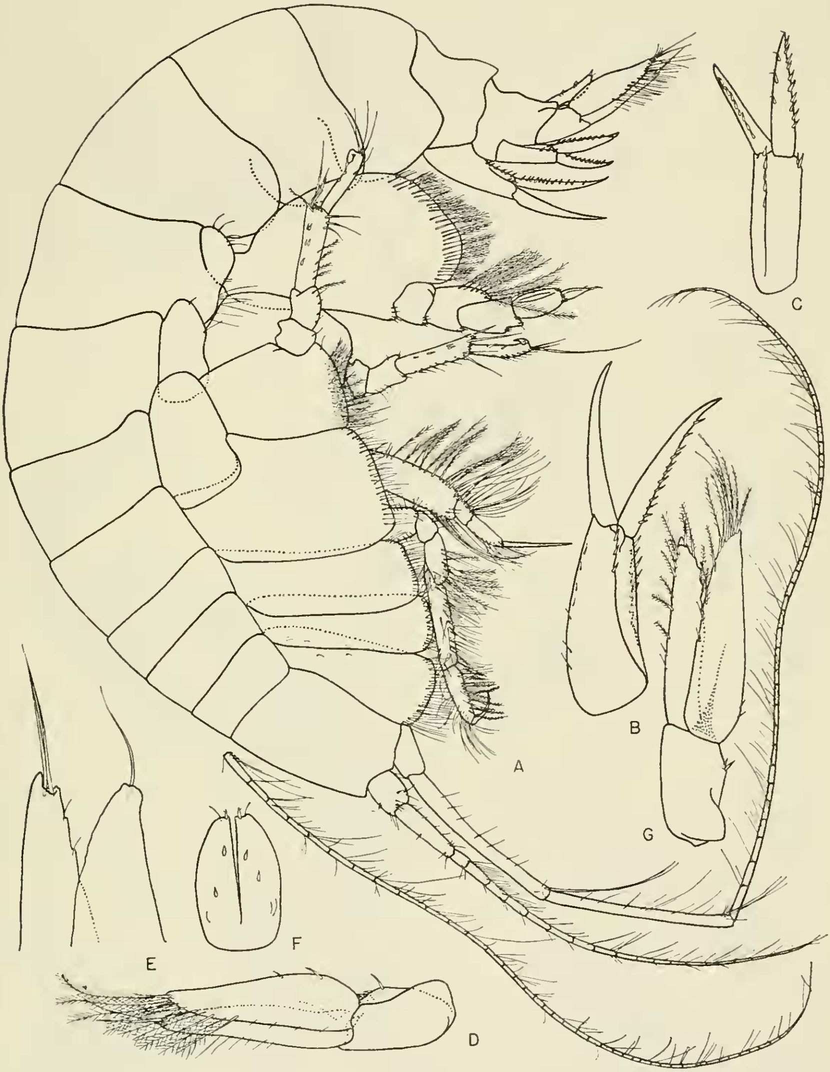

Figure 1

Ampelisca romigi ciego, new subspecies. Female, 9.5 mm, sta. 6833: A, lateral view; B,C,D, uropods 1, 2, 3; E, ends of rami of uropod 3; F, telson; G, uropod 3.

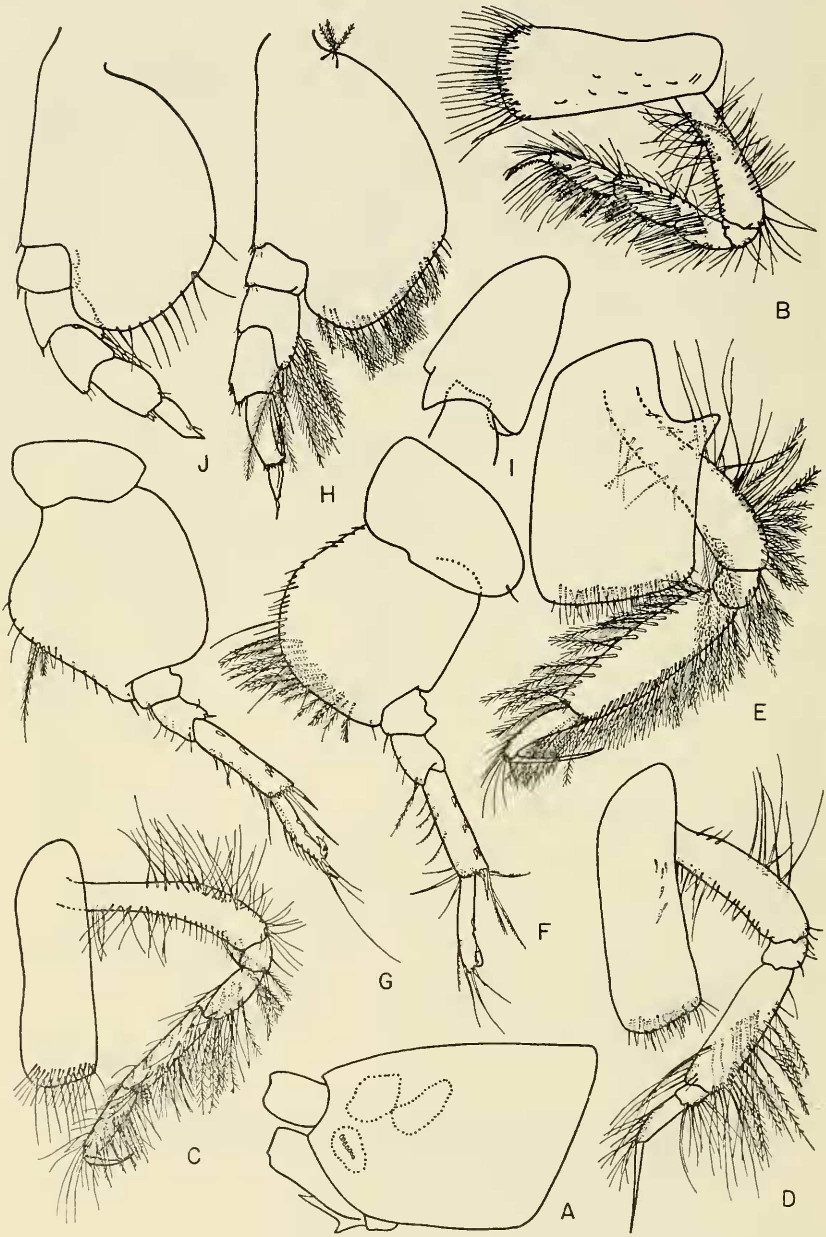

Figure 2
Ampelisca romigi ciego, new subspecies. Female, 9.5 mm, sta. 6833: A, head; B,C, gnathopods 1, 2; D,E,F,G,H, pereopods 1, 2, 3, 4, 5; I, article 5 of pereopod 5. Juvenile, 4.0 mm: J, pereopod 5.

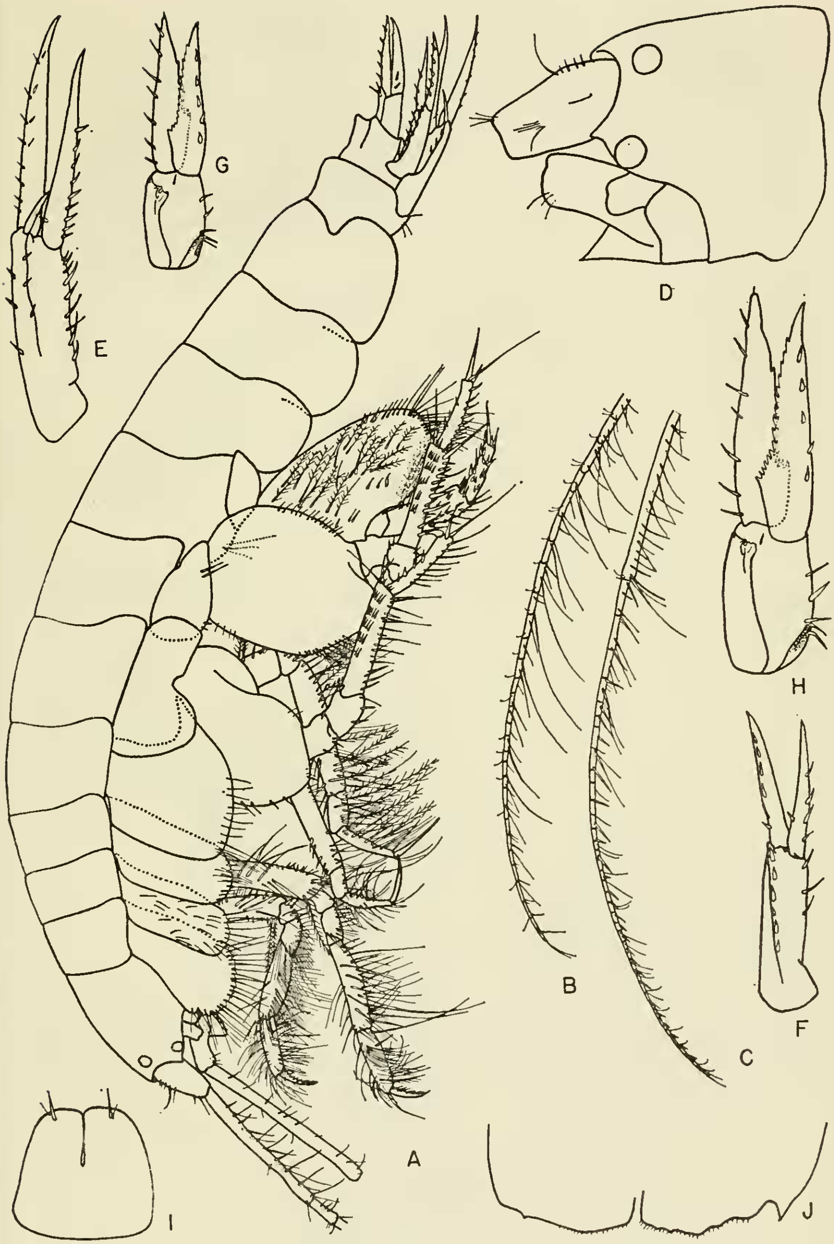

Figure 3

Byblis bathyalis, new species. Holotype, female, 9.7 mm, sta. 6836: A, lateral view; B,C, ends of antennae 1, and 2, cut from figure A; D, head; E,F,G,H, uropods 1, 2, 3, 3; I, telson; J, end of telson.

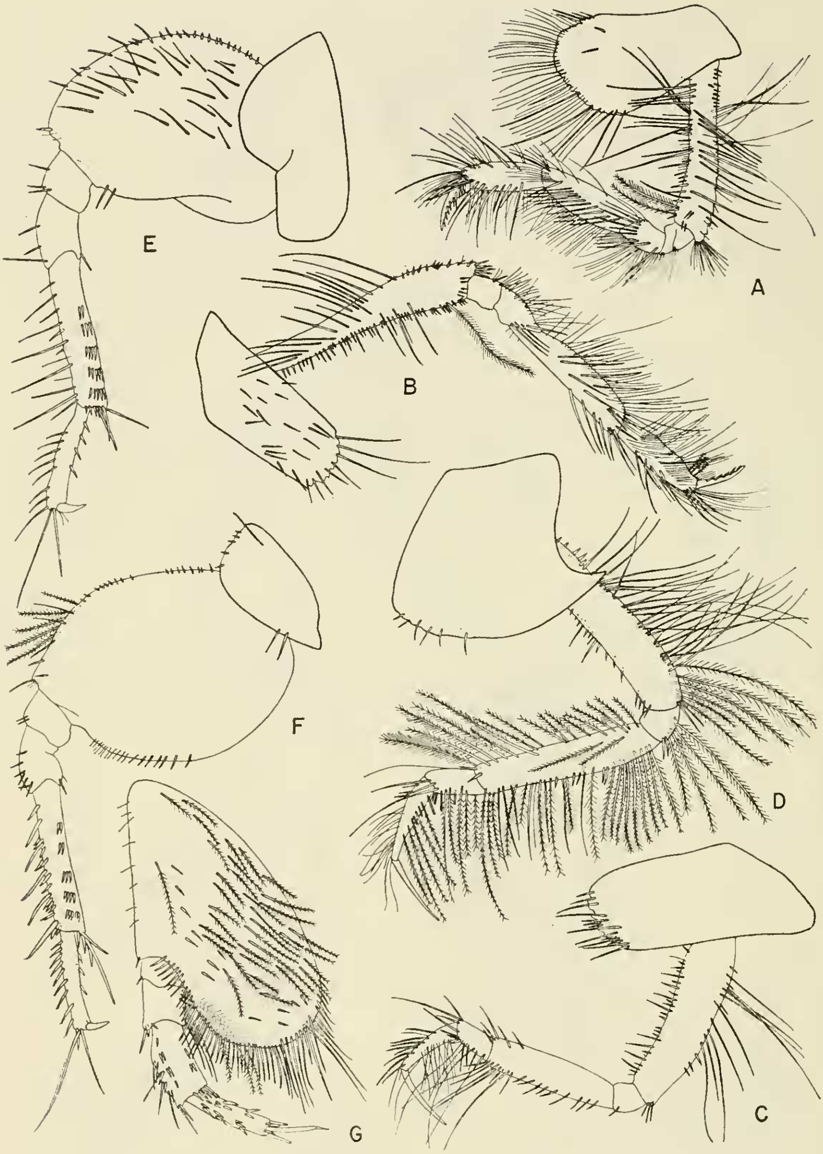

Figure 4
Byblis bathyalis, new species. Holotype, female, 9.7 mm, sta. 6836: A,B, gnathopods 1, 2,; C,D,E,F,G, pereopods 1, 2, 3, 4, 5.

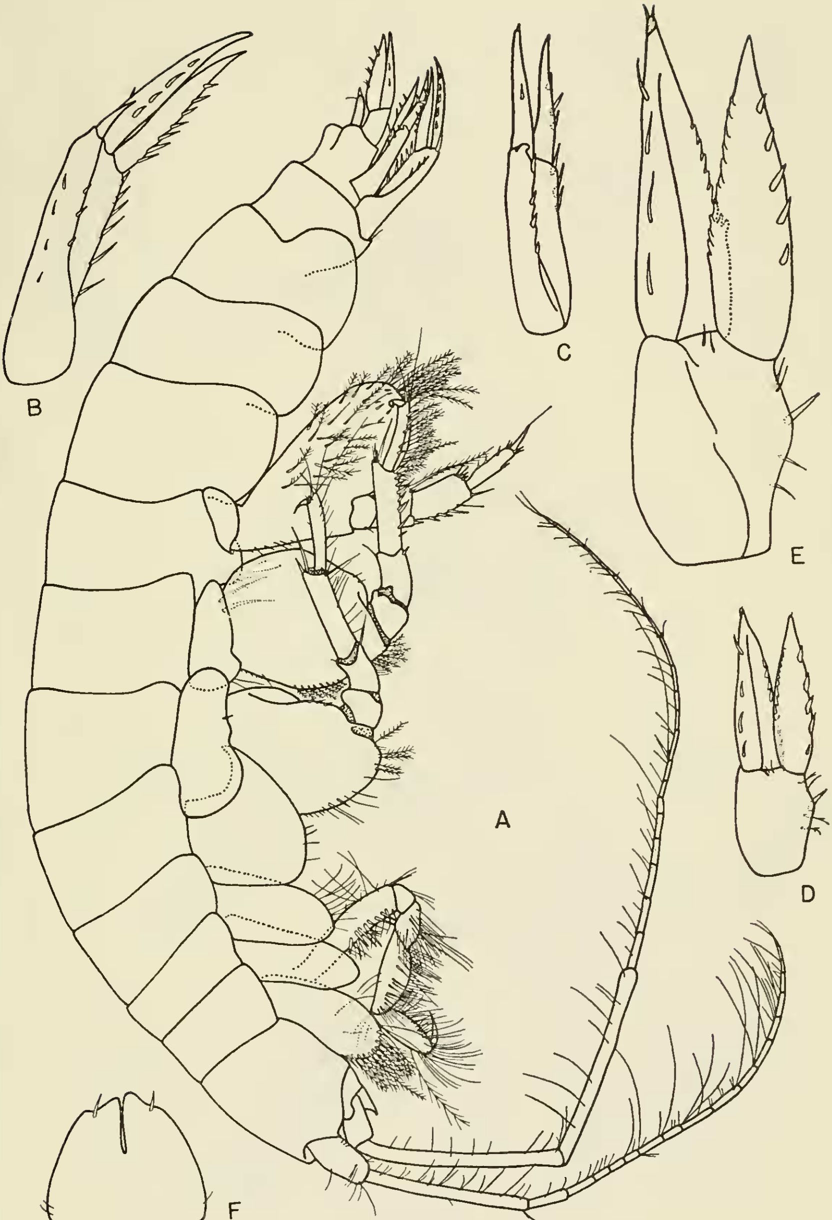

Figure 5
Byblis tannerensis, new species. Holotype, female, 9.5 mm, sta. 6833: A, lateral view; B,C,D,E, uropods 1, 2, 3, 3; F, telson.

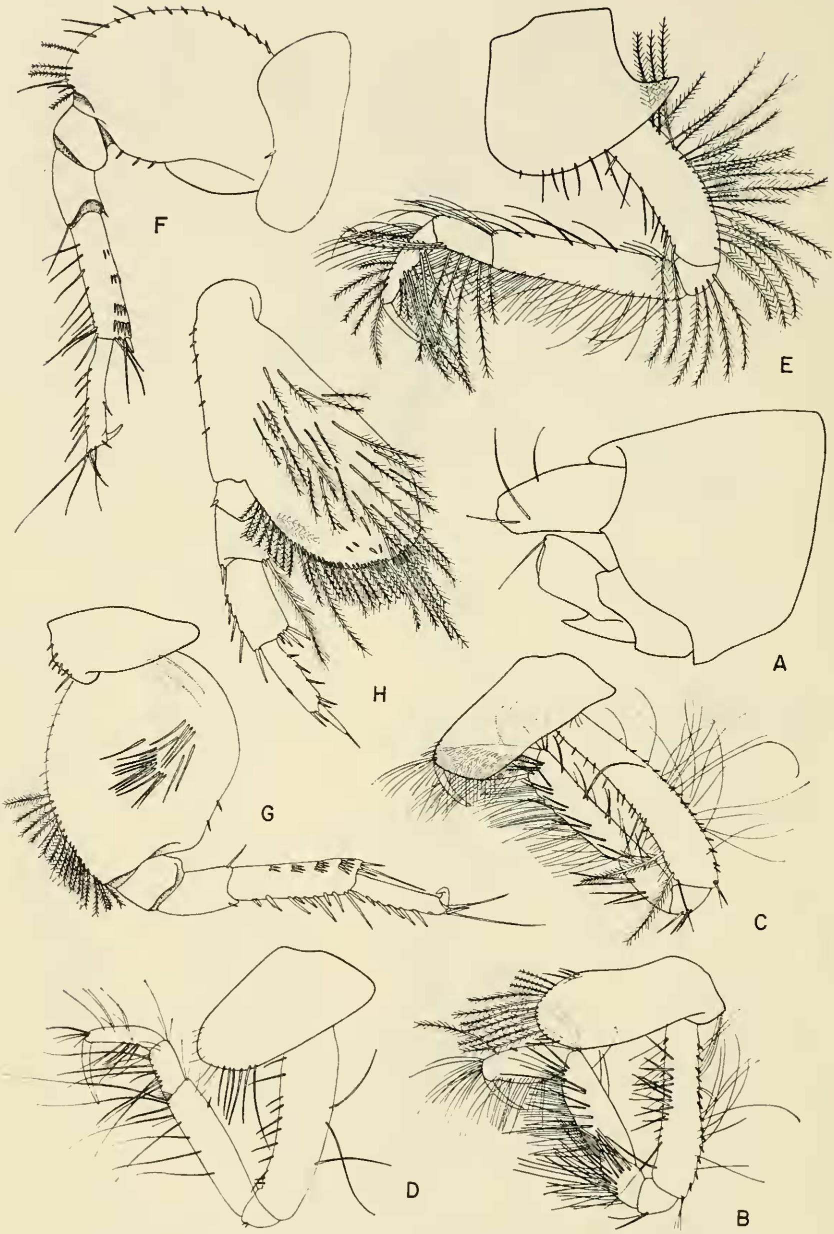

Figure 6

Byblis tannerensis, new species. Holotype, female, 9.5 mm, sta. 6833: A, head; B,C, gnathopods 1, 2; D,E,F,G,H, pereopods 1, 2, 3, 4, 5.

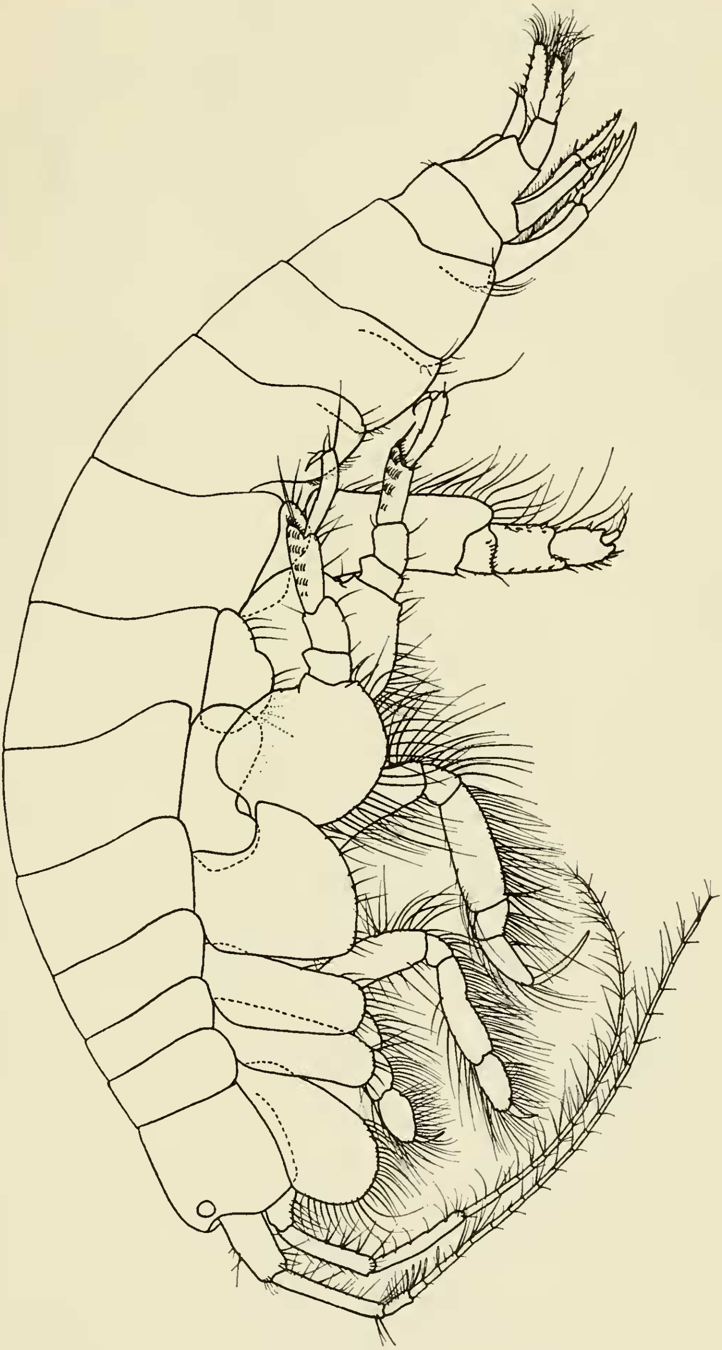

Figure 7
Haploops spinosa Shoemaker. Female, 9.0 mm, sta. 6002.

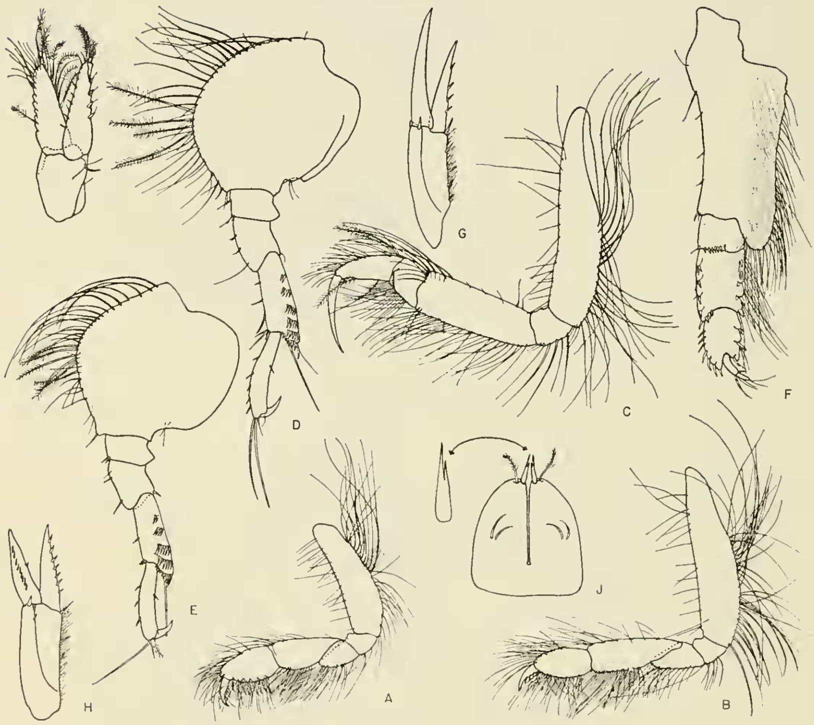

Figure 8

Haploops spinosa Shoemaker. Female, 9.0 mm, sta. 6002: A,B, gnathopods 1, 2; C,D,E,F, pereopods 2, 3, 4, 5; G,H,I, uropods 1, 2, 3; J, telson.

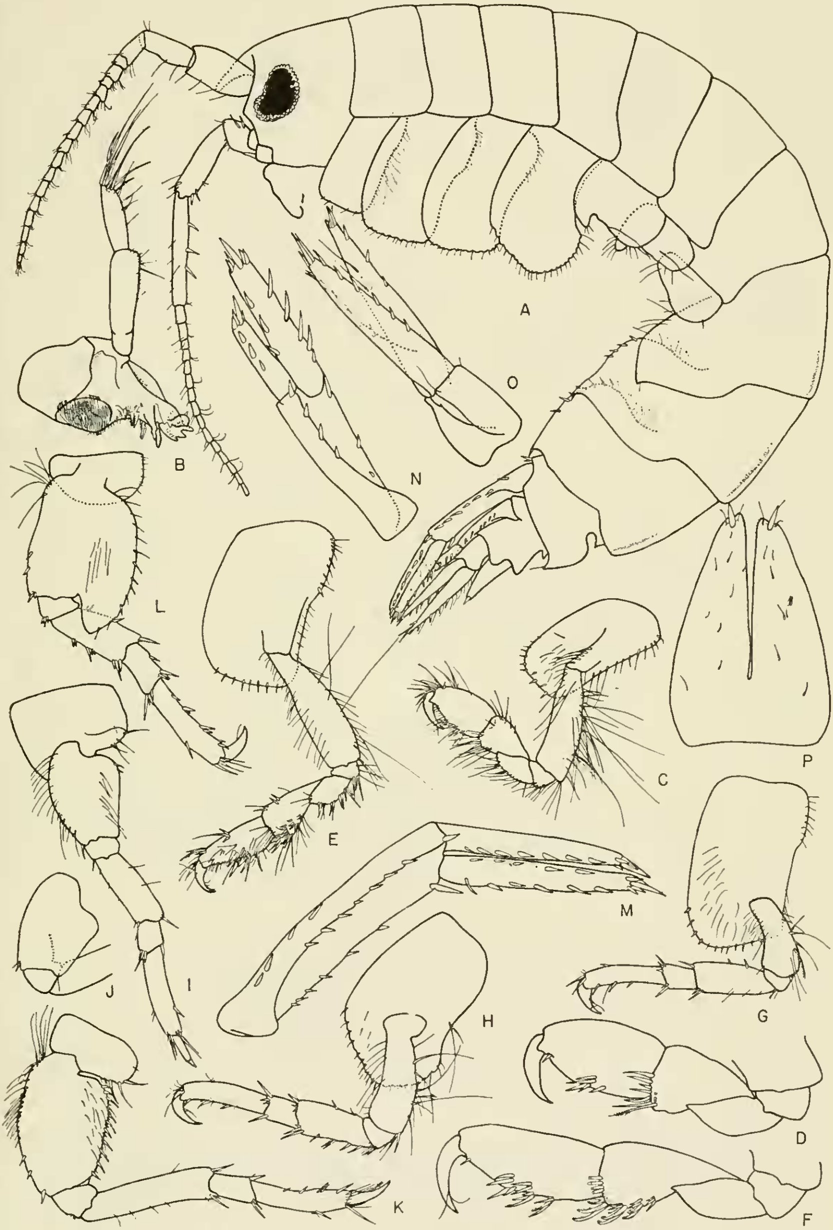

Figure 9

Atylus tridens (Alderman). Female, 6.0 mm, sta. 7043: A, lateral view, less legs; B, mandible; C,D, gnathopod 1 medial views; E,F, gnathopod 2, medial views; G,H,I,K,L, pereopods 1, 2, 3, 4, 5; J, pereopod 3 of other side of animal; M,N,O, uropods 1 2, 3; P, telson.

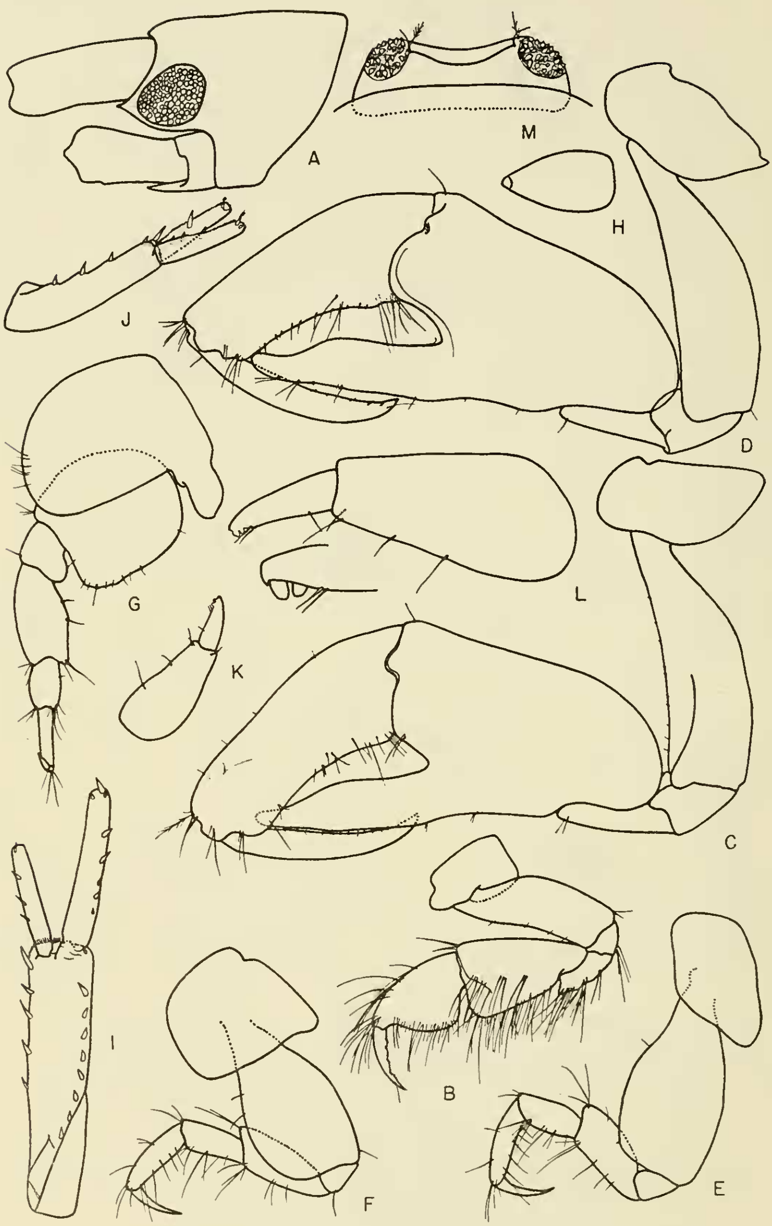

Figure 10
Ericthonius ?difformis Milne Edwards. Male, 7.5 mm, sta. 6909: A, head; B, gnathopod 1; C,D, gnathopod 2; E,F,G, pereopods 1, 2, 3; H, scale of telson; I,J,K,L, uropods 1, 2, 3, 3; M, telson.

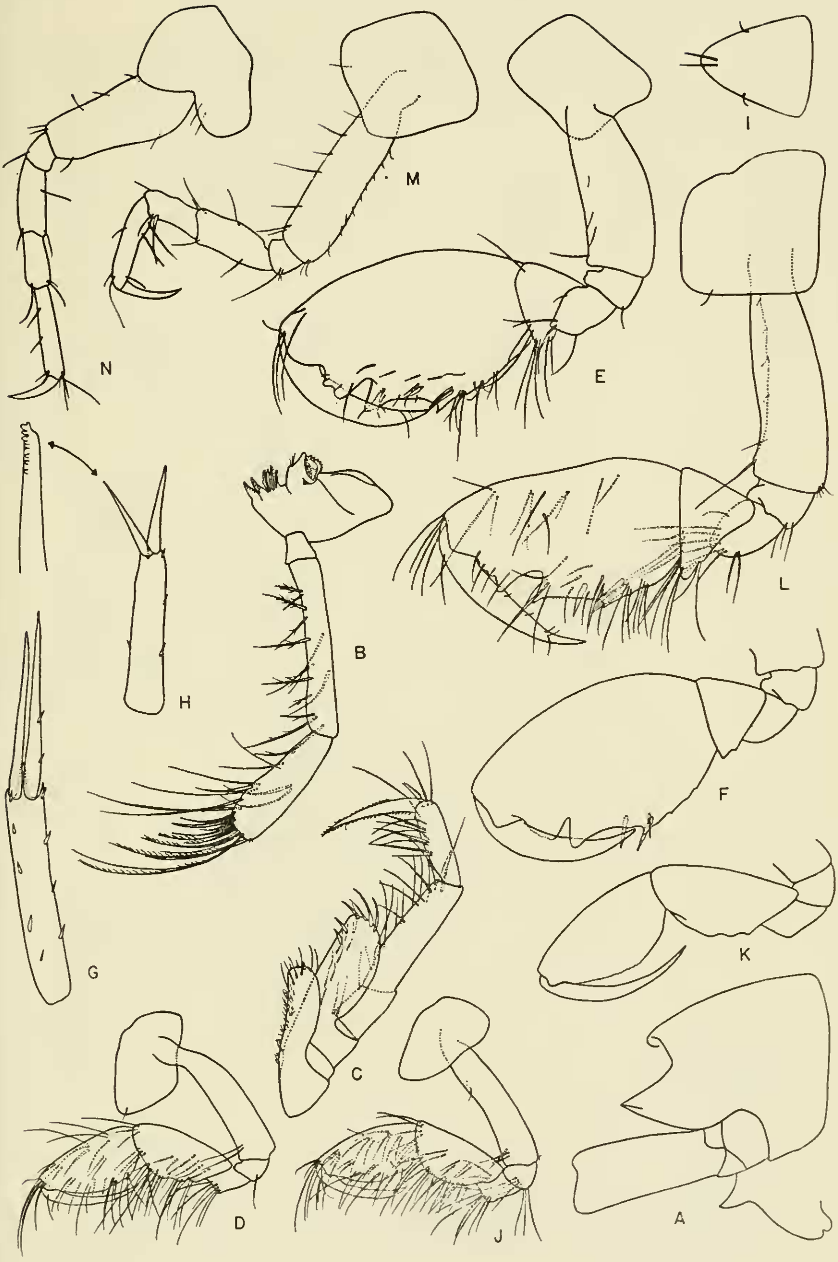

Figure 11

Bonnierella linearis californica, new subspecies. Holotype, male, 3.0 mm, sta. 6348: A, head and epistome-upper lip complex; B, mandible; C, maxilliped; D, gnathopod 1; E,F, gnathopod 2, medial and lateral views; G, uropod 1; H, uropod 3, with enlargement of outer ramus; I, telson. Female, 2.75 mm, sta. 6839: J,K, gnathopod 1; L, gnathopod 2; M,N, pereopods 1, 3.

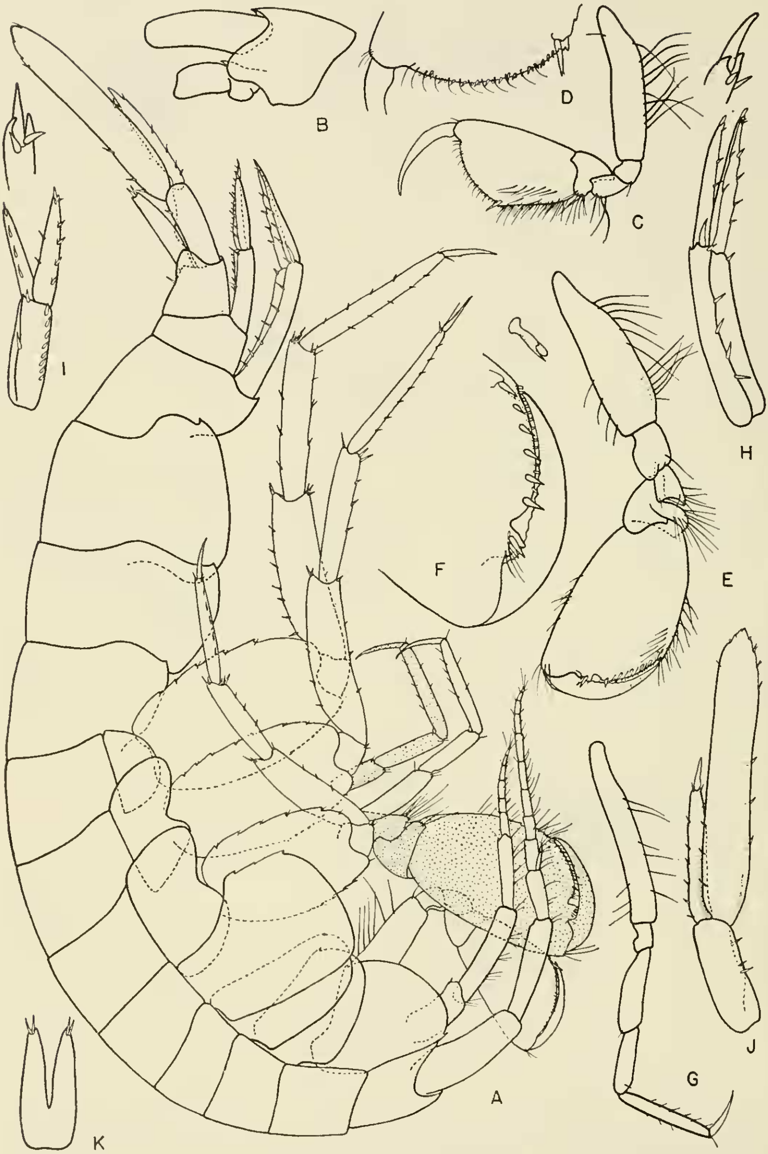

Figure 12

Listriella albina J. L. Barnard. Male, 5.4 mm, sta. 7288: A, lateral view; B, head; C,D, gnathopod 1; E,F, gnathopod 2; G, pereopod 1; H,I,J, uropods 1, 2, 3; K, telson.

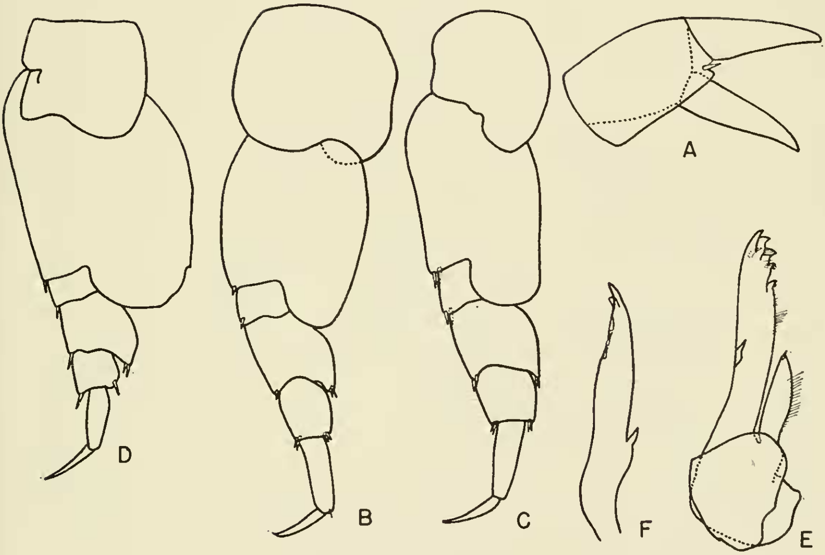

Figure 13
Acidostoma hancocki Hurley. Juvenile, 1.8 mm, sta. 6837: A, uropod 2; B,C,D, pereopods 3, 4, 5; E,F, maxilla 1.

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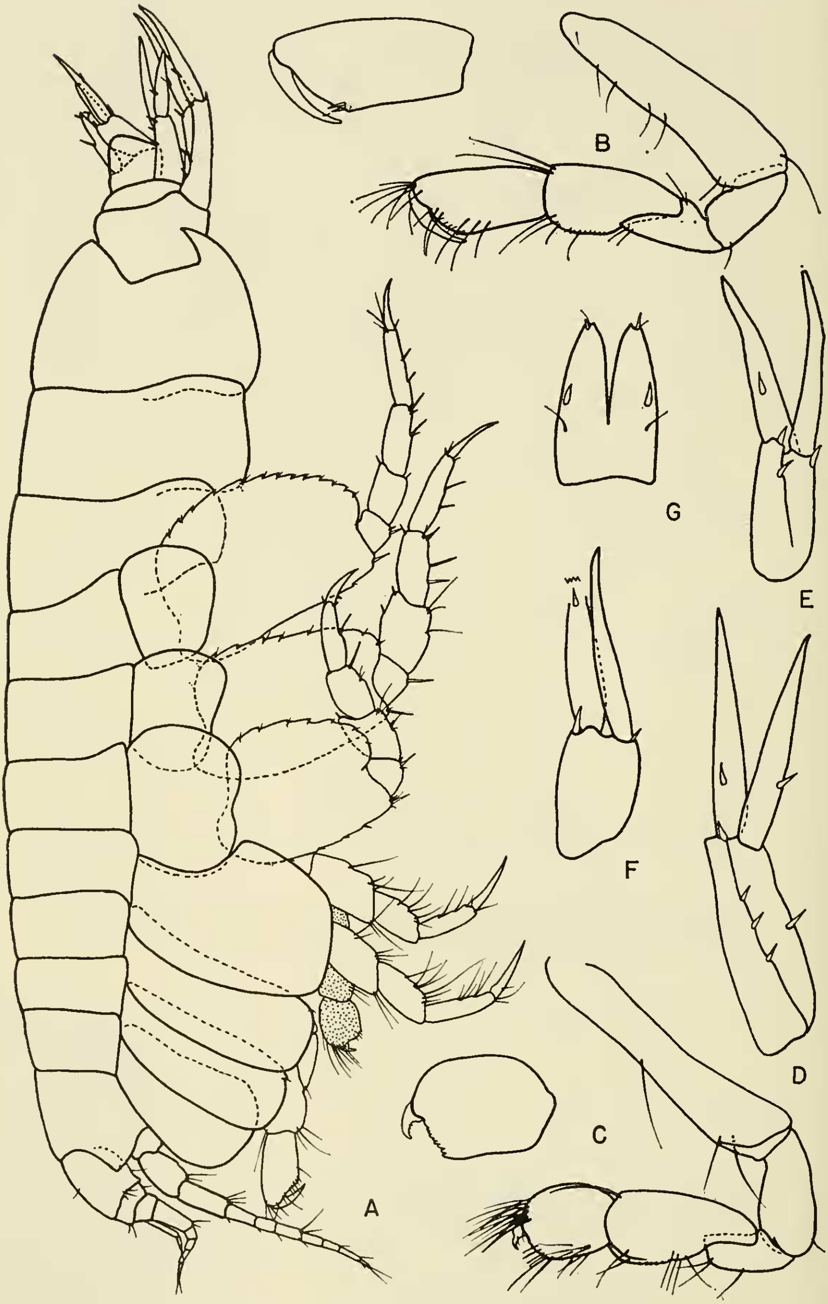

Figure 14
Hippomedon tenax, new species. Male, 4.0 mm, sta. 5828: A, lateral view; B,C, gnathopods 1, 2; D,E,F, uropods 1, 2, 3; G, telson.

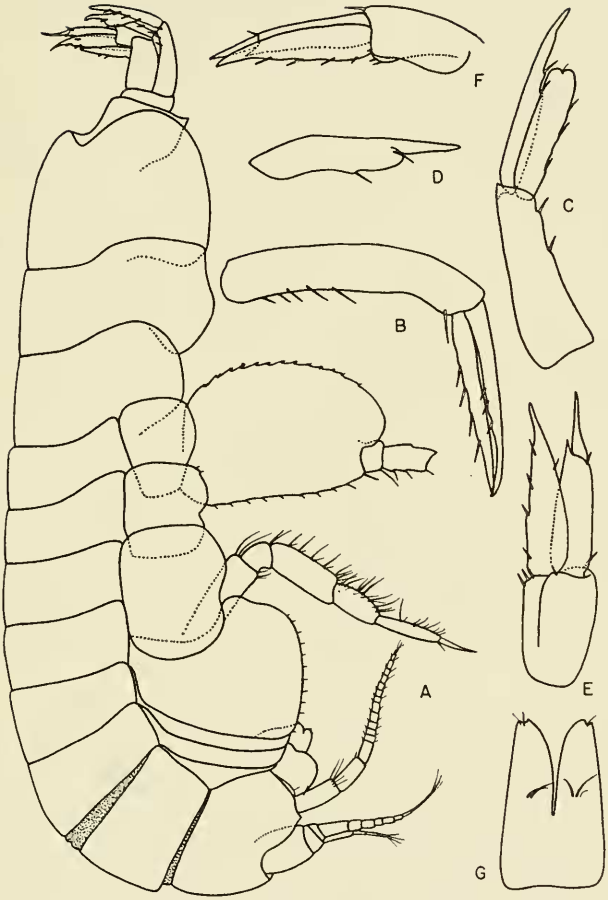

Figure 15

Hirondellea fidenter, new species. Male, 4.7 mm, sta. 6336: A, lateral view minus uropod 1; B,C, uropods 1, 2; D, inner ramus of uropod 2; E,F, uropod 3; G, telson.

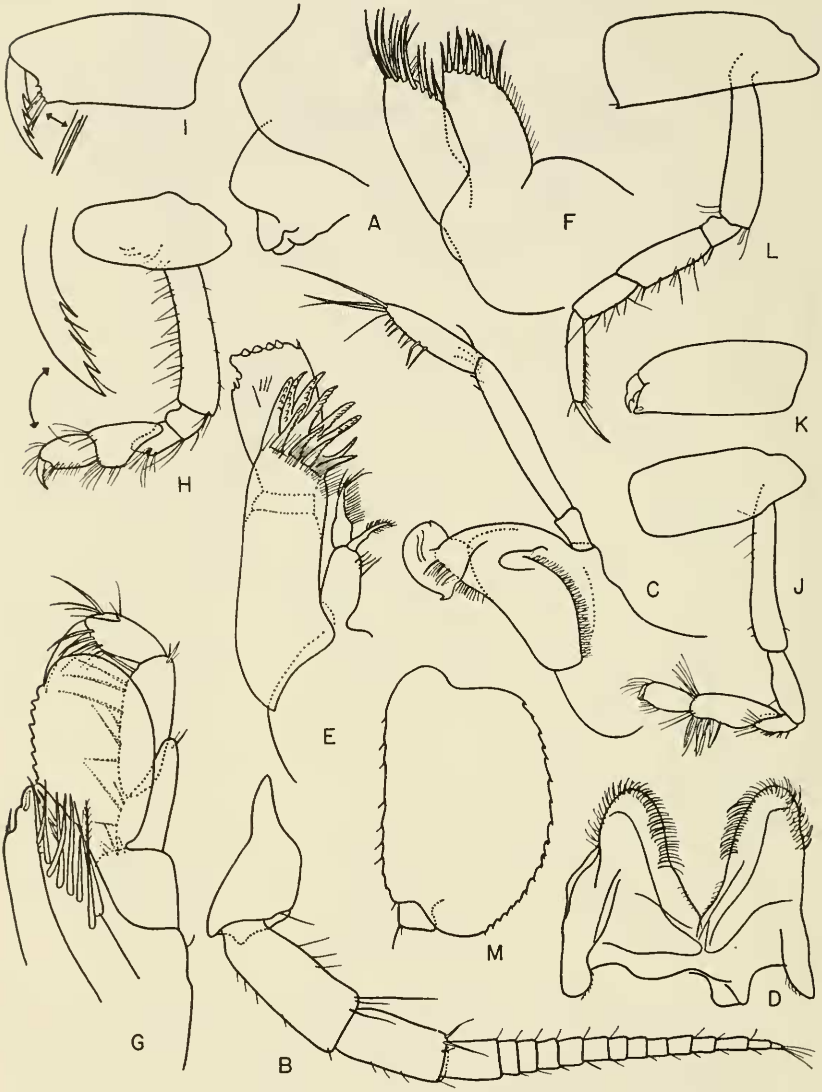

Figure 16

Hirondellea fidenter, new species. Male, 4.7 mm, sta. 6336: A, front of head and epistome-upper lip complex; B, antenna 2; C, mandible; D, lower lip; E,F, maxillae 1, 2; G, maxilliped; H,I, gnathopod 1; J,K, gnathopod 2; L,M, pereopods 1, 4.

Figure 17

Lepidepecreella charno, new species. Holotype, female, 4.5 mm, sta. 6091; A, lateral view; B, head with epistome-upper lip complex shaded; C,D, antenna 1; E, antenna 2; F, lower lip; G,H, maxilla 1; I, maxilla 2; J, maxilliped; K, gnathopod 1; L, gnathopod 2; M,N,O,P,Q, pereopods 1, 2, 3, 4, 5; R,S,T, uropods 1, 2, 3; U, telson; V, mandible.

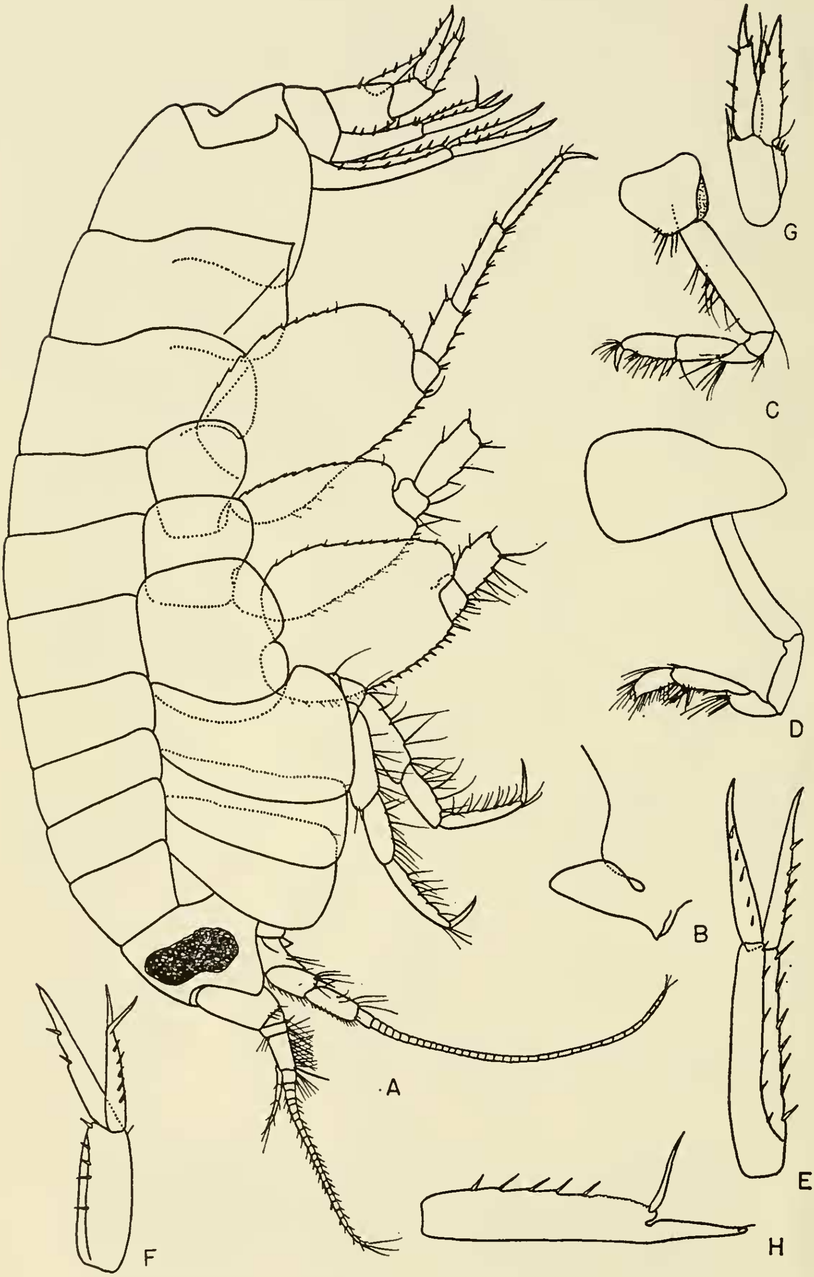

Figure 18
Schisturella cocula, new species. Holotype, male, 6.7 mm, sta. 5996: A, lateral view; B, upper lip and epistome complex; C,D, gnathopods 1, 2; E,F,G, uropods 1, 2, 3; H, inner ramus of uropod 2.

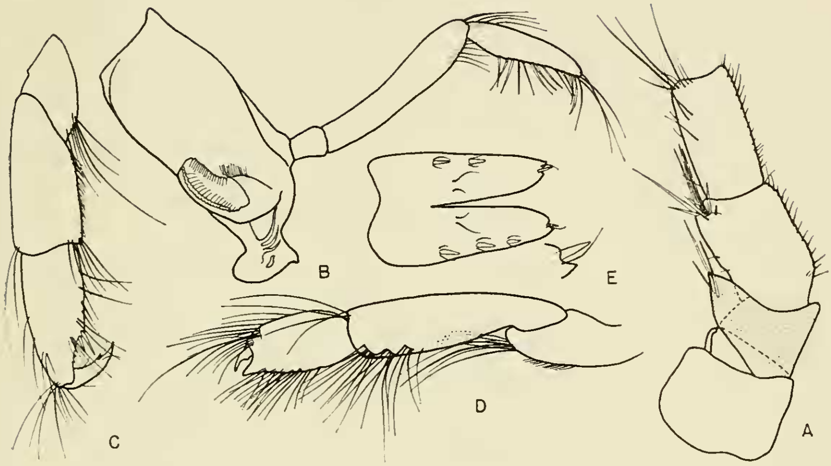

Figure 19

Schisturella cocula, new species. Holotype, male, 6.7 mm, sta. 5996: A, base of antenna 2; B, mandible; C,D, ends of gnathopods 1, 2; E, telson.

Figure 20

Schisturella zopa, new species. Holotype, 2.9 mm, sta. 2847: A, lateral view; B, head and epistome-upper lip complex; C,D, antennae 1, 2; E, mandible; F, maxilla 1; G, inner plate of maxilla 1; H, maxilla 2; I, maxilliped; J,K,L, gnathopod 1; M,N, gnathopod 2; O, pereopod 1; P,Q,R, uropods 1, 2, 3; S, inner ramus of uropod 2; T, telson.

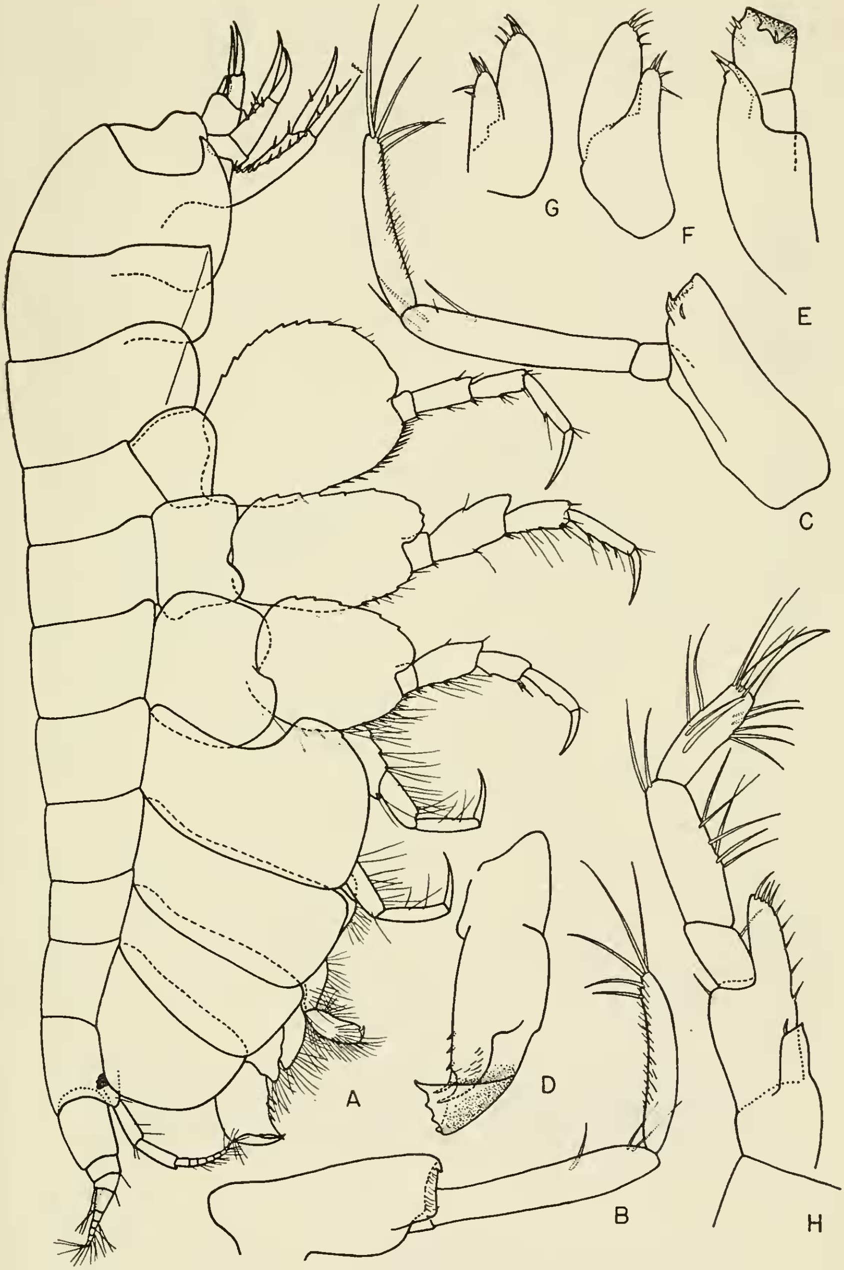

Figure 21

Sophrosyne robertsoni Stebbing and Robertson. Female, 8.0 mm, station 6832: A, lateral view; B,C, mandibles; D,E, first maxillae; F,G, second maxillae; H, maxilliped.

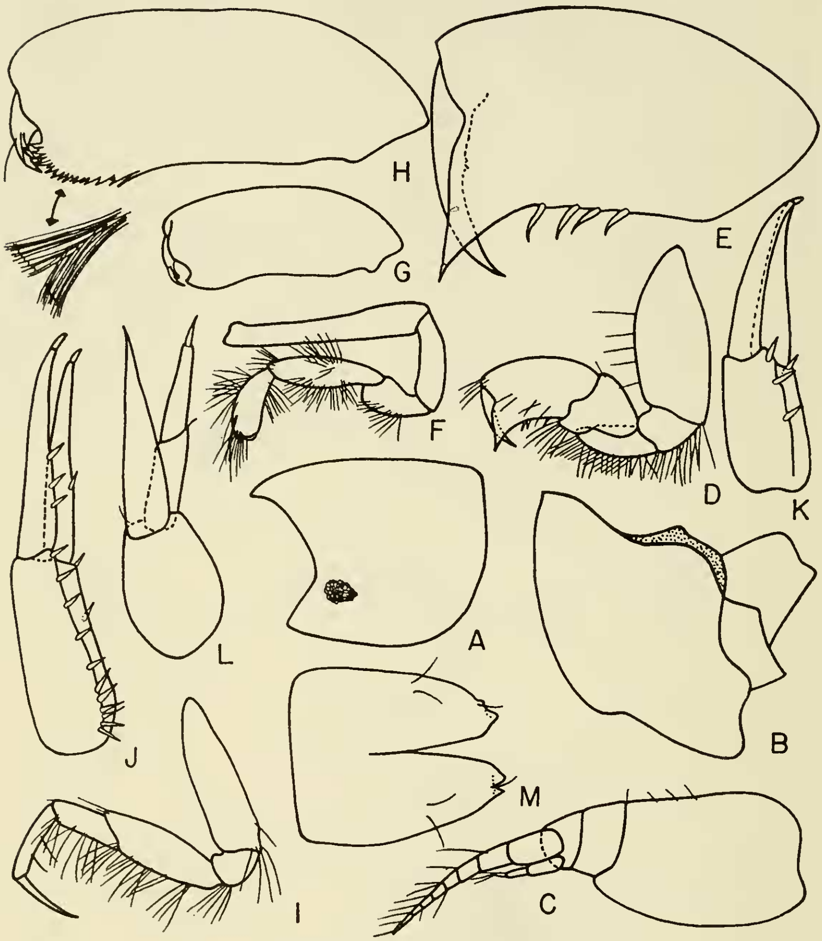

Figure 22

Sophrosyne robertsoni Stebbing and Robertson. Female, 8.0 mm, sta. 6832: A, head; B, urosome (pleonal segments 4, 5, 6); C, antenna 1; D,E, gnathopod 1; F,G,H, gnathopod 2; I, pereopod 1; J,K,L, uropods 1, 2, 3; M, telson.

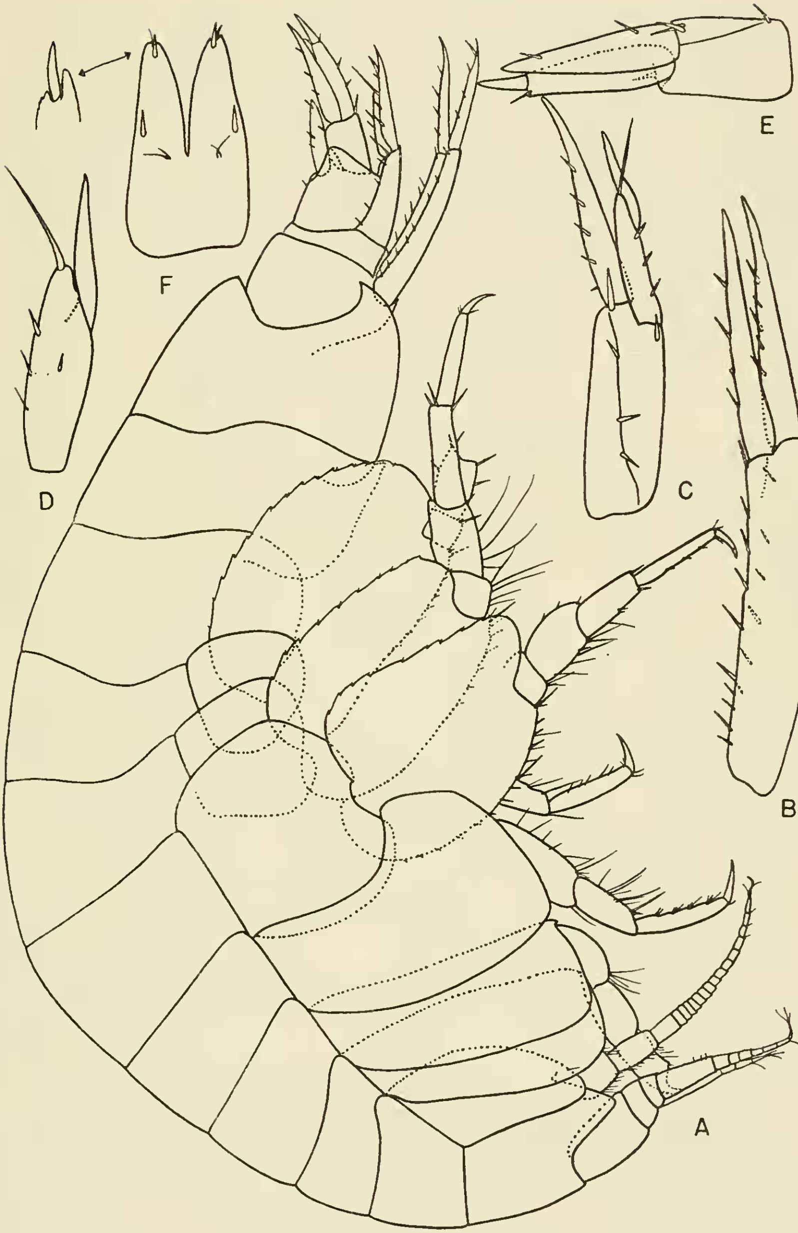

Figure 23

Thrombasia tracalero, new genus, new species. Holotype, male, 4.5 mm, sta. 2789: A, lateral view; B,C, uropods 1, 2; D, inner ramus of uropod 2; E, uropod 3; F, telson.

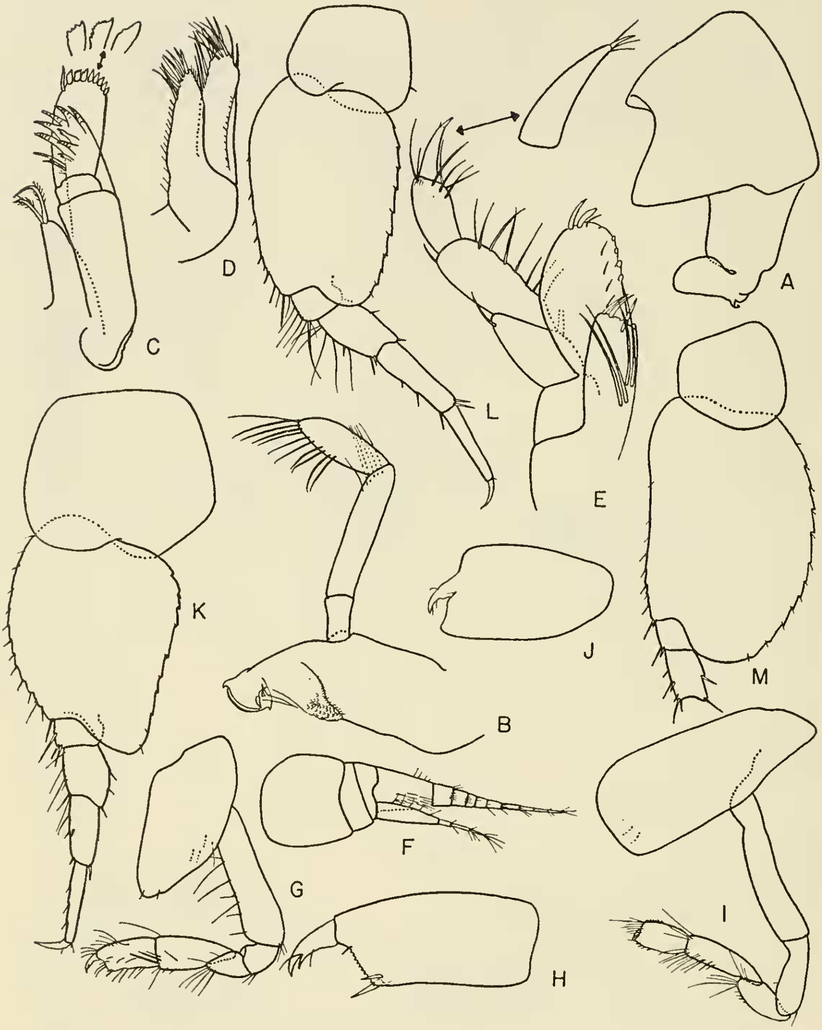

Figure 24

Thrombasia tracalero, new genus, new species. Holotype, male, 4.5 mm, sta. 2789: A, head and epistome-upper lip complex; B, mandible; C,D, maxillae 1, 2; E, maxilliped; F, antenna 1; G,H, gnathopod 1; I,J, gnathopod 2; K,L,M, pereopods 3, 4, 5.

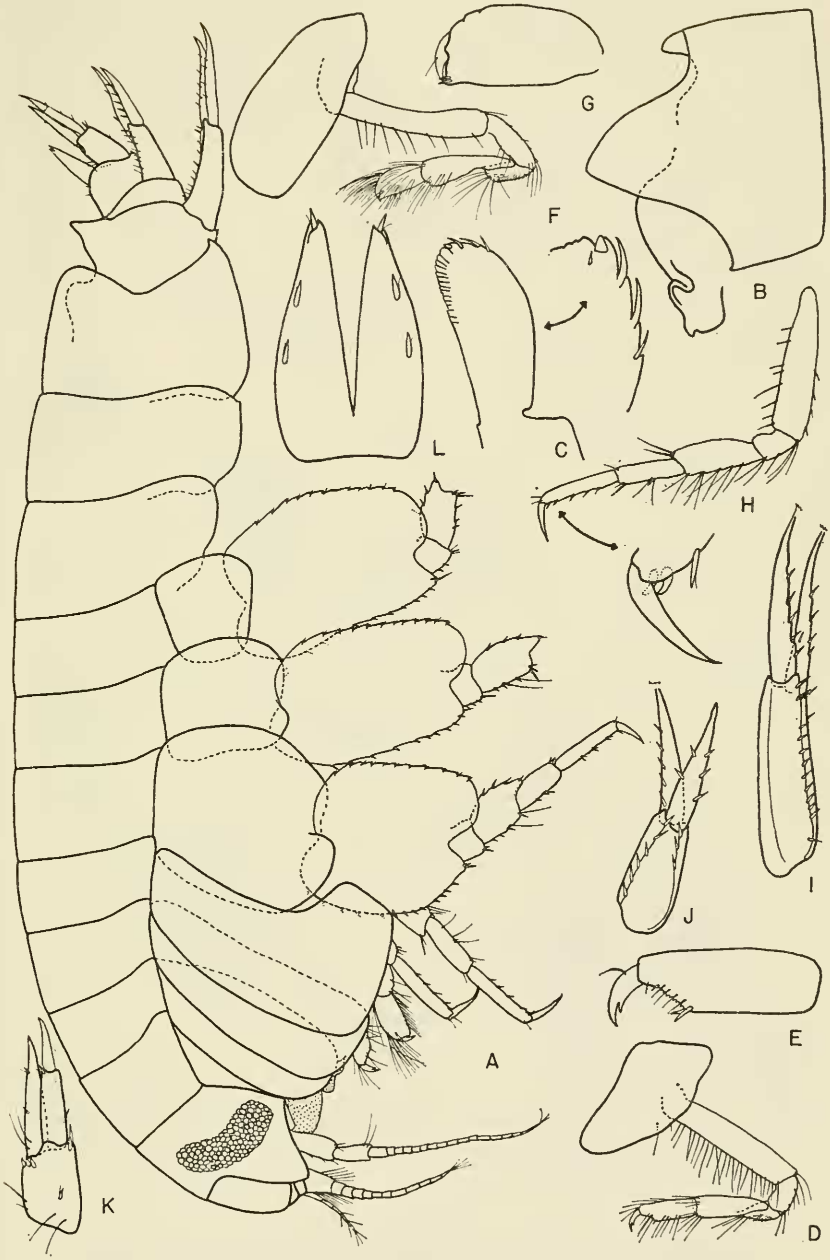

Figure 25

Tryphosa index, new species. Male, 6.5 mm, sta. 6840: A, lateral view; B, head and epistome-upper lip complex; C, outer plate of maxilliped; D,E, gnathopod 1; F,G, gnathopod 2; H, pereopod 2; I,J,K, uropods 1, 2, 3; L, telson.

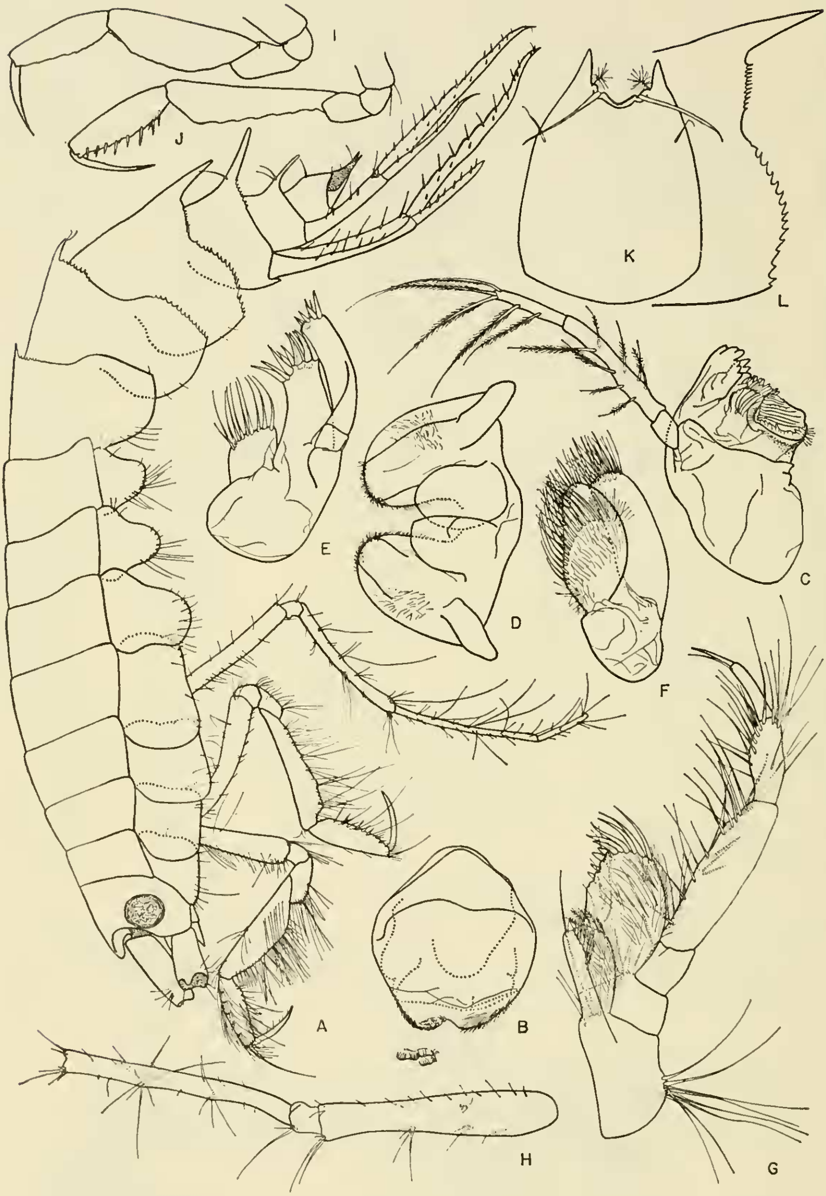

Figure 26

Melphidippa (?) *amorita*, new species. Holotype, female, 6.4 mm, sta. 6836: A, lateral view; B, upper lip; C, mandible; D, lower lip; E,F, maxillae 1, 2; G, maxilliped; H, pereopod 4, right side; I,J, gnathopods 1, 2; K, telson; L, enlargement of third pleonal epimeron.

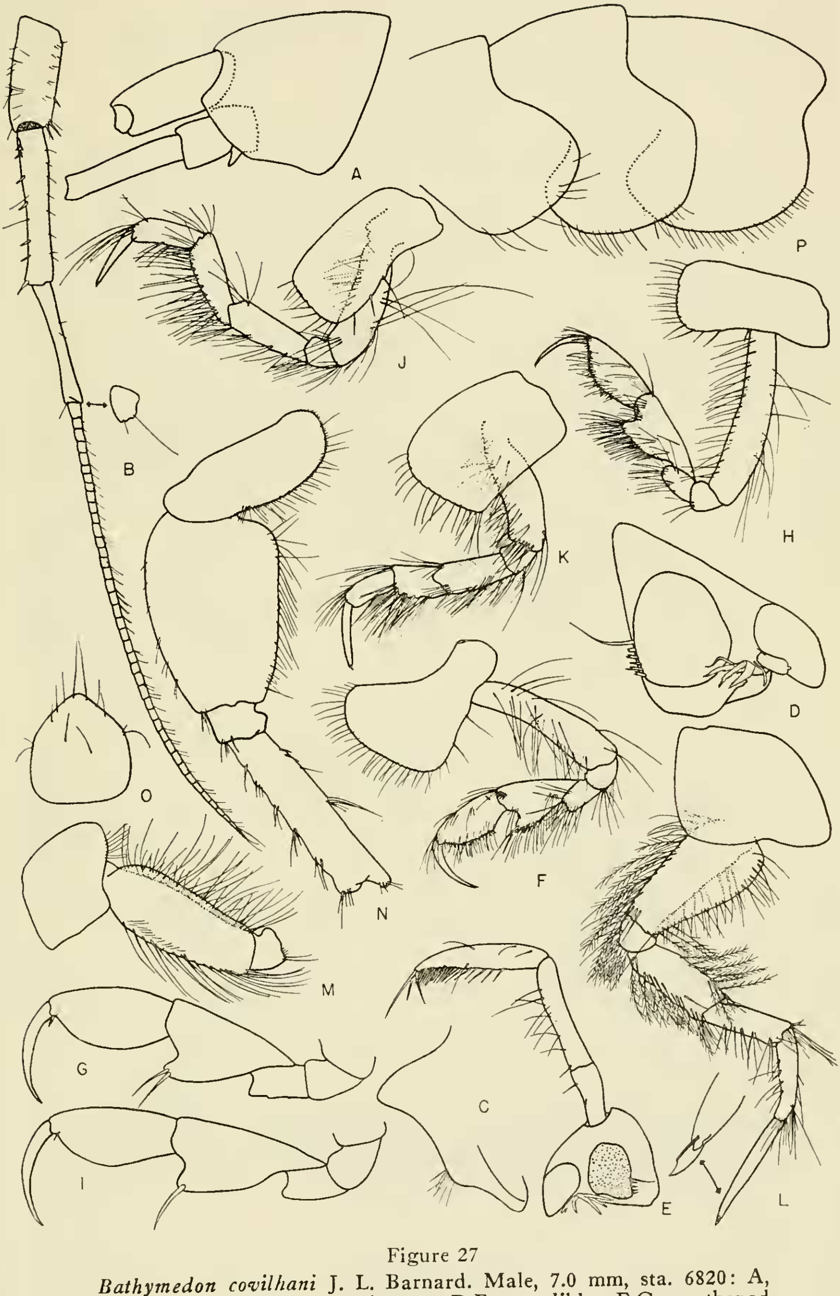

Figure 27

Bathymedon covilhani J. L. Barnard. Male, 7.0 mm, sta. 6820: A, head; B, antenna 1; C, epistome; D,E, mandible; F,G, gnathopod 1; H,I, gnathopod 2; J,K,L,M,N, pereopods 1, 2, 3, 4, 5; O, telson; P, metasome.

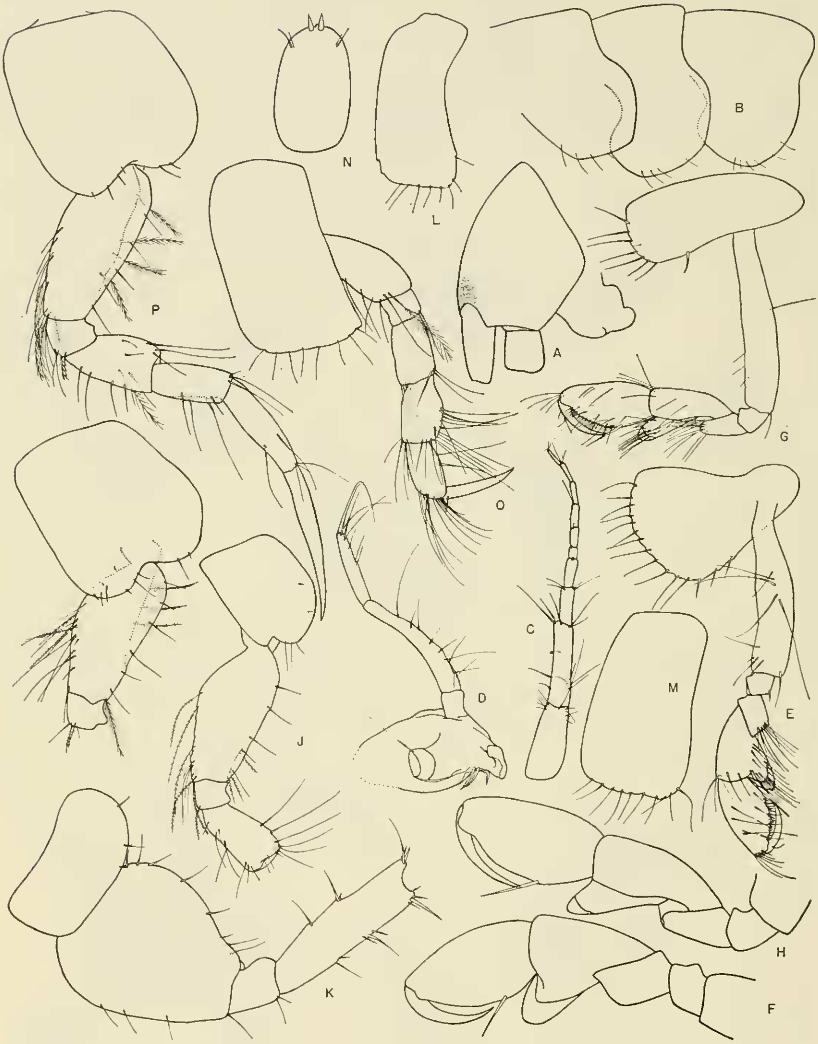

Figure 28

Bathymedon kassites, new species. Holotype, female, 3.2 mm, sta. 6494: A, head and epistome; B, metasome; C, antenna 1; D, mandible; E,F, gnathopod 1; G,H, gnathopod 2; I,J,K, pereopods 3, 4, 5; L,M, coxae 3, 4; N, telson. Female, 3.0 mm: O,P, pereopods 1, 3.

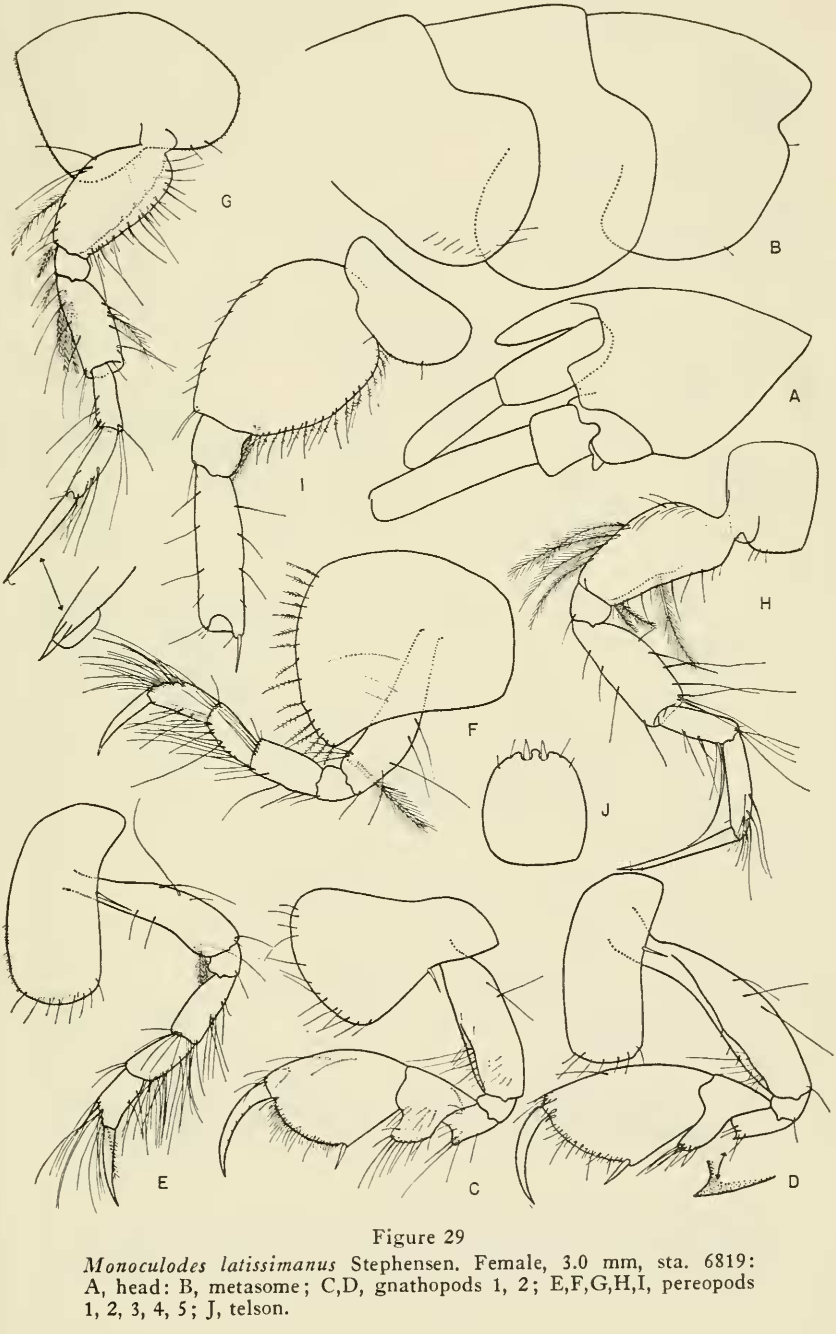

Figure 29

Monoculodes latissimanus Stephensen. Female, 3.0 mm, sta. 6819: A, head: B, metasome; C,D, gnathopods 1, 2; E,F,G,H,I, pereopods 1, 2, 3, 4, 5; J, telson.

Figure 30

Monoculodes perditus, new species. Holotype, male, 2.7 mm, sta. 6845: A, head; B, gnathopod 1. Male, 2.9 mm, sta. 6845: C, head; D, metasome; E, gnathopod 1; F,G, gnathopod 2; H, antenna 1; I,J,K,L, pereopods 1, 3, 4, 5; M, telson.

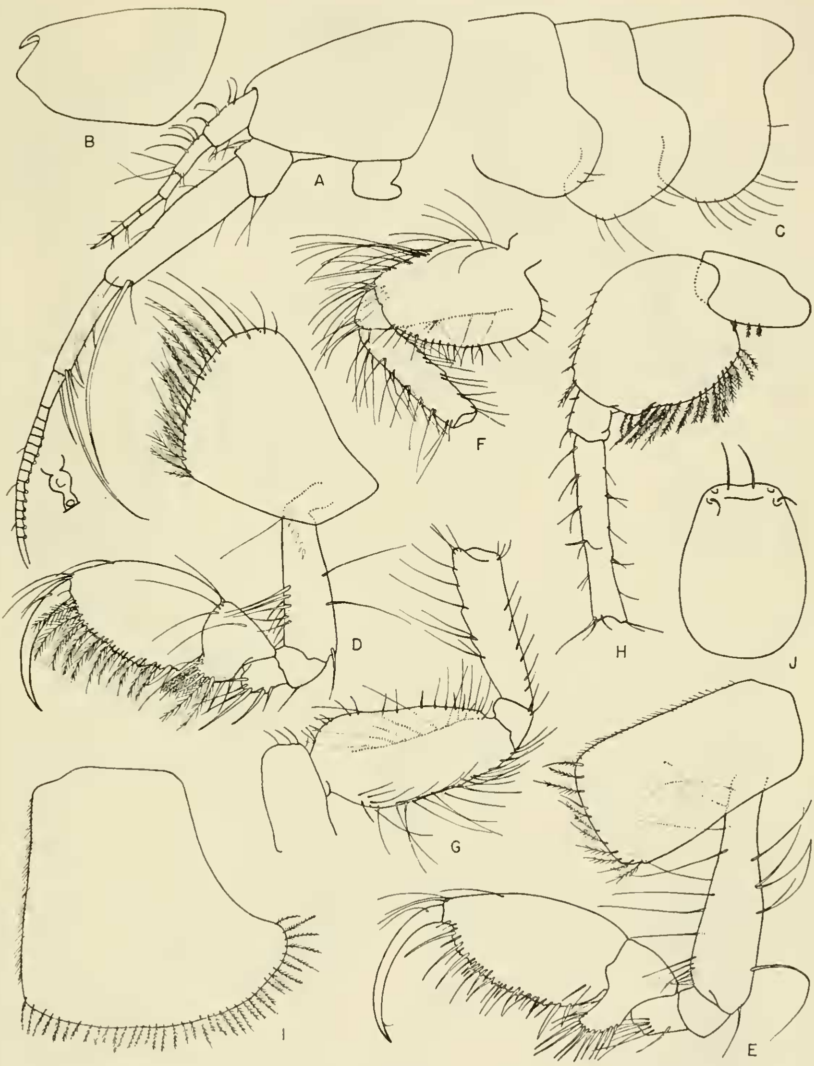

Figure 31
Oediceropsis (Paroediceroides) elsula, new species. Holotype, female, 3.6 mm, sta. 6837: A,B, head; C, metasome; D,E, gnathopods 1, 2; F,G,H, pereopods 3, 4, 5; I, coxa 4; J, telson.

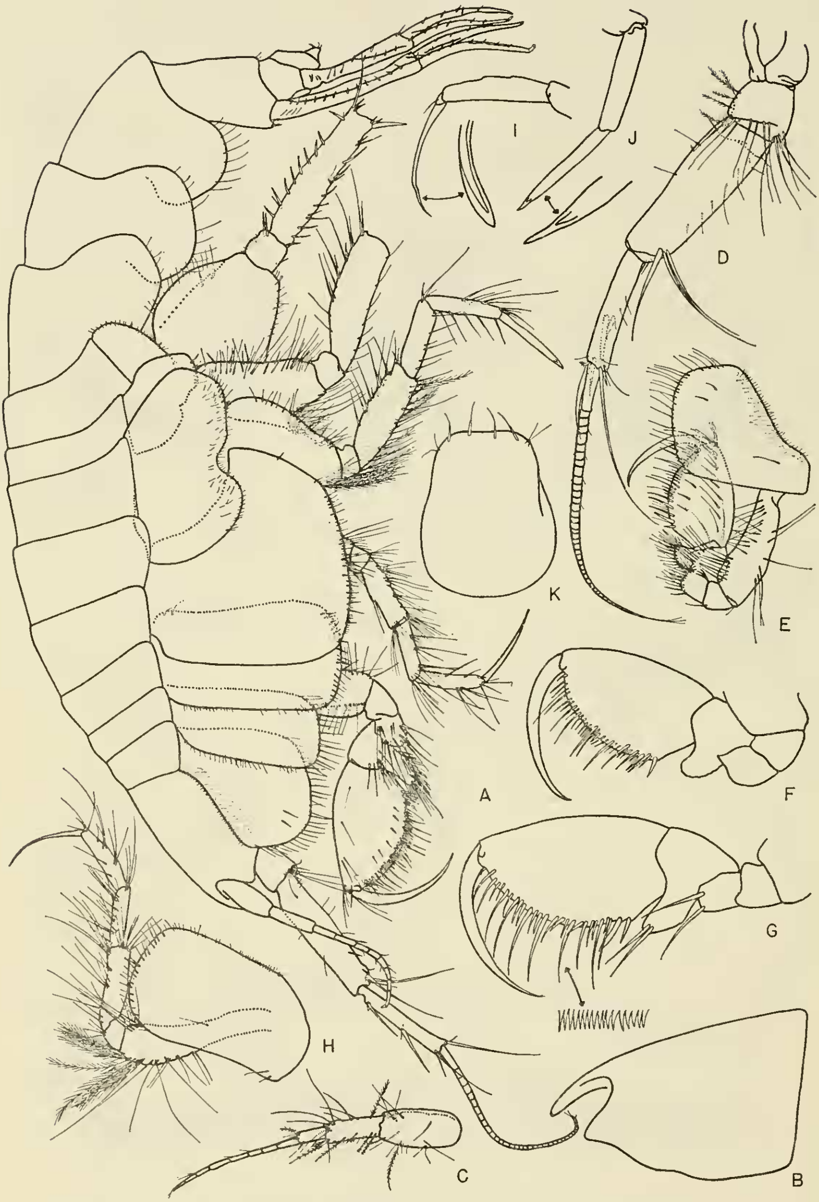

Figure 32

Oediceropsis (Paroediceroides) morosa, new species. Holotype, female, 5.5 mm, sta. 6833: A, lateral view; B, head; C,D, antennae 1, 2; E,F, gnathopod 1; G, gnathopod 2; H, pereopod 1; I, J, ends of pereopods 1, 3; K, telson.

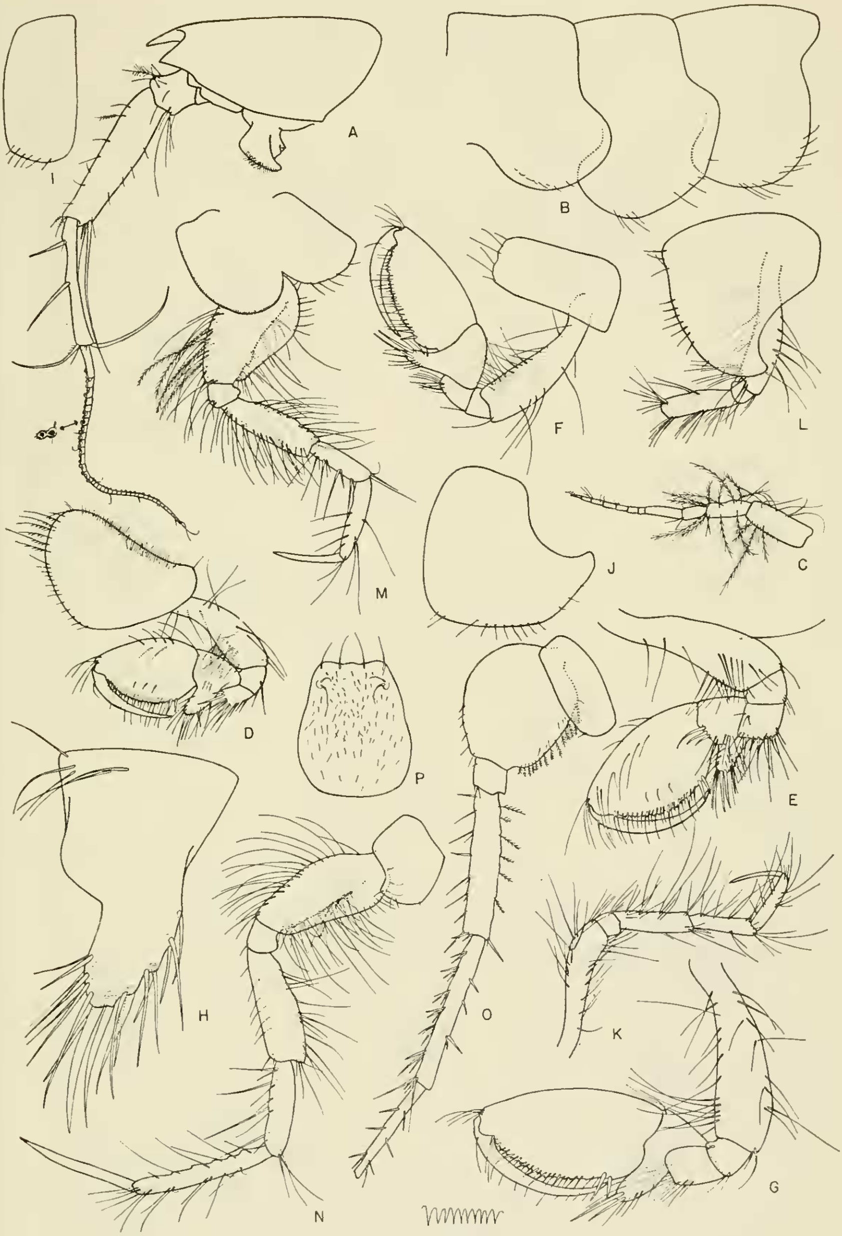

Figure 33

Oediceropsis (Paroediceroides) trepadora J. L. Barnard. Male, 5.0 mm, sta. 6839: A, head; B, metasome; C, antenna 1; D,E, gnathopod 1, lateral and medial views; F,G, gnathopod 2, lateral views; H, article 5 of gnathopod 1, lateral view; I,J, coxae 3, 4; K,L,M,N,O, pereopods 1, 2, 3, 4, 5; P, telson.

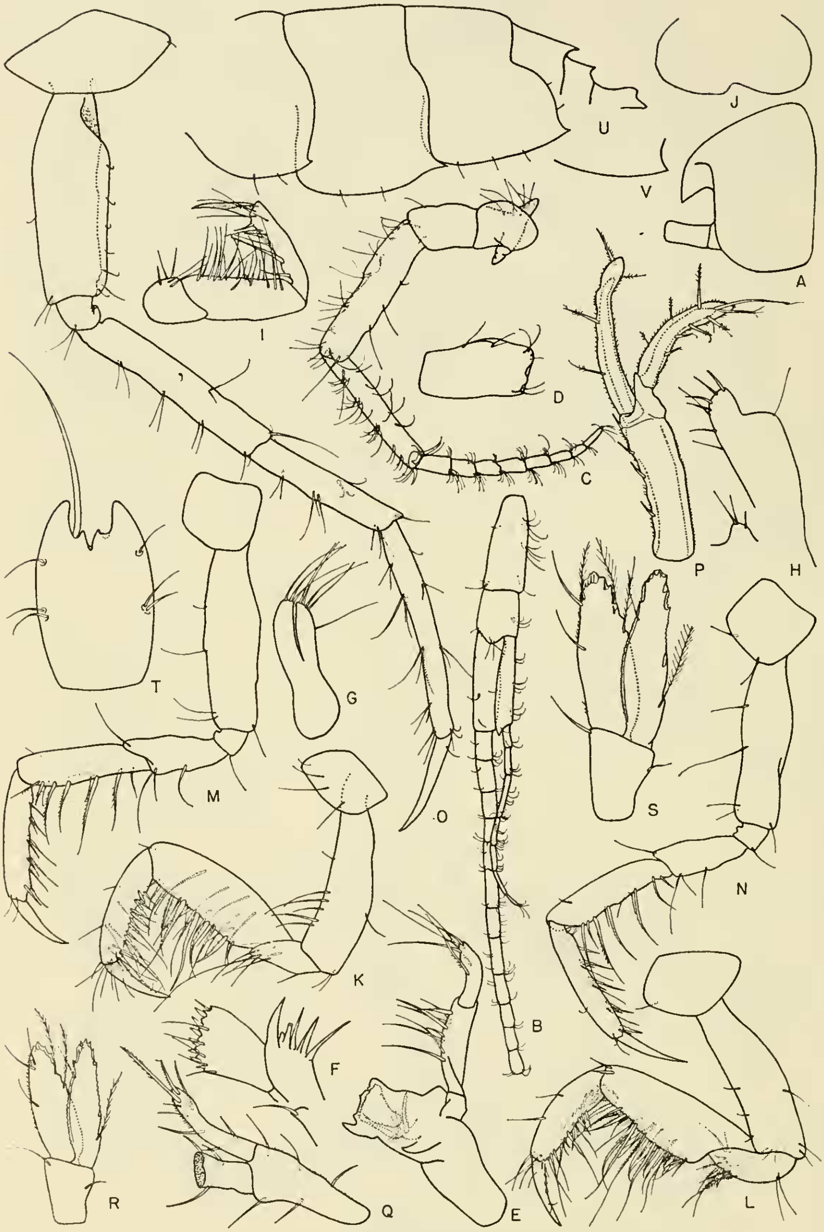

Figure 34

Pardaliscoides fictotelson, new species. Holotype, male, 2.7 mm, sta. 6805: A, head; B,C, antennae 1, 2; D, article 1 of antenna 1, base toward left; E, mandible; F,G, maxillae 1, 2; H, plates of maxilliped; I, palp of maxilliped; J, upper lip; K,L, gnathopods 1, 2; M,N,O, pereopods 1, 2, 4; P,Q,R,S, uropods 1, 2, 3, 3; T, telson; U, pleon; V, second pleonal epimeron from opposite side of animal.

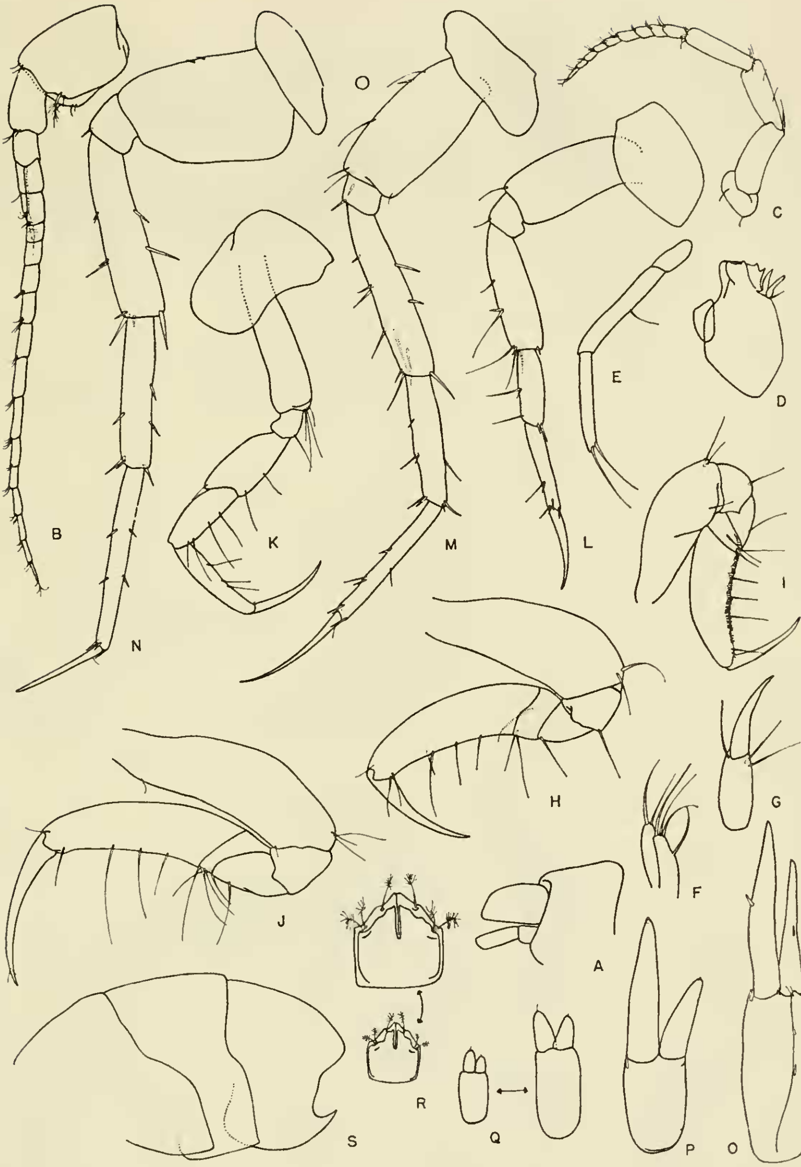

Figure 35

Tosilus arroyo, new genus, new species. Holotype, female, 3.8 mm, sta. 7049: A, head; B,C, antennae 1, 2; D, mandible; E, mandibular palp; F, maxilla 2; G, articles 3-4 of maxillipedal palp; H,I, gnathopod 1; J, gnathopod 2; K,L,M,N, pereopods 2, 3, 4, 5; O,P,Q, uropods 1, 2, 3; R, telson; S, metasome.

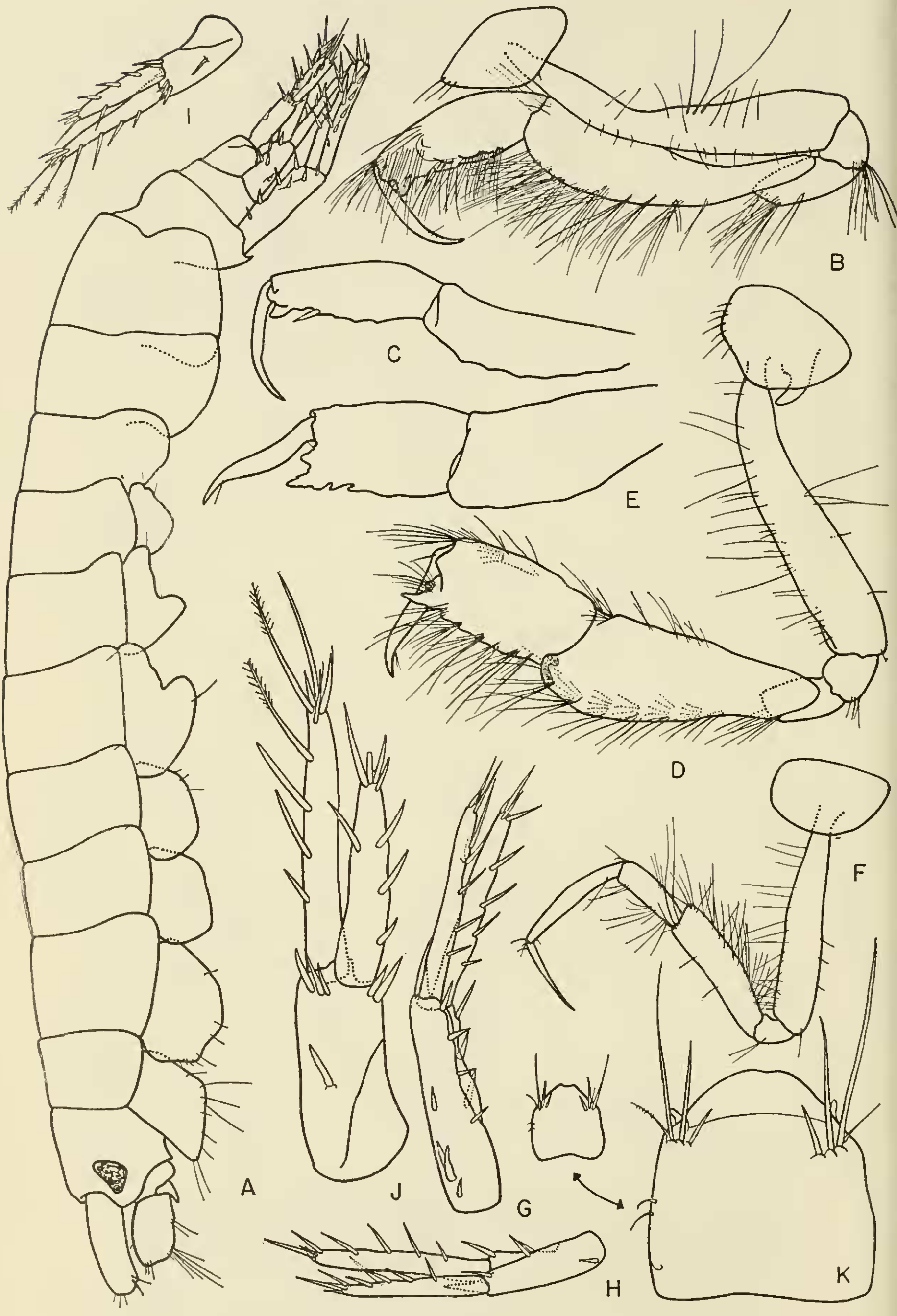

Figure 36
Protomedeia (?) *prudens*, new species. Holotype, male, 7.4 mm, sta. 7038: A, lateral view; B,C, gnathopod 1; D,E, gnathopod 2; F, pereopod 1; G,H,I,J, uropods 1, 2, 3, 3; K, telson.

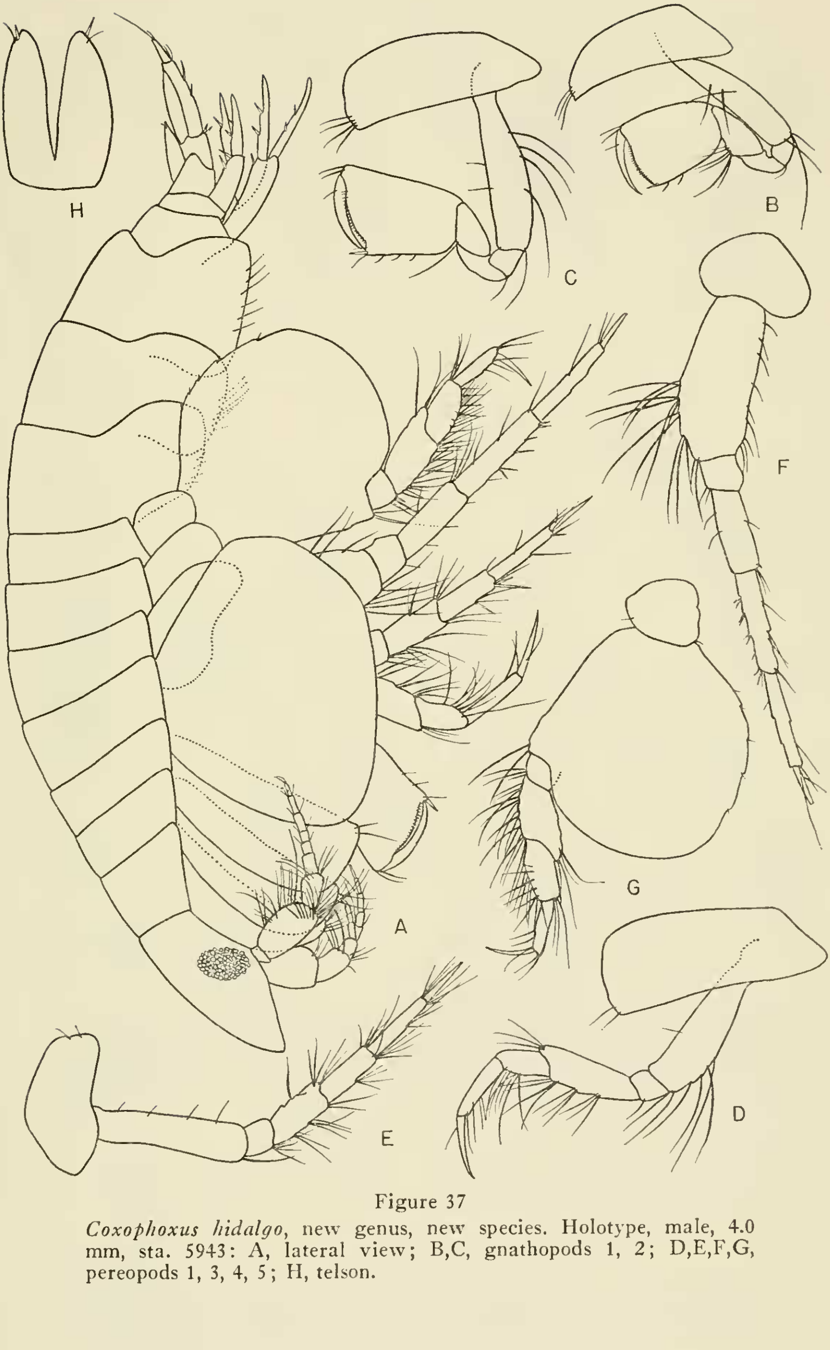

Figure 37

Coxophoxus hidalgo, new genus, new species. Holotype, male, 4.0 mm, sta. 5943: A, lateral view; B,C, gnathopods 1, 2; D,E,F,G, pereopods 1, 3, 4, 5; H, telson.

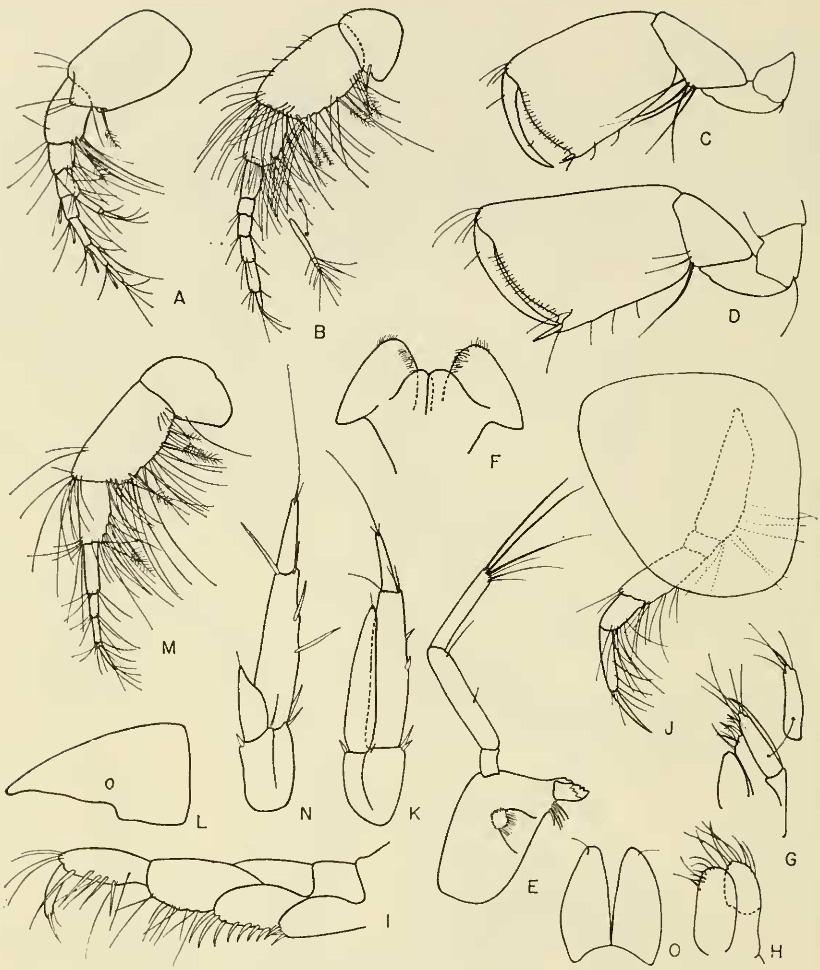

Figure 38

Coxophoxus hidalgo, new genus, new species. Holotype, male, 4.0 mm, sta. 5943: A,B, antennae 1, 2; C,D, gnathopods 1, 2; E, mandible; F, lower lip; G,H, maxillae 1, 2; I, maxilliped; J, pereopod 2; K, uropod 3. Female, 4.5 mm: L, head; M, antenna 2; N, uropod 3; O, telson.

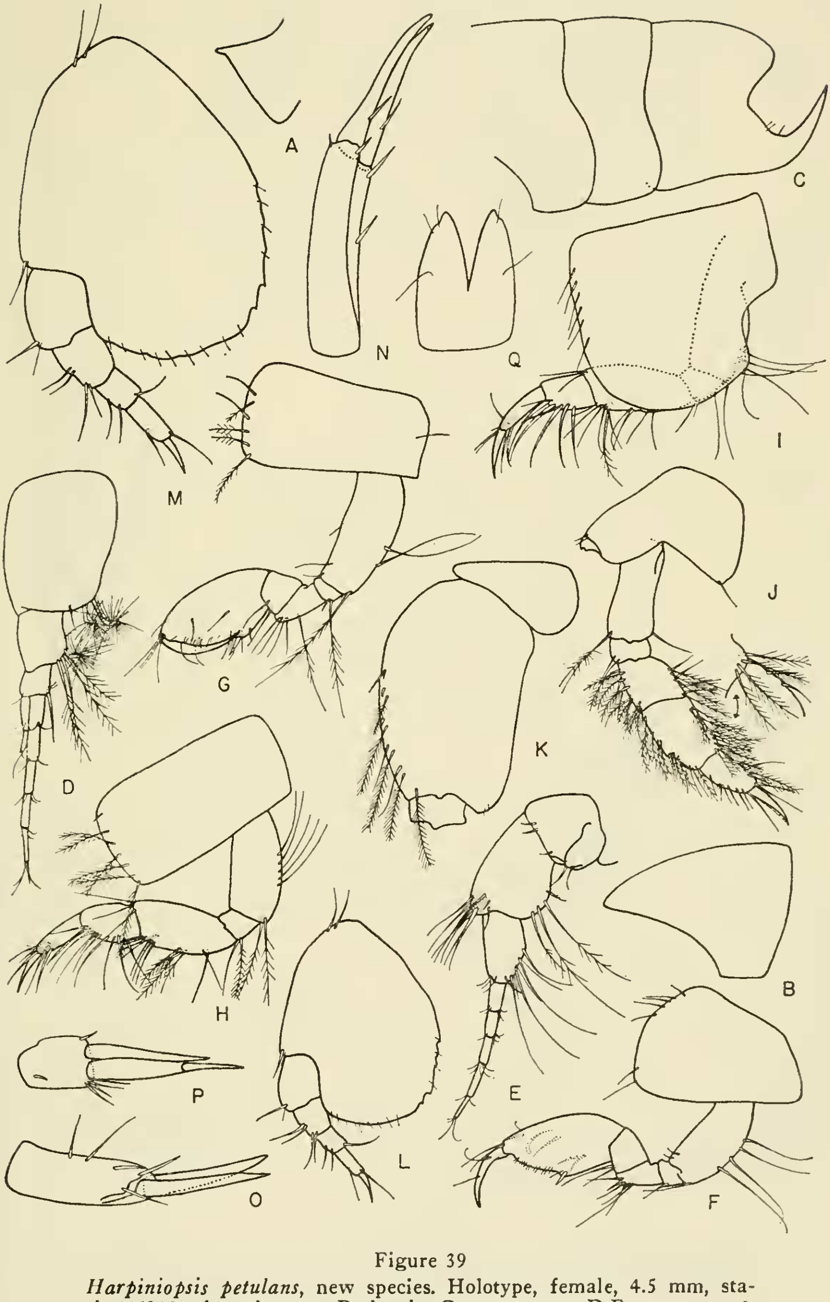

Figure 39

Harpiniopsis petulans, new species. Holotype, female, 4.5 mm, station 6842: A, epistome; B, head; C, metasome; D,E, antennae 1, 2; F,G, gnathopods 1, 2; H,I,J,K,L, pereopods 1, 2, 3, 4, 5; M, pereopod 5, enlarged; N,O,P, uropods 1, 2, 3; Q, telson.

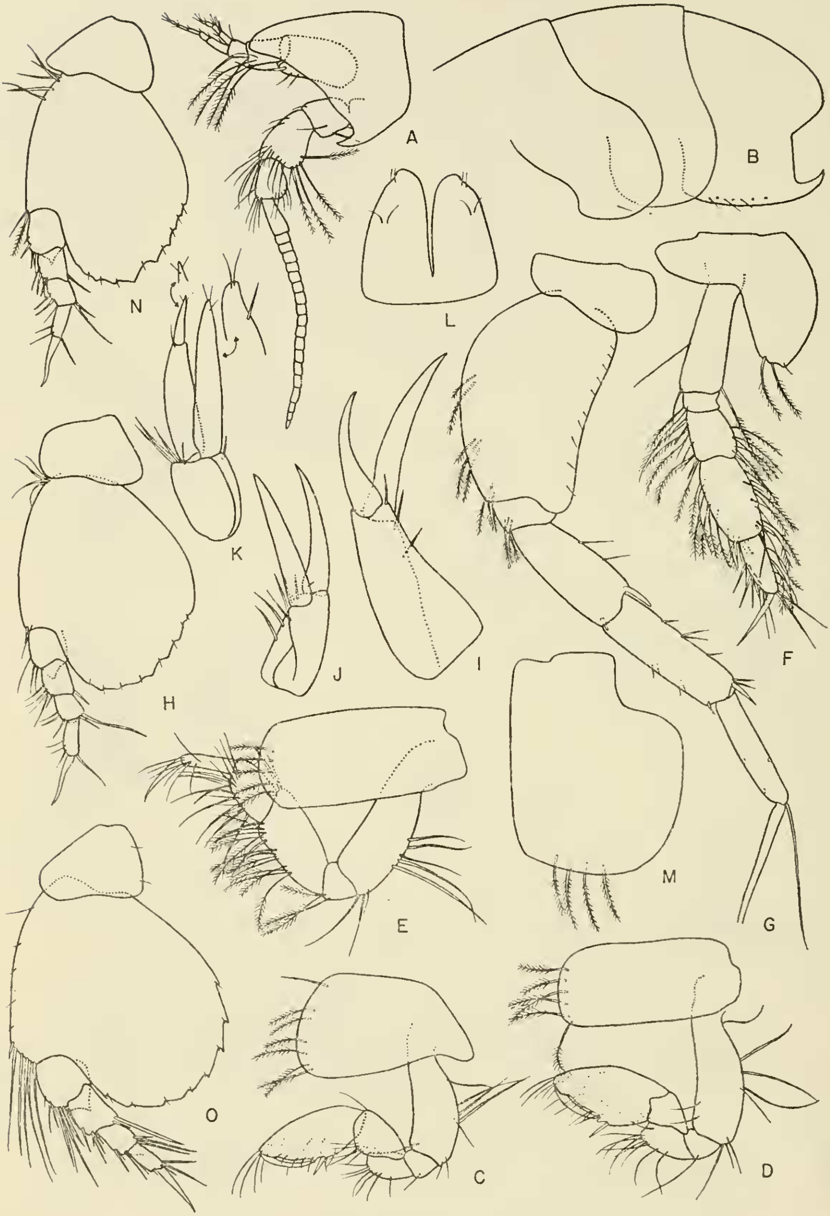

Figure 40
Harpiniopsis profundis Barnard var. Holotype, male, 4.8 mm, sta. 6832: A, head; B, metasome; C,D, gnathopods 1, 2; E,F,G,H, pereopods 1, 3, 4, 5; I,J,K, uropods 1, 2, 3; L, telson; M, coxa 4. Female, 3.6 mm: N, pereopod 5. *Harpiniopsis excavata* Chevreux. Female 5.0 mm, sta. 6833: O, pereopod 5.

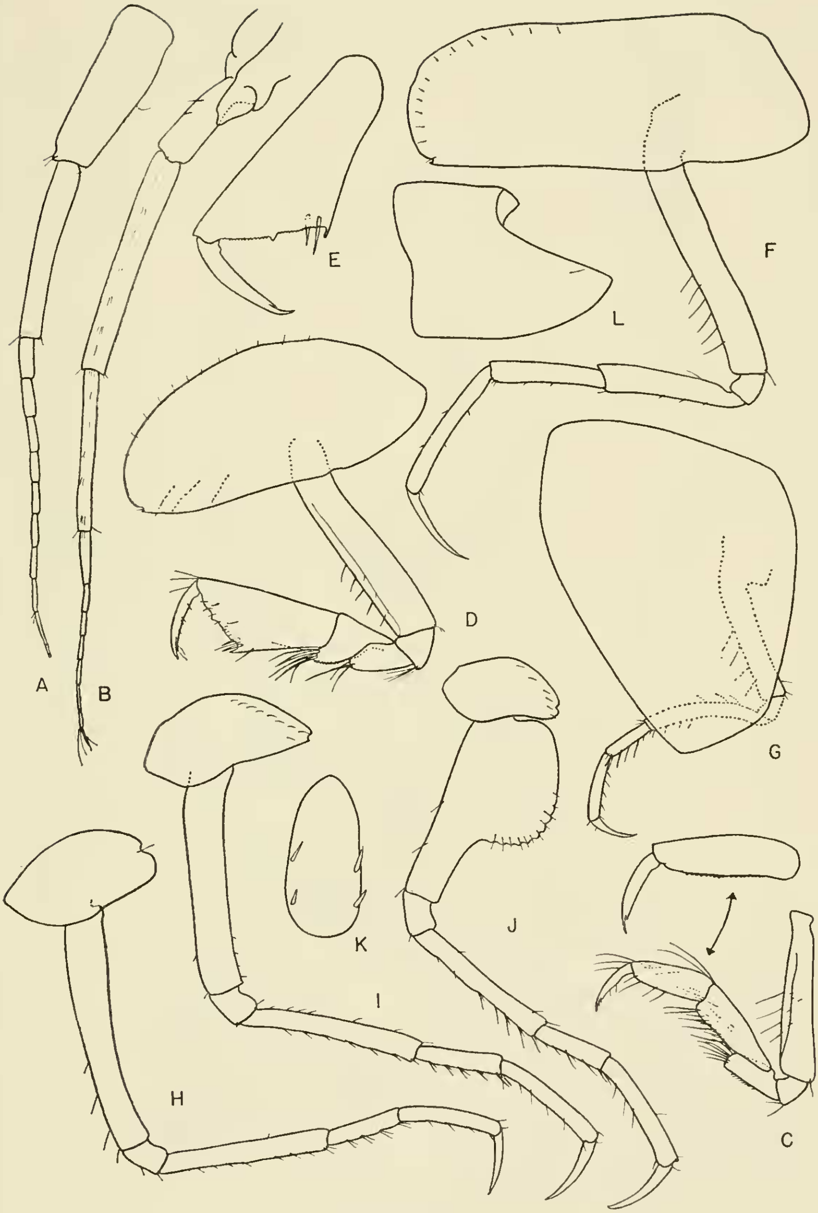

Figure 41

Mesometopa neglecta roya, new subspecies. Holotype, female, 3.0 mm, sta. 6806: A,B, antennae 1, 2; C, gnathopod 1; D,E, gnathopod 2; F,G,H,I,J, pereopods 1, 2, 3, 4, 5, pereopod 2 *reduced in size;* K, telson; L, third pleonal epimeron.

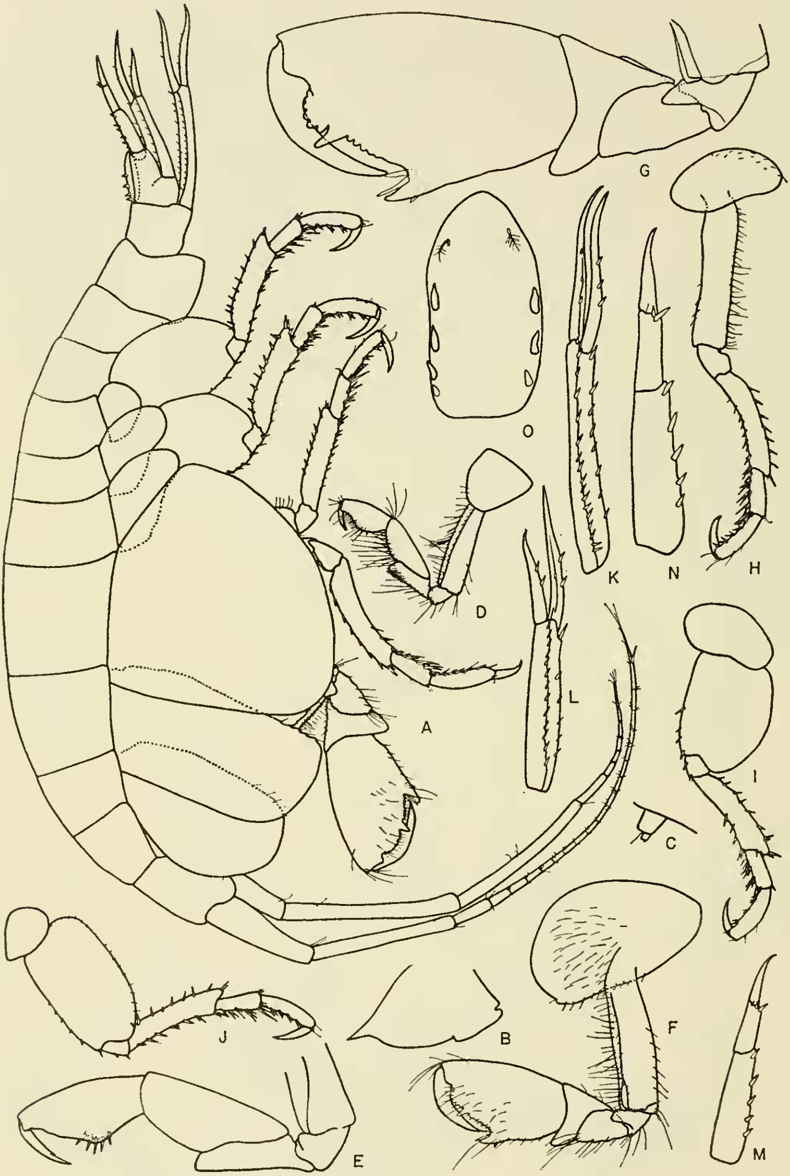

Figure 42

Metopa samsiluna, new species. Holotype, female, 4.5 mm, sta. 6840: A, lateral view; B, epistome; C, accessory flagellum; D,E, gnathopod 1; F,G, gnathopod 2; H,I,J, pereopods 3, 4, 5; K,L,M,N, uropods 1, 2, 3, 3; O, telson.

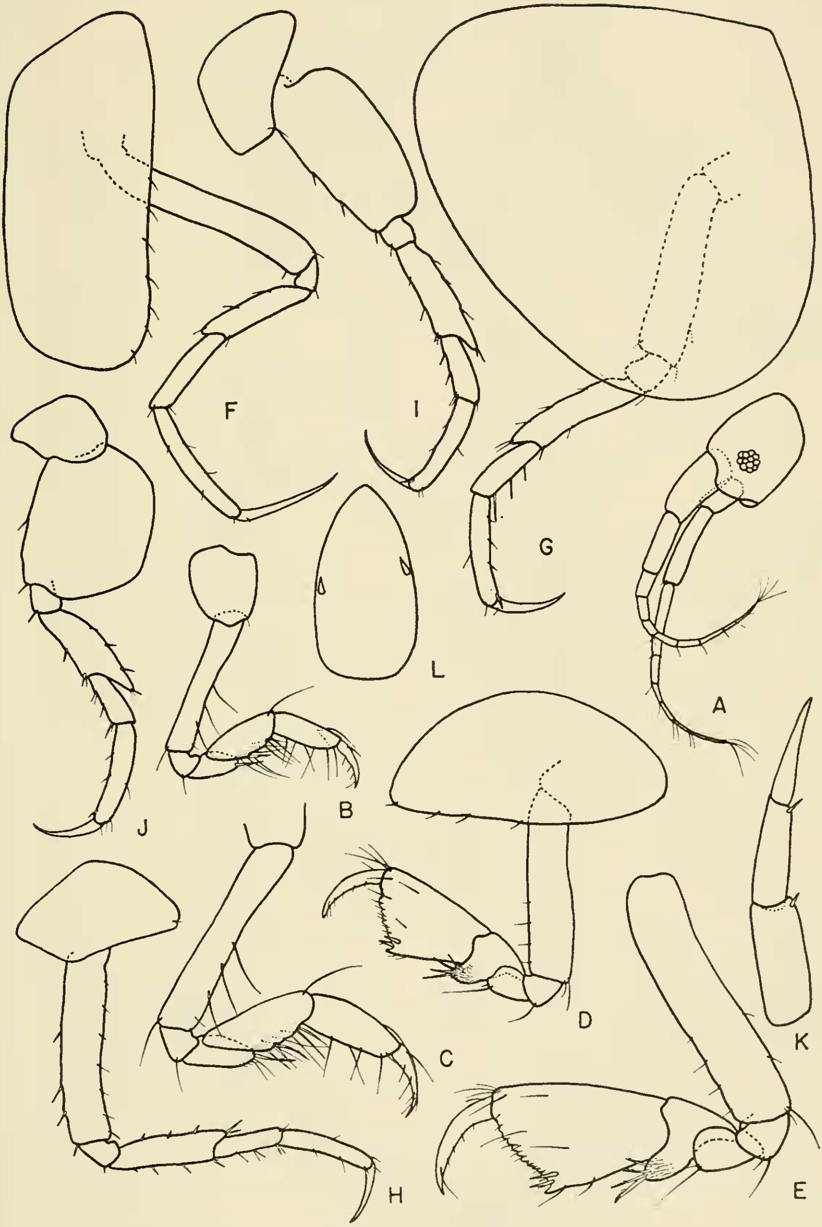

Figure 43

Metopa sp. Female, 2.2 mm, sta. 6499: A, head; B,C, gnathopod 1; D,E, gnathopod 2; F,G,H,I,J, pereopods 1, 2, 3, 4, 5; K, uropod 3; L, telson.

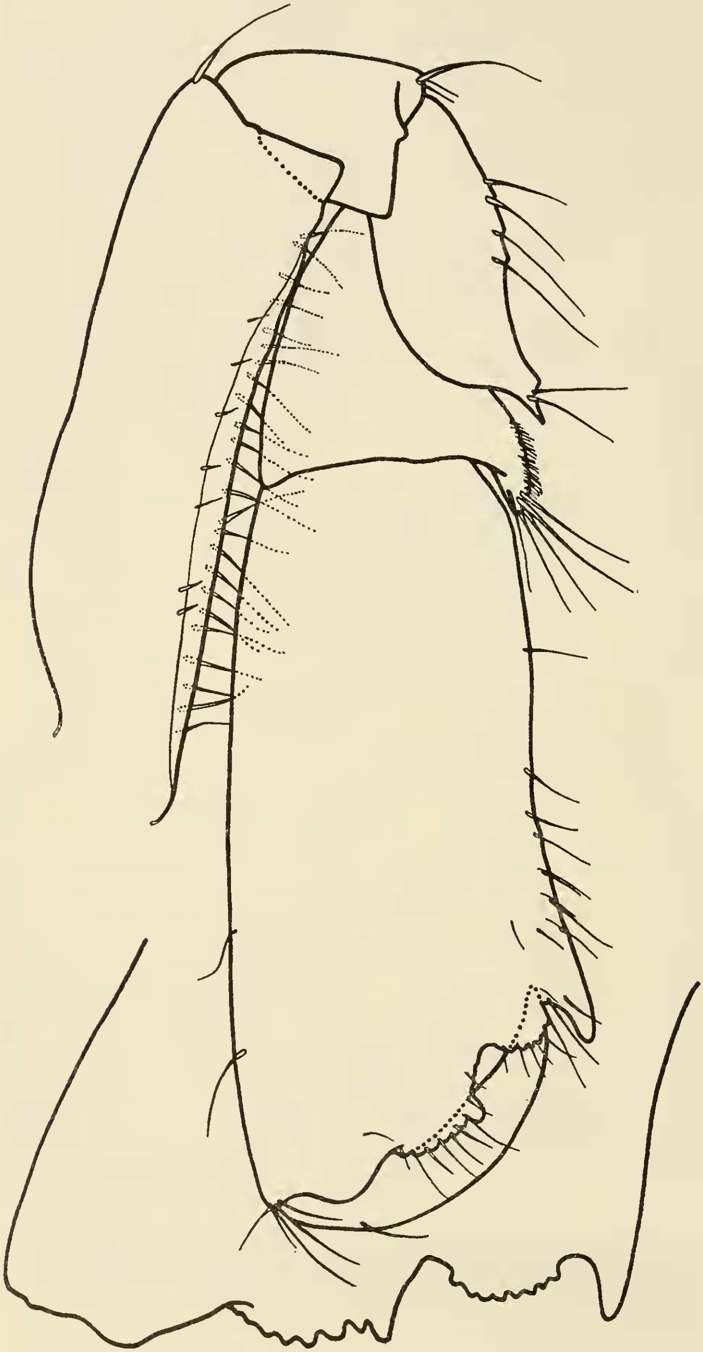

Figure 44
Proboloides tunda J. L. Barnard. Male, 3.5 mm, sta. 7290: gnathopod 2 and enlargement of palm.

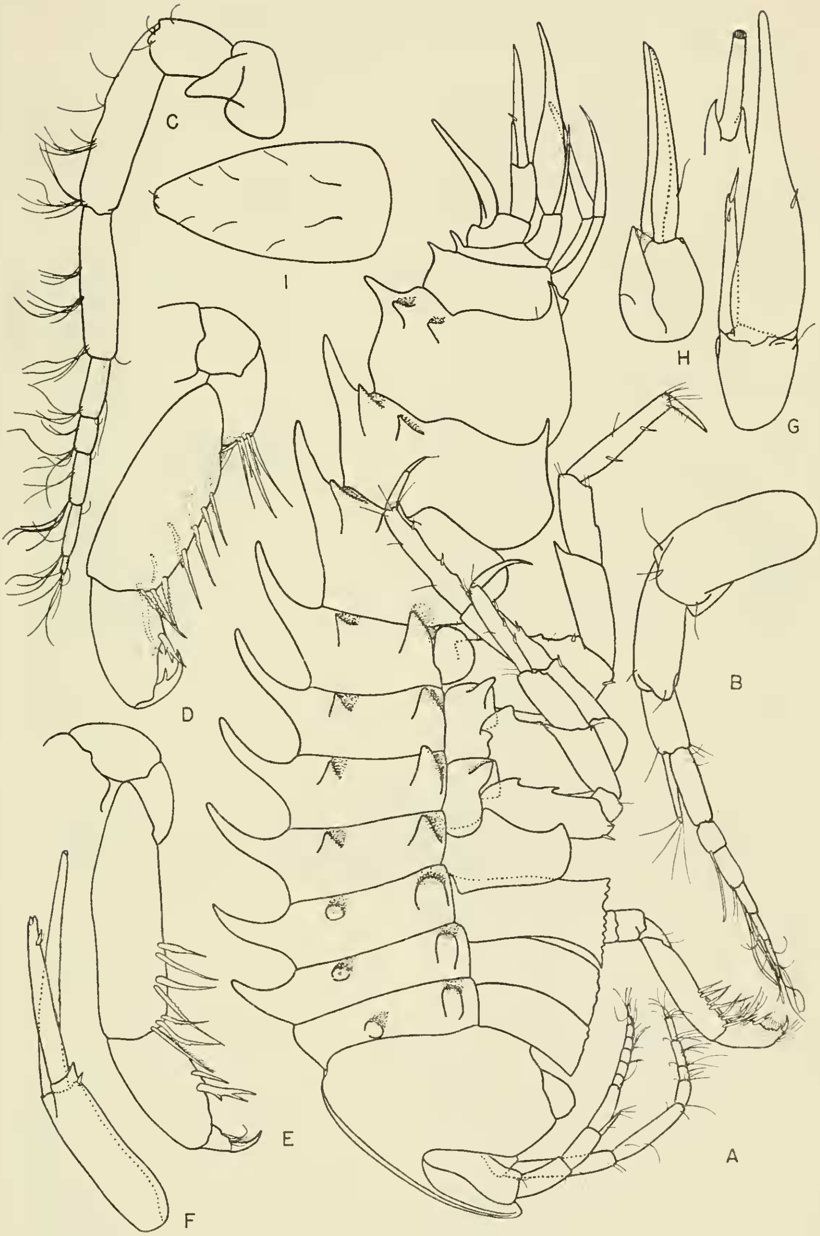

Figure 45

Bruzelia ascua, new species. Holotype, male, 4.7 mm, sta. 5938: A, lateral view; B,C, antennae 1, 2; D,E, gnathopods 1, 2; F,G,H, uropods 1, 2, 3; I, telson.

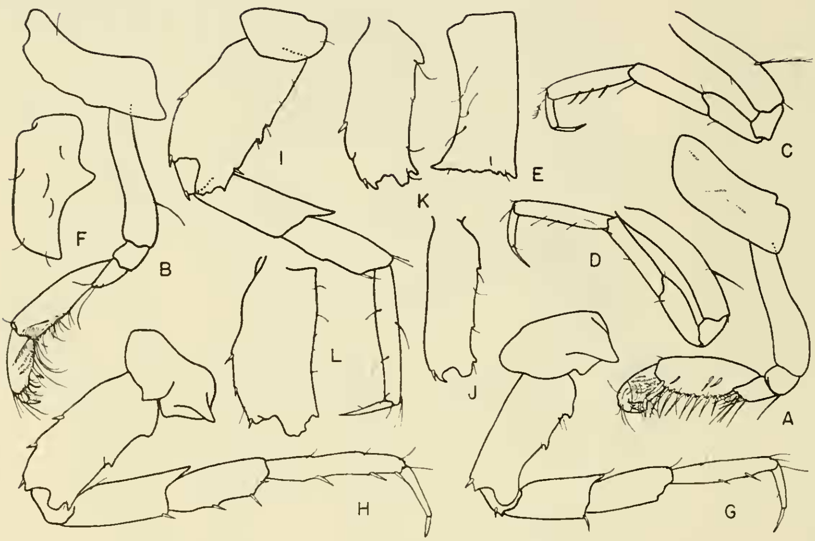

Figure 46
Bruzelia ascua, new species. Holotype, male, 4.7 mm, sta. 5938: A,B, gnathopods 1, 2; C,D, pereopods 1, 2; E,F, coxae 3, 4; G,H,I, pereopods 3, 4, 5, left side of animal; J,K,L, second articles of pereopods 3, 4, 5, right side of animal.

INDEX OF SCIENTIFIC NAMES

(Numbers in **boldface** type refer to plates)